10TH INTERNATIONAL IPM SYMPOSIUM

Implementing IPM across Borders and Disciplines

February 28–March 3, 2022

Denver, Colorado

welcome

Implementing IPM across Borders and Disciplines

Welcome to the 10th International IPM Symposium!

Little did the conference organizers know how our world would be transformed back in 2019 when we selected the "Across Borders and Disciplines" theme. But as committees constructed the 2022 program, it became evident that the IPM science and practitioner community has been instrumental in transdisciplinary work tackling the leading global issues of today. An unprecedented increase in invasive pests and diseases is occurring due to the intercontinental movement of people and materials, climate change, altered land use, and many other disruptions. At the same time, the poorest countries and communities worldwide are experiencing increased environmental disasters and associated food insecurity. The Population Division of the United Nations Department of Economic and Social Affairs predicts that between 9 and 10 billion souls will dwell on Earth by 2050.

The 10th international IPM Symposium will address a wide range of global challenges. The opening session will inspire and motivate you. There will be 35 concurrent sessions designed for IPM practitioners, growers, educators, consultants, researchers, industry professionals, students, and employees of non-governmental organizations. Additionally, there are more than 130 poster presentations this year which include 60 student posters submitted for the IPM Inspiration Award. Dedicated sessions for students and early career scientists are designed to provide new opportunities for our future IPM trailblazers to describe their ongoing work. Hot topic sessions include "Global Challenges" and mini symposia that address IPM actions and successes from around the world. As a special contribution, Lifetime IPM Achievement Award winners will deliver presentations on their work during the closing plenary session.

To conclude the Symposium, participants will hear from the three Lifetime IPM Achievement Award winners, Drs. Anthony M. Shelton, Thomas A. Green, and Charles Vincent. The student IPM Inspiration Award winners also will be announced during the closing session. We also hope you enjoy the local area, in addition to the field trips offered during the Symposium. A Post-Symposium Workshop, "Understanding spatial data collection and use" will be conducted by Joe LaForest, Chuck Bargeron, and Rebekah Wallace, who will explain how to work with IPM information systems, such as EDDMapS.

We would like to thank each of you for attending the 10th International IPM Symposium. Thanks also to our numerous committee members for their work and dedication. Finally, our sincere thanks to our sponsors, organizers, moderators, and presenters for making the 10th International IPM Symposium a truly special event. You, as IPM leaders, have the vision, knowledge, and dedication to forge a healthier and more sustainable future for the world.

Enjoy!

Dawn Gouge, Janet Hurley, Lynnae Jess, and Norm Leppla
Co-chairs, 10th International IPM Symposium Steering Committee

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The 10th International IPM Symposium is coordinated by Conferences & Event Services at the University of Illinois at Urbana-Champaign.

ipmsymposium.org/2022

sponsors and exhibitors

We thank our sponsors and exhibitors for their generous support of IPM and this symposium.

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Exhibitors

Exhibits are located in the Plaza Exhibit Hall.

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Colorado Wheat—PlainsGold

Crop Protection Network

Entomological Society of America

Gowan USA

Marrone Bio Innovations

Regional IPM Centers

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The Symposium organizers thank the U.S. Department of Agriculture, National Institute of Food and Agriculture for supporting student and early career scientist participation in the 10th International IPM Symposium.

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general information

Registration and Information Desk

Symposium registration/check-in is located at the Plaza Registration Desk on the Concourse Level of the Plaza Building of the Sheraton Denver Downtown Hotel.

The desk will be open:

Monday, February 28, 10:00 AM–7:00 PM

Tuesday, March 1, 7:30 AM–4:30 PM

Wednesday, March 2, 7:30 AM–4:30 PM

Thursday, March 3, 7:30 AM–12:00 PM

Denver visitor information and a small gift shop can be found near the front desk on the ground level of the Sheraton Denver Downtown Hotel.

Wireless Access

There is basic Wi-Fi in all meeting rooms at the Sheraton Denver Downtown Hotel. The network is MarriottBonvoy_Conference and the password is ipm2022 If you have trouble connecting, please go to the Registration Desk for assistance.

Poster Session

The poster session is on Wednesday, March 2, 4:30-6:30 PM in the Plaza Exhibit Hall of the Sheraton Denver Downtown Hotel. While all posters will be displayed throughout the symposium, authors are asked to stand by their posters according to their final poster number: odd numbers from 4:30-5:30 and even numbers from 5:30-6:30.

Posters can be set up beginning at 10:00 AM on Tuesday. We encourage you to have posters in place by 4:30 PM on Tuesday. Students entering the poster competition MUST have posters in place by 4:30 PM on Tuesday. Posters can be removed after the poster session ends at 6:30 PM on Wednesday. They must be removed by 9:00 AM on Thursday.

If you would like to have your poster posted on the 2022 IPM Symposium web site, copy your poster as a .pdf file and send it to Michelle Marquart at mmarqua2@illinois.edu by March 1, 2022.

IPM Symposium 2022 App

Download the "CrowdCompass Events" App from the Apple App Store or Google Play Store, then search for "10th International IPM Symposium 2022." For full access to all features, sign in with the same email address and password you used when registering for the symposium.

The Symposium App is sponsored by the Southern IPM Center.

Poster Session Reception

All registered participants and their registered guests are invited to attend the reception, held during the poster session on Wednesday, March 2 from 4:30–6:30 PM in the Plaza Exhibit Hall of the Sheraton Denver Downtown Hotel.

Presenter Practice Room

If presenters need to preview their presentations, come to the Registration desk during its hours of operation.

Media

Reporters and other members of the media should register at the Symposium Registration Desk located on the Concourse Level of the Plaza Building at the Sheraton Denver Downtown Hotel.

Post-Symposium Evaluation

Keep an eye out for an online evaluation form sent via email following the conclusion of the symposium. Your feedback is valuable and helps us plan future events.

Abstracts, Presentations, and Posters

Complete abstracts can be found at the website: ipmsymposium.org /2022.

Presentations and posters will be added to the website after the Symposium.

Congratulations to the 10th International IPM Achievement Award recipients!

These recipients will be recognized during the Opening Session on Monday, February 28.

Lifetime Achievement Awards of Excellence

Dr. Thomas Green, The IPM Institute of North America

Dr. Anthony Shelton, Cornell University

Dr. Charles Vincent, Saint-Jean-sur-Richelieu Research and Development Centre, Agriculture and Agri-Food Canada

Lifetime Achievement Awards of Recognition

Dr. Rangaswamy Muniappan, IPM Innovation Lab, Virginia Tech University

Dr. Tom Royer, Oklahoma State University

International IPM Awards of Excellence

Ms. Janet Hurley, Texas A&M AgriLife Extension Service (Practitioner–Academic)

Dr. Jawwad Qureshi, University of Florida (Practitioner–Academic)

Dr. Andrew Sutherland, University of California Cooperative Extension (Practitioner–Academic)

Mr. Frank Meek, Rollins Inc. (IPM Practitioner–Non-Academic)

Plantwise–CABI (Team)

The California Almond IPM Team, University of California Cooperative Extension (Team)

The IPM Innovation Lab, Virginia Tech University (Team)

International IPM Awards of Recognition

Mr. Lynn Braband, The New York State IPM Program, Cornell University (Practitioner–Academic)

Dr. Shahadath Hossain, Bangladesh Agricultural Research Institute (BARI), Bangladesh (Practitioner–Academic)

Dr. Richard Raid, UF/IFAS/Everglades Research & Education Center (Practitioner–Academic)

Mr. Leon Lucas, Glades Crop Care Inc. (Practitioner–Non-Academic)

Center for Biological Control IPM Team, Florida A&M University (Team)

Honeybear Brands, Minnesota (Team)

Prairie Pest Monitoring Network (PPMN), Canada (Team)

International IPM Award for Outstanding Ph.D. Student

Ms. Uta McKelvy, Montana State University

COVID-19 information

Current guidance from the Centers for Disease Control and Prevention: cdc.gov/coronavirus/2019-ncov/communication/guidance.html

Denver's COVID-19 Information: denvergov.org/Government/COVID-19-Information

Symposium Policies

All participants must do the following, regardless of vaccination status:

1) **Obtain a negative, self- or lab-administered COVID-19 test result within 72 hours prior to arriving at the symposium;**
2) **Wear a face mask over your nose and mouth, except when actively eating and drinking; and**
3) **Socially distance when possible.**

Cloth masks provided by EarthKind and the Texas School IPM Program are available at the Symposium registration desk.

If you feel sick and/or test positive while at the symposium, please follow the CDC's recommendations.

If you have quarantined for at least 5 days after first testing positive but are still testing positive via a PCR test, you may still attend the symposium.

If you test positive via an antigen test, you may not attend the symposium until you test negative.

Testing Locations

View the most up-to-date information about COVID-19 testing in Denver: denvergov.org/Government/COVID-19-Information/Getting-Tested#section-2

Hours and locations may change prior to the symposium. Most locations require an appointment or advance registration, and some locations may only offer a certain type of test. It is strongly recommended that you contact the location before going to it.

The testing locations closest to the Sheraton Denver Downtown Hotel are:

CVS Pharmacy (7-min walk from hotel)
1600 California St, Suite 14, Denver, CO 80202
Per CVS website: Patients should not have any out-of-pocket costs, but you should check with your health plan to confirm before scheduling a test.

Walgreens (10-min walk from hotel)
801 16th St Mall, Denver, CO 80202

5th Street Garage—Auraria Campus
(20-min walk from hotel)
955 Lawrence Way, Denver, CO 80204
Monday–Friday, 8:00 AM–6:00 PM

Union Station (23-min walk from hotel)
1701 Wynkoop St., Denver, CO 80202
Monday–Friday 7:00 AM–3:00 PM,
Saturday 7:00 AM–Noon

The State of Colorado is covering all costs for COVID-19 testing at community testing sites, such as the two listed above.

The **Denver Airport (DEN)** also offers testing for ticketed passengers. XpresCheck, a public COVID testing site, is located in the center of Concourse B, post security. You must have a boarding pass to access this location.

Currently, XpresCheck is open daily from 8 AM to 6 PM; phone: (720) 445-1368.

XpresCheck offers Standard Polymerase Chain Reaction (PCR) tests for $75 in clinic and an additional $100 Lab fee. Additionally available is a RT-PCR test for $250. Tests are available to anyone age 5 and older.

Standard PCR test results typically take 3–5 days, and RT-PCR test results vary from 45–60 minutes. All tests are Molecular.

Learn more and make an appointment at **xprescheck.com**.

schedule at a glance

Monday, February 28

8:00 AM–12:00 PM	Joint ERA Meeting
10:00 AM–7:00 PM	Registration Open
12:00–4:00 PM	Regional ERA Meetings
1:00–4:00 PM	Field Trip A: Butterfly Pavilion Tour
1:00–4:00 PM	Field Trip B: Botanic Gardens Tour
1:00–4:00 PM	Field Trip D: Museum of Nature & Science Tour
2:30–4:30 PM	Field Trip C: Novel Strand Brewery Tour
5:00–7:00 PM	Opening Plenary Session, including IPM Achievement Award winner recognition

Tuesday, March 1

7:30 AM–4:30 PM	Registration Open
7:00–8:30 AM	Continental Breakfast
8:30–10:00 AM	Mini-Symposia & Concurrent Sessions
10:15–11:45 AM	Mini-Symposia & Concurrent Sessions
11:45 AM–1:15 PM	Lunch on your own
1:15–2:45 PM	Mini-Symposia & Concurrent Sessions
3:00–4:30 PM	Mini-Symposia & Concurrent Sessions
4:40–5:40 PM	Mentorship Meetup
5:00–6:00 PM	Journal of IPM Informational Session and Social
7:00–9:00 PM	NIPMCC Strategic Plan Meeting (invitation only)

Wednesday, March 2

7:30 AM–4:30 PM	Registration Open
7:00–8:30 AM	Continental Breakfast
8:30–10:00 AM	Mini-Symposia & Concurrent Sessions
10:15–11:45 AM	Mini-Symposia & Concurrent Sessions
11:45 AM–1:15 PM	Lunch on your own
1:15–2:45 PM	Mini-Symposia & Concurrent Sessions
3:00–4:30 PM	Mini-Symposia & Concurrent Sessions
4:30–6:30 PM	Poster Session & Exhibits

Thursday, March 3

7:30 AM–12:00 PM	Registration Open
7:00–8:30 AM	Continental Breakfast
8:30–10:00 AM	Concurrent Sessions
10:15 AM–12:00 PM	Closing Plenary
1:30–5:00 PM	Optional Workshop: "Understanding spatial data collection and use"

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twitter.com/IPMSymposium

linkedin.com/groups/4107744

Be sure to use the hashtag #IPMSymp22 when posting!

interest tracks

See Daily Schedule for times and locations

Mini-Symposia

- S1 Global Challenges: Transboundary Pests of Global Significance (organized by Jhalendra Rijal, Cezarina Kora, Janny Vos)
- S9 Fresh from the Field: New IPM Technologies in Entomology and Plant Pathology (organized by Tyler Mays, Norman Leppla)
- S20 Beyond the Field and Into the Community (organized by Shaku Nair, Dawn Gouge)
- S26 IPM across Disciplines (organized by Dion Lerman)
- S31 Re-imagining IPM for Broader Social Challenges: Integrating Social and Ecological Dimensions (organized by Amy Lemay)

Communication

- S2 Bridging the Divide: Pathways to Partnership for Pesticide Safety Education and IPM (organized by Shannah Whithaus)
- S10 Using Active Learning to Enhance your IPM Programming (organized by Amara Dunn, Joellen Lampman)
- S21 Approaching IPM and Resistance Management through Understanding How Community Social Dynamics Can Affect Adoption (organized by Katherine Dentzman, George Frisvold, Clinton Pilcher)
- S27 Communicating and Building Partnerships for IPM in Communities (organized by Shujuan (Lucy) Li and Karey Windbiel-Rojas)

Forestry/Natural Landscapes/Turf & Sod

- S22 Utilizing Soil Amendments to Improve Turfgrass Health and Suppress Turfgrass Disease (organized by Ryan Anderson)
- S25 IPM in the US Department of the Interior Land Management Agencies and Partners (organized by James Pieper)

Horticulture and Specialty Crops

- S3 Novel Tools and Opportunities for Cucurbit IPM in North America (organized by Don Weber, Tom Kuhar, Ian Kaplan, Ann Wallingford)
- S4 Use of Drones in IPM Monitoring, Application of Low Risk Pesticides and for Biological Organism Releases (organized by Stanton Gill)
- S11 Furthering Small Fruit IPM after a Decade-Long Battle with Spotted-Wing Drosophila (organized by Ashfaq Sial)
- S16 Minimizing Disease and Weed Impacts on Pumpkin and Squash (organized by James Jasinski)
- S24 Managing Invasive Pests in the New Era of IPM in Specialty Crops (organized by Muhammad Haseeb, Youichi Kobori, Jawwad Qureshi)

= Sessions applicable to food company field and sustainability leads including retailers, packers, shippers and processors; large national producer representatives; producers; crop consultants

= Sessions that include presentations by recipients of the 10th International IPM Achievement Awards

Overarching/Multi-Disciplinary

S5 Students: The Future of IPM Research (organized by Kadie Britt, Katelyn Kesheimer, Ashley Leach, Mika Pagani, Samantha Willden)

S13 Early Career Researchers in IPM: Balancing Work, Life, and Everything In Between (organized by Katelyn Kesheimer, Ashley Leach, Lorena Lopez, Robert Morrison) 🏆

S15 IPM Award Winner Stories (organized by Shaku Nair) 🏆

S17 Global Challenges: Roundtable Discussion on IPM in Developing Countries (organized by Rangaswamy Muniappan, Jhalendra Rijal)

S18 Growing Big Trees from Small Seeds (organized Lynnae Jess, Laura Isles)

S23 Integrated Pest Management Programs and Centers: Bringing Diverse Experience into Action (organized by Matt Baur, Silvia Rondon)

S28 Predicting, Monitoring and Responding to New Plant Pests (organized by Godshen Robert Pallipparambil, Yu Takeuchi, Danesha Seth Carley)

S32 Ecostacking as an Approach to IPM (organized by Heikki MT Hokkanen, Ingeborg Menzler-Hokkanen)

Row/Field Crops

S7 Detection and Management of Fungicide-Resistant Plant Pathogens of Soybean (organized by Carl Bradley, Daren Mueller)

S12 Global Challenges: IPM for Tropical Crops in Asia and Africa (organized by Rangaswamy Muniappan) 🏆

S29 Management of Fall Armyworm in Africa and Asia (organized by Rangaswamy Muniappan) 🏆

S33 IPM of *Cannabis sativa*: Lessons Learned and Future Directions (organized by Katelyn Kesheimer)

S34 Cotton Insect Management in Water-Deficit Production Scenarios (organized by Megha Parajulee)

Urban/Structural/Landscape/School IPM/Public Health/Veterinary

S6 The Science and Practice of Glyphosate Alternatives in the Urban Landscape (organized by Maggie Reiter, Kai Umeda)

S8 Wood Destroying Insect Pest Exclusion Using Physical Barriers: A Sustainable Future for New and Existing Structures (organized by Roger Gold, Jill Heidorf)

S14 Meeting the IPM Needs of Urban Growers (organized by Laura Ingwell, Jacqueline Kowalski)

S19 Beyond CEUs: Developing Hands-on, Impact-Driven Programs for Structural Pest Management Applicator Education (organized by Matthew Frye) 🏆

S30 Integrated Tick Management: Increasing Adoption of ITM Practices to Address the Global Tick Problem (organized by Leah McSherry)

S35 Managing Rodents Using Multiple Control Tactics (organized by Janet Hurley) 🏆

🍃 = Sessions applicable to food company field and sustainability leads including retailers, packers, shippers and processors; large national producer representatives; producers; crop consultants

🏆 = Sessions that include presentations by recipients of the 10th International IPM Achievement Awards

daily schedule

Monday, February 28

8:00 AM–12:00 PM **Joint ERA Meeting** | *Plaza Ballroom BCEF*

12:00–4:00 PM **WERA-1017 Meeting** | *Governor's Square 15*

12:00–4:00 PM **SERA-003 Meeting** | *Governor's Square 14*

12:00–4:00 PM **NCERA-222 Meeting** | *Plaza Ballroom D*

1:00–4:00 PM **Field Trip A:** "Butterfly Pavilion Tour" | *Meet in the hotel lobby at 12:45 PM*

Field Trip B: "Botanic Gardens Tour" | *Meet in the hotel lobby at 12:45 PM*

Field Trip D: "Museum of Nature & Science Tour" | *Meet in the hotel lobby at 12:45 PM*

2:30–4:30 PM **Field Trip C:** "Novel Strand Brewery Tour" | *Meet in the hotel lobby at 2:15 PM*

5:00–7:00 PM **Opening Plenary Session** | *Plaza Ballroom BCEF*

Presentation of IPM Achievement Awards

Tuesday, March 1

8:30–11:45 AM **Concurrent Sessions**

8:30–11:45 AM S1. Global Challenges: Transboundary Pests of Global Significance (Mini-Symposium) | *Governor's Square 14*

8:30–11:45 AM S2. Bridging the Divide: Pathways to Partnership for Pesticide Safety Education and IPM | *Governor's Square 15*

8:30–11:45 AM S3. Novel Tools and Opportunities for Cucurbit IPM in North America | *Plaza Ballroom F*

8:30–10:00 AM S4. Use of Drones in IPM Monitoring Application of Low Risk Pesticides and for Biological Organism Releases | *Plaza Ballroom E*

8:30–11:45 AM S5. Students: The Future of IPM Research | *Plaza Ballroom AB*

8:30–10:00 AM S6. The Science and Practice of Glyphosate Alternatives in the Urban Landscape | *Plaza Ballroom D*

10:15–11:45 AM S7. Detection and Management of Fungicide-Resistant Plant Pathogens of Soybean | *Plaza Ballroom E*

10:15–11:45 AM S8. Wood Destroying Insect Pest Exclusion Using Physical Barriers: A Sustainable Future for New and Existing Structures | *Plaza Ballroom D*

11:45 AM–1:15 PM **Lunch on your own**

1:15-4:30 PM **Concurrent Sessions**

1:15–4:30 PM	S9. Fresh from the Field: New IPM Technologies in Entomology and Plant Pathology (Mini-Symposium) | *Plaza Ballroom E*
1:15–2:45 PM	S10. Using Active Learning to Enhance your IPM Programming | *Governor's Square 15*
1:15–2:45 PM	S11. Furthering Small Fruit IPM after a Decade-Long Battle with Spotted-Wing Drosophila | *Plaza Ballroom F*
1:15–2:45 PM	S12. Global Challenges: IPM for Tropical Crops in Asia and Africa | *Governor's Square 14*
1:15–2:45 PM	S13. Early Career Researchers in IPM: Balancing Work, Life, and Everything In Between | *Plaza Ballroom AB*
1:15–2:45 PM	S14. Meeting the IPM Needs of Urban Growers | *Plaza Ballroom D*
3:00–4:30 PM	S15. IPM Award Winner Stories | *Governor's Square 15*
3:00–4:30 PM	S16. Minimizing Disease and Weed Impacts on Pumpkin and Squash | *Plaza Ballroom F*
3:00–4:30 PM	S17. Global Challenges: Roundtable Discussion on IPM in Developing Countries | *Governor's Square 14*
3:00–4:30 PM	S18. Growing Big Trees from Small Seeds | *Plaza Ballroom AB*
3:00–4:30 PM	S19. Beyond CEUs: Developing Hands-on, Impact-Driven Programs for Structural Pest Management Applicator Education | *Plaza Ballroom D*
4:40–5:40 PM	Mentorship Meetup | *Plaza Ballroom AB*
5:00–6:00 PM	Journal of IPM Information Session and Social | *Plaza Ballroom E*
7:00–9:00 PM	NIPMCC Strategic Plan Meeting (invitation only) | *Governor's Square 14*

Wednesday, March 2

8:30–11:45 AM **Concurrent Sessions**

8:30–11:45 AM	S20. Beyond the Field and Into the Community (Mini-Symposium) | *Plaza Ballroom AB*
8:30–11:45 AM	S21. Approaching IPM and Resistance Management through Understanding How Community Social Dynamics Can Affect Adoption | *Plaza Ballroom E*
8:30–10:00 AM	S22. Utilizing Soil Amendments to Improve Turfgrass Health and Suppress Turfgrass Disease | *Plaza Ballroom D*
8:30–11:45 AM	S23. Integrated Pest Management Programs and Centers: Bringing Diverse Experience into Action | *Governor's Square 14*
8:30–11:55 AM	S24. Managing Invasive Pests in the New Era of IPM in Specialty Crops | *Plaza Ballroom F*
10:15–11:45 AM	S25. IPM in the US Department of the Interior Land Management Agencies and Partners | *Plaza Ballroom D*

11:45 AM–1:15 PM **Lunch on your own**

1:15–4:30 PM **Concurrent Sessions**

1:15-2:45 PM S26. IPM across Disciplines (Mini-Symposium) | *Governor's Square 15*

1:15–2:45 PM S27. Communicating and Building Partnerships for IPM in Communities | *Plaza Ballroom E*

1:15–2:45 PM S28. Predicting, Monitoring and Responding to New Plant Pests | *Plaza Ballroom F*

1:15–2:45 PM S29. Management of Fall Armyworm in Africa and Asia | *Governor's Square 14*

1:15–4:30 PM S30. Integrated Tick Management: Increasing Adoption of ITM Practices to Address the Global Tick Problem | *Plaza Ballroom AB*

1:15–4:30 PM S25. IPM in the US Department of the Interior Land Management Agencies and Partners | *Plaza Ballroom D*

3:00–4:30 PM S31. Re-imagining IPM for Broader Social Challenges: Integrating Social and Ecological Dimensions (Mini-Symposium) | *Governor's Square 15*

3:00–4:30 PM S32. Ecostacking as an Approach to IPM | *Governor's Square 14*

3:00–4:30 PM S33. IPM of *Cannabis sativa*: Lessons Learned and Future Directions | *Plaza Ballroom F*

4:30–6:30 PM **Poster Session and Exhibits** | *Plaza Exhibit Hall*

Odd numbers present 4:30–5:30 PM

Even numbers present 5:30–6:30 PM

Thursday, March 3

8:30–10:00 AM **Concurrent Sessions**

8:30–10:00 AM S34. Cotton Insect Management in Water-Deficit Production Scenarios | *Plaza Ballroom E*

8:30–10:00 AM S35. Managing Rodents Using Multiple Control Tactics | *Plaza Ballroom F*

10:15 AM–12:00 PM **Closing Plenary Session** | *Plaza Ballroom ABC*

"USDA-NIFA Grant Programs that Support Integrated Pest Management"

Awardee Presentations:

"One Entomologist's Experience with the Evolution and Practices of IPM Nationally and Internationally" | Dr. Tony Shelton

Charles Vincent: "Four Decades of IPM Research Onstage, Backstage and Offstage" | Dr. Charles Vincent

"Many Little Hammers, What I've Learned from Hitting my IPM Thumbs for 45 Years..." | Dr. Thomas Green

1:00–5:00 PM **Optional Workshop:** "Understanding spatial data collection and use" | *Plaza Ballroom F*

optional activities

Monday, February 28 | Afternoon

Field Trip A: Butterfly Pavilion Tour

Cost: $35 per person

Visit **Colorado's premier invertebrate zoo**! An experienced guide will take you through the exhibits and behind-the-scenes areas, giving your group the 'ins and outs,' animal knowledge, and personal attention that they may not experience on their own. See a honeybee hive, touch sea stars and horseshoe crabs, and hold our Chilean rose-hair tarantula, Rosie! Walk amongst the butterflies in our fully immersive rainforest exhibit, and see our behind-the-scenes areas where animal care staff work on invertebrate research and conservation.

Tour leaves the Sheraton Hotel by bus at 1:00 PM with an expected return of 4:00 PM.

Field Trip B: Botanic Gardens Tour

Cost: $35 per person

Discover an urban oasis throughout the seasons! **Denver Botanic Gardens** contains nearly 50 artistically designed gardens and more than 15,000 unique types of plants. Within its 24 acres, you can admire a wide range of specimens, from native beauties to exotic tropical plants. During your tour, experienced Gardens docents and staff will share their knowledge of and passion for plants, horticulture and art. These informative conversations will give you the opportunity to ask questions, share your thoughts, experience perennial favorites and uncover lesser-known spaces.

Tour leaves the Sheraton Hotel by bus at 1:00 PM with an expected return of 4:00 PM.

Field Trip C: Novel Strand Brewery Tour

Cost: $35 per person

Check out this unique, female- and minority-owned brewery. Back in 2012 Ayana Coker, Chantel Columna, and Tamir Danon would sit over a few pints of beer in a small town in upstate New York and joke about starting up a brewery of their own one day. Life continued along its course, and in 2015 Chantel and Tamir decided to move (almost) across the country to the mile high city to pursue the dream they joked about years before.

Novel Strand Brewing Company was officially formed in July of 2016 with one intention: "Brew the best beer we can. No gimmicks, no trends, no tricks, no shortcuts, no fads. Just beer. Changes in DNA are not inherently good or bad . . . just different."

Tour leaves the Sheraton Hotel by bus at 2:30 PM with an expected return of 4:30 PM. Includes (2) 10 oz. sample brews for those 21 and older.

Field Trip D: Museum of Nature & Science Tour

Cost: $35 per person

The **Denver Museum of Nature & Science** envisions an empowered community that loves, understands, and protects our natural world. Join us for an exciting behind the scenes tour of this 716,000-square-foot building that houses more than one million objects in its collections. The exhibitions, IMAX films, lectures, classes, and programs pertain to one or more of the following core competencies: anthropology, geology, health science, paleontology, space science, and zoology.

Tour leaves the Sheraton Hotel by bus at 1:00 PM with an expected return of 4:00 PM.

If you go on any of the trips, we encourage you to take pictures and post them on social media. Tag our Facebook or Twitter pages (@IPMSymposium) and use the hashtag #IPMSymp2022.

Tuesday, March 1, 4:40–5:40 PM

Mentorship Meetup

Open to all Symposium attendees. No registration required.

Share your story, lessons learned, or pose unfathomable problems. Come meet fellow IPM enthusiasts with greater, less, or different experience. This is an informal meeting where you are encouraged to ask candid questions about IPM, careers, or anything in between. Mentors and mentees will bring unique experiences to the meetup and our goal is to promote positive discussions across a variety of topics.

Tuesday, March 1, 5:00–6:00 PM

Journal of Integrated Pest Management Social Hour

Open to all Symposium attendees. No registration required.

Enjoy complimentary snacks and beverages with the *Journal of Integrated Pest Management* editors. Discussion topics will include an introduction to the journal, tips for publishing with the journal, notable recent papers, and more. Ample time will be left for discussion and interaction.

Thursday, March 3, 1:30–5:00 PM

Professional Development Workshop: "Understanding spatial data collection and use"

Workshop Leaders: Charles T. Bargeron, Joe LaForest, and Rebekah Wallace

Cost: $45 per person

There are many tools for collecting, managing, and visualizing spatial data. While we all benefit from these tools, many biologists don't understand how they work behind the scenes, how they are maintained, or how seemingly simple changes may have unforeseen consequences. This gap can make adopting these tools feel like a barrier to entry when planning for new projects, choosing between existing tools, and sharing data between programs.

This workshop invites participants to be more conversant in the basic terminology used in the design and operation of these systems to foster mindful collaboration.

Specifically, in this workshop, participants will gain an understanding of:

- Basic concepts of data, databases, websites, and apps
- Spatial data basics
- How to talk to programmers and other nerds
- Data collection tools and collection strategies
    - Setup for success—Metadata and thinking through data collection
        - Citizen science vs expert
        - Local level vs landscape scale
        - Data privacy & ownership
- Basic visualization tools
- Analysis and advanced visualization tools

At the end of this workshop, the participants will be conversant in the basic terminology used in the design and operation of these systems, though they will not be proficient in all tools mentioned or used in this workshop.

poster numbers and titles

The poster session is on Wednesday, March 2, 4:30–6:30 PM in the hotel. While all posters will be displayed throughout the symposium, authors are asked to stand by their posters according to their poster number: odd numbers from 4:30–5:30 PM and even numbers from 5:30–6:30 PM.

P1 A fresh perspective: Sysco's data-driven sustainability expansion

P2 Sustainable supply chains: Building a better apple at Honeybear Brands

P3 Online integrated pest management extension programming during the COVID-19 pandemic in South Carolina

P4 Evaluation of IPM online courses

P5 Lessons learned from three years of organizing and facilitating IPM webinars

P6 UC IPM diversity, equity, inclusion, and justice actions

P7 Tactical Science Coordination Network: An effort to grow awareness and collaboration among biosecurity programs

P8 Long-term impact of integrated pest management programs on pesticide use in North India

P9 "I See Dead Plants" podcast—Communicating IPM research to the public

P10 New York State IPM Program's response to Spotted Lanternfly's arrival

P11 IPM adoption perspectives from the regions: Barriers and recommendations

P12 University of Arizona Public Health IPM—Honoring and empowering tribal nations and indigenous peoples

P13 Pilot survey of dung beetles on cattle pastures in eastern New York

P14 Evaluation of the USGA sand-based rootzone with various organic amendments for growing creeping bentgrass

P15 Our beef with house flies: Understanding fly movement and behavior for risk assessment and improved fly management

P16 Handling invasive weeds in Migori county: An all-inclusive agenda for house holder food security

P17 Indirect effects of invasive insect management on forest insect biodiversity

P18 Rot diseases on Michigan chestnuts: pathogens, cultivar susceptibility and storage effect

P19 Understanding pest biology and exploring monitoring options for Pacific flatheaded borer in walnut orchards in California

P20 Improving in-row cultivation efficacy in carrots through seed selection and timing optimization

P21 Developing a degree-day model to predict overwintering carrot weevil emergence in Ohio parsley fields

P22 Reevaluation of squash bug, *Anasa tristis*, thresholds in Virginia summer squash (*Cucurbita pepo*) systems

P23 Improving two-spotted spider mite management in high tunnel cucumbers

P24 The art of attraction: Evaluation of vittatalactone, an aggregation pheromone, as an attractant for western cucumber beetles and possible synergies with plant volatiles

P25 Row covers provide sustainable resiliency to cucurbit pests

P26 Burkhard spore traps coupled with qPCR detect *Pseudoperonospora cubensis* sporangia in Michigan fields

P27 Evaluating new fungicides with the TOMCAST forecasting model to limit *Stemphylium vesicarium* on asparagus fern

P28 Effects of micro-rates of 2,4-D and dicamba on lettuce

P29 Evaluation of table beet varieties for resistance to rhizomania caused by beet necrotic yellow vein virus

P30 Toxicity of newer insecticides to the adults of *Trichogramma chilonis* Ishii. (Hymenoptera: Trichogrammatidae) in tomato under greenhouse condition

P31 Assessment of active compounds of *Azadirachta indica* and *Cymbopogon citratus* for Meloidogyne infestation prevention

P32 Investigating the mechanism of a natural-based repellent and miticide for *Tetranychus urticae* Koch using electrotarsogram and behavioral studies

P33 Establishing the mating disruption mechanism for San Jose scale in apples

P34 Evaluation of novel kairomone-based lures for attracting male and female tortricid moths in apple orchards

P35 Multi-cultivar grafting: Evaluating a novel low-cost, grower-friendly approach to monitor key apple pests

P36 Testing the efficacy of *Cydia pomonella* pheromone lures: A two state Study

P37 Fruit protective bags as a tool for valuable insights into a devastating fruit rot of wine grapes

P38 Peppermint response to mesotrione and S-metolachlor applied post-harvest

P39 Multiple pest management: Understanding the relationship between onion thrips and weed pressure

P40 Production of heirloom tomatoes on grafted rootstocks was highly variable in open field production in California

P41 Forty years of onion pest management: Advances and challenges.

P42 Is DOWNCAST an effective model for predicting onion downy mildew in Ontario, Canada?

P43 Western bean cutworm presence in Maine sweet corn

P44 Irrigation as a potato IPM component—Balancing in-field observations and soil water metrics

P45 Using spring-seeded grass cover crops to reduce herbicide inputs in plasticulture peppers

P46 Evaluation of alternative strategies for management of soilborne plant pathogens and nematodes

P47 Assessing the impact of Ruby-throated Hummingbird predation on spotted-wing Drosophila in raspberry

P48 Faunistic records of arthropods associated with elderberry in Missouri

P49 Integrated management of strawberry black root rot complex in a perennial organic production system

P50 The invasive *Aspidiotus rigidus*: A continuing IPM challenge in the Philippines

P51 Not being presented

P52 A decision support tool to track Spotted Lanternfly (*Lycorma delicatula*) development with a network of on-site real time microclimate data streams in the Eastern United States

P53 DDRP: A modeling tool to guide decision making for pest surveillance and management

P54 Digital epidemiology: Tool for timely phytosanitary decision making

P55 Data science: The challenges and opportunities in integrated pest management in the digital age

P56 Divided by water, united by need: Development of a best pest management report card for Puerto Rico & U.S. Virgin Islands' farmers

P57 Understanding pest and natural enemy populations in urban gardens

P58 Not being presented

P59 Utilizing Integrated Pest and Pollinator Management Strategies to improve plant production in community gardens

P60 Regional IPM Centers: Our shared mission and what it means

P61 NIFA awarded 77 Crop Protection and Pest Management proposals worth $19.79M

P62 Effective educational tactics using common outcomes from IPM and the pesticide safety education program

P63 Eco-based pest management: "Push-pull" technology and companion planting in organic vegetables

P64 Holistic biodiversity assessment of eight fruit and vegetable farms in western Michigan

P65 Pepper weevil (*Anthonomus eugenii*) infestations and their control in U.S. North Central region

P66 California rice, the "Environmental Crop"—Integrated strategies for pest management in a unique rice production system

P67 Monitoring southwestern corn borer flights with pheromone traps in conventional field corn in Arkansas

P68 IPM Strategic Plans for Ornamental Nurseries

P69 Oregon IPM Center at Oregon State University

P70 From corpses to the farm: How forensic entomology can assist agriculture

P71 IPM crop survey in North Dakota

P72 Integrated herbicide-resistant weed management practices: Current and future technologies

P73 Floral resources enhance fecundity, but not flight activity, in specialized aphid predator, *Hippodamia convergens*

P74 Feeding preference and mortality of *Osmia lignaria* bees exposed to two novel insecticides

P75 Not being presented

P76 Not being presented

P77 MSU Enviroweather: Providing weather-based IPM solutions through alliances with Michigan agriculture

P78 Not being presented

P79 Regenerative agriculture: Benefits, barriers and call to action

P80 Building capacity for effective IPM implementation

P81 Potatoes to turfgrass: Promoting Extension's IPM initiative across the North-Central East coast of Florida

P82 Promoting integrated pest management in Big Sky country: Meeting the diverse needs of the Montana population

P83 Better protected cowpea creates more business opportunities for women in West Africa

P84 Factors impacting soybean disease management decisions in Nebraska

P85 Not being presented

P86 Distribution and management of soybean cyst nematode, *Heterodera glycines*, in soybean and dry bean fields in New York State

P87 Integrated management of sudden death syndrome (SDS)—A disease of soybean caused by *Fusarium virguliforme*

P88 Peanut and nematode response to rotation sequence, cultivar, and chemicals applied at planting

P89 Not being presented

P90 Crop rotation for rice systems in California: Baseline assessment of barriers and opportunities

P91 Comparison of aerial and chemigation insecticide applications for western bean cutworm management

P92 Agronomic and pesticide decisions for managing ear rots, mycotoxins and quality in Michigan corn silage

P93 The effects of planting population and nitrogen fertility on severity of tar spot of corn

P94 Phenotyping hessian fly resistance using spectral and surface model drone maps

P95 Integrated effect of row spacing and herbicide programs for control of multiple herbicide-resistant Palmer amaranth in corn

P96 Koch's postulate of *Macrophomina phaseolina* on hemp and crops in rotation

P97 Evaluating an attract-and-kill tactic for Japanese beetle

P98 Identification of early and extra-early maturing tropical maize inbred lines with multiple disease resistance for use in sub-Saharan Africa

P99 IPM in potatoes: Predicting phenology of four hemipteran pests in the lower Columbia Basin

P100 Integrating environmental sensing and molecular pathogen detection methods for developing a risk prediction model on powdery scab in potato

P101 What's in spud soil? Findings from soil functional analysis

P102 How are pest management issues and farmer's practices evolving over time?

P103 Can a soil insecticide plus Bt corn effectively manage resistant western corn rootworms in Nebraska?

P104 Successful integrated pest management minimizes the economic impact of *Diatraea saccharalis* (Lepidoptera: Crambidae) on the Louisiana sugarcane industry

P105 Development of a dynamic action threshold for sugarcane aphids in sorghum

P106 Management of the sugarcane rust mite (Actinedida: Eriophyidae) using foliar miticides

P107 Image classification of sugarcane aphid densities using deep convolutional neural networks

P108 Aptness of indigenous natural products against pulse beetle, *Callosobruchus chinensis* l. (Bruchidae: Coleoptera) in mung bean

P109 Development of a disease management program for the new *Brassica* bioenergy feedstock crop, carinata

P110 Impact of climate change on biodiversity of mycoflora associated with maize grains sampled from all over Egypt

P111 Biointensive management of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize

P112 Integrated waterhemp management in corn and soybean of New York, USA

P113 The Glance-N-Go™ Sampling System: A presence-absence, sequential sampling system for scouting greenbug, sorghum aphid, and sorghum headworm

P114 Integrated pest management of cotton in New Mexico: Will okra leaf cotton reduce *Helicoverpa zea* populations in semi-arid environments with developing resistance to Bt cottons

P115 Establishing the integrated pest management (IPM) and pesticide reduction information system and their applications in Taiwan

P116 Whitefly resistance management: Time and space refugia in cross-commodity systems of Arizona and California

P117 Plant to plant communication in response to *Helicoverpa zea* herbivory

P118 Integrating short and long term risk models for boxwood blight

P119 Effects of drought treatments on arthropod populations in floral hemp over the reproductive cycle

P120 Phytotoxicity of tolerant exempt pesticides on *Cannabis sativa* L. hemp transplants

P121 Effect of plant extract *Ruta graveolens* against green peach aphid, *Myzus persicae*, at Biskra oasis, Algeria

P122 Developing sampling plans to estimate Asiatic garden beetle damage in commercial mint

P123 Not being presented

P124 Management of Phytophthora root rot using biofumigation for field grown boxwood

P125 Evaluation of fungicides at different application intervals in the management of boxwood blight in an IPM Program

P126 Assessment of physiological changes to monitor pests and diseases of container grown flowering dogwoods in drought condition

P127 Cover crop usage for the sustainable management of soilborne diseases in woody ornamental nursery production system

P128 Changes in IPM adoption by Utah's fruit industry

P129 The fight against fire blight to protect Utah's pome fruit industry

P130 IPM in action: Restoration of Lords Park, Elgin, IL

P131 Putting the "I" back in IPM: Using carbon monoxide to reduce rodenticide use at the Washington Monument grounds

P132 A success story of community online learning about ticks, tick-borne diseases and integrated tick management

P133 Creating a network to support urban growers

P134 Managing Agricultural Drainage Ditches to Improve Conservation Biological Control

plenary sessions

Monday, February 28

Opening Plenary Session

5:00 | *Plaza Ballroom BCEF*

Welcome

Presentation of IPM Achievement Awards, Shaku Nair, nairs@email.arizona.edu, University of Arizona-MAC, Maricopa, AZ

Lifetime Achievement Awards of Excellence

Dr. Tom Green, The IPM Institute of North America

Dr. Tony Shelton, Cornell University

Dr. Charles Vincent, Saint-Jean-sur-Richelieu Research and Development Centre, Agriculture and Agri-Food Canada

Lifetime Achievement Awards of Recognition

Dr. Rangaswamy "Muni" Muniappan, IPM Innovation Lab, Virginia Tech University

Dr. Tom Royer, Oklahoma State University

International IPM Awards of Excellence

Ms. Janet Hurley, Texas A&M AgriLife Extension Service (Practitioner–Academic)

Dr. Jawwad Qureshi, University of Florida (Practitioner–Academic)

Dr. Andrew Sutherland, University of California Cooperative Extension (Practitioner–Academic)

Mr. Frank Meek, Rollins Inc. (IPM Practitioner–Non-Academic)

Plantwise–CABI (Team)

The California Almond IPM Team, University of California Cooperative Extension (Team)

The IPM Innovation Lab, Virginia Tech University (Team)

International IPM Awards of Recognition

Mr. Lynn Braband, The New York State IPM Program, Cornell University (Practitioner–Academic)

Dr. Shahadath Hossain, Bangladesh Agricultural Research Institute (BARI), Bangladesh (Practitioner–Academic)

Dr. Richard Raid, UF/IFAS/Everglades Research & Education Center (Practitioner–Academic)

Mr. Leon Lucas, Glades Crop Care Inc. (Practitioner–Non-Academic)

Center for Biological Control (CBC) IPM Team, Florida A&M University (Team)

Honeybear Brands, Minnesota (Team)

Prairie Pest Monitoring Network (PPMN), Canada (Team)

International IPM Award for Outstanding Ph.D. Student

Ms. Uta McKelvy, Montana State University

Thursday, March 3

Closing Plenary Session

10:15 AM–12:00 PM | *Plaza Ballroom ABC*

10:15 Recognition of Winners of Student Poster Competition, Symposium Poster Committee

10:25 USDA-NIFA Grant Programs that Support Integrated Pest Management, Dr. Rubella Goswami and Dr. Vijay K. Nandula, National Institute of Food and Agriculture, United States Department of Agriculture

10:45 One Entomologist's Experience with the Evolution and Practices of IPM Nationally and Internationally, Dr. Tony Shelton, **ams5@cornell.edu**, Department of Entomology, Cornell University, Ithaca, NY

Vern Stern was the lead author on one of the most influential entomological publications of the 20th century, a 1959 landmark publication entitled, The Integrated Control Concept. His description of the integrated control concept contained the practical ideas that guide integrated pest management (IPM) today. Over my career I've tried to develop and deploy practices, both domestically and internationally, that adhere to the concepts advocated by Stern and other visionary pest managers. In this presentation, I will discuss projects that I've been involved with that utilize sampling and thresholds, host plant resistance, biological control, insect movement, and insecticide resistance management.

11:05 Four Decades of IPM Research: Onstage, Backstage and Offstage, Dr. Charles Vincent, **charles.vincent2@canada.ca**, Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, Canada

After working four decades as a scientist in agricultural entomology, I became convinced that science is like a theater. Some professional activities are apparent to all (onstage) while other activities are apparent to a few (backstage). Onstage activities include writing scientific publications and oral presentations before various audiences. Backstage activities include reading scientific publications, writing grant proposals, reviewing scientific manuscripts and grant proposals, committee work and, above all, thinking. To cope with the continuous demands, one has to keep a balance between professional and personal aspects of life (offstage). In the end, balance of onstage, backstage and offstage skills is required to have a sustainable and meaningful scientific career.

11:25 Many Little Hammers, What I've Learned from Hitting my IPM Thumbs for 45 Years..., Dr. Thomas A. Green, **ipmworks@ipminstitute.org**, IPM Institute of North America Inc., Madison, WI

During my IPM journey of 50 years and counting, in both ag and communities, my thumbs have often been black and blue! Fortunately, not often from the same hammer twice, pain is a good teacher. I'm grateful for all the learning opportunities. Ironically, hammers are a primary tool in my current "retirement" IPM occupation in pest-proofing. I use a rubber mallet whenever possible. Ideally I will share some lessons that may save you some pain. At a minimum I hope to generate some laughter at my expense, humor is a good life companion and also generally a cheap date.

11:45 Closing Remarks

1 • Global Challenges: Transboundary Pests of Global Significance

Governor's Square 14

Current state of the world continues to impose great pressures on the planet's natural capital and agriculture sector to produce safe and clean food for feeding the ever-growing world population with increasingly scarcer resources. In the meantime, increasing global trade, larger population movements and climate change are leading to even greater risks of crop and food losses from pests. This calls for increased emphasis on global pest issues and the need for better collaboration internationally to support sustainable and effective approaches for preventing and controlling current and future outbreaks. This session will focus on global threats from transboundary pests, including endemic and invasives, highlighting the coordinated multi-national efforts and programs to minimize their impacts on the economies and livelihood of many developing and developed countries of the world.

Organizers: Cezarina Kora, Cezarina.Kora@agr.gc.ca, Pest Management Centre, Agriculture and Agri-Food Canada, Ottawa, ON, Canada; Jhalendra Rijal, jrijal@ucdavis.edu, University of California Agriculture and Natural Resources & Statewide IPM Program, Modesto, CA; Janny Vos, j.vos@cabi.org, CABI, Leusden, Netherlands

8:30

1.1 • Introductory remarks: Jhalendra Rijal

8:35

1.2 • Strengthening pest outbreak alert and response systems, Sarah Brunel, sarah.brunel@fao.org, International Plant Protection Convention Secretariat, FAO, Rome, Italy

No global pest outbreak alert and response system exists. The International Plant Protection Convention (IPPC) is the sole global international treaty for protecting plant resources from plant pests by facilitating safe trade through common and effective action to prevent the spread and introduction of plant pests and promote appropriate measures for their control. By 2030, the IPPC's Strategic Framework for 2020-2030 envisions that: "a global pest alert system with mechanisms to assess and communicate emerging pest risks alerts via the International Phytosanitary Portal and messages to target National Plant Protection Organizations is in place, providing regular information on changes in pest status, including distribution and regulatory status around the world". A Focus Group of worldwide experts on the topic is currently working on delivering the Global Pest Outbreak Alert and Response Systems.

8:50

1.3 • Integration of biological control into IPM practices by smallholder farmers in developing countries, Wade Jenner, w.jenner@cabi.org, CABI, Delémont, Switzerland

Multiple barriers impede smallholder farmers' access to, and use of the many biological control technologies that exist. However, diverse initiatives are underway today to extend the benefits of biological control to those potential users. The limited awareness, understanding and uptake of biologically-based plant protection products is being tackled, in part, through new digital tools, such as the CABI BioProtection Portal, that guide advisors and farmers more directly to the products registered and available for their specific problems. Meanwhile, low-tech, local mass production of biological control agents helps to overcome the problem of poor availability of commercial products in rural areas.

9:05

1.4 • The Role of APHIS Preclearance Programs in the Management of Transboundary Pests and Disease, John E. Bowman, John.Bowman@usda.gov, Animal Plant Health Inspection Service, Plant Protection and Quarantine, Pest Exclusion and Import Programs, Preclearance and Offshore Programs, Riverdale, MD

The Animal and Plant Health Inspection Service (APHIS) of the USDA manages a global Preclearance Program which is operative in over 25 foreign countries. Preclearance is a first line of defense against pests and diseases (e.g., fruit flies, European Grapevine Moth) before they reach U.S. ports of entry. In 2021, over 2.8 billion kg of fruits and vegetables and over 1.1 billion bulbs for planting were precleared by APHIS inspectors in countries of origin. Preclearance inspectors execute inspections and phytosanitary treatments in order to control high risk transboundary pests and disease. Preclearance protocols are the result of bilateral agreements signed by the two countries and are full cost recovery.

9:20

1.5 • Precision agriculture to reduce negative impacts to the agro-ecosystem in the Netherlands, Corne Kempenaar, corne.kempenaar@wur.nl, Wageningen University & Research, Wageningen, Netherlands

Precision agriculture is a management concept of responding to spatial and temporal variation in crops and pests with the aim to meet economic and societal objectives. Precision Agriculture applies technology and knowledge to give crop plants the best treatment at the highest resolution possible. Examples of precision agriculture applications in crop protection at strategic and operational levels will be presented. With these applications, farmers can save up to 30% in pesticide use with limited amount of extra investments and still keeping a good yield. IPM and precision agriculture go hand in hand here.

9:35

1.6 • Supporting farmers in IPM: The road from Plantwise to PlantwisePlus, Janny Vos, j.vos@cabi.org, CABI, Leusden, Netherlands

Plantwise has helped millions of farmers in over 30.developing countries to diagnose and treat pest threats on their farms. This has been achieved through promoting IPM approaches whilst strengthening national plant health systems. Plantwise interventions have helped national plant health services to better respond to current and emerging plant health threats while reducing the reliance on high-risk, pesticide-based plant protection practices. PlantwisePlus builds on lessons learned in Plantwise by addressing major areas of weakness that remain. These include improving pest outbreak detection and response, boosting the availability of safer plant protection products, and expanding the supply of safer food to local markets.

9:50

Closing remarks

10:15

Introductory remarks: Jhalendra Rijal, jrijal@ucdavis.edu, University of California Agriculture and Natural Resources & Statewide IPM Program, Modesto, CA

10:20

1.7 • Pest Management in High Value Fruit Crops: Is IPM the Correct Framework? Michael Seagraves, michael.seagraves@driscolls.com, Driscoll's, Aromas, CA

Different frameworks have been proposed for IPM. The most influential has been its use as an economic decision-making tool. I will discuss the challenges of using this framework in high value crops as the effect size needed to be profitable from a pest management action is below the power threshold of most replicated experiments to detect. Moreover, in the environment where managers are more concerned about downside risk of inaction than cost of a spray the EIL/AT framework breaks down as a useful tool. I will use case studies to explore the status quo of decision making in berry crops and its consequences.

10:35

1.8 • IPM in soybean in Brazil and other South American countries, Adeney de Freitas Bueno, adeney.bueno@embrapa.br, EMBRAPA (Brazilian Agricultural Research Centre, Ministry of Agriculture), Brazil

In South America, soybean is predominantly cultivated in Brazil and Argentina, and in the 2020-2021 crop season, the area cultivated were approximately 39 and 17 million hectares, respectively. The major pests threating yield are lepidopteran pests and stinkbugs. Recently, the introduction of the transgenic Bt soybean cultivars, expressing the Cry1Ac protein from the bacteria *Bacillus thuringiensis*, has triggered an overall reduction of insecticide use around 38%. However, lower refugee compliance is a challenge in the IRM program in this Bt crop. Augmentative Biological Control has seen as a promising tool and its use has increased annually from 10% to 20% in the country, increasing cases of IPM success. Overall, IPM has reduced around 50% of insecticide use in the crop with significant environmental and financial benefits.

10:50

1.9 • Resistance Gene Rotation: A Novel Addition to the IPM Playbook, Dilantha Fernando, Dilantha.Fernando@umanitoba.ca, University of Manitoba, Winnipeg, MB, Canada

First developed in Canada, canola is the second largest oilseed crop in the world and brings an annual revenue of $29.6 billion to the Canadian economy. Blackleg is the most economically damaging disease of canola causing annual losses of $600 million worldwide. Our team developed an IPM strategy by understanding the host-pathogen genetics (Resistance and Avirulence/Virulence genes) and introducing

a resistance (R) gene rotation system to circumvent the blackleg disease in canola farms. Growers can now select the right canola cultivar carrying the suitable resistance genes appropriate to their field's pathogen population and mitigate the disease while maintaining farm viability and sustainability. This IPM strategy was built with researchers, farmers and seed industry coming together.

11:05

1.10 • Ongoing IPM practices in multiple cropping systems in China, William Guangwei Yu, yuguangwei@139.com, Weifang University of Science & Technology, Weifang, Shouguan, China

Relying on the principle of the sustainable development, China has fed 22% of the world population from its cultivated land which is 7% of the world's total. Since 2009, to improve the quality of agricultural products for ensuring food security, the government has established standards for vegetables, fruits, and tea gardens across China. Integrated pest management (IPM) is an important support for the sustainable economy in China. Many scientists, industry representatives, independent consultants, NGO professionals, policymakers, agency administrators, and IPM practitioners have adopted IPM practices for solving crop production and pest management-related problems. Many growers and others have recognized the value and use IPM tools such as yellow sticky traps, insect pheromone traps, biopesticides including microorganisms, fungus, plant extracts, natural enemies for vegetables, fruits, and tea productions. IPM practices have been accepted by people and the adoption has been slowly increasing.

11:20

1.11 • Successes and Lesson-learned from the Farmer's Field School-based IPM in tackling endemic and exotic pests in Nepal, Jhalendra Rijal, jrijal@ucdavis.edu, University of California Agriculture and Natural Resources & Statewide IPM Program, Modesto, CA

Farmer's Field School (FFS) is an informal educational approach that aims to educate participant farmers by involving in every step of decision-making when implementing integrated pest management (IPM) practices using in-field demo experiments. In Nepal, the FFS has been the main 'mantra' of practicing and implementing IPM in multiple cropping systems since 1997. The FFS IPM was first implemented in the rice system but expanded to several other cropping systems such as vegetables, tree fruits, field crops, and more. This approach has proven beneficial in educating pesticide safety and best pest management practices to predominantly small-scale farmers with diverse farming practices in several developing counties, including Nepal.

11:35

Closing remarks

2 • Bridging the Divide: Pathways to Partnership for Pesticide Safety Education and IPM

Governor's Square 15

Historically, IPM and Pesticide Safety Education (PSE) have been split into separate silos by government agencies, universities, not-for-profits, and other institutions. Recently, a growing recognition that IPM and PSE are linked in a way that makes it impossible to deliver content on one without the other has resulted in the inclusion of PSE in USDA-NIFA's National IPM Roadmap. This change is a critical first step to creating greater opportunities to educate and inform for both IPM and PSE programs. But it also increases the opportunities that only come when IPM and PSE Program Coordinators work together to assess educational needs at the intersection of IPM and pesticide safety. The idea that IPM and PSE programs work more effectively if they collaborate is new to many extension professionals working across the U.S. This panel discussion will endeavor to demystify the process of bringing these two programs together to form a healthy, productive team. Speakers will represent a mix of IPM and PSE Program Coordinators from various states who are actively improving the relationship between their programs. Through thoughtful questions, we will explore the avenues that professionals working in these programs are taking in order to increase collaboration opportunities in ways that better meet the needs of their (often overlapping) clientele, which includes a wide variety of pest control professionals (urban, ag, wildlands, regulatory, etc.). A series of pre-recorded, guided conversations involving state lead agency personnel and the program coordinators they support to achieve IPM Roadmap goals will supplement the live conversation.

Organizer: Shannah Whithaus, smwhithaus@ucanr.edu, University of California Statewide IPM Program, Davis, CA

8:30

2.1 • Panel Discussion, Amanda Bachmann, amanda.bachmann@sdstate.edu, South Dakota State University, Brookings, SD; Lisa Blecker, lisa.blecker@colostate.edu, Colorado State University, Fort Collins, CO; James Jay Farrar, jjfarrar@ucanr.edu, Statewide Integrated Pest Management

Program, University of California Agriculture and Natural Resources, Davis, CA; Joseph LaForest, laforest@uga.edu, Southern IPM Center, University of Georgia, Tifton, GA; Rebecca Melanson, rebecca.melanson@msstate.edu, Mississippi State University, Mississippi State, MS; Gene Merkl, gm53@msstate.edu, Mississippi State University, Mississippi State, MS; David Owens, owensd@udel.edu, University of Delaware, Newark, DE; Shelby Pritchard, Shelby.Pritchard@sdstate.edu, South Dakota State University, Brookings, SD; Kerry Richards, kerryr@udel.edu, University of Delaware, Newark, DE

10:15

2.2 • Panel Discussion, Conversations with state lead agency personnel and program coordinators about achieving IPM Roadmap goals

3 • Novel Tools and Opportunities for Cucurbit IPM in North America

Plaza Ballroom F

Cucurbits (squash, cucumber, muskmelon, watermelon and pumpkin) are popular and profitable crops, valued at >$1.5 billion annually in the US alone. Cucurbits are vulnerable to insect pests and pathogens, including cucumber beetles, squash bugs, aphids and whiteflies, and bacteria and viruses they transmit. The insect pests are mostly native host-plant specialists, associated with cucurbits >30 million years. In conventional production, insecticides are primary control tactics, including prophylactic systemic seed treatment or soil drench applications of neonicotinoids, followed by foliar sprays, often broad-spectrum insecticides such as pyrethroids. However, all cucurbits depend on insect pollinators for fruit production; thus use of broad-spectrum insecticides may negatively impact pollination and yield. Yet non-chemical control options are limited or not commonly used. Further, natural enemy systems are not well-known, apparently resulting in weak natural suppression from biocontrol agents. Some growers use row covers for early pest suppression, but this tactic is not always practical, adding labor, materials, and expense. Crop rotation tends to be ineffective because the dispersal range of highly mobile adult pests, particularly cucumber beetles, is well within the spatial confines of most farms. Innovative IPM-compatible tactics that target key pests and pathogens are sorely needed. Recently, pheromones have become available that may enable attract-and-kill tactics for cucumber beetles, and better knowledge of pest and pathogen biology as well as natural enemies and pollinators and the cultural methods to conserve and augment them, opens up further opportunities for sustainable IPM in the diverse regions and agroecosystems where cucurbits are grown.

Organizers: Ian Kaplan, ikaplan@purdue.edu, Department of Entomology, Purdue University West Lafayette, IN; Tom Kuhar, tkuhar@vt.edu, Virginia Tech, Department of Entomology, Blacksburg, VA; Anna Wallingford, anna.wallingford@unh.edu, Department of Agriculture, Nutrition & Food Systems, University of New Hampshire, Durham, NH; Don Weber, don.weber@usda.gov, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD

8:30 AM

3.1 • Implementing cucumber beetle IPM for pollinator protection, Ashley Leach, leach.379@osu.edu, Entomology Department, Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH; Jacob Pecenka, Laura Ingwell, Rick Foster, Christian Krupke, Ian Kaplan, Department of Entomology, Purdue University, West Lafayette, IN

Cucurbits, like many pollinator-dependent crops, face the challenge of balancing pest and pollinator management. Too many insecticide applications can impair pollinator function and too few can lead to poorly controlled pest densities. Imbalance between these two imperatives can lead to significant consequences that ultimately compromise marketable yields. Integrated pest management is ideally positioned to effectively manage pests while mitigating negative effects on pollinators. In my talk, I will present research from 6 trials over four years that showcase the utility of IPM in watermelon production with special consideration for pollinator protection.

8:45 AM

3.2 • Seasonal and spatial patterns of attraction to vittatalactone, Ariela Haber, ariela.haber@usda.gov, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD; Kayla Pasteur and Don Weber, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD

Both male and female striped cucumber beetles are attracted to and captured in our traps using the synthetic version of their male-produced aggregation pheromone, vittatalactone. Numbers can be caught all season but the position of traps (adjacent crop, border of cucurbits, within cucurbits) influences capture, in Maryland with two distinct peaks that are initially disproportionately male. Captures are dose-responsive and dependent on trap type.

9:00 AM

3.3 • Developing attractive and repellant semiochemicals for behaviorally-based cucumber beetle management, Christie Shee, cshee@purdue.edu, Department of Entomology, Purdue University, West Lafayette, IN; Zsofia Szendrei, Department of Entomology, Michigan State University, East Lansing, MI; Don Weber, USDA Agricultural Research Service, Beltsville, MD; Hui Zhu, School of Life Sciences, Northeast Normal University Changchun, China; Ian Kaplan, Department of Entomology, Purdue University West Lafayette, IN

Semiochemicals that alter pest behavior are useful tools in pest management, but are not widely used for cucurbit crops. Striped cucumber beetles primarily rely on scent to locate host plants, including both cucurbit volatiles and aggregation pheromones. This talk will summarize several years' of research using plant volatile organic compounds and aggregation pheromones to develop striped cucumber beetle management options.

9:15 AM

3.4 • Vittatalactone: A keystone semiochemical for use in cucurbit pest management?, Don Weber, don.weber@usda.gov, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD; Ariela Haber, Kayla Pasteur, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD

Vittatalactone, the male-produced aggregation pheromone of the striped cucumber beetle, is attractive to several insect pests of cucurbit crops, including squash bug, horned squash bug, and spotted cucumber beetle. This nontarget attraction (eavesdropping) likely arises from the coevolution of native cucurbit crops and their native herbivores over millennia, and offers potential pest management advantages. However, we need to learn more about pest response, as well as the possible involvement of additional species, particularly natural enemies, whose populations, and impacts could be negatively impacted by uninformed deployment of vittatalactone.

9:30 AM

3.5 • Integrating feeding stimulants into cucurbit IPM, Anna Wallingford, anna.wallingford@unh.edu; Department of Agriculture, Nutrition and Food Systems, University of New Hampshire, Durham, NH; Fathi Halaweish, Department of Chemistry and Biochemistry, South Dakota State University, Brookings, SD; Don Weber, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD; Tom Kuhar, Department of Entomology, Virginia Tech, Blacksburg, VA; Helene Doughty, Department of Entomology, Virginia Tech, Painter, VA; Brent Short, Trécé Inc., Hedgesville, WV

Cucurbits produce cucurbitacins, a group of bitter substances that deter feeding in most insects but act as important stimuli for host plant selection by several key pests in this system. The combination of feeding stimulant and toxicant may improve the efficacy of insecticides and potentially reduce the impact on beneficial organisms. Bitter Hawkesbury watermelon (*Citrullus lanatus* cultivar) contains high concentrations of water-soluble cucurbitacin-E-glycoside. Our work seeks to identify appropriate applications of bitter melon derivatives in cucurbit IPM systems, and to develop a water-soluble cucurbitacin product for use as an insecticide additive.

9:45 AM

3.6 • The egg parasitoid *Gryon pennsylvanicum* for biological control of squash bugs (*Anasa* spp.), Sean Boyle, seanboyle@vt.edu, Department of Entomology, Department of Entomology, Virginia Tech, Blacksburg, VA; Mary Cornelius, Invasive Insect Biocontrol and Behavior Laboratory, USDA Agricultural Research Service, Beltsville, MD; Tom Kuhar, Department of Entomology, Virginia Tech, Blacksburg, VA

Squash bugs are serious cucurbit insect pests across the USA. Conventional systems achieve success managing squash bugs with a variety of insecticides. However, organic growers have few effective chemical controls and must diversify their pest management plans. Since biological control is rarely integrated in control strategies, research has been undertaken to better understand the squash bug natural enemy, egg parasitoid *Gryon pennsylvanicum*. Specific research areas include the parasitoid's biology, host preferences, and potential as an inoculative biological control agent. Here, we present novel insights on *Gryon pennsylvanicum* and prospects of its integration in contemporary squash bug IPM efforts.

10:15 AM

3.7 • The pest control and pollinator protection dilemma: The case of thiamethoxam prophylactic applications in squash crops, Diana Obregon, do265@cornell.edu, Department of Entomology, Cornell University, Ithaca, NY; Grace Pederson, Department of Biological Sciences, Cornell University, Ithaca, NY; Alan Taylor, Department of

Horticulture, Cornell AgriTech, Cornell University, Geneva, NY; Katja Poveda, Department of Entomology, Cornell University, Ithaca, NY

Squash is a highly pollinator-dependent crop that is also attractive to herbivores. Thus, growers need to balance pest management with pollinator protection to ensure optimal yield. Thiamethoxam is a commonly used insecticide in squash crops. The aim of this study was to evaluate how different thiamethoxam application methods (seed treatments, in-furrow applications, and early foliar sprays) impact pest control, bee visitation, yield, and pesticides in flowers. We found that in-furrow application best prevented defoliation and resulted in the highest yield. However, it also produced the most frequent and highest concentrations of thiamethoxam in flowers, reaching lethal levels for bees.

10:30 AM

3.8 • Relating *Bombus* visitation to colony density and field scale: Implications for balancing bee safety and *Acalymma* management, Shelby J. Fleischer, **sjf4@psu.edu**, Department of Entomology, Penn State University, University Park, PA; Carley McGrady, Department of Entomology, Penn State University, University Park, PA; Margarita Lopez-Uribe, Department of Entomology, Penn State University, University Park, PA; James Strange, Department of Entomology, Ohio State University, Columbus, OH

Among 37 bee species that utilized pumpkin floral resources in commercial fields, three comprised >95% of the visits, each alone exceeding pollination thresholds. Using genetic methods, we estimated fields recruited *Bombus impatiens* bumble bee foragers from 543 + 22 colonies in a dilution pattern driven by field scale. Visitation rate and colony abundance declined exponentially with field size, and colony abundance explained visitation rate when scaled by field size. Implications of cultural and insecticidal management targeting the striped cucumber beetle *Acalymma,* for bee populations under these commercial settings, will be discussed.

10:45 AM

3.9 • Novel approaches to addressing the challenge of cucumber beetles in California cucurbits, Ian Grettenberger, **imgrettenberger@ucdavis.edu**, Department of Entomology and Nematology, University of California Davis, Davis, CA; Jasmin Ramirez Bonilla, Department of Entomology and Nematology, University of California Davis, Davis, CA; Amber Vinchesi-Vahl, University of California Cooperative Extension, Colusa County, Colusa, CA

Cucumber beetles are key, difficult-to-manage pests for fresh market melons in California. Typically, management has relied on repeated use of insecticides, with limited information on risk to fields. We have been investigating novel approaches to IPM of cucumber beetles, with an emphasis on western striped cucumber beetle. We evaluated vittatalactone as an attractant that could be used for scouting or management. We paired this pheromone with a floral lure to test of combined effects. In addition, we examined non-crop habitat use of the western striped cucumber beetle. Our work helps clarify IPM tactics that could be exploited for cucumber beetles.

11:00 AM

3.10 • Can living mulches harmonize chemical and biological control of cucurbit pests? Carmen Blubaugh, **carmen.blubaugh@uga.edu**, Department of Entomology, University of Georgia, Athens, GA; Allison Stawara, Department of Entomology, University of Georgia, Athens, GA; Tom Kuhar, Department of Entomology, Virginia Tech, Blacksburg, VA; Jim Walgenbach, Tom Bilbo, Department of Entomology and Plant Pathology, North Carolina State University, Mountain Horticultural Crops Research & Extension Center, Mills River, NC; Helene Doughty, Department of Entomology, Virginia Tech, Painter, VA; Lorena Lopez, Courtney Walls, Sean Boyle, Department of Entomology, Virginia Tech, Blacksburg, VA; Adam Alford, Assistant Professor of Agronomy, Southwest Minnesota State University, Marshall, MN

Agricultural intensification and pesticide use often come at a cost of ecosystem services delivered by beneficial insects. However, re-integrating diverse and structurally complex non-crop habitat may buffer natural enemies from adverse effects of pesticides, harmonizing chemical and biological control. Here, we manipulate diverse living mulch intercrops (crimson clover, buckwheat, and teff grass) and pesticide treatments on zucchini crops across four replicated experiments in Georgia, North Carolina, and Virginia, to determine how refuge habitat moderates non-target effects on natural enemies.

11:15 AM

3.11 • Breeding to support IPM in cucurbit crops, Lauren Brzozowski, **ljb279@cornell.edu**, Section of Plant Breeding & Genetics, School of Integrative Plant Science, Cornell

University, Ithaca, NY; Michael Mazourek, Section of Plant Breeding & Genetics, School of Integrative Plant Science, Cornell University, Ithaca, NY

Plant breeding for insect-resistant cultivars is an important facet of IPM, yet a challenge towards implementation is that the genetic loci that confer resistance are often tissue-, pest-, or environment- specific. We discuss progress in breeding for resistance to striped cucumber beetles (*Acalymma vittatum*) and squash bugs (*Anasa tristis*) in summer squash and zucchini (*Cucurbita pepo*). Specifically, we characterized a genetic locus for cucurbitacin production in *C. pepo* with tissue-specific expression and contrasting implications for different pests. We also found that cultivar cucurbitacin levels did not interact with other management measures, like vittatalactone, during the development stage measured.

11:30 AM

3.12 • Virus and vector IPM in *Cucumis melo*: Trying to hit a moving target, Kerry Mauck, kerry.mauck@ucr.edu, Department of Entomology, University of California, Riverside, Riverside, CA; Jaimie Kenney, Penglin Sun, Department of Entomology, University of California, Riverside, CA; Quentin Chesnais, Institut National de Recherche en Agriculture, Alimentation et Environnement, Université de Strasbourg, Colmar, France; Marco Gebiola, Department of Entomology, University of California, Riverside, CA

Insect-transmitted viruses are serious threats to melon production (cantaloupe, honeydews, and specialty melons) by reducing plant growth and fruit quality. New viruses are appearing every 3-5 years, with most transmitted by whiteflies. The abundance of different viruses varies regionally and virus effects on melons can influence vector behavior, possibly accelerating secondary spread and preservation in reservoirs. To address this complex situation, we are testing multiple approaches, including real-time immunity manipulation for broad-spectrum protection, strategies to disrupt vector attraction to infected hosts, and plant breeding. Our results demonstrate that some of these approaches can disrupt virus spread and improve plant growth.

4 • Use of Drones in IPM Monitoring Application of Low Risk Pesticides and for Biological Organism Releases

Plaza Ballroom E

The University of Maryland IPM team has been working with commercial greenhouse and nurseries over the last 3 years in evaluating how to use drones in an IPM program for ornamental plant growing in-ground and in potted plants grown outdoors. This relatively new technology of drone use enhances abilities of IPM scouts and growers in early detection of plant problems as part of an IPM approach. We have conducted field trials with working nurseries and greenhouse operations in evaluating the use of cameras with filters that enable detection of early incidence of plant disease and plant stress. We have also conducted trials using a drone with a 3-gallon spray tank and spray nozzles to spot treat plant material in commercial nurseries with low risk pesticides. We have been working closely with chemical companies interested in applications of low risk pesticides using drones. In 2021, we will be evaluating the use of drones to apply beneficial organisms on nursery and greenhouse crops.

Organizer: Stanton Gill, sgill@umd.edu, Central Maryland Research and Education Center, University of Maryland Extension, Ellicott City, MD

8:30

4.1 • Introduction

8:35

4.2 • Drone in Commercial Uses, Kirk Floyd, kdroneservices@gmail.com, Kdrone Services LLC, Damascus, MD

What are the rules, regulations, licenses and insurance involved with using drones in nurseries and greenhouse operations? What type of equipment is used, including models, sprayers, and spray nozzles? Mapping nursery and greenhouse treatment area will be discussed.

8:55

4.3 • Use of drone to apply low risk pesticides to commercial horticulture crops, Stanton Gill, sgill@umd.edu, Central Maryland Research and Education Center, University of Maryland Extension, Ellicott City, MD

Materials, methods, and results of drone field trials in working greenhouses and nurseries will be presented. In the nursery trial we used drones to apply four low-risk pesticides using drones applying 10 gallons per acre. Results will be discussed in the presentation. In the second trial that was conducted at a 16.1-acre greenhouse with a field grown chrysanthemum crop, we used a drone to apply low risk pesticides for aphids, thrips and caterpillar control using a 5 gallon per acre rate. Results will be discussed in the presentation.

9:25

4.4 • Identification of Nutrient Deficiency and Water Stress in Ornamental Plant Production, Andrew G. Ristvey, aristvey@umd.edu, Wye Research and Education Center, University of Maryland Extension, Queenstown, MD

Plant nutrient deficiencies and water stress can be identified using unmanned aerial vehicles (UAV) and special cameras to record differences in light transmittance from plant leaves. Normalized Differential Vegetative Index (NDVI) is a method of quantifying and comparing plant-leaf absorption and reflection of red and near-infrared wavelengths. This can determine a plant's nitrogen status and other nutrient or water stresses based on healthy reference plants. The technology has been proven in agronomic crop production and may prove to be useful in the ornamental industry by helping to identify various stress symptoms through UAV imaging and catching problems sooner. Autonomous drones will reduce labor time in scouting and can be effective with large areas of monocultures or single variety plants. However, it may not be economically effective on small groups of multiple plant species or cultivars within species. Healthy reference plants are needed for comparison and the specialized cameras for different electro-magnetic wavelengths (i.e., light) are expensive. Additionally, advanced algorithms need to be developed to allow UAVs to operate on their own, but in time these may be more accessible as the technology advances. Plants transpire water through their leaves and as transpired water exits the leaf stomata, evaporation lowers the leaf's surface temperature. A plant in water stress has less evaporation at the leaf surface and higher leaf-surface temperature compared to a non-stressed plant. The difference in temperature can be measured by thermal imaging, indicating when plants need irrigation. In large monocultures, drones with thermal imaging cameras can be used daily to identify locations where plant-water stress occurs, and solutions can be immediately implemented.

9:40

4.5 • Use of Drone in Disease Monitoring in Commercial Horticulture Crops, David Clement, Clement@umd.edu, Home and Garden Information Center, University of Maryland Extension, Ellicott City, MD; Karen Rane, Plant Diagnostic Laboratory, Department of Entomology, University of Maryland, College Park, MD

Monitoring (using Normalized Difference Vegetation Index), drones may be used as a quick screening tool in IPM scouting for diseases. Drones can decrease scouting time when surveying large planting blocks especially with close plant spacing. Random checking of individual plants for disease within large planting blocks before obvious symptoms are visible can be a time consuming task. Drone flights can be optimized to track disease progression and development and used as a tool for checking disease foci before initiating remedial treatments.

5 • Students: The future of IPM research

Plaza Ballroom AB

This student symposium highlights the next generation of integrated pest management scientists by bringing together 15 students from 12 universities and two countries. Oral presentations and a virtual poster presentation cover topics ranging from weed, insect and disease management to evaluating new technologies for pest control and pest-themed games. Undergraduate and graduate students are involved with organizing and presenting in this symposium that gives current students of IPM a platform to share their novel research and connect with their peers.

Organizers: Kadie Britt, kadieb@ucr.edu, Department of Entomology, University of California, Riverside, Riverside, CA; Katelyn Kesheimer, kesheimer@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL; Ashley Leach, leach.379@osu.edu, Entomology Department, Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH; Mika Pagani, mika396@vt.edu, Department of Entomology, Virginia Tech, Blacksburg, VA; Samantha Willden, saw326@cornell.edu, Department of Entomology, Cornell University, Ithaca, NY

8:30

5.1 • Developing management systems for corn earworm, *Helicoverpa zea*, in Alabama hemp, Alejandra Velez, azv0040@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL; I.N. Thweatt; K.A. Kesheimer

Corn earworm, *Helicoverpa zea* (Lepidotera: Noctuidae), has emerged as an injurious insect pest to hemp, (*Cannabis sativa*). Given the damage caused by this pest, we sought to explore the efficacy of different biological insecticides registered for corn earworm in hemp and compare them to insecticides that are used against this pest in other crops. Pheromone traps were located on two locations of the hemp field and assessed once a week to control moth activity. Three sprays were made and three days after treatment we counted caterpillar numbers and plant damage.

8:42

5.2 • Understanding Fov4 infection in cotton, Catherine Danmaigona Clement, cdanmaigona@tamu.edu, Dept. Soil and Crop Sciences, Dept. Biochemistry and Biophysics, Texas A&M University, College State, TX; Fausto Andres Ortiz, Texas A&M University, College Station, TX; Zunyong Liu, Texas A&M University, College Station, TX; Steve Hague, Texas A&M University, College Station, TX; Terry Wheeler, Texas A&M AgriLife Research, Lubbock, TX; Jane K Dever, Texas A&M AgriLife Research, Lubbock, TX; Ping He, Texas A&M University, College Station, TX; Libo Shan, Texas A&M University, College Station, TX

Fusarium wilt disease of cotton race 4 (Fov4) poses a strategic threat to US upland cotton production. Fov4 is difficult to control as the hyphae reside in the woody vascular tissues protected from fungicides with recalcitrant chlamydospores and commercial resistant cultivars are limited. There is a critical need to understand the disease mechanism and develop resistant cultivars. We characterized 54 Texas isolates and our study revealed genetic and virulence diversity. We also established a fast, and highly reproducible disease assay to detect cotton response to Fov; and monitored the infection process of Fov in cotton seed and seedlings.

8:54

5.3 • Remote Sensing as a new approach to monitor defoliation in soybean plants, Fernando Iost Filho, fernandohiost@usp.br, Department of Entomology and Acarology, University of São Paulo/ESALQ, Piracicaba, SP, Brazil

Defoliation by caterpillars is a critical damage to soybean plants, and it is a laborious task to monitor the fields, searching for this damage. Therefore, our goal was to assess the potential of hyperspectral remote sensing to monitor defoliation by two important caterpillar species: *Chrysodeixis includes* and *Spodoptera eridania.* We tested four infestation levels: 0, 2, 5 and 10 caterpillars per cage, for 10 days, and collected reflectance data from the top leaves from these plants. The reflectance data were analyzed using a Machine Learning approach, and we concluded that some models could classify plants with different infestation levels with accuracy higher than 80%.

9:06

5.4 • Reduced dispersal capacity of the invasive larger grain borer (*Prostephanus truncatus*) and the cosmopolitan maize weevil (*Sitophilus zeamais*) after exposure to a novel and reduced risk insecticide, Hannah Quellhorst, hquellho@ksu.edu, Department of Entomology, Kansas State University, Manhattan, KS; Frank H. Arthur, USDA, Agricultural Research Service, Center for Grain and Animal Health Research, Manhattan, KS; Kun Yan Zhu, Department of Entomology, Kansas State University, Manhattan, KS; William R. Morrison III, USDA, Agricultural Research Service, Center for Grain and Animal Health Research, Manhattan, KS

The larger grain borer (*Prostephanus truncatus*) and the maize weevil (*Sitophilus zeamais*) are major pests of stored maize. With the phase-out of methyl bromide, our most effective fumigant, and increasing resistance to phosphine, the most commonly used fumigant, there is a need for alternative management tactics. Here, we tested the effectiveness of a novel reduced-risk insecticide (insect growth regulator + pyrethroid + synergist) compared to the existing commercial standard at reducing the dispersal capacity of these two stored product pests of maize. We found both compounds reduced the dispersal capacity of each species compared to an untreated control.

9:18

5.5 • Plot Size Effects on Non-Target Organism Ecology in Cotton, Isodora Bordini, icb@arizona.edu, Maricopa Agricultural Center, University of Arizona, Maricopa, AZ; Peter C. Ellsworth; Steven E. Naranjo

The Arizona cotton integrated pest management plan has dramatically reduced the number of sprays needed by using selective insecticides to control *Bemisia argentifolii* and *Lygus hesperus*. Plot size is an important consideration when assessing insecticide and trait selectivity due to potential interplot interference that can impact the interpretation of results. Two years of field studies investigated the effects of plot size, ranging from 0.01 to 0.06 ha, on community diversity, abundance and biological control function of the arthropod community (27 taxa), including the key predators: *Collops* spp., *Orius tristicolor*, *Geocoris* spp., *Misumenops celer*, *Drapetis* nr. *divergens* and *Chrysoperla carnea s.l.*

9:30

5.6 • Evaluating Nitrogen Rates on Plant Growth and Chemical Composition in Outdoor Hemp in Alabama, Ivy Thweatt, int0002@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL; Alejandra Velez; Katelyn Kesheimer

Hemp, *Cannabis sativa L*, is one of the oldest cultivated plants and is now primarily grown for its cannabidiol (CBD) oils. Growers must balance CBD content with legal tetrahydrocannabinol (THC) content, which cannot exceed 0.3%. Therefore, this study examined variable nitrogen rates on hemp growth, CBD, and THC content. We took weekly plant measurements and analyzed leaf tissue and flower

samples for nutrients and cannabinoid potency. We saw no effect across nitrogen treatments on plant growth and nutrient levels. The middle nitrogen rates had higher CBD and THC content. Future studies will explore the potential relationship between insects and nitrogen.

9:42

5.7 • Parasitism rates of *Trichopoda pennipes* on *Nezara viridula* in Corn, Kendall Stacey, **kstacey@ufl.edu**, Department of Entomology and Nematology, University of Florida, Gainesville, FL; Norman Leppla, Glynn Tillman, Lillie Rooney, Nolan Missigman, Department of Entomology and Nematology, University of Florida, Gainesville, FL

Trichopoda pennipes is a dipteran endoparasitoid of the southern green stink bug, *Nezara viridula.* Much about the biology and life history of *T. pennipes* still remains to be known. In order to use this organism efficiently in biocontrol programs we must understand their life history, how to rear them, and their efficacy as a biocontrol agent to control pest populations. Over the span of 6 weeks we sampled parasitized and unparasitized *N. viridula* in Prattville, Alabama in corn and took data on percent parasitism, number of eggs laid on host, amount of eggs laid on host, and fecundity of parasitized bugs compared to unparasitized bugs.

9:54

5.8 • Occurrence and Duration of Mating Prior to First Oviposition in the Southern Green Stink Bug, *Nezara viridula* (Hemiptera: Pentatomidae), Lillie Rooney, **rooney.lillie@ufl.edu**, Department of Entomology and Nematology, University of Florida, Gainesville, FL

The southern green stink bug, *Nezara viridula* (L.), is an economically important agricultural pest whose life history is not fully understood. The occurrence and duration of mating in eleven pairs was recorded to determine the: 1) duration from initiation of mating to first oviposition, 2) number of matings, 3) mating duration, 4) number of separations between matings, 5) separation duration, and 6) duration between the last mating and oviposition. The average duration from initiation of mating to first oviposition was 6.67 days, meaning that management tactics must be applied within the first week of pest sightings to prevent reproduction.

10:15

5.9 • Cannabis aphid: A New Aphid Vector of Potato Virus Y, Lisa Kairy, **Lisa.Kairy@colostate.edu**, Department of Agricultural Biology, Colorado State University, Fort Collins, CO; William Jacob Pitt; Punya Nachappa

Potato virus Y (PVY) is an aphid-transmitted plant virus that poses a threat to potato production worldwide. With increasing hemp acreage in the United States, we were interested to know if the cannabis aphid (*Phorodon cannabis* Passerini) is a vector of PVY. Our results have shown that the cannabis aphid can transmit the virus from an infected host plant to both hemp and potato plants. Using the Electrical Penetration Graph (EPG), we analyzed their feeding behaviors, providing insight on the cannabis aphid's efficiency as a vector of PVY and possible virus-induced effects on aphid feeding behaviors.

10:21

5.10 • Utilizing Spore Trapping to Understand White Mold in Delaware, Madeline Henrickson, **madelhen@udel.edu**, Department of Plant and Soil Sciences, University of Delaware, Georgetown, DE; Alyssa M. Koehler

White mold, *Sclerotinia sclerotiorum*, is an economically significant disease across the United States. In Delaware, it is observed in peas and snap beans, among other hosts. To better characterize the timing of ascospore release in the state, a pH indicator medium was used to detect and quantify ascospores. Plates were set up in a field with a history of white mold. Optimal spore release was observed from 12-1:00 pm and peaked during the month of April. This experiment will improve the understanding of ascospore release in Delaware to identify when susceptible crops may be at risk for infection.

10:33

5.11 • Pest Quest: A game of strategy, uncertainty, and sticky traps, Max Helmberger, **helmberg@msu.edu**, Department of Entomology, Michigan State University, East Lansing, MI; Timothy P. Lampasona, Department of Entomology, Rutgers University, Rutgers, NJ; Amanda R. Lorenz-Reaves, Department of Entomology, Michigan State University, East Lansing, MI; Matthew Grieshop, Department of Entomology, Michigan State University, East Lansing, MI

Pest Quest is a tabletop game designed to teach introductory Integrated Pest Management (IPM). We evaluated its impact on student learning with pre- and post-assessments 10 weeks into a non-majors entomology course delivered online in Fall 2021. Students played an online port in class. We also gauged students' opinions of the game. Students

enjoyed Pest Quest and had the impression it helped them learn. However, this was not borne out in the assessment data. Potential ways to better leverage the game include using a paper or fully digital version, playing it earlier in the semester, and incorporating post-game discussion activities.

10:45

5.12 • Volunteer Hemp Resilience to Spring Burndown Herbicide Application in Soybean Influenced by Selection of Active Ingredient, Milos Zaric, milos.zaric@huskers.unl.edu, Department of Agronomy & Horticulture, University of Nebraska, North Platte, NE; Jeff Golus; Kelly Bruns; Sam Wortman

Implementation of industrial hemp throughout diverse crop rotations in the U.S. has caused concerns regarding the appearance of subsequent volunteer hemp. At present, no herbicide is currently registered for industrial hemp in the US, and knowledge on volunteer hemp control options in diverse cropping systems is limited. The objective of this study was to evaluate the resilience of volunteer hemp to commonly used herbicides for spring burndown in 2,4-D-tolerant soybean. A trial was conducted under field conditions in a randomized complete block design with 21 treatments, including non-treated control, with each treatment replicated four times. Evaluated active ingredients included glyphosate, 2,4-D, sulfentrazone, cloransulam-methyl, metribuzin, carfentrazone-ethyl, flumioxazin, pyroxasulfone, imazethapyr, and saflufenacil applied alone or in combination. All treatments were applied in a mixture at 140 L ha-1 using a TTI11002 nozzle at 221 kPa when plants were 15 cm in height with volunteer hemp density of 1160 (± 122) plants per m^2. Visual evaluation of injury was evaluated at 7, 14, 21, and 28 days after application (DAA). At 28 DAA, plant biomass was harvested from an area of 0.093 m2 and oven-dried at 65°C to reach a constant weight. The dry weights were recorded and used for further analysis. Dataset was analyzed using a generalized linear mixed model in Statistical Analysis Software, with treatment comparisons performed using a Tukey's test at significance level $\alpha = 0.05$. Volunteer hemp exhibited increased sensitivity to glyphosate alone or tank-mixed with other active ingredients, with 90% biomass reduction when applied alone and 95% when combined with sulfentrazone plus metribuzin. In general, 2,4-D treatments were more effective when sprayed in tank-mixture with other herbicides. The pyroxasulfone alone or in combination with saflufenacil and imazethapyr did not affect biomass reduction. Results indicated that a variety of chemical control options could be utilized effectively in soybean for volunteer hemp control. Also, multiple occurrences of active ingredient tolerance were observed, suggesting potential use in industrial hemp, with further evaluation required to understand consequences when used in crop situations.

10:57

5.13 • Resistance is Futile: Whitefly Resistance Management and Pesticide Usage, Naomi Pier, nmpier@arizona.edu, Entomology and Insect Science Graduate Interdisciplinary Program, Maricopa Agricultural Center, University of Arizona, Maricopa, AZ; Peter C. Ellsworth, University of Arizona, Department of Entomology, Maricopa, AZ; John Palumbo, University of Arizona, Department of Entomology, Yuma, AZ; Yves Carrière, University of Arizona, Department of Entomology, Tucson, AZ; Al Fournier, University of Arizona, Department of Entomology, Maricopa, AZ; Wayne Dixon, University of Arizona, Department of Entomology, Maricopa, AZ; Steven E. Naranjo, USDA-ARS, Maricopa, AZ; Steven J. Castle, USDA-ARS, Maricopa, AZ (deceased); Nilima Prabhaker, University of California, Riverside, CA (deceased)

Insecticides are central for control of whiteflies (*Bemisia argentifolii* = *B. tabaci* MEAM1); however, this pest has frequently evolved resistances. Chemical controls are available for whiteflies in Arizona and California's cross-commodity agricultural communities. To curtail chemical resistances in whiteflies, resistance management programs are a necessary component of an Integrated Pest Management (IPM) plan. Diversifying practices and not over relying on available chemistries allows us to actively manage refugia. Available section-level application records of whitefly control chemistries from 2013-2017 were used in developing insights into local and regional usage patterns and the availability of temporal and spatial refuges to whitefly populations. Populations collected from cotton were tested for susceptibility to seven chemistries: acetamiprid, imidacloprid, buprofezin, cyantraniliprole, fenpropathrin, pyriproxyfen, and spiromesifen. Temporal and spatial refugia for six whitefly modes of action (MoA) were calculated over a region-wide and community level associated with collected populations. Mortality data were compared with pesticide usage patterns over five look-back periods preceding the date of collection. We produced validated partition models that predicted whitefly susceptibilities based on the availability of spatial or temporal refugia in ca. 23 sq km communities for each mode of action. In our analyses there were variations in model performance with some performing relatively well, while others did not. Further refinement may be needed to optimize look-back periods for better model performance. Insights gained should support development of practical decision tools that could be used by growers to better partition chemistry through space and time in their local communities.

11:09

5.14 • Systems approach to IPM on low tunnel strawberry, Samantha Willden, saw326@cornell.edu, Cornell AgriTech, Cornell University, Geneva, NY

Growing strawberries under low tunnels is a relatively new system in the northeastern U.S. that has received little attention regarding pest presence and approaches to management. This talk will evaluate how tunnel systems impact the presence of pathogens, weeds and arthropod pests and will present IPM options for spider mites. We found that low tunnels provided an optimal environment for growing strawberries and reduced the incidence of disease and spotted-wing drosophila. Unfortunately, biocontrol predators provided limited control of spider mites in the field, but cultural control including cultivar section may provide some additional protection against spider mites.

11:21

5.15 • Discussion

6 • The Science and Practice of Glyphosate Alternatives in the Urban Landscape

Plaza Ballroom D

Managing weeds without the use of conventional herbicides, in particular glyphosate, is of growing interest in urban landscapes where consumers desire alternatives perceived as more sustainable. Although individuals and organizations recognize these preferences, many are unsure what alternative weed control options are available and/or how to implement alternatives for desired outcomes. There is a need for validated frameworks that engage stakeholders and promote evidence-based practices. Effective frameworks must consider product toxicity, labor requirements, carbon footprint, aesthetic expectations, ecosystem functions, and economic awareness. The objective of this session is to identify opportunities that engage stakeholders with science-based information and appropriate technology, all while managing expectations. This session will feature dynamic viewpoints from extension education faculty, practitioners, and private industry leadership. Presentations will cover 1) evaluating organic herbicides as alternatives to glyphosate-containing products, 2) using thermal weed control on a university campus, and 3) responding to cultural shifts in sustainable weed management as an environmentally-responsible lawn care company. These presentations will be followed by a moderated discussion with the audience.

Organizers: Maggie Reiter, reit0215@umn.edu, University of Minnesota Extension, St. Paul, MN; Kai Umeda, kumeda@cals.arizona.edu, University of Arizona Cooperative Extension, Phoenix, AZ

8:30

6.1 • Research on organic and alternative herbicide efficacy, Maggie Reiter, reit0215@umn.edu, University of Minnesota Extension, St. Paul, MN; Kai Umeda, University of Arizona Cooperative Extension, Phoenix, AZ

Organic, alternative, or natural herbicides are becoming increasingly popular in urban landscapes, but are often misunderstood. This presentation will summarize data from a series of field research trials conducted to evaluate organic and reduced-risk herbicides. Discussion will outline tradeoffs associated with these alternative products, identify research gaps remaining, and remark on logistics of use in urban landscape systems.

8:55

6.2 • Practical application of lethal steam on educational campuses, David Lawson, david.lawson@colorado.edu, University of Colorado, Boulder, CO

Over the past decade University of Colorado Boulder Housing and Dining Services has maintained turfgrass and landscape beds on campus without conventional herbicides. A major component of their integrated pest management program is steam-based weed removal. This presentation will provide a case study of weed steamer implementation across an educational campus. Speaker will cover a detailed examination of weed steam technology, considerations related to economics and labor, and lessons learned about addressing needs of diverse stakeholders.

9:20

6.3 • Empowering homeowners with custom natural lawncare programs, Coulter Lewis, coulter@getsunday.com, Sunday, Boulder, CO

Sunday is a venture-funded, Boulder-based startup that's reinventing the lawn and garden space through a lens of e-commerce and technology. Sunday provides custom lawncare programs with natural weed control options. Currently with over 100,000 customers, the company has been successful aligning with consumer attitudes for environmentally-friendly and easy-to-use products. This presentation will cover building a brand targeted at the new American homeowner, engaging customers and collecting data, and a vision for the sustainable yard.

9:45

6.4 • Discussion

7 • Detection and Management of Fungicide-Resistant Plant Pathogens of Soybean

Plaza Ballroom E

Soybean farmers deal with the challenge of diseases every year. In the U.S., soybean diseases cause estimated losses that exceed 200 million bushels each year, which result in economic losses as high as approximately $4.6 billion. Most diseases can be managed by integrating different control tactics, but the use of seed- and foliar-applied fungicides has risen to become one of the most frequently used control tactics today compared to 20 years ago. Unfortunately, the increased use of fungicides also has given rise to fungicide resistance in a few soybean pathogens. Foliar soybean pathogens in the U.S. that have been detected with resistance to certain fungicide classes include those that cause frogeye leaf spot, Cercospora blight, aerial blight, target spot, and brown spot. In some cases, fungicide resistance may be widespread, such as the frogeye leaf spot pathogen, in which strains have been detected to be resistant to quinone outside inhibitor (QoI) fungicides in 19 states. In other cases, such as with the aerial blight pathogen, resistance to QoI fungicides may be limited to a single state. Resistance to fungicides may not be limited to foliar disease pathogens, as soilborne pathogens such as *Fusarium* spp. and *Pythium* spp. also may be subject to developing fungicide resistance. This session will share up-to-date information about the current state of fungicide resistance in soybean pathogens in the U.S., which will include new methods used to detect fungicide resistance and integrated management approaches that are necessary to limit losses from the diseases these pathogens cause.

Organizers: Carl A. Bradley, carl.bradley@uky.edu, Department of Plant Pathology, University of Kentucky, Princeton, KY; Daren S. Mueller, dsmuelle@iastate.edu, Department of Plant Pathology and Microbiology, Iowa State University, Ames, IA

10:15

7.1 • Current status of fungicide-resistant pathogens that cause foliar diseases of soybean in the U.S., Carl A. Bradley, carl.bradley@uky.edu, Department of Plant Pathology, University of Kentucky, Princeton, KY; Danilo Neves, Department of Plant Pathology, University of Kentucky, Princeton, KY

Since the mid-2000s, foliar fungicide use on soybean in the U.S. has increased dramatically. During this period, quinone outside inhibitor (QoI) fungicide-resistant strains of *Cercospora sojina*, causal agent of frogeye leaf spot, have been observed in over 20 states. In addition, QoI-resistant strains of other foliar soybean pathogens, including *Corynespora cassiicola* and *Septoria glycines*, have been reported. This presentation will focus on how changes in production practices have led to selection and spread of QoI-resistant foliar soybean pathogens, how diseases are currently managed in light of QoI resistance, and the potential for selections of strains resistant to additional fungicide classes.

10:27

7.2 • Molecular assay identifying mutation associated with QoI-fungicide resistance in *Cercospora* spp. associated with Cercospora leaf blight of soybean, Bishnu Shrestha, Bshrestha@agcenter.lsu.edu, Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, LA; Ernesto da Silva, Vinson P. Doyle, Department of Plant Pathology and Crop Physiology, LSU AgCenter, Baton Rouge, LA; Tom Allen, Delta Research and Extension Center, Mississippi State University, Stoneville, MS; Pengyin Chen, Fisher Delta Research Center, University of Missouri, Portageville, MO; Blair Buckley, Red River Research Station, LSU AgCenter, Bossier City, LA; Guy B. Padgett, Dean Lee research and Extension Center, LSU AgCenter, Alexandria, LA; Xin-Gen Zhou, Texas A&M University System, AgriLife Research and Extension Center, Beaumont, TX; Heather M. Kelly, Department of Entomology and Plant Pathology, University of Tennessee, West Tennessee Research and Education Center, Jackson; Edward Sikora, Department of Entomology and Plant Pathology, Auburn University, AL; Terry Spurlock, Department of Plant Pathology, University of Arkansas System Division of Agriculture Cooperative Extension Service, Monticello, AR; John C. Rupe, Department of Plant Pathology, University of Arkansas, Fayetteville, AR; Jenny Koebernick, Department of Crop, Soil and Environmental Sciences, Auburn University, AL; Carl A. Bradley, Department of Plant Pathology, University of Kentucky Research and Education Center, Princeton, KY; Paul P. Price III, Macon Ridge Research Station, LSU AgCenter, Winnsboro, LA

Cercospora leaf blight (CLB), caused by *Cercospora* cf. flagellaris, C. cf. *sigesbeckiae* and *C. nicotianae*, is characterized by purpling, bronzing, and blighting of leaves during reproductive stages resulting in premature defoliation.

CLB causes estimated losses of > $94 million annually in the southern U.S. Growers rely on fungicides to manage CLB because of few resistant cultivars which has resulted in development of QoI resistance in the pathogen population. PCR-RFLP analysis of the cytochrome b gene of *Cercospora* spp. isolated from 8 different states identified QoI-fungicide resistance in 65 to 74% of the populations from 2018–2020.

10:39

7.3 • Fungicide resistance of *Phakopsora pachyrhizi* in Brazil: An overview, Jhonatan Barro, jhonatan.barro@uky.edu, Department of Plant Pathology, University of Kentucky, Lexington, KY; Emerson M. Del Ponte, Department of Plant Pathology, Universidade Federal da Vicosa, MG, Brazil; Carl A. Bradley, Department of Plant Pathology, University of Kentucky, Princeton, KY

Brazil is one of the largest soybean producers in the world. Soybean yield losses caused by soybean rust (*Phakopsora pachyrhizi*) can reach up to 80% due to photosynthetic leaf area reduction and premature defoliation. The overuse of fungicides in the large soybean producing area in Brazil, in addition to the high genetic variability of *P. pachyrhizi* resulted in fungicide resistance. This presentation will share an overview about the current state of *P. pachyrhizi* fungicide resistant populations to different modes of actions in Brazil and highlight which integrated management approaches have been adopted to minimize yield losses caused by soybean rust.

10:51

7.4 • Fungicide Sensitivity of *Sclerotinia sclerotiorum* from U.S. Soybean and Dry Bean, Compared to Different Regions and Climates, Edgar Nieto Lopez, edgar.nieto@huskers.unl.edu, Department of Plant Pathology, University of Nebraska, Lincoln, NE; Thomas Jose Justo Miorini, Department of Plant Pathology, University of Nebraska, Carrington Research and Extension Center, North Dakota State University, Carrington, ND; Cristian A. Wulkop-Gil, Department of Plant Pathology, University of Nebraska, Department of Molecular Medicine, Scripps Research Institute, La Jolla, CA; Martin Chilvers, Department of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing, MI; Loren J. Giesler and Tamra A. Jackson-Ziems, Department of Plant Pathology, University of Nebraska, Lincoln, NE; Mehdi Kabbage, Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI; Daren S. Mueller, Department of Plant Pathology and Microbiology, Iowa State University, Ames, IA; Damon L. Smith, Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI; Juan Manuel Tovar-Pedraza, Centro de Investigación en Alimentación y Desarrollo, A. C., Culiacán, Mexico; Jaime F. Willbur, Department of Plant, Soil, and Microbial Sciences, East Lansing, MI; Sydney E. Everhart, Plant Science and Landscape Architecture, University of Connecticut, Storrs, Connecticut, CT

Fungicide sensitivity of 512 *Sclerotinia sclerotiorum* isolates from the USA (443), Brazil (36), and Mexico (33) was determined using discriminatory concentration (DC) previously identified of tetraconazole (2.0 ppm; FRAC group 3; EC50(D) ranged of 0.197–2.27 ppm), boscalid (0.2; group 7; 0.042–0.222), picoxystrobin (0.01; group 11; 0.006–0.027), and thiophanate methyl (group 1; 10 ppm qualitative DC). Among the 10 least sensitive isolates to boscalid and picoxystrobin, no isolates from U.S. presented mutations known to confer resistance, however, two Mexican isolates presented mutations. There was no fungicide resistance in the U.S. although small shifts in fungicide sensitivity were found.

11:03

7.5 • Evolution of fungicide resistance in oomycete communities associated with soybeans, Zachary Noel, zan0002@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL

Over 80 oomycete species are associated with soybeans. This diversity makes management decisions for seedling damping-off complex, and seed applied fungicides are the primary management tool. We present the level of interspecific variation in mefenoxam and ethaboxam sensitivity as determined using a high-throughput assay. For mefenoxam, interspecific variation in sensitivity was present, but insensitive isolates were rare. However, inherent insensitivity to ethaboxam was widespread across oomycetes, having evolved repeatedly from a C239S mutation in beta-tubulin. This information provides essential knowledge on the breadth of activity and current levels of insensitivity to common anti-oomycete seed treatment chemicals.

8 • Wood Destroying Insect Pest Exclusion Using Physical Barriers: A Sustainable Future for New and Existing Structures

Plaza Ballroom D

Advances in the use of physical barriers to effectively exclude subterranean termites and other pests have made it possible to add new dimensions to integrated pest management strategies for both pre-construction and post-construction implementations. These exclusionary concepts were done through interdisciplinary efforts that included

entomologists, engineers, architects, construction scientists, and landscape designers. Both laboratory and field trials have demonstrated the efficacy of these barriers for periods exceeding 5 years without the use of traditional pesticides. The history of physical barriers and the research involved are shared. These concepts have been "reduced to practice", and as such are now available as commercial products for use in sustainable IPM programs. IPM through LEED and green building standards are shared with some of the updated building codes and construction specifications.

Organizers: Roger Gold, r-gold@tamu.edu, Department of Entomology, Texas A&M University, College Station, TX; Jill Heidorf, jheidorf@polyguard.com, TERM Barriers by Polyguard Products, McKinney, TX

10:15

8.1 • Qualifications and history of subterranean termite physical barriers and how research has evolved different barrier designs, Roger E. Gold, r-gold@tamu.edu, Department of Entomology (Emeritus), Texas A&M University, College Station, TX

Physical barrier, mechanical approaches, and improved sanitation are the foundational blocks on which Integrated Pest Management strategies are based. These concepts will be presented and discussed as they pertain to wood destroying insect populations. The results of laboratory and field testing will be explained, for pre- and post-construction situations. The broad concepts within the Second Law of Thermodynamics will be briefly discussed as the importance of "sustainability" is put into perspective as pest populations are managed in complex environments.

10:45

8.2 • Green Market and Code Compliance Challenges showing Hawaii Research from Jia Wei, what it looks like for CLT and MT, Holly Beard, hbeard@polyguard.com, TERM® Barriers by Polyguard Products, Honolulu, HI

With the high growth potential of Mass Timber structures in regions with heavy termite pressure, studies by Mississippi State University and the US Forest Service point to the possibility of termite damage and water absorption. Research reports from the University of Hawaii's own Dr. Jia-Wei Tay are shared to show Formosan termite pressure on cross-laminated timber. As construction practices advance with a greener focus, some of the challenges surrounding code compliance and governing bodies will be shared.

11:15

8.3 • Termite Barriers in the Building Envelope, Jill Heidorf, jheidorf@polyguard.com, TERM Barriers by Polyguard Products, McKinney, TX

Building Envelope Science has come a long way. We have engineered tighter walls with better air and vapor permeance which improves our indoor air quality. But why haven't we been able to reduce or not use pesticides as a soil pretreatment? If we add a few more upgrades to the building envelope, we can significantly not only improve the envelope but provide a long-lasting indoor air quality that no longer needs quarterly pest-control visits. If we can keep a termite out, as it is the smallest and most invasive pest, then we have a win-win for the occupants. By adding a few items to your specifications and updating a few of your standard building envelope products, you can provide a structure that will last the test of time without being polluted with chemicals during the life of it.

9 • Fresh from the Field: New IPM Technologies in Entomology and Plant Pathology

Plaza Ballroom E

This mini-symposium will involve some of the most important new IPM technologies that have been adopted recently or are on the horizon. Nationally prominent innovators will share their experiences in implementing new and emerging IPM technologies. Examples of these novel technologies include the following: digital technology (data acquisition and analysis), sensors (water, nutrients), apps (information delivery), drones and remote sensing for pest and disease scouting, satellite imaging, diagnostic techniques, automation, robotics, new fumigants and pesticides, nanotechnology for crop disease management, RNAi, pesticide resistance management, and practical IPM training. Included will be examples of newly emergent pests and diseases encountered by leading crop advisors and disruption of IPM by these organisms and food safety regulations. Updates on disease forecasting, GMO crops and advances in the use of sterile insects in areawide pest management also may be addressed.

Organizers: D. Tyler Mays, tyler.mays@ag.tamu.edu, Hill and McLennan Counties, Texas A&M AgriLife Extension Service, Hillsboro, TX; Norman Leppla, ncleppla@ufl.edu, Department of Entomology and Nematology, University of Florida, Gainesville, FL

1:15

9.1 • Welcome, D. Tyler Mays

1:20

9.2 • Advanced Insect Pest Scouting Applications for Smart Devices, Kristopher L. Giles, kris.giles@okstate.edu, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, OK; Tom A. Royer, Nina Rudin, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, OK; Brian Arnall, Department of Plant and Soil Sciences, Oklahoma State University, Stillwater, OK; Norman C. Elliott, USDA-ARS, Stillwater, OK; Jessica Lindenmayer, Trece, Inc., Adair, OK; Brian McCornack, Department of Entomology, Kansas State University, Manhattan, KS; Mike Brewer, Department of Entomology, Texas A&M University AgriLife Research Center, Corpus Christi, TX; Thomas Hess, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, OK

Smart devices provide the most efficient platform for utilizing complex insect pest sampling plans, but more importantly, can allow for dynamic integration of count data and decision outcomes over time. Integrating decisions for multiple pests or the impact of natural enemies remain as primary challenges to the adoption of these Apps. We review available Apps that are being utilized for insect pest management decisions, and focus specifically on those developed for cereal crops in the Central and Southern Great Plains of the U.S. We also propose how landscape context and natural enemy impact can be integrated into management decisions.

1:38

9.3 • In-Field Sensors for Plant Volatile Analysis, Qingshan Wei, qwei3@ncsu.edu, Department of Chemical and Biomolecular Engineering, North Carolina State University, Raleigh, NC

Determination of plant diseases and stresses is currently dependent on time-consuming and complicated molecular technologies, which is inadequate for rapid disease monitoring. We recently demonstrated a set of miniaturized sensor devices that can noninvasively monitor plant disease and stress via analyzing plant volatile organic compound (VOC) emissions. The first platform is a handheld smartphone-based VOC sensor that can detect late blight caused by *Phytophthora infestans* in tomato plants as early as 2 days after inoculation. The second platform is a leaf-attachable VOC sensor patch for real-time profiling of leaf volatiles. This flexible sensor array allows for accurate detection and classification of 13 individual plant volatiles with >97% classification accuracy. Together, these low-cost sensor devices demonstrated the feasibility of in-field detection of plant diseases and stresses of great concerns.

1:56

9.4 • Pest Cotton App in Florida: Keep simple with identification and IPM information for farmers, Silvana V. Paula-Moraes, paula.moraes@ufl.edu, West Florida Research and Education Center/Entomology & Nematology Department/IFAS/University of Florida, Jay, FL; Marcelo Mendes Rabelo, West Florida Research and Education Center/Entomology & Nematology Department/IFAS/University of Florida, Jay, FL; Ethan Carter, Jackson County Extension Office/IFAS/University of Florida, Marianna, FL; Mauricio Alex Zientarski Karrei, Clyde William Fraisse, Agricultural and Biological Engineering/IFAS/University of Florida, Gainesville, FL

Farmer survey and focus meetings were performed in the Florida Panhandle with the objectives to document farmer knowledge and demands to improve knowledge of seasonal occurrence of pests during the cotton growth season and IPM practices. An online system "App Cotton Pests in Florida" were produced summarizing the region-specific research work and is intended to be a tool for agricultural professionals, providing high quality photographic material and short pest description for the identification of cotton pests and natural enemies, and searchable tables with information about Bt technology, safety of insecticides labeled to Florida, rate, and mode of action.

2:14

9.5 • MyIPM for Row Crop Pests: A Smartphone Application to Increase Adoption of IPM, Francis Reay-Jones, freayjo@clemson.edu, Department of Plant and Environmental Sciences, Clemson University, Pee Dee Research Education Center, Florence, SC; Tim Bryant, Department of Plant and Environmental Sciences, Clemson University, Pee Dee Research Education Center, Florence, SC; Guido Schnabel, Department of Plant and Environmental Sciences, Clemson University, Clemson, SC

In collaboration with extension specialists at universities in the southeastern U.S. and the Southern IPM Center, a smartphone app was developed to provide information on pest identification, life cycle, chemical control, and non-chemical control options for major pests of corn, cotton, sorghum, soybeans, and peanut. The app will be updated each year and will provide regional management information to promote the adoption of IPM practices for field crop pests.

2:32

9.6 • What is Holding Back the Adoption of Technology For Field Crop IPM, D. Tyler Mays

3:00

9.7 • Welcome, D. Tyler Mays

3:05

9.8 • IPM Wheat Model: Digital-Results of 37 Years of Experience for Development of Prognosis Systems Against Important Wheat Diseases in Germany, Jospeh Alexander-Verreet, **javerreet@phytomed.uni-kiel.de**, Institute of Phytopathology, University of Kiel, Kiel Germany; T. Birr, H. Kline, W. Hammer, R. Duttmann

Increasing intensity of wheat cultivation in the northern part of Europe has been achieved through shorter rotations, high plant populations and multiple nitrogen applications. These intensified agronomic practices result in substantial grain yields (Schleswig-Holstein average wheat yield 8.6 tons/ha) but also increased pressure from diseases. Control of the diseases caused by wheat pathogens has a high priority in minimizing yield losses (average 2 tons). Pathogens that have become economically important are *Mycosphaerella graminicola* (leaf blotch), *Blumeria graminis f. sp. tritici* (powdery mildew), *Puccinia recondita* (brown rust) and *Fusarium* spp. (FHB). A timely prediction of yield-relevant infestation events therefore is of crucial importance. In a multi-year cooperation (1995-2019) of the plant protection service of the German state Schleswig-Holstein and the University of Kiel, an Integrated Plant Protection System (IPM Wheat Model) has been developed for the most important fungal wheat diseases. In summary, the amount of fungicide active ingredients was reduced by 48% in the IPM Wheat Model Digital variant compared to the´ professional variant, with a comparable yield and disease control.

3:23

9.9 • Leveraging Data Science and Digital Tools to Support Precision Pest Management Practices, Andre Felli, **Andre.felli@bayer.com**, Climate FieldView, St. Louis, MO

Variable rate technologies and the creation of prescription maps for pesticide applications enable farmers, ranchers, foresters and other land managers to adopt pest management strategies to protect investments and minimize risk. By combining machine learning and agronomic modeling with field imagery and other data layers, the Climate FieldView™ platform can provide land managers with tools to identify pest management needs, create management zones based on known variabilities, and enable more precise use of pesticides through variable rate technology or targeted aerial applications. This session will demonstrate current and future pest management capabilities that support the IPM community within Climate FieldView.

3:41

9.10 • Unmanned Aerial Systems (UAS) and Data Analytics in Disease Assessment of Field Crops, Mahendra Bhandari, **Mahendra.bhandari@ag.tamu.edu**, Texas A&M AgriLife Research and Extension Center-Corpus Christi, Corpus Christi, TX; Amir M.H. Ibrahim, Department of Soil and Crop Sciences, Texas A&M University, Hend Alkittawi, Jose Landivar, Anjuin Chang, Juan Landivar, Texas A&M AgriLife Research and Extension Center-Corpus Christi, Corpus Christi, TX; Jinha Jung, Purdue University, West Lafayette, IN

The technological advancements in Unmanned Aerial Systems (UAS) have increased our capability of collecting high spatial and temporal resolution data previously unobtainable through manual methods or conventional airborne and spaceborne remote sensing platforms. The high-resolution measurements captured by the UAS is helpful to assess the disease severity of field crops. Additionally, these measurements from UAS generate large volume of data that provides an opportunity to utilize big data analytics for developing, testing, and validating machine learning models. We collected UAS data over a wheat breeding nursery to develop a decision support tool to assess disease severity in winter wheat genotypes using machine learning models. Developed models were tested and validated across seasons for their generalizations and the models are performing with high level of accuracy with respect to assessing disease severity in winter wheat genotypes. Thus, there is a potential of integrating UAS and data analytics for developing decision support systems to manage the crops with respect to disease and pests.

3:59

9.11 • Using AgPest Monitor to coordinate data collection and near-real time visualization of outbreak data, Joe LaForest, **laforest@uga.edu,** Southern IPM Center, Tifton, GA; Roger Magarey, Southern IPM Center, Raleigh, NC; Rebekah Wallace, Charles Bargeron, Bugwood Center for Invasive Species and Ecosystem Health, University of Georgia, Tifton, GA

AgPestMonitor.org provides a free set of tools to coordinate pest activity reports from county agents, scouts, extension specialists, and growers. The end result is near-real time alerts sent to users based on their location, maps that update to show progress of the pest, and insights that inform growers on the best management strategy given current

conditions. National programs are currently active for corn, soybean, wheat, pecan, and cucurbit downy mildew. More programs exist and can be set up for state, regional, or pest specific programs.

4:17

9.12 • What is Holding Back the Adoption of Technology for Field Crop IPM

Panel Discussion

10 • Using Active Learning to Enhance your IPM Programming

Governor's Square 15

Active learning recognizes and embraces the different learning styles to increase engagement, learning, and, the ultimate goal, behavior change for all participants. Active learning techniques require the audience to participate in their own learning, instead of only passively listening to information presented by the instructor. Rather than a lecture-style format, active learning can include: time for self-assessment and reflection; hands-on activities; paired participant discussion; problem solving solo, with a partner, or in a small group; use of technology such as audience response systems to enhance audience participation and engagement. This session will feature extension professionals who are using active learning in their IPM programming. They will discuss their techniques and how they fit it in! It will also include time for participants to work on their own plans to add a new active learning component to their IPM outreach and extension. Whether you're already employing some active learning strategies in your extension programming, or thinking about trying it for the first time, come learn something new!

Organizers: Amara Dunn, **arc55@cornell.edu**, New York State Integrated Pest Management Program, Cornell University, Geneva, NY; Joellen Lampman, **jkz6@cornell.edu**, New York State Integrated Pest Management Program, Cornell Cooperative Extension Albany County, Voorheesville, NY

1:15

10.1 • Welcome & Introduction, Amara Dunn and Joellen Lampman

We will start by sharing goals for the session and a brief definition of active learning.

1:25

10.2 • Teaching IPM through real-world scenarios, Dawn H. Gouge, **dhgouge@email.arizona.edu**, Department of Entomology, College of Agriculture and Life Science, University of Arizona, Maricopa, AZ

This presentation will describe the use of real-world scenarios in IPM workshops focused on implementation in the built environment. During workshops participants are given a specific pest challenge, and work in small groups to create and present a plan to prepare and respond to the challenge using an IPM approach.

1:40

10.3 • Hands-free Hands-on: Transforming a hands-on greenhouse IPM program during COVID, Elizabeth Lamb, **eml38@cornell.edu**, New York State Integrated Pest Management Program, Cornell University, Ithaca, NY; Brian Eshenaur, NYS IPM; Neil Mattson, Cornell University; John Sanderon, Cornell University

NYS IPM has organized a hands-on IPM program for greenhouse growers for over 10 years, bringing them to campus for modules on disease and insect IPM and plant production practices. What happens when campus closes and an in-person program is no longer possible? The presenter will share her experiences working hands-on activities into a Zoom based program for 2020 and 2021 and how the growers responded.

1:55

10.4 • Using quizzes to engage audiences and teach pest ID, Edward Zaworski, **zaworski@iastate.edu**, Plant Pathology and Microbiology, Iowa State University, Ames, IA

This presentation will discuss and demonstrate the use of quizzes on pest identification to engage audiences at the Field Extension Education Laboratory at Iowa State University.

2:10

10.5 • Small changes to add active learning to your existing extension programs, Amara Dunn, **arc55@cornell.edu**, New York State Integrated Pest Management Program, Cornell University, Geneva, NY

If you're used to mostly giving talks (with or without PowerPoints), designing and implementing a hands-on workshop can feel daunting. This talk will cover some small and simple active learning techniques you can add to an extension talk of any length, in any location.

2:25

10.6 • Planning your own active learning & Final Questions, All speakers

Using a planning worksheet to guide them, participants will draft and discuss plans to incorporate one of the active learning strategies they learned about into their IPM extension program. Session organizers and speakers will be available to answer questions during this time.

11 • Furthering Small Fruit IPM after a Decade-Long Battle with Spotted-Wing Drosophila

Plaza Ballroom F

The spotted-wing drosophila (SWD), *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), is an invasive pest from Southeast Asia that was first detected in the continental United States in 2008. It has since rapidly expanded to many countries in North and South America and Europe where it has become a keystone pest of small fruits. Since its invasion, there have been several research breakthroughs including better monitoring tools, advances in seasonal biology, and biological, behavioral, cultural, and chemical control. In this symposium researchers, investigating novel strategies to improve SWD management in conventional as well as organic systems as part of the USDA-NIFA funded multi-state OREI and SCRI projects, will present findings of their research.

Organizer: Ashfaq A. Sial, ashsial@uga.edu, Department of Entomology, University of Georgia, Athens, GA

1:15

11.1 • Introductory Remarks

1:20

11.2 • Progress on behavior-based control strategies to manage spotted-wing drosophila, Cesar Rodriguez-Saona, crodriguez@njaes.rutgers.edu, Department of Entomology, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

Three behavior-based tactics, that contain an attractive cue (visual and/or olfactory) and/or a phagostimulant mixed with an insecticide, have shown promise for managing spotted-wing drosophila (SWD). These include: 1) attracticidal red spheres containing a feeding stimulant and an insecticide; 2) SPLAT/HOOK SWD that contains an attractant, a phagostimulant, and a toxicant such as spinosad or spinetoram; and 3) a new bait named Combi-protec that when mixed with spinosad or spinetoram, at the full and half rates, provides SWD control that is comparable to the full insecticide rate. The advantages and disadvantages of using these strategies to manage SWD are discussed.

1:35

11.3 • Open-field observations and implementation of an Attract-and Kill strategy against *Drosophila suzukii,* Vaughn Walton, vaughn.walton@oregonstate.edu, Department of Horticulture, Oregon State University, Corvallis, OR; Gabriella Tait, Ryan Chave, Serhan Mermer, Edwin Harris, Chris Adams, Department of Horticulture, Oregon State University, Corvallis, OR; Jimmy Klick, Claira Castillo, Driscoll's Inc., Watsonville, CA; Marco Corradi, Berry Gardens, Maidstone, UK; Alberto Grassi, Marco Valerio Rossi-Stacconi, Fondazione Edmund Mach, St. Michele, Italy; Fatemeh Ganjisaffer, Frank Zalom, University of California, Davis, CA; Gregory Loeb, Nicholas Aflitto, Department of Entomology, Cornell AgriTech, Geneva, NY; Cesar Rodriguez-Saona, Department of Entomology, Rutgers University, New Brunswick, NJ; Ashfaq Sial, Department of Entomology, University of Georgia, Athens, GA; Phillip Fanning, Maine Food and Agriculture Center, University of Maine, Orono, ME; Rufus Isaacs, Steve Van Timmerin, Department of Entomology, Michigan State University, East Lansing, MI

We describe benefits, disadvantages, and efficacy data from 2017-2021 for an organic Attract and Kill (A&K) management tool. Efficacy with and without the use of toxic insecticides are reported from 10 days to three months. Collaborators report an average of ~45% reduction over a 21-day period for *D. suzukii* damage when using the A&K tool either alone, or with conventional insecticides. Shortcomings include possible incompatibility with other behavioral methods, rodents, and dependency on controlled irrigation systems. Benefits include ease of application, cost, and the fact that weather events such as rain does not impact its efficacy.

1:50

11.4 • Spotted-wing drosophila—An overview of classical biological control in the United States, Judith Stahl, judithmstahl@berkeley.edu, ESPM Department, University of California, Berkeley, CA; Xingeng Wang, Kim Hoelmer, Matt Buffington, Vaughn Walton, Greg Loeb, Jana Lee, Brian Hogg, Amanda Stout, Betsy Beers, Marc Kenis, Emilio Guerrieri, Massimo Giorgini, Claudio Ioriatti, Gianfranco Anfora, Antonio Biondi, Annabelle Firlej, Fu-Shou Chen, Hong-Mei Zhang, Yoohan Song, Kent Daane, ESPM Department, University of California, Berkeley, CA

Biological control efforts of the major invasive pest spotted-wing drosophila, *Drosophila suzukii*, are focusing on augmentative and classical biological control. Explorations of natural enemies in the pest's areas of origin from several

international groups of researchers in the past years have discovered three species of parasitic wasps as potential classical biological control agents. Summaries of the quarantine laboratory evaluations of the three species are provided. In depth exploration of the most promising parasitoid species, *Ganaspis brasiliensis*, and the status of its releases in the United States are discussed.

2:05

11.5 • Chemical control of spotted-wing drosophila (Diptera: Drosophilidae)—Current tactics, Philip D. Fanning, philip.fanning@maine.edu, School of Biology and Ecology, University of Maine, Orono, ME

Chemical control is still the key management tactic for growers and fruit producers are reliant on to protect their fruit from infestation by spotted-wing drosophila (SWD). This talk will explore the current tactics and recommendations for chemical management of SWD including the efficacy of key insecticide, resistance management, and timing of applications.

2:20

11.6 • Strategies to manage spotted-wing drosophila in organic systems, Ashfaq Sial, ashsial@uga.edu, Department of Entomology, University of Georgia, Athens, GA; Craig Roubos, Department of Entomology, University of Georgia, Athens, GA; Vaughn Walton, Department of Horticulture, Oregon State University, Corvallis, OR; Cesar Rodriguez-Saona, Department of Entomology, Rutgers University, New Brunswick, NJ; Rufus Isaacs, Department of Entomology, Michigan State University, East Lansing, MI; Kelly Hamby, Department of Entomology, University of Maryland, College Park, MD; Mary Rogers, Department of Horticultural Science, University of Minnesota, Saint Paul, MN; Oscar Liburd, Entomology and Nematology Department, University of Florida, Gainesville, FL; Donn Johnson, Entomology Department, University of Arkansas, Fayetteville, AR; Frank Zalom, Department of Entomology and Nematology, University of California Davis, Davis, CA; Kent Daane, ESPM, University of California, Berkeley, CA; Hannah Burrack, Department of Entomology and Plant Pathology, North Carolina State University, Raleigh, NC; Jana Lee, USDA-ARS, Horticultural Crops Research Laboratory, Corvallis, OR; Philip Fanning, School of Biology and Ecology, University of Maine, Orono, ME

Spotted-wing drosophila (SWD), *Drosophila suzukii* (Diptera: Drosophilidae) is a devastating pest of small and stone fruits throughout the U.S. Losses due to SWD can be as high as 100%. Currently SWD management is achieved primarily through preventative insecticide applications and is particularly challenging for organic producers due to lack of OMRI approved effective materials. Studies were conducted to evaluate behavioral, cultural, and chemical strategies to develop and implement systems based organic SWD management programs. Results of those studies and their implications for season long SWD management in organic systems will be presented.

2:35

11.7 • Discussion and Concluding Remarks

12 • Global Challenges: IPM for Tropical Crops in Asia and Africa

Governor's Square 14

Pests and diseases of crops in the Old World differ from those in the New world. Since IPM is crop, site and season specific, it requires development, technology transfer, and adoption for each crop. Often, technologies developed for large-scale farming in developed countries are either not suitable or require modification to suit the local economic, environmental, and social conditions of developing countries. In recent years, several exotic species have invaded Africa and Asia, requiring development of additional management technologies for these pests and incorporating them into the IPM packages already developed. The IPM packages for tropical cereal, legume, vegetable, and fruit crops developed and implemented in Asia and Africa for the past quarter-of-a-century by the IPM Innovation Lab will be presented. Additionally, problems encountered in technology transfers will be highlighted.

Organizer: Rangaswamy (Muni) Muniappan, rmuni@vt.edu, Integrated Pest Management Innovation Lab, Virginia Tech, Blacksburg, VA

1:15

12.1 • Role of IPM Innovation Lab in Developing IPM Packages for Tropical Crops, Rangaswamy (Muni) Muniappan, rmuni@vt.edu, Integrated Pest Management Innovation Lab, Virginia Tech, Blacksburg, VA

The IPM Innovation Lab (formerly IPM Collaborative Research Support Program) has been in operation from October 1993 to November 2021. In its 28 years of operation, it has covered over 30 countries in the tropics and has taken a holistic approach to crop protection. Early on, it worked extensively on high value vegetable crops and later expanded to cereal, legume, and fruit crops. The approach the program has taken is preparing a matrix of problems faced by farmers from the time of planting the seed up to the harvest for each crop. Then, the IPM Innovation Lab develops non-chemical pesticide technologies and

integrates them into an IPM package for the selected crops. Farmers can choose crop solutions in the package based on their needs, conditions, and resources. To scale up these technologies in developing countries, a variety of venues are used to disseminate the information, including involvement and relationships with of extension services, value chain projects, agricultural input providers, and NGOs, and inclusion of print and electronic media. In recent years, much attention has been paid for tackling invasive pests and integrating their management techniques with the existing IPM packages.

1:30

12.2 • IPM packages for chickpea in Ethiopia, Tadele Tefera, ttefera@icipe.org, International Centre of Insect Physiology and Ecology (ICIPE), Addis Ababa, Ethiopia; Tarekegn Fite, International Centre of Insect Physiology and Ecology (ICIPE), Addis Ababa, Ethiopia and School of Plant Sciences, College of Agriculture and Environmental Sciences, Haramaya University, Dire Dhawa, Ethiopia

Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae), is a destructive pest of chickpea that has proven difficult to control using conventional methods. We evaluated botrack lure with funnel type efficient and specific pheromone trap for *H. armigera*. Population build up starts in September and climbing up for the highest peak during February. Besides, we identified five species of hymenopteran and dipteran larval parasitoids on *H. armigera* in chickpea. Moreover, we developed a management options including botanicals (*Azadirachta indica* and *Milletia ferruginea*) extracts and bio-pesticides (*Beauveria bassiana, Metarhizium anisopliae* and *Bacillus thurengiensis)* for the management of *H. armigera* under field conditions. Selective and low dose synthetic insecticides can be used at peak time followed by bio-pesticides and botanical extracts.

1:45

12.3 • IPM package for Longan [*Dimocarpus longan* (Sapindaceae)], Anamika Sharma, anamika.sharma@FAMU.EDU, Department of Entomology, Florida A&M University, Tallahassee, FL; Hanh Tran, Hoa Nguyen Van, Plant Protection Division, Southern Horticultural Research Institute, My Tho city, Tien Giang, Vietnam; Rangaswamy Muniappan, Integrated Pest Management Innovation Lab, Virginia Tech, Blacksburg, VA

Longan (*Dimocarpus longan*) produces an edible fruit similar to the lychee (*Litchi chinensis*). It is native to tropical Asia and is currently grown in Asia, Africa, the USA, and Australia. Longan naturally grows in tropical conditions, in well-drained rich and sandy loam soils. Major abiotic stresses for this crop include salinity, flooding, and cold temperatures. Major biotic stresses include witches broom syndrome which can cause more than 80% yield loss. Diseases such as anthracnose [*Colletotrichum gloeosporioides,* ceratocystis blight (*Ceratocystis fimbriata*), fruit rot (*Phytophthora palmivora*), insect pests *viz*. fruit borer (*Conogethes punctiferalis*), fruit and shoot borers (*Conopomorpha sinensis*, *Conopomorpha litchiella*), fruit piercing moth (*Eudocima phalonia*), and mite (*Eriophyes dimocarpi*) pose a major problem to the crop. To manage diseases, arthropod pests, and weeds, cultural and biological practices are used including mulching, fruit bagging, canopy management, pruning, light and pheromone traps, application of entomopathogenic fungus such as, *Beauveria bassiana*, *Paecilomyces* sp., *Metarhizium* sp., spraying sulfur, neem oil, and petroleum oil.

2:00

12.4 • Ecologically-based IPM package for rice in Cambodia: Results and status of adoption, Virender Kumar, virender.kumar@irri.org, International Rice Research Institute, IRRI-Los Baños, Laguna, Philippines; Ricardo Oliva, Nancy Castilla, International Rice Research Institute, IRRI-Los Baños, Laguna, Philippines; Rica Joy Flor, Rathmuny Then, Akhara Ouk, Sokheng Keo, International Rice Research Institute, IRRI-Cambodia Office, Phnom Penh, Cambodia; Khay Sathya, Cambodian Agricultural Research and Development Institute, Phnom Penh, Cambodia; Chou Cheythyrith, General Directorate of Agriculture, Phnom Penh, Cambodia; Alexander Stuart, Pesticide Action Network, Brighton, UK; Buyung Hadi, Food and Agriculture Organization of the United Nations, Rome, Italy

Cambodian rice farmers overuse pesticides, and it continues to be the dominant rice pest management regime in the country. This persistent problem calls for fresh thinking on how rice IPM should be validated and mainstreamed. Through "Developing Ecologically-based Participatory IPM strategy for rice in Cambodia (EPIC)", a USAID-funded project in Cambodia, we conducted a number of studies validating integrated pest management (IPM) tactics against multiple biotic stresses. The studies also attempt to tease out the intricacies of policy and stakeholder interactions to formulate a scaling strategy. A wide range of tactics were tested including resistant variety, microbials and botanicals, trap barrier system, integration of pre- and post-emergence herbicides at right time, and better bet agronomy such as good land preparation and leveling, and use of mechanized seeder for line sowing to ensure regular crop geometry and low seed rate for insect-pest, disease, weed and rodent management. These tactics were shown to be at least as efficacious as the current farmers' practice of pesticide reliance.

2:15

12.5 • IPM Training for Vegetable Farmers in Mozambique, Surendra K. Dara, skdara@ucanr.edu, University of California Cooperative Extension, San Luis Obispo, CA

A group of Mozambican farmers that grow a variety of vegetables in small holdings near the town of Gondola in the western part of the country were trained in IPM in August 2019. This training was provided through the USAID-funded Farmer-to-Farmer program to improve the farmers' understanding of effective and safe pest management to reduce crop losses and increase returns. During this 10-day training, farmers were trained in various good agricultural practices that included both crop production and protection aspects using the new IPM model. They demonstrated a very high level of enthusiasm and understanding of all aspects of the new IPM model. Although they could not take any notes, they remembered everything that was taught and answered every question throughout the training period. Information gathered through the interpreter earlier this year indicated that these farmers applied many relevant parts of their training to improve their crop production and pest management efficiencies. They indicated improvements in planting, monitoring crop health, and irrigation and pest management practices. They collaborated with each other in developing approaches that benefited everyone. Among several international research and outreach programs I have been involved, I consider this as the best example to demonstrate the potential of farmers to learn and implement new approaches and realize positive results.

13 • Early Career Researchers in IPM: Balancing Work, Life, and Everything In Between

Plaza Ballroom ABC

This session will celebrate the IPM research of Early Career Researchers (ECR, those within roughly the first 5 years after terminal degree) while also recognizing the unique challenges that come with the position. We will show case how ECRs are contributing to innovations in IPM across different disciplines while tackling both life and a career. This session will show the large diversity of innovative IPM research and communication strategies across plant pathology, weed science, and entomology. Presentations will highlight the challenges and opportunities that come with being an early career scientist, and foster important discussions on surviving and thriving early in your career.

Organizers: Katelyn Kesheimer, kesheimer@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL; Ashley Leach, leach.379@osu.edu, Entomology Department, Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH; Lorena Lopez, lorelopezq257@vt.edu, Department of Entomology, Virginia Tech, Blacksburg, VA; Robert Morrison, william.robert.morrison@gmail.com, Stored Product Insects and Engineering Research Unit, USDA-ARS Center for Grain and Animal Health Research, Manhattan, KS

1:15

13.1 • AWaRe: Communicating risk factors associated with wheat streak mosaic disease in the Northern Great Plains through the interactive learning tool AWaRe, Uta McKelvy, uta.mckelvy@montana.edu, Department of Plant Science and Plant Pathology, Montana State University, Bozeman, MT; Mary Burrows, Department of Plant Science and Plant Pathology, Montana State University, Bozeman, MT

Wheat streak mosaic (WSM) is a persistent, wheat curl mite-transmitted virus disease of wheat that causes sporadic epidemics in the Northern Great Plains. Its complex disease dynamics are challenging for growers to dissect and translate into effective management practices. Here we present AWaRe, Assessment of Wheat streak mosaic Risk. AWaRe is a unique, interactive learning tool that dissects the individual and combined effects of key factors driving WSM risk in the Northern Great Plains through specific and applied questions. The tool was designed for wheat growers, extension agents, and industry professionals and is available online at http://plantpath.msuextension.org/resources/index.html#plant-path-tools.

1:30

13.2 • Perennial grass weed infestations within perennial grass forage systems, Zachary Howard, zachary.howard@ag.tamu.edu, Texas A&M AgriLife, College Station, TX

Perennial grass weed infestations within perennial grass forage systems present a serious challenge to many hay and pasture system managers across the southern United States. Smutgrass *(Sporobolus indicus*) is problematic due to its poor palatability to cattle and its difficulty to control once established. The Extension Weed Science program at Texas A&M University began research trials to gain a better understanding of how to control this weed. Research efforts are being made to better understand how to use the currently recommended herbicide for control (hexazinone), evaluate additional herbicide options, and how to use site specific weed management by identification and herbicide application through UAS (unmanned ariel system). This

presentation outlines past, current, and future research being conducted by Texas A&M Extension Weed Science and collaborators across the state, with a look at the current state of our knowledge of this plant, and how our approach to assisting ranchers through the AgriLife Extension service has been altered as we continue research.

1:45

13.3 • Transdisciplinary management of invasive vascular wilt pathogens: From the Colombian Pacific coast to Michigan in the US, Pedro Pablo Parra, parragir@msu.edu, Department of Plant, Soil and Microbial Sciences, Michigan State University, East Lansing, MI; Bernhard Löhr, Independent Palm Specialist, Germany; Romina Gazis, Tropical Research & Education Center, Department of Plant Pathology, University of Florida, Homestead, FL; Karan Chahal, Department of Plant, Soil and Microbial Sciences, Michigan State University, East Lansing, MI; Monique L. Sakalidis, Department of Plant, Soil and Microbial Sciences and Department of Forestry, Michigan State University, East Lansing, MI

Widespread and rapid mortality due to the infection and spread of invasive vascular wilt pathogens are devastating plant populations in natural and agricultural ecosystems worldwide. To mitigate their impact, robust integrated management programs focused on reducing the spread and rapid containment or eradication are critical. Here we will discuss advantages and limitations of alternative methods for mechanical root disruption and the use of prophylactic treatments against the oak wilt in Michigan; rapid diagnostic protocols to stop the spread of laurel wilt in Florida; and educational campaigns to mitigate the impact of the red ring disease in coconut plantations in Colombia.

2:00

13.4 • A year of firsts: My experiences as a new mom and postdoc, Ashley Leach, leach.379@osu.edu, Entomology Department, Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH

Never has the importance and significance of work/life balance been more apparent than during my first year as a mom. My son was born in July 2020, right in the middle of my first field season as a postdoctoral scientist. My first 3 months postpartum were difficult, I was pushed to my physical, emotional, professional limits. After reaching out to other new and expecting moms (many of them fellow researchers), I realized that my experience was not unique. In many ways, my challenges mimicked those before me, but I was surprised that I heard so little until I became a mom myself. In this presentation, I will detail my experiences as a new and expectant mom, review recent trends in modern family dynamics (times are changing!), and finally discuss what tactics helped limit my stress. It's not easy, but it's fun.

2:15

13.5 • Fostering a sense of togetherness and balance among your mentees and yourself in the lab starting from the ground up, Robert Morrison, william.robert.morrison@gmail.com, Stored Product Insects and Engineering Research Unit, USDA-ARS Center for Grain and Animal Health Research, Manhattan, KS

Integral to having a productive career and lab is having a sense of balance and feeling like you and your mentees are all collectively working towards common goals. More important than the quantity of work by you or your mentees is working more efficiently to accomplish what you need to in less time, and dedicating the extra time to activities that build a sense of comradery among your lab. Two other key concepts are open and frequent communication with your mentees, as well as sticking to firm boundaries with your own work-life balance to preserve your mental health as PI.

2:30

13.6 • Navigating grants, fellowships and funds in academia, Priyadarshini Chakrabarti, pb1090@msstate.edu, Department of Biochemistry, Molecular Biology, Entomology and Plant Pathology, Oregon State University and Mississippi State University, Mississippi State, MS

As an Early Career Professional, it is important to be able to secure research funding as a testament of supporting independent research. It is important that we strategize and think ahead. As an immigrant post doc or ABD graduate student, the options may seem even more limited. This talk will focus on recognizing and understanding the various avenues of funding and how to utilize these resources.

14 • Meeting the IPM Needs of Urban Growers

Plaza Ballroom D

Diverse audiences are finding their way back to farms in innovative ways, increasing the number of vegetable and fruit farms in peri-urban and urban environments including for-profit farms, community gardens, and school gardens. This growth is often in response to food security challenges, which have increased in relation to COVID 19, especially among economically challenged populations. Retired

professionals, impoverished communities, schools and churches, and millennials are growing their own food. The goal of our symposium is to highlight the unique conditions under which food is being produced in urban environments and the unique challenges associated with developing and disseminating IPM resources. Research is just beginning to uncover the unique pest challenges and management solutions experienced in urban production settings. Furthermore, much of the population that is growing in urban environments are not familiar with or historically served by Extension services. This includes new and beginning farmers, non-English speakers, BIPOC communities or those living at or below the poverty level. Participants are often coming to the farm or garden without baseline experience with specialty crop production and/or associated pest management tools, creating new opportunities for IPM engagement. As this need has emerged, Extension Educators and research faculty have developed innovative programs, intensive approaches, and IPM research to meet the needs of urban agriculture communities. The session will provide the opportunity to share new resources, programs and strategies for the creation and delivering of IPM tools tailored to urban food production.

Organizers: Laura L. Ingwell, lingwell@purdue.edu, Entomology, Purdue University, West Lafayette, IN; Jacqueline A. Kowalski, jacqueline.kowalski@uconn.edu, University of Connecticut Extension-Fairfield County, Bethel, CT

1:15

14.1 • Meeting the needs of urban growers, Jacqueline A. Kowalski, jacqueline.kowalski@uconn.edu, University of Connecticut Extension-Fairfield County, Bethel, CT

The session was organized to share work that is taking place in urban agriculture to meet the IPM needs of urban growers. We will share different perspectives, approaches, and strategies.

1:20

14.2 • Understanding the goals and needs of Urban Farms in the Midwest: Results from a needs assessment survey in Indiana, Laura L. Ingwell, lingwell@purdue.edu, Entomology, Purdue University, West Lafayette, IN; Nathan Shoaf, Urban Agriculture State Coordinator, Extension, Purdue University

To address the production challenges experienced by urban farmers we need to understand their community and culture. This includes the major crops being produced and pests attacking them in addition to the broader goals of the farm and the tools they have available and are willing to use to help achieve these goals. Is it the same as conventional or rural farmers? In this presentation, we will share what we have learned through a series of roundtable discussions and a formal needs assessment. I will discuss how we are moving forward with tailoring our programs for Urban Agriculture.

1:32

14.3 • Observations on promoting IPM in urban agriculture, Marissa Schuh, mschuh@umn.edu, Extension, University of Minnesota, Minneapolis, MN

Needs assessments across states tell us that growers in urban areas want information on pests and practices to deal with them. However, the combination of growing practices and farm structure make the application of IPM difficult. This session will cover experiences in urban vegetable production in Michigan and Minnesota, highlighting how across the midwest, organic production goals run up against the reality of land history, personnel changes, and niche crops.

1:44

14.4 • University of Missouri Extension and Springfield Community Gardens—A productive IPM partnership, Patrick L. Byers, byerspl@missouri.edu, Extension, University of Missouri, Marshfield, MO

Springfield Community Gardens (SCG), a nonprofit organization in urban Greene County, MO, coordinates a farmer incubator program, 17 community gardens, and a hospital farm. From 2018-date University of Missouri Extension partnered with SCG, offering a wide range of programming targeting SCG staff, beginning and established urban farmers, and the general public. A primary programming focus is urban IPM. Impact included over 250 attendees at 12 beginning farmer IPM workshops; 5 professional development IPM workshops for SCG staff; 4 IPM modules in an 18-module beginning farmer curriculum; and over 30 individual IPM consultations at SCG sites.

1:56

14.5 • Utilizing Integrated Pest and Pollinator Management Strategies to Improve Pollinator Habitats and Plant Production and Urban Gardens. Jennifer B. Noseworthy, Jennifer.Noseworthy@indwes.edu, Biology, Indiana Wesleyan University, Marion, IN; Laura L. Ingwell and Brock Harpur, Purdue University

Pollinator species are in decline, particularly in the Midwest. Development of native pollinator gardens are thought to bolster local pollinator communities. Little evidence exists for this effect in Midwestern urban settings. Additionally, insect pest outbreaks are common among urban gardens due to habitat fragmentation and disruption. Utilizing Integrated Pest Management strategies, insect pests and

pollinators were identified and monitored among eight urban gardens within Grant County. Four gardens were selected to introduce pollinator gardens plots featuring native pollinator plants. Little data exists on how these IPM strategies impact pest populations and what impact interactions between native pollinators and insect pests have in these settings.

2:08

14.6 • Vegetable grafting for the urban grower, Margaret Lloyd, mglloyd@ucanr.edu, Extension, University of California, Woodland, CA

The use of grafted vegetables is growing. For the urban producer, grafted vegetables can be an effective pest management strategy for soilborne pathogens and nematodes.

2:20

14.7 • Supporting Pest Management Needs of Urban Farmers in California, Karey Windbiel-Rojas, kwindbiel@ucanr.edu, Statewide Integrated Pest Management Program (UC IPM), University of California Agriculture and Natural Resources, Davis, CA

Urban agriculture is practiced by a diverse population who might participate in community gardens, very small production farms, or anyone who grows vegetables, ornamentals, fruit, herbs, or other such products in an urbanized setting. To assist these smaller-scale and often organic farmers and gardeners, the University of California Statewide Integrated Pest Management Program (UC IPM) maintains information on nearly 1000 pests and how to manage them with or without the use of pesticides, as well as resources on beneficial insects, environmental practices to support plant health while protecting water quality, human health, and the environment.

15 • IPM Award Winner Stories

Governor's Square 15

This symposium session will highlight the work of some of the IPM Achievement Award winners. You will hear about handling change in the pest management industry, controlling a pest in California nut production, IPM programs in Oklahoma, and applying Extension to urban pest control.

Organizer: Shaku Nair, nairs@email.arizona.edu, University of Arizona-MAC, Maricopa, AZ

3:00

15.1 • Oklahoma! IPM Oklahoma! EIP Programs "Near and Far", Tom A. Royer, tom.royer@okstate.edu, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater, OK

IPM Oklahoma! http://entoplp.okstate.edu/ipm/ works with a multi-disciplined group of qualified, experienced research and extension faculty and staff to provide educational programs dedicated to IPM delivery and adoption. Oklahoma's agriculture economy is worth $6.1 billion annually. More than 59% of Oklahoma's 3.72 million people live within the metropolitan areas of Oklahoma City and Tulsa (29th and 46th largest cities in the U.S respectively). Oklahoma is also home to 38 federally recognized Native American tribes, who make up 9% of Oklahoma's population. This presentation will highlight some of the historical and current IPM projects that impact Oklahoma stakeholders.

3:20

15.2 • Extension to Urban IPM Clientele: Why are low-hanging fruit so difficult to pick? Andrew M. Sutherland, amsutherland@ucanr.edu, University of California Cooperative Extension, Hayward, CA

Urban pest control is a consumer-driven service industry too often characterized by very low thresholds, reactive programs, underutilization of preventive tactics, reliance on chemical tactics, and widespread ignorance or apathy regarding the principles of integrated pest management. Extension to urban pest management professionals (PMPs), who often view regular pesticide applications as crucial service offerings, can be very challenging but also extremely impactful. Significant increases in knowledge, changes in industry-standard practices, and positive community-level impacts can be realized when extension programs help PMPs adapt and evolve in a changing marketplace and offer solutions and opportunities rather than restrictions and admonitions.

3:40

15.3 • Paradigm Shift, Change Management, Frank Meek, fmeek@rollins.com, Rollins, Inc., Atlanta, GA

Change. The word itself scares a lot of people. Change requires planning, persistence, determination, discomfort, but most of all a purpose. In the pest management business, change is one of the constants. Educating and convincing the service providers is only one aspect of embracing change. Educating and convincing the clients is often much more difficult. In this talk, we will discuss the efforts to change

service approaches towards IPM based solutions, having to change client perception, acceptance and in some cases cultural norms. Along with that, the challenge of a consistent understanding of the meaning of IPM.

4:00

15.4 • Team Efforts Foster Adoption of Mating Disruption for Navel Orangeworm in California, David Haviland, dhaviland@ucanr.edu, University of California Cooperative Extension-Kern County, Bakersfield, CA; Jhalendra Rijal, Emily Symmes, Brad Higbee

During the past decade a group of public and private researchers, regulatory agencies, manufacturers, commodity boards, and industry representatives formed a team to drive the adoption of mating disruption for navel orangeworm in California almonds and pistachios. Large-scale on-farm research focused on product efficacy and predictability of results, coupled with economic data on return on investment. Following extensive extension efforts, mating disruption adoption has increased annually to approximately 160,000 hectares (45 million trees). Each year, mating disruption reduces crop losses by approximately 5 million pounds, meaning that approximately 1.7 billion kernels each year are eaten by people instead of worms.

16 • Minimizing Disease and Weed Impacts on Pumpkin and Squash

Plaza Ballroom F

Pumpkins are iconic fruiting vegetables grown mostly for fall ornamental use in both the U.S. and Canada, with over 70K acres planted annually between the two countries. Unfortunately, pumpkin is a host of several damaging diseases and like other cultivated crops, is in constant competition with weeds from seeding through harvest. This session will cover recent work on bacterial diseases of pumpkin and squash with a review of current best practices based on field and lab research conducted at the University of Guelph–Ridgetown campus. Management options include chemical controls, varietal tolerance and potential seed disinfestation strategies. Next, we move to explore the limited herbicide options in pumpkin given that product registration often varies by state. Fomesafen (Reflex) and expanded S-metolachlor (Dual Magnum) use may have a fit in current pumpkin production systems but will require local crop safety data. This presentation will cover the weed science challenges of growing pumpkins, current research efforts and how to integrate herbicides into a broader weed management program inclusive of biological and mechanical weed control. Lastly, we will review the cultural practice of using a mustard cover crop as a biofumigant to reduce an expanding soil borne disease in pumpkin, Plectosporium blight. The process and results of two years of data generated at a research station plus one year of on-farm strip trial results will be discussed, including potential soil health and pollinator habitat benefits.

Organizer: James Jasinski, jasinski.4@osu.edu, Extension, Ohio State University, Urbana, OH

3:00

16.1 • Three Approaches to Managing Bacterial Leaf Spot of Pumpkins and Squash, Elaine Roddy, elaine.roddy@ontario.ca, Agriculture Development Branch, Ontario Ministry of Agriculture, Food and Rural Affairs, Ridgetown, ON, Canada

Pumpkins are iconic fruiting vegetables grown mostly for fall ornamental use in both the US and Canada, with over 70K acres planted annually between the two countries. Unfortunately, pumpkin is a host of several damaging diseases and like other cultivated crops, is in constant competition with weeds from seeding through harvest. This presentation will cover recent work on bacterial diseases of pumpkin and squash with a review of current best practices based on field and lab research conducted at the University of Guelph–Ridgetown campus. Management options include chemical controls, varietal tolerance and potential seed disinfestation strategies.

3:25

16.2 • Integrated Weed Management in Pumpkin—Opportunities and Challenges, Stephen Meyers, slmeyers@purdue.edu, Department of Horticulture and Landscape Architecture, Purdue University, West LaFayette, IN

Pumpkins are iconic fruiting vegetables grown mostly for fall ornamental use in both the US and Canada, with over 70K acres planted annually between the two countries. This presentation will explore the limited herbicide options in pumpkin given that product registration often varies by state. Fomesafen (Reflex) and expanded S-metolachlor (Dual Magnum) use may have a fit in current pumpkin production systems but will require local crop safety data. Current research efforts and integration of herbicides into a broader weed management program inclusive of biological and mechanical weed control will also be covered.

3:50

16.3 • Using Mustard Cover Crops as a Biofumigant to Manage Plectosporium Blight on Pumpkin, James Jasinski, jasinski.4@osu.edu, Extension, Ohio State University, Urbana, OH

Pumpkins are iconic fruiting vegetables grown mostly for fall ornamental use in both the US and Canada, with over 70K acres planted annually between the two countries. In this presentation we will review the cultural practice of using a mustard cover crop as a biofumigant instead of conventional fungicides to reduce a regionally expanding soil borne disease in pumpkin, Plectosporium blight. The biofumigation process and results of two years of research station data plus one year of on-farm strip trial results will be discussed, including potential soil health and pollinator habitat benefits.

17 • Global Challenges: Roundtable Discussion on IPM in Developing Countries

Governor's Square 14

In developed countries, the pyramid of different components of IPM has been turned upside down due to the emerging issue of pesticide resistance. Meanwhile, IPM in developing countries is still at its infancy and addresses basic components of IPM listed at the base of the pyramid. There is a certain degree of skepticism concerning adoption of IPM in both developed and developing countries mostly due to lack of understanding or misinterpretation. The term "pest" in IPM, for example, encompasses arthropod pests, diseases and weeds. However, many books written on IPM by entomologists addresses only arthropod pests and not diseases, and vice versa with plant pathologists. There are even publications written for development of IPM for a particular pest—missing the fundamental concept that IPM is for a crop. In this roundtable discussion, international scientists from developing countries will discuss the status of IPM in their countries, giving an opportunity to share accurate and current development of its adoption.

Organizers: Jhalendra Rijal, jrijal@ucdavis.edu, University of California Agriculture and Natural Resources & Statewide IPM Program, Modesto, CA; Rangaswamy (Muni) Muniappan, rmuni@vt.edu, IPM Innovation Lab, Virginia Tech, Blacksburg, VA

3:00

17.1 • Roundtable Discussion on IPM in Developing Countries

18 • Growing Big Trees from Small Seeds

Plaza Ballroom ABC

One of the missions of Regional IPM Centers is to promote and amplify IPM activities and personnel on a regional and national level. The primary mechanism used to accomplish this mission is by funding Working Groups. With funding of $20,000 a year, or less, these groups have been able to increase the productivity of their members, collaborate on multi-million-dollar grants, reduce duplication of efforts by sharing resources and presentations, etc. These Working Groups have clearly accomplished the mission of amplifying IPM activities and each one has gone about this a little differently. Some Working Groups have been in existence for many years, and some for a short time. Some Working Groups continue meeting even though they no longer request funding. They have seen the benefit of networking, collaboration, using the listserv to diagnose problems, and hearing what others in the group are working on each year. The Working Groups membership crosses many state and country boundaries, along with being cross discipline. At this session, Working Group leaders will discuss how their group has been successful at working with non-traditional audiences; using listservs to diagnose plant problems quickly (saving growers/producers money); producing webinars and on-line classes; networking outcomes (products, grants, etc.); using new initiatives to work with new audiences; using international expertise to serve the needs of small acreage/minor crops; and how outputs have been used by other groups and countries. Attendees will learn how each Working Group successfully (or less successfully) was able to work together to increase IPM adoption.

Organizers: Laura Iles, ljesse@iastate.edu, North Central IPM Center, Ames, IA; Lynnae Jess, jess@msu.edu, North Central IPM Center, East Lansing, MI

3:00

18.1 • Introduction to the session: Growing Big Trees from Small Seeds, Lynnae Jess and Laura Iles

A short introduction to the North Central IPM Center and the history of funding working groups in our region.

3:05

18.2 • Great Lakes Urban Agriculture IPM Working Group, Jacqueline A. Kowalski, jacqueline.kowalski@uconn.edu, University of Connecticut Extension-Fairfield County, Bethel, CT

Urban agriculture continues to grow to address food insecurity, economic and community development, and land reuse. The urban agriculture community is diverse and often consists of historically underserved audiences. The North Central Great Lakes Urban Agriculture IPM Working Group was formed to identify the needs of urban growers, to develop resources to increase food production, implement the IPM roadmap, and develop a network of extension, urban growers, and other urban agriculture practitioners to better serve this growing audience.

3:12

18.3 • Do most with mess, Ben Phillips, phill406@msu.edu, Extension, Michigan State University, East Lansing, MI

University Extension admins across the country ask us to do more with less, do more with more, and other variations of the phrase. Here is how the vegetable people in Midwest and Great Lakes region worked together to do the most with that mess.

3:19

18.4 • Rights-of-Ways as Habitat| Collaborative Conservation in Practice, Caroline Hernandez, cah272@uic.edu, Energy Resources Center, University of Illinois-Chicago, Chicago, IL

The Rights-of-Way as Habitat Working Group supports energy companies and transportation agencies in the creation and conservation of pollinator habitat on rights-of-way and working lands. This presentation will cover how the Rights-of-Way as Habitat Working Group engages participants through collaborative initiatives to create tools, share resources, and educate on habitat-oriented best management practices.

3:26

18.5 • Great Lakes Fruit: Maintaining connections to the past so that we can make the most of the future, Julianna Wilson, jkwilson@msu.edu, Entomology, Michigan State University, East Lansing, MI

Common regional challenges and opportunities in fruit systems are shared across disciplines in this group that first met officially in 1996. Through an active listserv and an annual in-person meeting, the newer members of the group can tap into institutional knowledge from veteran colleagues—propelling the work of fruit researchers and extension practitioners forward.

3:33

18.6 • Public gardens as sentinels against invasive horticultural plants, Kurt Dreisilker, kdreisilker@mortonarb.org, Morton Arboretum, Lisle, IL; Theresa Culley, University of Cincinnati; Clair Ryan. Midwest Invasive Plant Network

North American botanic gardens and arboreta are pulling together to track and share standardized data about plants escaping from their gardens and collections. This new public garden focus has tremendous potential to inform invasive plant councils, horticulture industry, propagators, landscape architects, and others about escaping cultivated plants. Ultimately this initiative can help prevent problematic species from becoming invasive.

3:40

18.7 • The Pulse Crops Working Group: Advancing Stakeholder Research Priorities and Increasing IPM adoption, Audrey Kalil, audrey.kalil@ndsu.edu, Williston Research Extension Center, North Dakota State University, Williston, ND; Mary Burrows, Montana State University

Pulse crops are legumes which are harvested as a grain and include dry edible pea, lentil, and chickpea. These are healthful food choices and vital components of cropping systems in semi-arid regions of the US Great Plains and Pacific Northwest. Pulse crops have replaced fallow in wheat cropping systems, which has been an economic boon to rural communities. However, these crops also bring new and challenging disease and pest problems. The Pulse Crops Working Group fosters relationships among researchers and stakeholders through in-person and virtual meetings to address IPM priorities via development of outreach materials and research prioritization.

3:47

18.8 • The Midwest Grows Green Lawn & Land Forum, Ryan Anderson, randerson@ipminstitute.org, Community IPM, IPM Institute of North America, Madison, WI

Anderson explains how NCIPM funding has helped Midwest Grows Green and its working group identify, teach and implement sustainable landscaping.

3:54

18.9 • Sunflower Pathology Working Group, Tom Gulya, tjgulya@gmail.com, USDA-ARS (retired), Santa Rosa, CA; Samuel Markell, North Dakota State University

The Sunflower Pathology Working Group (SPWG) consists of seven scientists from five US states (ND, SD, IA, NE, CA) and from Queensland, Australia. The SPWG was formed to address the underserved pathology needs of the sunflower crop and industry. Our mission is to help sunflower growers better identify diseases and improve their ability to use IPM. We strive to do this by developing and delivering reference and extension materials in formats understandable and available to both a domestic and international audience that consists of agricultural industry personal, farmers and homeowners. Our output mediums range from traditional (such as the APS Compendium of Sunflower Diseases, book chapters, journal articles and extension publications), to less-traditional, such as pocket-sized "diagnostic cards" and decks of disease playing cards. We multiply our messaging by working closely with the U.S. National Sunflower Association (NSA), the agrochemical industry supporting sunflower and the agricultural media. These partnerships have led to activities that increase both local and global reach of SPWG information, which range from enhanced disease pages of the NSA website that supports local needs, to translation of SPWG materials into other languages, and to delivery of international trainings to sunflower growers and the industry staff who support them.

19 • Beyond CEUs: Developing Hands-on, Impact-Driven Programs for Structural Pest Management Applicator Education

Plaza Ballroom D

Structural pest management applicators operate under state and federal regulations to legally apply pesticides where people live, work, learn, play, or worship. In many states, applicators receive basic classroom training and pass an exam to become certified. Subsequently, continuing education is often lecture-based, conforming to criteria established by state regulatory agencies. But does classroom learning lead to knowledge gain, adoption of best practices and skills improvement in the field? Surveys say: No! Evidence suggests that applicator knowledge and performance are improved by hands-on training, where participants learn and demonstrate techniques. This session is designed to challenge the convention of lecture-based training for pesticide applicators and offer alternative continuing education programs that are outcome- and impact-driven. We will explore training needs from the perspective of consumers that pay for professional pest management, and outcomes for applicators that participate in trainings. Presentations will discuss meaningful metrics used to demonstrate applicator knowledge gain, and challenges and opportunities for developing hands-on educational programs. Session attendees will learn about the materials, resources and time needed to develop impactful hands-on programs.

Organizer: Matthew Frye, mjf267@cornell.edu, New York State IPM Program, Cornell University, Carmel, NY

3:00

19.1 • Welcome and Introduction to Session, Matthew Frye, mjf267@cornell.edu, New York State IPM Program, Cornell University, Carmel, NY

3:05

19.2 • The National Pesticide Information Center: What concerns the public about pest professionals? Kaci Buhl, buhlk@ace.orst.edu, Pesticide Safety Education Program, Oregon State University, National Pesticide Information Center [National], Pesticide Educational Resources Collaborative [National], Corvallis, OR

The National Pesticide Information Center helps people make informed decisions about pesticide use by providing unbiased, science-based information. One of the many objectives of their program is to collect pesticide incident data, which can result from product misapplications. In this presentation, participants will learn about public perceptions of pesticide applicators, including concerns about pesticide safety, formulations, and improper applications. These topics highlight the importance of applicator training, which is intended to minimize risks associated with pest management techniques.

3:25

19.3 • Educational accountability and the 10,000 hour rule? Faith Oi, foi@ufl.edu, Entomology and Nematology Department, University of Florida, Gainesville, FL

In many states across the US, lecture-based classroom education is required before a person can take an exam to become a pesticide applicator. After a license is issued, continuing education credits are required to maintain that license. But does classroom learning lead to knowledge gain, adoption of best practices and skills improvement in the field to help applicators minimize risks associated with pesticide use? This presentation will explore the limitations

of lecture-based education, highlight knowledge gains and satisfaction associated with hands-on learning, as well as challenge us collectively to develop experts within our clientele groups.

3:50

19.4 • Creating a pest house for hands-on applicator training, Janet Hurley, jahurley@ag.tamu.edu, Department of Entomology–IPM Program, Texas A&M AgriLife Extension Service, Dallas, TX

Hands-on experience houses are training facilities that provide pest professionals with the opportunity to learn and practice skills and techniques. A handful of training facilities are distributed across the US, mostly associated with university extension programs. This presentation will discuss the steps needed to create a hands-on experience house for applicator training, and address questions about who funds the facility, who provides training, and how are classes structured and scheduled.

4:05

19.5 • Incentivizing hands-on training with the Master Pest Control Technician certification designation, Eric Benson, ebenson@clemson.edu, Plant and Environmental Sciences Department, Clemson University, Clemson, SC

Obtaining recertification credits to maintain a pesticide license is often the key motivating factor for pest professionals to attend training events. With credits as the motivating factor, however, it may be difficult to engage participants in ways that lead to acquisition of new knowledge and behavior change. On the other hand, certification programs that elevate the status of an individual or company can also motivate applicators to attend training events, and offer an opportunity to raise the expectations of applicator knowledge. This presentation will highlight the value of certification programs in attracting applicators to hands-on training courses.

4:20

19.6 • Questions/Closing remarks

20 • Beyond the Field and Into the Community

Plaza Ballroom ABC

This mini-symposium will look at non-agricultural applications of Integrated Pest Management (IPM), including IPM for pests in the built-environment, medical, veterinary, and public health issues, and adoption of IPM practices in community environments. While IPM philosophy began in agricultural settings, progressive practices in and around the built environment have surpassed the original fundamentals. Rodent and arthropod related vector impacts continue to increase in many countries, and recognition that the health of people is inherently connected to the health of animals and the environment is a driving force behind the adoption of a One Health approach in community environments. Pests such as cockroaches and mice are asthma triggers as well as pathogen carriers, and research suggests that other pests including bed bugs, have significant negative health impacts. Pests can trigger mental and behavioral health issues, including anxiety, depression, sleep, hoarding disorders, and delusory parasitosis. Overuse and misuse of pesticides remains a challenge, but novel chemistries and safer delivery systems are entering the market. As increasing levels of healthcare are embedded in social support systems, pest management is increasingly accepted as a critically important element in the support of healthy communities. Since pests typically present the greatest problems in low-income and other marginalized populations, health equity or environmental justice issues arise. In this mini symposium, we will address current trends in stakeholder needs, vulnerabilities, and attitudes towards these issues, and highlight research and Extension efforts in these areas.

Organizers: Dawn H. Gouge, dhgouge@email.arizona.edu, University of Arizona-MAC, Maricopa, AZ; Shaku Nair, nairs@email.arizona.edu, University of Arizona-MAC, Maricopa, AZ

8:30

20.1 • Introduction, Shaku Nair

8:35

20.2 • Communicating IPM to Urban & Community Audiences, Karey Windbiel-Rojas, kwindbiel@ucanr.edu, Statewide Integrated Pest Management Program, University of California, Davis, CA

Communicating information about pests and pesticide to urban and community audiences can be challenging. Differences in culture, ethnicity, education, and other demographics shape people's attitudes and practices regarding the control of pests. How to effectively communicate science-based information often varies greatly between experienced gardeners, point-of-sale businesses such as retail garden centers, service industries such as landscapers and pest control operators, municipal employees, landlords and housing managers, and the general public. Added to the challenge of how to reach this wide array of people, is the ever-growing mistrust

of the media, scientists, and government agencies. This presentation will discuss some of the concepts and needs in addressing potential obstacles.

9:05

20.3 • Reducing pests, insecticide residues, and cockroach allergens in low-income communities through the adoption of IPM, Changlu Wang, changluw@rutgers.edu, Department of Entomology, Rutgers University, The State University of New Jersey, New Brunswick, NJ

Pest management is increasingly accepted as a critically important element in the support of healthy communities. Since pests typically present the greatest problems in low-income and other marginalized populations, health equity or environmental justice issues arise. Cockroaches and bed bugs are two of the common indoor pests found in homes. Control of these pests usually involve frequent insecticide applications by residents and by contracted pest control providers. Cockroaches produce allergens. Frequent insecticide applications leave residues in the indoor environment. IPM is a more effective pest management strategy, but rarely practiced for managing indoor pests. In a 12-month long study, we evaluated the effectiveness of a building-wide IPM program for reducing cockroaches and bed bugs, insecticide residues and cockroach allergen levels. Bed bug and cockroach infestation rates decreased by 63 and 75%, respectively. The geometric mean cockroach allergen (Bla g 1 and Bla g 2) concentrations were reduced by > 90%. The mean insecticide residue concentration per apartment decreased by 74%. IPM is an effective strategy for reducing pests, cockroach allergens, and indoor insecticide residues.

9:35

20.4 • Using pest biology and assessment-based management to reduce the use of chemical pesticides and manage insecticide resistance in bed bug control, Nina Ellen Jenkins, nej2@psu.edu, Department of Entomology, Penn State University, University Park, PA

Bed bugs are among the most difficult pests to eradicate in an urban environment. Their prevalence, and easy spread within low-income and multi-family housing is particularly troubling. However, new products with longer residual activity, and improved education for pest management professionals can provide critical tools for successful IPM programs within this setting. Principles for the management of insecticide resistance for bed bugs cannot be drawn from an agricultural model. However, bed bug control does provide some unique opportunities for PMPs to implement highly effective protocols for management of this pest while significantly reducing the further development of pesticide resistance in the bed bug population.

10:15

20.5 • Tick Surveillance in an Urban County, Jody Gangloff-Kaufmann, jlg23@cornell.edu, The NY State IPM Program, Cornell University, Babylon, NY

With the increasing geographic distribution of ticks and rates of tick borne disease, it is important for all communities to understand their own risks. Tick surveillance is an important undertaking in much of the Northeast, but some locations may be overlooked as too urban to sustain the wildlife necessary to support significant tick populations. On Long Island, Nassau County, NY, is adjacent to the eastern side of New York City. Nassau is home to 1.35 million residents making it three times as densely populated as neighboring Suffolk County, which is well known for its tick populations and vector control program. We decided to map Ixodes scapularis populations in each of Nassau County's public parks and preserves to help fill the knowledge gap. Additionally, ticks were tested at the Cornell Animal Health Diagnostic Laboratory for the presence of 17 pathogens. The results demonstrate how urban communities should not be overlooked as sources of ticks and tick-borne disease.

10:45

20.6 • Survey Reveals Greatest Needs and Obstacles to IPM in Affordable Housing, Susannah Krysko Reese, sck27@cornell.edu, StopPests in Housing, Northeastern IPM Center, Cornell University, Ithaca, NY

StopPests trains affordable housing staff to utilize IPM to prevent and address pest infestations. After each "IPM in Multifamily Housing" training, participants are asked these questions: "After this training what will you do differently?" and "What resources do you need?". These questions allow us to see what non-practitioners see as the most essential things they can do to help to prevent and reduce pest infestations in the buildings they work in and what resources they need to accomplish this. The talk will summarize 4 years of survey data and raises these questions: Do housing staff perceptions match what scientific research reveals are obstacles to IPM in affordable housing? And, how can we use this information to adapt our strategy and training to consider the audience's needs, create better extension materials, and even inform policy makers.

11:15

20.7 • The public is primed for learning more about the eco-epidemiology of vector-born disease, Dawn H. Gouge, dhgouge@email.arizona.edu, University of Arizona-MAC, Maricopa, AZ

Since January 2020 the general public has been immersed in news of a novel pathogen and spread of a new disease caused by SARS-CoV-2. Pandemics have changed the course of human history and COVID-19 is shaping everyday life and human future around the globe. This session will address One Health concepts and how we can use the current crisis to educate and influence policy and practices supportive of a healthier future.

21 • Approaching IPM and Resistance Management through Understanding How Community Social Dynamics Can Affect Adoption

Plaza Ballroom E

Resistance management continues to be a challenge across disciplines after decades of efforts. Weed, insect, and disease resistance continue to wreak havoc on farmers, which continues to challenge regulators and industry to innovate and try to stay ahead of this "wicked" problem. It often feels like the "pesticide treadmill", coined by IPM practitioners so long ago, continues to challenge the experts in these areas of study. Many scientists and IPM practitioners have addressed these problems as being biological or technological in nature. However, resistance to pesticides is an evolutionary response to individual- and community-overuse of beneficial technology to support crop production. Therefore, implementation of IPM or resistance management is, in part, a social process that involves the interaction of stakeholders across agricultural sectors within their communities. A growing group of stakeholders have been convening to address the socio-economic complexities of community formation and studying the social dynamics that take place. They involve a broad set of diverse and cross-disciplinary participants. Representatives include: government, academia, farmers, local community members, ag retail, NGOs, commodity groups, and technology providers. Biological expertise includes weed scientists, entomologists, and plant pathologists. However, the unique dimension is the inclusion of sociologists and economists to assist in navigating and convening local communities to develop and implement local practical solutions. This cross-disciplinary set of speakers will address our learnings and discuss current research along with discussion of future opportunities to improve community formation and adoption of IPM, as well as resistance management.

Organizers: Katherine Dentzman, dentzman@iastate.edu, Sociology and Criminal Justice, Iowa State University, Ames, IA; George Frisvold, gfrisvold@gmail.com, Agricultural & Resource Economics, University of Arizona, Tucson, AZ; Clinton Pilcher, clint.pilcher@corteva.com, Global Technical Education, Corteva Agriscience, Johnston, IA

8:30

21.1 • IPM in Ag Retail is not an oxymoron, Amy Asmus, amy@afschem.com, Asmus Farm Supply, Rake, IA

Agronomists, retail or independent are often the most trusted adviser to a farmer. Regardless if an agronomist sells products and management tools to growers or not, it is our job to make sure that any pest management plan contains diverse practices to address resistance. Often it is on our shoulders to disprove the "pesticide treadmill" stigma placed on us. I will walk through a discussion of what our role is in the stakeholder group to promote resistance management, and the understanding that IPM along with pesticides are needed to address the wicked problem of pest resistance.

8:42

21.2 • The Wicked Nature of Herbicide Resistance, Jill Schroeder, jischroe1@gmail.com, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM; David Shaw, Mississippi State University, Mississippi, MS

Weed scientists have long recognized the challenges of herbicide resistance evolution. Research and educational tools have been developed in response to this threat, but resistance has continued to develop unabated even with all of these efforts. Our work with stakeholders pointed out that resistance management cannot be implemented singularly; it must be in the context of the myriad of other decisions that must be made. Our work with social scientists has pointed out the complex nature, often called a "wicked problem", and the need for all relevant entities to work together if we are to truly address resistance holistically.

8:54

21.3 • Fungicide resistance to frogeye leaf spot pathogen in Iowa, Daren S. Mueller, dsmuelle@iastate.edu, Department of Plant Pathology and Microbiology, Iowa State University, Ames, IA

The three most common fungicide classes are QoI (strobilurin), DMI (triazole), and SDHI (carboxamide) and most commercial products are pre-mixes of two (or three) of these. Ten years ago, resistance to some fungicide classes, particularly the QoI fungicides, was reported and now fungicide resistance is widespread across Iowa and the U.S. This talk will walk through how decisions can be made, individually and across a community, to slow resistance development. This includes spraying fungicides only when needed, using a fungicide pre-mix, following label rates and considering cultural practices that reduce disease risk. We encourage the use of fungicides as tools to manage fungal diseases, which may require making tough choices—committing to in-season scouting to determine if fungicides are really needed.

9:06

21.4 • Resistance Management Lessons from Area-Wide Insect Control, George Frisvold, gfrisvold@gmail.com, Agricultural & Resource Economics, University of Arizona, Tucson, AZ

Successful area-wide insect control programs in the Western United States provide lessons for designing and implementing collaborative resistance management programs. Examples from programs to control codling moth, whitefly, and pink bollworm illustrate the central role of IPM principles in program success. Institutional innovations fostered collaboration between growers, industry, state agencies, and federal agencies. The different organizations had complementary, but unique and essential, functions. Coordinated application of multiple control tactics that combined non-chemical and chemical methods ultimately led to both improved pest control and reduced insecticide applications and costs.

9:18

21.5 • Community Collaborative as an Alternative to Techno-Optimism and Individualism in Pest Resistance Management, Katherine Dentzman, dentzman@iastate.edu, Sociology and Criminal Justice, Iowa State University, Ames, IA

Adoption of IPM practices that would slow the development of pesticide resistance is hampered by farmers' belief in the development of new 'miracle' pesticides and their commitment to independence. These beliefs are neither unfounded nor unique to farmers—they are reflective of historical experiences and societal-level worldviews. How best to proceed, then, becomes a difficult question loaded with norms, values, and beliefs that are central to American farmers' identities. It is not, however, impossible. Community-based management is one alternative, employing collective action principles to break down individualism while also rendering non-chemical approaches more feasible and handing agency back to farmers.

9:30

21.6 • Eliciting Local Stakeholder Input to Evaluate the Economics of Community-Based Resistance Management, Alicia Rosburg, alicia.rosburg@uni.edu, Economics, University of Northern Iowa, Cedar Falls, IA; Alejandro Plastina, Michael Witt, Iowa State University, Ames, IA

Community-based pest resistance management will depend on both social and economic factors. Our project uses enterprise budgets to evaluate the economic tradeoffs underlying individual and community-based management decisions. A key component of our modeling approach is the direct input from a wide range of local stakeholders in each community such that the enterprise budgets reflect current practices. We will share an overview of how we developed baseline enterprise budgets in four Iowa communities, the process we are using to identify alternative scenarios under community-based resistance management in each community, and highlight some challenges and lessons learned in the process.

9:42

21.7 • Industry ideas to enable community-based resistance management adoption, Clinton Pilcher, clint.pilcher@corteva.com, Global Technical Education, Corteva Agriscience, Johnston, IA

Industry plays a significant role in delaying the onset of pest resistance. Recent socio-economic research demonstrates new methodologies that could be used to improve grower adoption of effective pest resistance management. This talk will explore a few ideas that industry could pursue in designing and conveying solutions to growers. We will also discuss how those ideas might enable local community-based organization to solve wicked pest problems.

10:15

21.8 • Panel Discussion

22 • Utilizing Soil Amendments to Improve Turfgrass Health and Suppress Turfgrass Disease

Plaza Ballroom D

Growing evidence indicates that organic matter dense materials can increase turfgrass field performance. This session will review the turfgrass management research and work that investigates how fertilizers and soil amendments influence the microbiome that lives in the rhizosphere and plant health. First, IPM Institute Community Manager and leader of the Midwest Grows Green (MGG) sustainable landscaping initiative, Ryan Anderson, will detail the importance of this rhizosphere research to managing highly trafficked sports and recreational fields with limited inputs of pesticides, fertilizers and water. MGG's Technical Assistance Program has utilized this research to help municipalities, park districts and schools across the Midwest leverage the soil microbiome to improve turfgrass performance despite budget cuts during Covid-19 (see bit.ly/MGGassistance). Anderson will provide insight into how other IPM educators and institutions can use soil microbiome research to help communities improve the health of urban and residential soils and reduce overall inputs. Assistant Professor Dr. Lee Miller of Purdue University will provide a review of research describing the impact of varying fertility practices and soil amendments on disease suppression. The review will center on the manipulation of both turfgrass health status and soil conditions to manage turfgrass diseases. Where applicable, studies with a focus on the dynamics of the soil microbial community in turfgrass systems in reaction to management practices will be highlighted. North Shore Country Club Golf Course Superintendent Dan Dinelli will complement Dr. Miller with a firsthand account into how he has leveraged these rhizosphere studies to improve the performance of his golf course. This will include a demonstration of how he has renovated his greens with biochar mixed with compost or inoculated with probiotics such as mycorrhizae, bacillus and azospirillum. These treatments amend the soil structure to create more hospitable environments for healthy bacteria by retaining water, oxygen, and water-soluble nutrients.

Organizer: Ryan Anderson, randerson@ipminsitute.org, Community IPM, IPM Institute of North America, Inc., Madison, WI

8:30

22.1 • Leveraging the rhizosphere to improve sports and recreational turfgrass field performance, Ryan Anderson, randerson@ipminsitute.org, Community IPM, IPM Institute of North America, Inc., Madison, WI

Anderson details the importance of rhizosphere research to managing highly trafficked sports and recreational fields with limited inputs of pesticides, fertilizers and water.

8:55

22.2 • Case Study: North Shore Country Club, Dan Dinelli, ddinelli@aol.com, North Shore Country Club, Glenview, IL

Dinelli provides a firsthand account into how he has leveraged the rhizosphere to improve the performance of his golf course. This includes a demonstration of how he has renovated his greens with biochar mixed with compost or inoculated with probiotics such as mycorrhizae, bacillus and azospirillum. These treatments amend the soil structure to create more hospitable environments for healthy bacteria by retaining water, oxygen and water-soluble nutrients.

9:20

22.3 • Fertility and soil amendment manipulation for turfgrass disease management, Lee Miller, purdueturfpath@gmail.com, Purdue University Extension, West Lafayette, IN

Turfgrass areas, particularly in high amenity situations, are especially prone to diseases that may limit utility, aesthetics, and player safety. Nitrogen fertility timing and source selection can suppress diseases caused by foliar and soilborne pathogens. Researchers at Rutgers University demonstrated sand topdressing of golf putting greens reduces anthracnose development and provides a better playing surface. Research at Missouri demonstrated large patch development on zoysiagrass was suppressed by nitrogen applications during the infection period. This presentation will provide a short review of research in this area, concentrating on the impact of treatments on soil microbial diversity where applicable.

23 • Integrated Pest Management Programs and Centers: Bringing Diverse Experience into Action

Governor's Square 14

Integrated Pest Management centers that function at state and regional levels in the United States are unique in the way they support the development of smart, safe and sustainable pest management to protect the people,

environment and economy in the U.S. The Centers achieve their mission by identifying stakeholder priorities through focus groups and other mechanisms and solve the problems by forming collaborative teams and working groups that span diverse geographies and disciplines. In this symposium, the organizers bring together the leadership from various regional and state IPM centers to share their program's successes and their diverse perspectives and experiences coordinating and managing these unique programs. The discussion of these case studies will benefit IPM practitioners in the public and private sectors by demonstrating the utility of the state and regional center structure and highlighting resources available for organizing widespread collaboration across geographies and disciplines.

Organizers: Matt Baur, mebaur@ucanr.edu, Western IPM Center, University of California, Davis, CA; Silvia Rondon, silvia.rondon@oregonstate.edu, Oregon IPM Center, Oregon State University, Corvallis, OR

8:30

23.1 • Utah IPM Program in specialty crops yields results, Marion Murray, marion.murray@usu.edu, Department of Biology, Utah State University, Logan, UT; Diane Alston, Department of Biology, Utah State University, Logan, UT

Utah's population is dispersed across 87,000 square miles but the majority live on just 1% of the land. The Utah State University IPM Program in specialty crops caters to the unique pest management needs of commercial and hobby producers, who are challenged by this urbanization plus the state's arid climate, alkaline soils, high elevation, and varied eco-regions. Limited resources demand creative methods to deliver information to wide audiences that addresses diverse commodities and pests. Through support of USDA NIFA EIP, the Western IPM Center (WIPMC) and other programs, the Utah IPM Program achieves this through a variety of activities. The Pest Advisory Program is a combination newsletter, recording, and social media blast that reaches over 16,400 subscribers. Utah TRAPs (Temperature Resource and Alerts for Pests) is an online degree-day calculator and pest management resource that provides real-time degree days, pest phenology, and treatment recommendations for over 75 locations. Other outreach activities include crop production guides, webinars and videos, fact sheets, websites, mobile apps, workshops, grower meetings, and more. Our work, which has been evaluated in part by industry surveys funded by the WIPMC, has resulted in positive impacts in IPM adoption.

8:55

23.2 • Overview of the North Central IPM Center, Laura Iles, ljesse@iastate.edu, North Central IPM Center, Ames, IA

9:20

23.3 • Idaho State IPM Program, Arash Rashed, arashed@uidaho.edu, Entomology, University of Idaho, Moscow, ID

10:15

23.4 • California Statewide IPM Program, Jim Farrar, jjfarrar@ucanr.edu, UC Statewide IPM Program, UC Agriculture and Natural Resources, Davis, CA

University of California Statewide IPM Program is comprised of 20 academics and staff in the statewide office, 9 Area IPM Advisors located throughout the state, and five affiliated Advisors and an affiliated AES faculty, who fill important geographic and discipline gaps. UC IPM includes the Pesticide Safety Education Program, hosts the Western IPM Center, and currently manages a master grant on invasive shothole borers and Fusarium dieback disease. UC IPM works with researchers, Cooperative Extension personnel, state agencies, state-licensed pest management professionals, commodity groups, and community groups with the goal of "making IPM THE way Californians manage pests."

10:40

23.5 • Outline of the Center for IPM, Danesha Seth-Carley, Danesha_Carley@ncsu.edu, Center for IPM, University of North Carolina, Raleigh, NC

11:05

23.6 • Overview of the Northeast IPM Center, Deb Grantham, dgg3@cornell.edu, Northeast IPM Center, Cornell University, Ithaca, NY

24 • Managing Invasive Pests in the New Era of IPM in Specialty Crops

Plaza Ballroom F

The concept of integrated pest management (IPM), a sustainable strategy for managing pests, has been in practice for a long time now. Although, multiple sources define IPM in different ways, previous models primarily focused on the ecological, and to some extent on the evolutionary aspects of pest management. A recent IPM pyramid identifies a lack of a holistic IPM approach that uses both traditional and modern tools and strategies. However, this conceptual framework mainly dealt with the

ecological aspects of pest management with an emphasis on interdisciplinary research approach. Globally, several reports indicated that IPM implementation depends on numerous factors including the level of education, economic and social conditions, environmental awareness, rational thinking, moral values, regulatory aspects, government policies, availability of IPM tools and resources, extension education, consumer preference, and marketing. The scientists, educators, and extension & outreach experts are committed to new innovations to enhance development and implementation of IPM in specialty crops (vegetables, fruits, & nuts). The major goal is to provide pest management solutions, social & economic benefits and human and environmental protection for the stakeholders and clientele around the world. This IPM session is intended to bring together scientists, educators, and extension and outreach experts from different disciplines and crop systems around the world. It is organized around the International IPM Symposium's theme of 'New Innovations Across Borders and Disciplines' by emphasizing the pest management along with a multidisciplinary approach to explore and expand our scientific frontiers.

Organizers: Muhammad Haseeb, muhammad.haseeb@famu.edu, Center for Biological Control, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, FL; Youichi Kobori, koboriy@affrc.go.jp, Japan International Research Center for Agricultural Sciences, Japan; Jawwad A. Qureshi, jawwadq@ufl.edu, Southwest Florida Research and Education Center, University of Florida, Immokalee, FL

8:30

24.1 • Welcome and Introduction

8:35

24.2 • Abundance of pestiferous mite species in blueberries and opportunities to use IPM principles to manage mite populations, Oscar E. Liburd, oeliburd@ufl.edu, Entomology and Nematology Department, University of Florida, Gainesville, FL; Lorena Lopez, Stella Ruber, Rosangela C. Marucci, Entomology and Nematology Department, University of Florida, Gainesville, FL

The southern red mite, *Oligonychus ilicis* (McGregor), false spider mite, *Brevipalpus yothersi* (Baker) and Blueberry bud mite, *Acalitus vaccinii* (Keifer) attack blueberries in eastern United States. Each mite species exhibits different symptoms on blueberry plants. Recently, the southern red mite has become more problematic, owing to intensive sprays directed at other key pests. We studied the biology, symptoms associated with each species and management. Our results indicate that fenpyroximate (Portal) and fenazaquin (Magister) provided the most consistent control. Among the biological control agents evaluated, *Phytoseiulus persimilis* and *Neoseiulus californicus* reduced the population of the southern red mite.

8:45

24.3 • Developing novel approaches for IPM of key insect pests in apple, Jaime C. Piñero, jpinero@umass.edu, Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA; Dorna Saadat, Prabina Regmi, Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA

The first part of this presentation will focus on recent IPM research conducted in the apple agroecosystem with a focus on attract-and-kill (AK) systems. Then, I will describe the results of field research aimed at assessing the efficacy of a novel AK strategy for apple maggot fly (*Rhagoletis pomonella*) management involving lures and phagostimulants. The efficacy of this approach was compared against that of grower standard blocks. Whole-block infestation levels did not differ significantly between the two management approaches. The new AK approach is grower-friendly and represents an element of an ecologically based approach to growing apples in New England.

8:55

24.4 • Managing Asian citrus psyllid and the pest complex of citrus using integrated approaches, Jawwad A. Qureshi, jawwadq@ufl.edu, Southwest Florida Research and Education Center, University of Florida, Immokalee, FL

Huanglongbing (HLB) or citrus greening disease is caused by the phloem-restricted bacteria *Candidatus Liberibacter asiaticus* (CLas) and is transmitted by the Asian citrus psyllid (ACP) *Diaphorina citri*. Cultural, biological, and chemical methods of pest control have been shown to reduce ACP populations between 80-100% in traditional open orchards. However, advanced production systems providing a physical barrier against vector colonization in individual trees and large acreage have shown complete protection from ACP-HLB and improved plant health and yield. However, the occurrence of other pests is reported from these systems. Pest management in traditional and advanced systems will be discussed.

9:05

24.5 • Effectiveness of alternatives to broad-spectrum insecticides to manage spotted-wing drosophila in southeastern blueberry systems, Ashfaq Sial, ashsial@uga.edu, Department of Entomology, University of Georgia, Athens, GA

Spotted-wing drosophila (SWD), *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) is an insect pest of Asian origin and has recently expanded its range worldwide. It has emerged as a major pest of small and stone fruits in the United States causing significant crop losses. Management is achieved primarily through preventative insecticide applications and is particularly challenging due to risk of insecticide resistance and non-target effects of broad-spectrum insecticides. Studies were conducted to evaluate novel behavioral technologies that can be utilized as alternatives to broad-spectrum insecticides. Once implemented, these technologies will decrease broad-spectrum insecticide use and improve sustainable SWD management.

9:15

24.6 • Push-pull technology evaluation of selective vegetable crops in north Florida, Alejandro Bolques, alejandro.bolques@famu.edu, College of Agriculture and Food Sciences, Cooperative Extension Program, Research and Extension Center, Quincy, FL; Jesusa C. Legaspi, United States Department of Agriculture, Agricultural Research Service, Center for Medical, Agricultural and Veterinary Entomology, Tallahassee, FL

Whiteflies and aphids are important insect pests of vegetable crops grown in open field and agricultural protective structures. Conventional pest control practices that make use of synthetic pesticides can be costly, harmful to the environment if not managed properly, and may be harmful to non-target organisms, such as bees. A novel pest management practice that utilizes a combination of plant-pest behavior stimuli to repel, attract, and in some cases trap insect pest is providing farmers with an affordable, non-chemical pest control treatment known as push-pull strategy or technology. Push-pull technology involves intercropping with a pest repellent plant to drive away (push) an economically important pest from food crop, while utilizing other trap plants that attract the insect pest away from the food crop (pull). Complementing the push-pull technology is the use of flowering refuge plants that can increase beneficial natural enemies to reduce the insect pest population. Push-pull technology is being evaluated at the Florida A&M University, Research and Extension Center in Quincy, Florida on tomato, leafy greens, and strawberries that were grown using organic methods to determine the appropriateness of push-pull plant selections.

9:25

24.7 • Delivering specialty crop IPM research, extension, and educational programs for underserved small farmers, Daniel J. Collins, dcollins1@alcorn.edu, Alcorn State University Lorman, MS; Tahir Rasheed, Derrick Owens, Kaleb Robinson, Alcorn State University Lorman, MS

Small farmers in the southern region of the U.S. face serious challenges in managing plant diseases, weeds, and insects in crops and forest ecosystems. Yield losses due to sub-tropical climate conditions, and pest outbreaks have been substantial. Socially disadvantaged small farmers are more vulnerable to losses due to lack of Integrated Pest Management (IPM) knowledge. Alcorn State University is addressing IPM concerns of underserved small farmers by integrating research, extension, education programing in collaboration with a diverse group of small farmers, entrepreneurs, students, and agricultural alliances to address key agricultural problems and identify IPM research and extension needs of small farmers.

9:35

24.8 • What have we learned on hemp arthropods in two years in Kentucky? Raul Villanueva, raul.villanueva@uky.edu, University of Kentucky, Research and Education Center at Princeton, KY; Zenaida Viloria, Armando Falcon-Brindis, Christine Bradley, University of Kentucky, Research and Education Center at Princeton, KY

Information will be provided on behavior, phenology, and management of three key hemp pests: hemp russet mite, corn earworm, and cannabis aphid. We will present an innovative method to tally hemp russet mites, control, and presence of a natural airborne entomopathogen. For corn earworm, we will discuss outcomes from research in experimental and commercial fields, and its interactions with two tachinids. Also, the management of Cannabis aphid using organic compounds, and its viability as a single prey of four lady beetle species will be discussed.

9:45

24.9 • Management of *Drosophila suzukii* in blueberry planting in Florida, Muhammad Haseeb, muhammad.haseeb@famu.edu, Center for Biological Control, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, FL; Lambert H.B. Kanga, Center for Biological Control, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, FL; Dasia Harmon, FoodCorps,

Inc., Atlanta, GA; Jesusa C. Legaspi, United States Department of Agriculture—Agricultural Research Service, Center for Medical, Agricultural and Veterinary Entomology, Tallahassee, FL; Oscar E. Liburd, Entomology and Nematology Department, University of Florida, Gainesville, FL

Drosophila suzukii is an invasive pest that was detected in Florida in 2009 in Hillsborough County. Limited information is available for berry growers to properly monitor this serious pest in berry crops. We compared several traps and lures/baits at two sites in Florida. The traps evaluated included Trécé, Scentry, and a standard homemade cup trap. Data were recorded as overall trends, as well as in 4–5 trapping periods. Overall, the Scentry trap baited with Scentry lure, the Trécé trap baited with Trécé lure + yeast, and the Trécé trap baited with Scentry lure were the best performing traps.

10:25

24.10 • Migration and dispersal of the fall armyworm in East Asia, Akira Otuka, aotuka@affrc.go.jp, Institute for Plant Protection, NARO, Japan

The fall armyworm is a long-distance migratory insect pest. It arrived for the first time in East Asia in 2019. This talk summarizes how it spread quickly in East Asia, especially focusing on first overseas migrations to Korea and Japan. Parameters of the migration, including timing, path, source, flight duration and flight height, were estimated with flight trajectory analysis. Overwintering in East Asia, migration pattern established in the region in following years, and host plants found are discussed as well. In addition, possible migration distance of immigrants captured in northern Japan was suggested to be much longer than previously believed.

10:35

24.11 • Rapid identification of fall armyworm using loop-mediated isothermal amplification (LAMP), Gaku Akiduki, akiduki@affrc.go.jp, Migratory Insect Pests and Advanced Control Technology Group, Division of Core Technology for Pest Control Research, Institute for Plant Protection, National Agriculture and Food Research Organization, Japan

For control of fall armyworm, it is important to detect the outbreak in the field at an early stage. As there are many related species of maize pest in Japan, it is important to develop the method identifying the fall armyworm from young larvae, which are difficult to distinguish by morphology. In this presentation, we show that we developed the LAMP assay to identify fall armyworm from 22 species of noctuid moths those are the pest of maize, and that we can easily identify fall armyworm in young larvae using this assay that are difficult to distinguish in morphology.

10:45

24.12 • Current status of chemical control in the fall armyworm in Japan, Sachiyo Sanada-Morimura, sanadas@affrc.go.jp, Institute for Plant Protection, NARO, Japan

The Fall armyworm (FAW) cannot overwinter in most parts of Japan, but it has migrated from overseas every early spring, causing damage mainly feeding maize since first reported in 2019. Although there are only a few varieties of insecticides approved for the FAW control in feeding maize in Japan, many insecticides are used in other Asian countries where are migration-source area. The issue of insecticide resistance occurred in these Asian countries is an important concern as a problem that is directly related for FAW control in Japan. This presentation will introduce trends of insecticide susceptibility and chemical control for the FAW in Japan.

10:55

24.13 • Current situation and management of fall armyworm in Thailand, Sarute Sudhi-aromna, sarutes@yahoo.com, Plant Protection Research and Development Office, Department of Agriculture, Thailand; Pruetthichat Punyawattoe, Plant Protection Research and Development Office, Department of Agriculture, Thailand

With Thailand as a major player in the global corn production industry, the damages incurred, particularly during the first stage of spread of FAW in the country. The estimated Thailand corn producing area in 2019 is about 1.07 million hectares and decreasing dramatically by more than 60% in 2021. The country improved in fighting this new pest since the start of the onslaught of FAW, as collaborations between the Department of Agriculture and other sectors of the industry have been established. The adoption of IPM is also showing a lot of promise, particularly on diagnostics and genetic diversity, chemical control and application technology, and biological control.

11:05

24.14 • Population dynamics of the fall armyworm in maize fields in Thailand, Youichi Kobori, koboriy@affrc.go.jp, Japan International Research Center for Agricultural Sciences, Japan; Siwilai Lapbanjob, Nakhon Sawan Field Crops Research Center, Department of Agriculture, Thailand, Pruetthichat Punyawattoe, Plant Protection Research and Development Office, Department of Agriculture, Thailand

The fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae), is a pest originating from the Americas. It is a polyphagous insect and a major pest of maize that has spread to countries in the Indochinese Peninsula, including Thailand. To establish an IPM against

the FAW, basic ecological data of the pest in this region is required. In the present study, the population dynamics of the FAW were investigated by counting the number of the egg mass in Nakhon Sawan Province in northern Thailand. In this presentation, the key period of FAW management in maize cultivation will be discussed.

11:15

24.15 • Cause and frequent seasonal occurrence of *Autographa nigrisigna* (Lepidoptera: Noctuidae) in mating disrupted IPM fields in Japan, Masashi Nomura, nomuram@faculty.chiba-u.jp, Aoi Igarashi-Hashiyama, Laboratory of Applied Entomology, Graduate School of Horticulture, Chiba University, Matsudo, Chiba, Japan

Autographa nigrisigna (Lepidoptera: Noctuidae), was not suppressed in the IPM lettuce field, and the control effect was not apparent. So, we examined the activity of female moths, using an actograph system. The mated females were also found to be active, indicating that they may have mated outside the field and entered the mating disruption field to lay eggs. In addition, male adults can distinguish between female sex pheromones and lure pheromones, which may allow them to find and mate with real females. These factors were thought to be responsible for the occurrence of *A. nigrisigna* in the IPM field.

11:25

24.16 • IPM challenges and opportunities in Ecuador, Amanda C. Hodges, achodges@ufl.edu, University of Florida, Entomology and Nematology Department, Gainesville, FL; Morgan Pinkerton, University of Florida, IFAS Extension, Seminole County, Sanford, FL; Jenny M. Gavilanez-Slone, University of Florida, Entomology and Nematology Department, Gainesville, FL; Lisbeth Espinoza, Escuela Superior Poltécnica del Litoral, Correra de Biologia, Guayaquil, Ecuador; Daniel Mancero, Universidad Agraria del Ecuador, Guayaquil, Ecuador

Interdisciplinary strategies for IPM are increasingly complex during invasive species incursions, emerging pest and pathogen issues, and when limited resources occur. The University of Florida, Doctor of Plant Medicine (DPM) degree provides a unique and holistic approach for solving plant health problems. The utility of the degree to DPM graduates holding faculty positions in Ecuador, as well as experiences associated with the practical integration of DPM student interns into research and industry in-country internships will be discussed. Collaboratively, a synthesis of IPM lessons learned across boundaries continues through student and professional exchange between the University of Florida and Ecuador.

11:35

24.17 • Quantifying diversity of natural enemies for IPM of vegetable pests, Ihsan Nurkomar, ihsan.nurkomar@umy.ac.id, Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia; Dina Wahyu Trisnawati, Jefri Ardi Saputra, Aswinda Damar Prayoga, Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia; Azru Azhar, Biological Control Laboratory, Department of Plant Protection, Faculty of Agriculture, IPB University, Bogor, Indonesia

Natural enemies are an important component of the agroecosystems, while studies on the diversity of natural enemies as pest control agents are also critical. This study aims to compare the biodiversity of parasitoids and predators in the cassava agroecosystem. The study was conducted using survey methods in three study areas: Bedoyo, Karangasem, Kenteng villages, Gunungkidul, Yogyakarta, Indonesia. Observation of natural enemies was conducted in three plots for each study area. The sample of natural enemies was collected using a sweep net and yellow pan traps. The results showed that the biodiversity of predators was higher than parasitoids in all research locations.

11:45

24.18 • Bio-based technologies for managing cacao pests in the Philippines, Divina Amalin, divina.amalin@dlsu.edu.ph, Department of Biology, College of Science and Center for Natural Science and Environmental Research, Biological Control Research Unit, De La Salle University, Malate, Metro Manila, Philippines; Jose Isagani Janairo, Department of Biology, College of Science and Center for Natural Science and Environmental Research, Biological Control Research Unit, De La Salle University, Malate, Metro Manila, Philippines; Lilia Fernando, Institute of Crop Science, University of the Philippines Los Baños, Laguna, Philippines; Dionisio Alvindia, Department of Agriculture, Philippine Mechanization, Science City, Muñoz, Nueva Ecija, Philippines; Billy Joel Almarinez, Department of Biology, College of Science and Center for Natural Science and Environmental Research, Biological Control Research Unit, De La Salle University, Malate, Metro Manila, Philippines; Alberto Barrion, Department of Biology, College of Science and Center for Natural Science and Environmental Research, Biological Control Research Unit, De La Salle University, Malate, Metro Manila, Philippines

Recently, cacao growing in the Philippines is making a comeback because of increasing global demand for cacao beans. Domestically, there is also a big demand for cacao

beans. The current production capacity of the Philippines is only around 12,000 metric tons annually. The potential expansion for cacao growing is huge just utilizing the existing millions of hectares of coconut plantation. However, with the threat of climate change this potential increase in production might be hampered. Thus, there is a need to prepare to mitigate the effect of climate change on cacao production in the Philippines through sustainable farming system.

25 • IPM in the US Department of the Interior Land Management Agencies and Partners

Plaza Ballroom D

Since 1979, the land management agencies of the U.S. Department of the Interior (USDOI) have strived to implement an integrated pest management approach across a varied landscape of sites and conditions; from conserving natural lands and wildlife to eliminating invasive species, and from preventing pests in curatorial and museum collections to excluding pests from historic structures. The USDOI defines a pest as any organism that interferes with the management objective of a site, which includes all invasive fauna and flora. As such, the agencies implement a multidisciplinary One Health approach to provide a low-risk treatment method that protects the health of employees, the visiting public, and the environment. Implementing a comprehensive conservation strategy across the more than 2,000 discrete recreation and conservation sites managed by USDOI, located in all states and territories, can be a nearly insurmountable task, unless taken step-by-step and project-by-project. This session highlights some of the great work at the U.S. National Park Service, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, U.S. Geologic Survey, and with our partners.

Organizer: James Pieper, James_Pieper@nps.gov, U.S. National Park Service, Department of the Interior, Fort Collins, CO

10:15

25.1 • Biological control impacts using a post-release assessment tool and its implementation in the USA, Joseph Milan, jmilan@blm.gov, Bureau of Land Management (BLM), Department of the Interior, Boise, ID

Biological control is an often-neglected component of many Integrated Pest Management plans. Post-release monitoring of biological control is a crucial component to determine biocontrol agent establishment and the impact on the target invasive plant and plant community response. As biological control agents become established at multiple locations, the time-consuming process of monitoring post-release biological control agents and personnel to conduct the monitoring become scarce. To remedy this problem, a regional, multi-system, interagency post-release assessment program—the 'Standard Impact Monitoring Protocol' (SIMP) was developed to document the change in vegetation cover, target weed density and biological control agent abundance over time.

10:30

25.2 • Carbon dioxide as a control tool for aquatic nuisance species, Aaron Cupp, acupp@usgs.gov, U.S. Geological Survey-Upper Midwest Environmental Sciences Center, Department of the Interior, La Crosse, WI

Carbon dioxide (CO2) was recently registered as an aquatic pesticide by the U.S. Environmental Protection Agency. The pesticide label developed by the U.S. Geological Survey and U.S. Fish and Wildlife Service allows applications as a behavioral deterrent for invasive carps (silver, bighead, grass, black carp) and as an under-ice lethal control for any aquatic nuisance species. Carbon Dioxide-Carp is a restricted use pesticide that is limited to federal and state natural resource agencies or those under their direction. Technology transfer of CO_2 into management applications is currently ongoing as agencies develop workflows for pesticide requests and EPA reporting requirements.

10:45

25.3 • IPM Tool-kits and Road Show in the National Park Service, John D. Nelson, John.nelson3@usda.gov, US Forest Service–Forest Health Protection, Department of Agriculture, Gunnison, CO

Within the NPS, limited resources and constant turnover have made it difficult to conduct a centralized training program for Integrated Pest Management (IPM) across the Service. With such a deficit, innovation is bound to occur. Developing and deploying personalized IPM kits and demonstration-based training based on One Health principles has been a game changer in the NPS. This novel program is aimed at engaging and encouraging park staff, residents, and concessionaires to tackle their own pest issues to better preserve the resource they have been assigned, as well as, to empower them to proactively mitigate public health risks from pests.

11:00

25.4 • IPM Projects and Research at the Bureau of Reclamation, Scott O'Meara, someara@usbr.gov, Bureau of Reclamation, Technical Service Center, Department of the Interior, Denver, CO

Reclamation is responsible for managing invasive and pest species that impact our lands, facilities, and waters. Collaborative interagency IPM efforts have been an effective approach for complex sites that cross jurisdictional boundaries. Reclamation's Research and Development Office has supported several IPM research projects such as biological control of mussels and UV-C treatments for canals. Reclamation also conducts prize competitions to advance IPM technologies, including burrowing rodent management and open water mussel eradication. Reclamation's capabilities in research and development of IPM tools, planning, and implementation allows the agency to adapt and continue to protect out land, water, and infrastructure assets.

11:15

25.5 • Historic Preservation Training Center (HPTC)–IPM in Historic Buildings Workshop, James Howard, James_C_Howard@nps.gov, National Park Service, Department of the Interior, Fort Collins, CO

The Historic Preservation Training Center is an internal NPS program who utilizes historic preservation projects as the main vehicle for teaching preservation philosophy and building crafts, technology, and project management skills. This workshop bridges the knowledge of natural and cultural resource experts with structural management expertise of facility management professionals. The primary goal of the workshop is to help trainees become familiar with the specific considerations regarding common structural pests such as mice and bats as well as review options for exclusion and control that remain sensitive to historic structures' integrity and comply with the Secretary of the Interior's Standards for the Treatment of Historic Properties.

11:30

25.6 • Building a Community-Based Stewardship Effort to Control Perennial Pepperweed (*Lepidium latifolium*) in the Great Marsh of Massachusetts, Lauren Healey, Lauren.healey@usda.gov, Natural Resources Conservation Service, US Department of Agriculture, Moro, OR

The Great Marsh of the north shore of Massachusetts includes over 20,000 acres of salt marsh, barrier beach, tidal river, estuary, mudflat, and upland islands, and is the largest continuous stretch of salt marsh in New England. Approximately 4,700 acres of the marsh fall within the boundaries of the Parker River National Wildlife Refuge (NWR). In 2006, perennial pepperweed (*Lepidium latifolium*) was observed to be expanding in the Great Marsh threatening the high marsh that is critical for many species including the declining saltmarsh sparrow (*Ammodramus caudacutus*). In response to this threat, Parker River NWR reached out to local conservation organizations and established a key partnership with Mass Audubon. After years of treatment 26% of sites that were previously infested are now clear.

1:15

25.7 • Powder Post Beetle Management on Alcatraz Island, National Park Service, Bruce Badzik, Bruce_Badzik@nps.gov, National Park Service-Golden Gate National Recreation Area, Department of the Interior, San Francisco, CA

Alcatraz Island located in the middle of San Francisco Bay, has a many-layered history. first as a Civil War fortress, military prison, then a federal prison. All the 15 structures located on the 22-acre island are infested with powderpost beetles, commonly known as the Deathwatch Beetle to varying degrees. Managing these beetles is a challenge due to the location of the island, the extent of damage and the fact that the buildings are all historic structures. The fact that the island is a bird sanctuary and has extensive amounts of hazardous materials has created additional challenges to managing the pests.

1:30

25.8 • Investigating Invasive Mussel Biocontrol, Sherri Pucherelli, spucherelli@usbr.gov, Bureau of Reclamation, Technical Service Center, Department of the Interior, Denver, CO

Bureau of Reclamation hydropower facilities have experienced unplanned outages and increased maintenance because of invasive mussels. Reclamation is investigating non-traditional biological control methods for dreissenid mussels, including identification of parasites from other dreissenid species in Europe to be used as biocontrol agents in the United States. Research is also focused on building the foundation to pursue genetic biocontrol methods, including sequencing and analyzing the quagga mussel genome for genetic targets. Another project, identified from a crowdsourcing prize challenge, is seeking to develop methods needed to achieve dreissenid genetic modification to induce a lethal disseminated neoplasia.

1:45

25.9 • Integrated Pest Management Strategies for Round-tailed Ground Squirrels, Shakunthala Nair, nairs@arizona.edu, Department of Entomology, University of Arizona, Maricopa, AZ

The round-tailed ground squirrel (*Spermophilus tereticaudus*) is a common resident of natural areas throughout most of the desert southwest region of North America. They are well adapted to desert life and live in burrows excavated in the ground. Their burrowing is usually not a significant cause of concern. However, they may lead to human-wildlife interactions that include the squirrels themselves, or their predators such as rattlesnakes, coyote, and other large mammals. This presentation describes successful use of integrated pest management strategy at an archaeological site in AZ to manage these rodents, using a combination of monitoring, trapping and repellents.

2:00

25.10 • Desecheo Film Project, US Fish and Wildlife Service and Island Restoration

Desecheo National Wildlife Refuge supports important populations of plants and animals found nowhere else in the world, such as the Desecheo Anole, Desecheo Ameiva, and Desecheo Dwarf Gecko. Before the introduction of invasive rats, the island hosted large colonies of breeding seabirds, including the largest Brown Booby colony in the Caribbean. But, due to the destruction of native vegetation and predation on eggs and chicks by invasive rats, seabirds nesting was reduced significantly. In response to this threat, the US Fish and Wildlife Service (USFWS), Island Conservation, and other key partners, made the island safe once again for seabirds, endemic lizards, three endemic arachnids, the federally Threatened Higo Chumbo cactus and native plants by removing invasive rats.

2:15

25.11 • Restore New Mexico, State-wide and Multi-Jurisdictional Landscape Restoration Efforts, Ty Carter, Tjcarter@blm.gov, Bureau of Land Management (BLM), Department of the Interior, Roswell, NM

The Restore New Mexico Initiative was created in 2005 as a collaborative restoration effort that is built on capacity-building partnerships. The program strives to be "colorblind" and includes restoration efforts across multiple jurisdictions and ownerships, including state, private and public lands. The initiative's roots are in abandoned oil and gas well reclamation, but the Restore NM Initiative has broadened its portfolio to include forest thinning, brush management, riparian restoration, wildlife habitat enhancement, noxious and invasive species removal, fuels reduction and rangeland improvements. The Restore Initiative program includes 13.5 million acres of BLM lands within New Mexico.

2:30

25.12 • Competitive Plantings–A Final Step to Successful Long-Term Invasive Weed Control, Lynn A. Danly, ldanly@blm.gov, Bureau of Land Management (BLM), Department of the Interior, Cottonwood, ID

Long-term, successful weed management routinely falls short of established goals without the use of all integrated tools. A tool often overlooked is competitive planting to halt re-invasion of weed control sites by non-desired plant species. Case studies from projects in the northern part of Hells Canyon in Idaho detail lessons learned about implementing a successful site rehabilitation project in this challenging setting. The opportunity for failure is high, but the benefits of success are lasting. Even failed projects provide the opportunity to learn and improve the chance of successful future efforts.

3:00

25.13 • Invasive Plant Management: Increasing the Likelihood of Success on National Wildlife Refuges, Jess Wenick, jess_wenick@fws.gov, United States Fish and Wildlife Service, Department of the Interior, Ridgefield, WA

The NWRS Invasive Species Working Group developed a step-wise invasive plant management process that incorporates the concepts of adaptive management, invasion ecology, and integrated pest management, now known as the NWRS' Strategic and Adaptive Invasive Plant Management Model. We identified common barriers to practicing this approach and then used this information to focus our work on developing tools and resources to help the field. Here, we highlight the Model and describe how this national team develops tools and resources nationally and implements locally for customized support of individual National Wildlife Refuges.

3:15

25.14 • A Land Manager's Guide to Invasive Plant management Planning, Giselle Block, Giselle_block@fws.gov, United States Fish and Wildlife Service, Department of the Interior, Sacramento, CA

The purpose of the Land Manager's Guide to Developing an Invasive Plant Management Plan is to help land managers create a plan that is focused, actionable, adaptive, and more likely to succeed. The process helps users answer key questions, such as the following:

- Why is invasive plant management needed? What is the problem?
- Which invasive plant species and where should management focus?
- What is the current and desired future status of invasive plants?
- What management strategies should be implemented? Where? How? Cost?
- How will implementation and effectiveness be measured?
- What is the process for evaluation, learning and adapting strategies?

3:30

25.15 • Conducting Workshops to Prioritize Invasive Plant Species and Areas on Refuges across Oregon, Washington, Idaho, and Hawaii, Jess Wenick, jess_wenick@fws.gov, United States Fish and Wildlife Service, Department of the Interior, Ridgefield, WA

The Branch of Refuge Biology for Interior Regions 9 and 12 offers invasive plant prioritization workshops for National Wildlife Refuges (refuges) across OR, WA, ID and the Pacific Islands. The workshops help refuges and their partners reflect on invasive plant management priorities using tools such as the Invasive Plant Inventory and Early Detection Prioritization Tool and the Invasive Plant Management Tool. The prioritization process provides a transparent, repeatable, and defensible framework for deciding which species and locations should be a focus of monitoring and management. We highlight benefits of using the workshop format as well as implementation challenges.

3:45

25.16 • South Warner Habitat Restoration, Grace J. Haskins, ghaskins@blm.gov, Bureau of Land Management (BLM), Department of the Interior, Lakeview, OR

The South Warner Project was initiated due to the reduction in vegetative diversity caused by expansion of juniper woodlands and dense, late-seral sagebrush communities resulting in degraded habitat for sage-grouse, mule deer, bighorn sheep and pronghorn. Treatments have included juniper cutting, prescribed burning, herbicide targeting invasive annual grass and noxious weeds, seeding and planting.

4:00

25.17 • Adaptive management of invasive plants: Case studies from National Wildlife Refuges in the Midwest region, Joshua Booker, Joshua_booker@fws.gov, United States Fish and Wildlife Service, Department of the Interior, Oak Harbor, OH

Adaptive management is a structured decision-making process designed to reduce uncertainty about managing resources. This makes it a promising tool for addressing the complexities of protecting and restoring native plant communities from invasive species. In 2006, five adaptive management projects were initiated in the Midwest Region to improve the efficacy of National Wildlife Refuge management over time through collaborative learning. All five projects attempted to manage the problem of invasive plants in varying ways. This presentation will review how these projects approached invasive plant management, and what we learned from 14 years of development and implementation.

4:15

25.18 • **[CANCELLED]** Multi-Agency Mission Support: How a unique Sikes Act partnership helps implement invasive species control projects on US Air Force bases and National Wildlife Refuges, Meg H. Duhr, mduhr@umn.edu, Minnesota Aquatic Invasive Species Research Center, University of Minnesota, St. Paul, MN

Under the authority of the Sikes Act, the Department of Defense and the US Fish and Wildlife Service (USFWS) coordinate natural resource conservation on military lands. While most Sikes Act coordination involves planning and compliance, USFWS staff of the Mid-Columbia River National Wildlife Refuge Complex take this partnership further by actually implementing projects on bases. This team functions as a true mobile invasive species strike team, traveling to eight Refuges and two Air Force bases in Oregon, Washington, and Idaho, to implement invasive species control and mapping projects. This presentation describes this partnership's structure and several key projects.

26 • IPM across Disciplines

Governor's Square 15

This mini-symposium will focus on the integration of Integrated Pest Management (IPM) into related disciplines, and the impacts that it can have. Examples include guidelines for building and landscape design to exclude pests; custom Spanish-language trainings for farmworkers for IPM in mushroom houses and other specialty crops; beginning

with Medicare reimbursement for pest control in the homes of disabled adults; and better communication about IPM to stakeholders. Since pests typically present the greatest problems in low-income and other marginalized populations, health equity or environmental justice issues arise. This session will focus on creative outreach and engagement strategies with a focus on Pathways to Persuasion: education, publicity and politics; addressing cultural, language and trust issues, and forming partnerships to address pest issues.

Organizer: Dion Lerman, dlerman@psu.edu, Pennsylvania Integrated Pest Management (PA IPM) Program, Penn State University, Philadelphia, PA

1:15

26.1 • Pandemic response, social equity and federal environmental policy formulation, Marc Lame, mlame@indiana.edu, O'Neill School of Public and Environmental Affairs, Indiana University, Bloomington, IN

1:45

26.2 • Latinos and Agriculture: A Changing Demographic, Maria Gorgo, mag38@psu.edu, Penn State Extension, Penn State University, West Chester, PA

As Pennsylvania's land-grant institution, Penn State University addresses state and national needs through teaching, research and extension. Due to the current demographic changes, Latinos play a critical role in the country's Agriculture industry and related fields. Penn State Extension is actively reaching out to Latinos and providing statewide educational programs in Pests and Pesticide Management, Farm Safety, Food Safety, Horticulture and is providing agricultural business development and risk management information to potential Spanish-speaking farm owners and employees throughout the state.

2:15

26.3 • Landscape IPM by Design, Chris Geiger, chris.geiger@sfgov.org, Department of the Environment, City & County of San Francisco, San Francisco, CA

Designing pests out of the landscape emphasizes prevention by manipulating all of the factors that influence landscape problems. We developed an online and printed database of tactics geared to the landscape architect or designer. Building on the success of a companion handbook for structural pests, we solicited tactics from IPM practitioners, public contract managers, and maintenance staff in public and private practice. We also searched peer-reviewed publications, trade journals, and other published sources for successful design tactics. A cross-disciplinary team of landscape professionals peer-reviewed each proposed tactic in a series of inter-active meetings. Outreach to design professionals and use of the database continues, as City of San Francisco staff begin implementing these new ways of preventing pests through design, and incorporating language and details from the database into contracts.

27 • Communicating and Building Partnerships for IPM in Communities

Plaza Ballroom E

Communicating scientific research and concepts to non-scientist audiences across a wide range of socioeconomic, demographic, and educational levels brings challenges. This symposium will address strategies and tools researchers, educators, public agencies, and cooperative extension agents use to educate the general public on science-based integrated pest management (IPM). Extension specialists and professionals will talk about their successful stories and experience on how to communicate with different audiences/stakeholders about IPM. By fostering associations with different audiences and establishing effective partnerships with stakeholders, Extension can enhance communication about IPM with target clientele. These associations and partnerships will in turn improve relationships and enhance educational activities that will increase the knowledge and promote the adoption of integrated pest management practices.

Organizers: Shujuan (Lucy) Li, lucyli@email.arizona.edu, Department of Entomology, Arizona Pest Management Center, University of Arizona, Maricopa Agricultural Center, Maricopa, AZ; Karey Windbiel-Rojas, kwindbiel@ucanr.edu, University of California Division of Agriculture and Natural Resources, UC Statewide Integrated Pest Management Program (UC IPM), Davis, CA

1:15

27.1 • Opportunities and Outcomes of Working with Elected Officials to Advance the Adoption of IPM, Matt Frye, mjf267@cornell.edu, NYS IPM Program, Cornell University, Elmsford, NY; Julie Suarez, Cornell University, Albany, NY

Elected officials, especially state legislators, endeavor to serve the needs of their constituents. With guidance from Cornell University's College of Agriculture and Life Science Associate Dean of Land Grant Affairs, staff from the New York State IPM Program meet with legislators on an annual basis to discuss program objectives and successes, and to request funding. Based on program expertise, legislators may turn to IPM staff to address an educational need for their constituents, or solicit feedback when drafting legislation on an issue related to pests or pesticides. Because of their

impact at the state level, and their role as elected officials at the local level, legislators serve as important conduits to disseminate IPM information to the public.

1:30

27.2 • Successes with Establishing and Fostering the *Space Coast Golf and Turf Association* to Promote Extension's IPM Initiative to the Local Turfgrass Industry, Bonnie C. Wells, bcwells@ufl.edu, UF/IFAS Extension Brevard County, Cocoa, FL

The *Space Coast Golf and Turf Association (SCGTA)*, a network of urban landscape management professionals including golf course superintendents, sports turf managers, lawn care maintenance employees, sod farmers and industry representatives, was established by University of Florida IFAS Extension to enhance communication, outreach of sustainable management practices, and promote adoption of IPM by these important stakeholders. The *SCGTA* conducts quarterly pest management needs-assessments and implements extension-led "In-Service Seminars" to meet the identified needs. Knowledge gain and intent to adopt IPM practices presented at seminars has been well documented, and site visits performed to support the adoption of IPM practices. This presentation will discuss the successes (outcomes and impacts) with establishing and fostering the *SCGTA* to promote extension's IPM initiative and enhance communication with target clientele, so that the industry will remain profitable, sustainable and be stewards of their landscapes.

1:45

27.3 • Honoring and Empowering Tribal Nations and Indigenous Peoples Through IPM, Shujuan (Lucy) Li, lucyli@email.arizona.edu, Department of Entomology, Arizona Pest Management Center, University of Arizona, Maricopa Agricultural Center, Maricopa, AZ

We actively engage with tribal communities in Arizona to promote IPM as a solution to reduce pest-related public health threats and have established effective partnerships with many tribes. This session will focus on the University of Arizona Public Health IPM Team partnering with tribal community leaders and professionals to solve problems and develop activities and outputs on a wide range of public health related topics. Nearly 950 tribal participants from 2019–2021 indicated up to 80% increase in knowledge of pests and IPM topics, and 100% agreed that they would use newly learned IPM knowledge to empower their tribes to improve lives and communities.

2:00

27.4 • IPM Speaks: Communicating Risks of IPM Practices to the Public, Al Fournier, Fournier@cals.arizona.edu, Arizona Pest Management Center, University of Arizona, Maricopa Agricultural Center, Maricopa, AZ

Integrated Pest Management is risk management; balancing and reducing economic, environmental and human health risks is central to IPM practice. Whether the source of the risk is the pest itself or the risk arises in how the pest is managed, applicators, pest managers, consumers and the general public have a right to know about risks surrounding pest management. This session will focus on tools and resources to increase the effectiveness of how we communicate pest management risks, including pesticide risks, to non-scientists.

2:15

27.5 • University and Private Partnerships: A Road to Quality and Sustainable Programs, Niamh Quinn, nmquinn@ucdavis.edu, University of California Cooperative Extension, South Coast Research and Extension Center, Irvine, CA; Sylvia Kenmuir, sylvia.kenmuir@basf.com, BASF, Irvine, CA

Forming partnerships between Universities and the pest management industry can be challenging for a number of reasons. However, successful outcomes are in abundance once productive partnerships are developed. This session will focus on the development of research and extension programs developed in conjunction with the pest management industry and provide insights from both public and private partners.

2:30

27.6 • Train-the-trainer Model for Educating Master Gardeners and Retail Nurseries, Karey Windbiel-Rojas, kwindbiel@ucanr.edu, University of California Division of Agriculture and Natural Resources, UC Statewide Integrated Pest Management Program (UC IPM), Davis, CA

Master Gardener volunteers and employees of retail nurseries and garden centers are often the first people residents turn to when they have a pest problem. Training these audiences on pest identification and IPM is important, but showing them how the read and understand pesticide labels is even more critical so they can share the knowledge with clients. Karey will talk about hands-on and virtual training activities UC IPM's Urban & Community team has developed for guiding these audiences through pesticide labels. The train-the-trainer materials include PowerPoint slides, handouts, activity sheets, and a loaner collection of empty, never

filled, pesticide bottles UC IPM sends to UC Master Gardeners so they can provide the same training to the general public.

28 • Predicting, Monitoring and Responding to New Plant Pests

Plaza Ballroom F

Invasive species threaten agriculture and natural resources in a country and affect its trade opportunities with other countries. Recent reports have documented an increase in the entry and establishment of highly damaging plant pests in new areas. Examples include the rapid spread of the tomato leafminer, *Tuta absoluta*, in Africa, Europe and Asia, followed by the introduction and spread of the fall armyworm, *Spodoptera frugiperda*, in Africa and Asia. Many of these new introductions are attributed to a surge in global trade and travel that provide novel pathways of introduction for the invasive pests. Furthermore, global changes in climate are creating suitable environments where plant pests can expand the current habitat and the newly established pests can thrive after invading a new area. In this session, we will discuss strategies and case studies to predict pre-emergent invasive pest species, how to allocate and prioritize resources when responding to new invasions, techniques to conduct detection surveys, and how to respond to new detections through delimitation surveys and eradication strategies. The ability to predict the introduction of high impact invasive pests allows regulatory agencies to prevent new pest entries, prepare for detection and response activities, and lessen the overall impact of the newly introduced species.

Organizers: Godshen Robert Pallipparambil, godshenrobert@ncsu.edu, Danesha Seth Carley, Danesha_Carley@ncsu.edu, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC

1:15

28.1 • Predicting introductions of emerging pests and diseases and designing risk-based surveys, Weiqi Luo, wluo2@ncsu.edu, Center for Integrated Pest Management, Fort Pierce, FL; Drew Posny, Center for Integrated Pest Management, Fort Pierce, FL

Early detection and evidence-based decision support tools are essential for slowing the spread and establishment of emerging pests and diseases. We developed a probabilistic model that predicts the most likely locations for pest and disease introduction with consideration of international travel, epidemiological characteristics, host populations, and environmental conditions. Furthermore, combining additional spatiotemporal risk variables with geographic information system data, we design surveys and maps for stakeholders, helping facilitate the appropriation of fiscal and human resources for cost-effective sampling. Statewide risk-based surveys have been deployed for multiple plant pests and diseases in Florida, California, New York, and Texas.

1:30

28.2 • Pest Prioritization, Preparedness, and Opportunities, Godshen Pallipparambil, godshenrobert@ncsu.edu, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC; Michelle Gray, Wendy Marchant, USDA APHIS PPQ (U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection Quarantine), Raleigh, NC; Jennifer Cook, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine develops New Pest Response Guidelines for prioritized moderate and high-risk pests that are not present in the United States. Development of these guidelines require coordination with subject matter experts to ensure the delimitation surveys, molecular identification, and eradication and control strategies are feasible. Knowledge gaps are often identified during this process, presenting an opportunity for the research community to assist the USDA with managing and reducing the risk associated with new pest incursions.

1:45

28.3 • Designing delimitation surveys for new pest introductions, Godshen Pallipparambil, godshenrobert@ncsu.edu, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC; Kevin Bigsby, Barney Caton, USDA APHIS PPQ (U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection Quarantine), Raleigh, NC; Hui Fang, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine is developing a tool to help tailor delimitation surveys to specific scenarios of new pest introductions. Here, we will discuss some processes for designing customized surveys for delimiting new pests based on the pest biology, available survey techniques, logistics, operational environment, and available resources.

2:00

28.4 • Dramatic Range Expansion of the Oriental Fruit Fly (OFF), *Bactrocera dorsalis* (Hendel), (Insecta: Diptera: Tephritidae) in Asia, Yulu Xia, yuluxia@ncsu.edu, Center for Integrated Pest Management, North Carolina State University, Raleigh, NC

Few pests have a greater potential impact on global fruit and vegetable production and trade than the oriental fruit fly (OFF). The voracious tropical pest feeds on more than 600 host species, and has explosive reproduction and dispersal rates. OFF detections in the U.S. have been increasing over the last decade. Recently, OFF had large-scale outbreaks in temperate regions of northern China, a climate similar to much of the continental U.S. We will discuss about this apparent range expansion into temperate climates and the elevated biosecurity risk it poses to the fruit and vegetable production in U.S. and other countries.

2:15

28.5 • Modeling spread in different landscapes to inform management programs, Drew Posny, dsposny@ncsu.edu, Center for Integrated Pest Management, Fort Pierce, FL; Weiqi Luo, Center for Integrated Pest Management, Fort Pierce, FL

Pest and disease dynamics vary across different landscapes, and thus, may require alternative strategies for effective control and sustainability. Mathematical modeling can quickly analyze all stages of a pest or disease outbreak: predicting introduction points, designing risk-based surveys for early detection and rapid response, and developing simulation models to explore cost-effective management program options in real-world landscapes. These decision support systems provide stakeholders with rapid, comprehensive spatiotemporal analyses to enhance/inform effective mitigation approaches for critical pests and pathogens at multiple scales.

2:30

28.6 • Invasive species response toolkit, Joseph LaForest, laforest@uga.edu, Southern IPM Center, Tifton, GA; Kevin Judd, Northeastern IPM Center, Ithaca, NY; Jacque Pohl, North Central IPM Center, Ames, IA; Rebekah Wallace, Charles Bargeron, Bugwood Center for Invasive Species and Ecosystem Health, University of Georgia, Tifton, GA

Invasive species are a constant threat to agricultural, forested, and natural ecosystems. Mitigation of that threat requires directed efforts to detect new invasives, dedicated resources to contain recently introduced pests, coordinated research to develop new management strategies, and timely outreach to help extend the latest information. Limited resources and the wide-ranging impact of invasive species requires all organizations to work together and leverage each other's efforts. The IPM Centers provide a set of tools that anyone can use to jumpstart their programs for early detection and rapid response while promoting awareness of a new invasive species.

29 • Management of Fall Armyworm in Africa and Asia

Governor's Square 14

Fall armyworm (*Spodoptera frugiperda*) is a native of tropical and subtropical Americas. It invaded Africa in 2016, Asia in 2018 and Australia in 2020. It is a polyphagous pest, over 350 species of plants have been recorded as hosts. However, in the invaded continents, it prefers maize over others. Loss caused by this pest has been estimated to be several billions of dollars affecting food security. Several management technologies such as physical control, cultural control, mating disruption, host plant resistance, push-pull technology, chemical control, and biological control have been introduced, tested, and evaluated under local conditions. Progress made in developing and implementing management technologies in some African and Asian countries will be presented and discussed.

Organizer: Rangaswamy (Muni) Muniappan, rmuni@vt.edu, IPM Innovation Lab, Virginia Tech, Blacksburg, VA

1:15

29.1 • IPM Innovation Lab and Fall Armyworm Management, Rangaswamy (Muni) Muniappan, rmuni@vt.edu, IPM Innovation Lab, Virginia Tech, Blacksburg, VA

Since 2014, the IPM Innovation Lab (IPM IL) has been operating in Bangladesh, Cambodia, Nepal, and Vietnam in Asia, and Ethiopia, Kenya, and Tanzania in Africa. When fall armyworm (FAW) reached Ethiopia in 2017, IPM IL took an active role in management of FAW. In 2017, it organized an awareness and management workshop in Addis Ababa, Ethiopia for East African countries. Subsequently, when FAW reached India, it organized awareness workshops in Nepal, Cambodia, and Vietnam. Collaborators of IPM IL have identified several egg and larval parasitoids of FAW in Africa and Asia. IPM IL has conducted workshops on rearing and release of FAW parasitoids for participants in over 25 countries from Africa and Asia at Nairobi, Kenya and Niamey, Niger. Currently, the program is setting up national parasitoid rearing and release centers in Cambodia, Kenya, Tanzania, and Tanzania.

1:30

29.2 • An Integrated Approach to Managing Fall Armyworm in Small-holder Maize Farming System in Africa, Tadele Tefera, ttefera@icipe.org, International Center of Insect Physiology & Ecology (icipe), Addis Ababa, Ethiopia; Birhanu Sisay, International Center of Insect Physiology & Ecology (icipe), Addis Ababa, Ethiopia; Paddy Likhayo, Kenya Agricultural and Livestock Research Organization (KARLO), Nairobi, Kenya; Josephine Simiyu, Ministry of Agriculture, Bungoma County, Kenya

The fall armyworm (FAW), *Spodoptera frugiperda*, was first reported in Africa in 2016. Since then, it has become a very destructive invasive pest of maize in sub-Saharan Africa. Different approach to managing FAW are being tested in Africa. Farmers scouting maize field at different plant growth stages and pheromone traps are used to monitor FAW. Recent report shows several larval and egg parasitoids attaching FAW. The egg parasitoids, *Trichogramma mwanzai* parasitizes >75% of FAW eggs in Tanzania, while parasitism by *Telenomus remus* ranged from 25 to 34-25% in east Africa. Augmentative release of *Telenomus remus* in Kenya in few sites showed effective control of FAW. Different cropping systems, including the push pull technology and maize legume-intercropping played considerable role in reducing FAW infestation. Farmers traditional practices such as handpicking as well as the efficacy some biopesticides, botanical extracts and chemical insecticides commonly used across the countries are discussed.

1:45

29.3 • Delivering Scalable Fall Armyworm IPM Technologies to Smallholder African Farmers Through Research and Partnerships, Peter Chinwada, P.Chinwada@cgiar.org, IITA, Southern Africa Research and Administration Hub Campus, Lusaka, Zambia

Since it was first introduced into Africa, Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) has increased the food vulnerability of the continent's poorest inhabitants particularly in those regions where maize is the staple crop. The need for its control on maize using chemical pesticides has also introduced an unwanted production cost to African smallholder farmers in sub-Saharan as well as increased their exposure to harmful chemicals. IITA's approach to FAW IPM in sub-Saharan Africa is a combination of applied research and creating partnerships for devolvement of technology demonstrations and scaling, and capacity building of target beneficiaries. The menu of technologies being validated by IITA for scaling and deployment include the systemic seed treatment Fortenza™ Duo (cyantraniliprole + thiamethoxam), sprayable conventional chemical pesticides, biopesticides, botanicals, mechanical/physical control, habitat management and cultural practices. Results from validations of selected IPM technologies and stakeholder capacity building efforts through the Technologies for African Agricultural Transformation (TAAT) program, highlights of some visibility or promotional campaigns conducted in collaboration with partners, challenges and lessons learnt to date and key recommendations for sustainable area-wide FAW management are presented.

2:00

29.4 • Harnessing climate-smart IPM for long-term management of fall armyworm *Spodoptera frugiperda* in Africa, Ghislain Tepa-Yotto, G.Tepa-Yotto@cgiar.org, Biorisk Management Facility (BIMAF), International Institute of Tropical Agriculture (IITA-Benin), Cotonou, Benin and Ecole de Gestion et de Production Végétale et Semencière (EGPVS), Université Nationale d'Agriculture (UNA), Kétou, Bénin; Jeannette Winsou, Biorisk Management Facility (BIMAF), International Institute of Tropical Agriculture (IITA-Benin), Cotonou, Benin and Faculty of Biosciences (BIOVIT), Norwegian University of Life Sciences, Ås, Norway and Department for Invertebrate Pests and Weeds in Forestry, Horticulture and Agriculture, Norwegian Institute of Bioeconomy Research (NIBIO), Ås, Norway; Manuele Tamò, Biorisk Management Facility (BIMAF), International Institute of Tropical Agriculture (IITA-Benin), Cotonou, Benin

The fall armyworm (FAW) *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) has now become a pest of global concern. Originally known to be endemic to the Western Hemisphere, its first detection into Africa was followed by astonishing outbreaks and spread to almost all sub-Saharan countries. The rapid incursion of *S. frugiperda* on maize fields in Africa transitioned the crop production regimes to a crucial need of a comprehensive assessment of an integrated pest management strategy in most smallholder farms. A set of inductive species distribution models was developed during the current endeavor and provided pioneering information for horizon scanning of the pest and its key parasitoid species. Further pheromone trapping studies were designed to advance FAW monitoring agenda in Africa. An unexpected *Spodopotera frugiperda* multiple nucleopolyhedrovirus (SfMNPV) was discovered locally soon after FAW reports, which is prospective for viral biopesticide development. Climate-smart approaches to IPM are proposed to reduce emerging risks from pest insects under climate change. We have examined four key nature-based solutions central to IPM: habitat manipulation, biological control, semiochemical control, and the use of biopesticides. We concluded by laying out a road map for 'climate-smart IPM', which outlines the types of support required for practical implementation,

such as climate-informed advisory services, information and communication technology, and policy. While emphasis throughout is placed on smallholder production systems–particularly for sub-Saharan Africa–the principles of climate-smart IPM can be considered relevant to crop production generally.

2:15

29.5 • Integrated Pest Management of Fall Armyworm (*Spodoptera frugiperda*) in Cambodia: Experiments on commercially-available and laboratory reared biological control, Rica Joy Flor, r.flor@irri.org, International Rice Research Institute, IRRI-Cambodia Office, Phnom Penh, Cambodia; Sokheng Keo, International Rice Research Institute, IRRI-Cambodia Office, Phnom Penh, Cambodia; Vichet Sorn, Chhunneang Hak, Oeurn Samoul, Nit Ti, General Directorate of Agriculture, Phnom Penh, Cambodia; Kim Eang Tho, Marb Thanuth, Royal University of Agriculture, Phnom Penh, Cambodia; Khay Sathya, Cambodian Agricultural Research and Development Institute, Phnom Penh, Cambodia; Buyung Hadi, Food and Agriculture Organization of the United Nations, Rome, Italy; Nurmi Pangesti, International Rice Research Institute, IRRI-Cambodia Office, Phnom Penh, Cambodia; Virender Kumar, International Rice Research Institute, Los Baños, Laguna, Philippines

The invasive Fall Armyworm (FAW, *Spodoptera frugiperda*) has been damaging thousands of hectares of corn since it was observed in Cambodia in 2019. The management options within reach for Cambodian farmers are pesticide based. It was necessary to explore potential alternatives that complement an IPM strategy against FAW in the country. We implemented three studies to understand the potential options for farmers, and then test these options. Considering that farmers obtain information and products from the input industry, we surveyed input companies (N=57) on their awareness and recommendations for FAW. In 2019-2020, we implemented an experiment to compare commercially-available pesticide and biocontrol options on FAW damage and yield. There were four treatments (1) doing nothing (control), (2) pesticides as per farmers' practice (Emamectin benzoate applied two times), (3) pesticides as per recommendations from companies or literature (Chlorantiniliprole fb Emamectin benzoate fb Chlorantiniliprole), and (4) biocontrol (*Beauveria bassiana* applied three times). The experiment was replicated in the following season (2020), with another biocontrol treatment (*B. bassiana* applied two times) added as a potentially cheaper biocontrol option. Lastly, in 2020-2021 a locally available egg parasitoid, *Telenomus remus,* was reared in the laboratory and released in the field to test its efficacy against FAW. We present the findings from these three studies and reflect on the potential for adoption by farmers, as well as what is further needed to develop an IPM strategy against FAW in the country.

2:30

29.6 • Parasitoids for biological control of the fall armyworm in Africa, Malick N. Ba, b.malick@cgiar.org, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niamey, Niger; Saidou A. Laminou, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and University Abdou Moumouni, Niamey, Niger; Laouali Karimoune, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niamey, Niger; Ali Doumma, University Abdou Moumouni, Niamey, Niger; Rangaswamy Muniappan, Virginia Tech, Blacksburg, VA

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), is an insect native to the tropical and subtropical Americas that has recently spread to Africa, where it predominately attacks maize, sorghum and other plant species. Biological control is an environmentally friendly way of combatting the pest and contributes to an integrated pest management approach. The parasitoids associated with the fall armyworm in Niger (Africa) included 7 species among which the larval parasitoid *Habrobracon hebetor* Say (Hymenoptera: Braconidae), and two egg parasitoids, *Trichogrammatoidea* sp. (Hymenoptera: Trichogrammatidae), and *Telenomus remus* Nixon (Hymenoptera: Platygastridae) were also encountered. The egg parasitoid *T. remus* parasitized both hairy and non-hairy egg masses of FAW while *Trichogrammatoidea* sp. tend to parasitize the non-hairy external layer egg masses. Therefore, *T. remus* parasitized up to 75% of FAW eggs compared to only 27% for *Trichogrammatoidea* sp. On-farm releases of *T. remus* in sorghum fields caused up to 64% of FAW egg parasitism. The larval parasitoid *H. hebetor* sting and inject venom in *S. frugiperda* stage 3-6 caterpillar leading to it death and it parasitized stage 5 and 6 caterpillars but did not produce enough progeny. *H. hebetor* could be used in augmentative release to work as an "insecticide". Our findings are a contribution to the use of parasitoids in augmentative releases against FAW in Africa.

30 • Integrated Tick Management: Increasing Adoption of ITM Practices to Address the Global Tick Problem

Plaza Ballroom ABC

Integrated Tick Management (ITM) combines a number of tick control strategies, including: habitat modification, personal protection, spray applications and interventions

targeted at tick hosts. Successful and affordable ITM practices for preventing human disease have been an elusive goal of public health officials and entomologists for many years. Efforts to decrease tick-borne diseases in humans by controlling tick populations have been unsuccessful even when significant decreases in tick abundance is achieved. Additionally, individuals often fail to use basic precautions (i.e., using spray-on repellents and checking their bodies for ticks after spending time in tick habitat). However, emerging technologies and treatments are now being evaluated by homeowners, landholders, and communities. Recently developed biological agents (such as nootkatone and Met52) and vaccines—coupled with greater awareness of tick-borne diseases—should increase adoption of ITM practices among all stakeholders to address the global tick problem. Pathogens that cause Lyme disease are found worldwide and vectored by *Ixodid* ticks, but other tick species are also concerning to ITM practitioners. For example, in North America, the non-native Asian longhorned tick (*Haemaphysalis longicornis*) and the red sheep tick (*Haemaphysalis punctata*) have recently emerged as vectors of pathogens that cause disease in livestock and humans. This 90-minute session will feature three presentations: 1) dispelling tick myths, 2) ITM adoption in Colorado and surrounding states and 3) the challenges to ITM adoption and expanding implementation of effective ITM practices.

Organizer: Leah McSherry, lmcsherry@ipminstitute.org, Integrated Pest Management Institute of North America, Madison, WI

1:15

30.1 • Introduction/information about the Tick IPM Working Group

1:30

30.2 • Strategies and Challenges to Adoption and Implementation of Integrated Tick Management Practices, Kirby C. Stafford III, Kirby.Stafford@ct.gov, Department of Entomology, Center for Vector Biology & Zoonotic Diseases, The Connecticut Agricultural Experiment Station, New Haven, CT

Tick-associated diseases are increasing, native ticks are expanding their geographic range, and exotic ticks pose an ever-growing threat, with increasing risk to the public, companion animals, livestock, and wildlife. The presentation will briefly review various tick management strategies and highlight some of the barriers and challenges to the adoption and implementation of effective ITM and tick-bite prevention practices in the United States.

3:05

30.3 • Local issues: ITM adoption in Colorado and other Rocky Mountain states, Dan Salkeld, dansalkeld@gmail.com, Colorado State University, Fort Collins, CO

Ticks pose an emerging threat of infectious disease due to expanding suitable habitat ranges, climate change, host movement, etc. Active surveillance for ticks is accurate but resource-limited. Passive tick surveillance incorporating citizen science submissions can create a massive database on human- and pet-tick exposures, tick distributions and behavior, and pathogen prevalence. Of course, there can be limitations e.g., uncertainty about exposure sites, uneven efforts. Nonetheless, citizen science data is able to recreate distribution maps, abundance indices and disease risk maps created by public health agencies, and potentially act as an early-warning system for tick-borne disease dynamics.

3:50

30.4 • Cigarettes and Kerosene: Addressing 20 years of Tick Myths Heard at the Veterinary Clinic through Education, Timothy McDermott, Mcdermott.15@osu.edu, Ohio State University Extension, Franklin County, Agriculture and Natural Resources, Columbus, OH

Ticks only live in the woods. Ticks are only active in summer. You burn them off with a cigarette or drown them with motor oil. These are statements heard from clients during twenty years in private veterinary practice. Veterinarians have long been on the forefront of outreach on tick-vectored disease to as it is an essential part of each examination or farm visit. Eradication of ticks is not feasible meaning we will be battling tick-borne disease for the foreseeable future. What lessons can be learned from the Veterinary-Client-Patient bond that can be extended into human integrated pest management outreach?

31 • Re-Imaging IPM for Broader Social Challenges: Integrating Social, Political, Cultural, Economic and Ecological Dimensions

Governor's Square 15

IPM is increasingly being recognized for its potential to contribute to the new realities of sustainable agriculture production: food security, biodiversity, agri-ecosystem services, and climate change. However, low adoption levels and inconsistent efficacy limit the capacity of IPM to be responsive to these broader societal needs. Research focused on understanding the role social dimensions and how they interact with traditional ecological principles and

factors in the development, delivery, and adoption of IPM is leading to new 'integrated' models of IPM. Understanding the complex dynamics of the social, economic, political, cultural, and ecological factors in IPM is critical to the future of crop protection and for meeting broader social expectations of IPM within a sustainable agriculture system. The panel, which includes natural and social scientists, will highlight how IPM is being re-imagined and understood through a multi-disciplinary lens that integrates ecological, socio-political, cultural, and economic dimensions to improve IPM adoption and efficacy. The goals of this interdisciplinary panel are to:

- Propose new models of IPM that integrate social, political, cultural, economic, and ecological dimensions
- Explain how these factors influence IPM research, strategies, outreach, implementation, adoption, and efficacy

A major takeaway of the panel will be an improved understanding of the evolving role of IPM in contributing to the challenges of sustainable food production in the 21st century and the factors that influence its successful implementation.

Organizer: Margaret (Amy) Lemay, lemaym@uoguelph.ca, Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada

3:00

31.1 • Introduction, Margaret (Amy) Lemay

3:10

31.2 • The new IPM Model, Surendra K. Dara, skdara@ucanr.edu, University of California, Cooperative Extension, San Luis Obispo, CA

Crop production has undergone significant transformation in the past few decades around the world. An increasing focus on environmental health, integration of modern technologies, emergence and spread of invasive pests, demand for food security, depletion of natural resources including arable land, climate change, and global trade of agricultural commodities have put significant pressure on the farming community to produce food in an economically viable, environmentally sustainable, and socially acceptable manner. The new integrated pest management (IPM) model proposed in this presentation incorporates various elements that influence crop production to provide a universally applicable template that meets the needs of modern age agriculture.

3:23

31.3 • Training for stakeholders, from IPM educators to agricultural workers, is critical to the success of IPM programs, Ryan Gott, rgott@maitrigenetics.com, Maitri Genetics, Pittsburgh, PA; David Coyle, Department of Forestry & Environmental Conservation, Clemson University, Clemson, SC

While the scientific bases of IPM are well-developed and churning out useful information all the time, the human and social-centric considerations are much less so. People are at the core of IPM, performing critical tasks like scouting, making management decisions, relaying information, training, teaching, and, yes, conducting research. I will present an overview of work conducted to assess IPM educators' needs in the realm of these social aspects as well as personal experience with humans being the keystone of IPM programs both in public horticulture and the medical *Cannabis* industry.

3:36

31.4 • The Role of Knowledge Mobilization in the Adoption of IPM, Margaret (Amy) Lemay, lemaym@uoguelph.ca, Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada; Mary Ruth McDonald, Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada

As a knowledge-intensive, research-based innovation, the widespread adoption of IPM is dependent on effective knowledge mobilization. The difficulties of transforming new scientific knowledge into use are well documented. Grounded in concepts from the sociology of science, knowledge mobilization involves putting research into action through synthesis, dissemination, collaboration and brokering among a complex network of researchers, intermediaries, and research users. This presentation will provide an overview of knowledge mobilization and highlight the critical success factors of knowledge mobilization that lead to increased adoption and enhanced efficacy of IPM designed to meet broader social, economic and ecological expectations of sustainable agriculture.

3:49

31.5 • Ecoefficiency and IPM: A joint solution to pesticide overreliance in the age of industrial agriculture, Roger Magarey, rdmagare@ncsu.edu, Southern IPM Centre, North Carolina State University, Raleigh, NC

The pesticide quandary is a new term for a wicked problem characterized by: i) increasing reliance upon pesticide use to meet food security needs; ii) environmental and human health impacts caused by this use; and iii) increased

social resistance resulting in loss of critical pesticides. One solution is ecoefficiency, a strategy for sustainably increasing production while simultaneously decreasing these environmental and human health impacts. We propose tracking changes in pesticide risk levels (usage and toxicities) over time as an eco-efficiency index. This could allow the benefits of IPM strategies to be more readily quantified and thus potentially incentivized.

4:02

31.6 • Systems Thinking and the New Integrated Pest Management Paradigm: Opportunities for growth and engagement, Camille Ryan, **camille.ryan@bayer.com,** Regulatory Scientific Affairs, Bayer Crop Science, St. Louis, MO

Systems-thinkers in agriculture are defined in the literature as those with the ability "...to view a problem through different perspectives, can effectively adapt to change, problem solve, think long-term, and experiment and test new solutions and strategies to help improve an existing system". This presentation will highlight the concept of 'systems thinking' and how it can shape our approaches to the new integrated pest management paradigm. As we seek to optimize ways to encourage and support on-farm adoption of sustainable production practices like IPM, the broader system would do well to see the 'bigger picture' too. Systems-thinking needs to be adopted and applied along the entire agricultural value chain. There is need for learning and action for all of us.

4:15

31.7 • Discussion

32 • Ecostacking as an Approach to IPM

Governor's Square 14

Ecostacking as a concept makes full use of the benefits accruable from ecosystem services via stacking and conservation of functional biodiversity in cropping systems. Stacking implies combining in a synergistic manner the beneficial services of functional biodiversity from all levels and types. This is a comprehensive approach, where the various ecosystem service providers are fully integrated with the rest of the cropping system including agronomic practices. During the past six decades, IPM has promoted sustainable forms of agriculture, pursued drastic reductions in synthetic pesticide use, and thereby has attempted to solve socio-economic, environmental, and human health challenges associated with modern agriculture. Global pesticide use has, however, largely continued unaffected, with negative implications for farmer livelihoods, biodiversity conservation, and the human food systems. Elegant solutions have been found to many problems, based on discoveries related to pest biological properties, ecology, ecosystem function, and technological innovations. Uptake of these methods and application by growers has lagged far behind, despite ambitious government programmes to reduce pesticide use, and political support to IPM. Recently, the whole concept of IPM has been challenged due to its ambiguity, inconsistencies in implementation, insufficient engagement of farmers, and lack of basic understanding of its ecological concepts. Ecostacking as an approach aims to stimulate the scientific community to develop, design, and implement integrated systems for optimised provision of ecosystem services and the use of plant protection tools, with focus on ecological, economic, and social sustainability of the integrated system.

Organizers: Heikki MT Hokkanen, **heikki.hokkanen@uef.fi**, University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland; Ingeborg Menzler-Hokkanen, **ingeborg.menzler-hokkanen@uef.fi**; University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland

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3:00

32.1 • Using the principles of ECOstacking to develop ecologically-based IPM approaches in apple agroecosystems in New England, Jaime C. Piñero, **jpinero@umass.edu**, Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA; Prabina Regmi, Dorna Saadat, Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA; Tracy Leskey, USDA-ARS, Appalachian Fruit Research Station, Kearneysville, WV; David -Shapiro-Ilan, USDA ARS Southeastern Fruit and Tree Nut Research Laboratory, Byron, GA; Binita Shrestha, Entomology and Nematology Department, Citrus Research and Education Center, University of Florida, Lake Alfred, FL; Deborah Finke, Division of Plant Sciences, University of Missouri, Columbia, MO

We highlight promising IPM approaches that can be readily implemented to support ecologically-based pest management via ECOstacking. First example involves the '*Botanical Triad*' of cash crop, trap crop, and insectary plants developed for organic cabbage agro-ecosystem. Second example presents a multi life-stage management strategy for plum curculio (*Conotrachelus nenuphar*), a key pest of apple, integrating attract-and-kill and biological control via soil application of entomopathogenic nematodes. We currently develop permanent trap cropping systems involving grafting perimeter-row trees with apple cultivars attractive to multiple pests.

Biodiversity promoting methods are expected to reduce chemical pesticide inputs and provide for more sustainable crop production.

3:30

32.2 • IPM for a crop, Anamika Sharma, anamika.sharma@famu.edu, Center for Biological Control, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, FL; R. Muniappan, IPM Innovation Lab, Virginia Tech, Blacksburg, VA

IPM has endured several changes over time and many definitions have been proposed to encompass the changes. Major emphasis in each IPM version has been the focus on single or multiple insect pests. IPM concept for a crop, however, has still not been considered seriously. Although IPM includes insect pest, disease, and weed management, every stress is addressed separately. Inclusion of all biotic stresses not only enables a practical IPM strategy but also provides a holistic approach to understand and evaluate appropriate methods. This holistic approach enables human and institutional capacity building and improved sustainability specifically in developing countries.

3:45

32.3 • Development of entomopathogens for the management of wireworms, Gadi V.P. Reddy, gadi.reddy@usda.gov, USDA-ARS-Southern Insect Management Research Unit, Stoneville, MS; David I. Shapiro-Ilan, USDA-ARS, SE Fruit and Tree Nut Research Unit, Byron, GA

Wireworms are major pests of spring wheat and barley. Currently insecticides are available as seed treatments. We use entomopathogenic fungi and nematodes to develop cost-effective management strategies. Nutritive carriers increased efficacy of EPFs via regrowth and conidiation. Fungi included *Beauveria bassiana* GHA, *Metarhizium robertsii* DWR356 and DWR2009. EPFs provided greater yields and cost-effective results at irrigated and non-irrigated sites in trials in 2017-2018. In the laboratory, *Steinernema carpocapsae* was effective against all three wireworm species. *Steinernema riobrave* was most virulent causing 62% *Limonius californicus* larval mortality, while *Steinernema feltiae* caused 50% mortality. Thus, microbial agents show promise for wireworm control.

4:00

32.4 • Cabbage-faba bean strip cropping: Biological pest control, crop compatibility and yield, Joonas Mäkinen, Joonas.makinen@uef.fi, Department of Environmental and Biological Sciences, University of Eastern Finland (UEF), Kuopio, Finland; Sari J. Himanen, Natural Resources Institute Finland and South-Eastern Finland University of Applied Sciences; Pirjo Kivijärvi, Natural Resources Institute Finland; James D. Blande, University of Eastern Finland

Strip intercropping is a method used in agriculture to regulate agroecosystem functions such as nutrient and water dynamics, but also to provide biological pest control and overyielding effects. The purpose of this experiment was to assess whether cabbage-faba bean crop combination offers biological pest control and overyielding, with minimal fertilization and without pesticides. We hypothesized that increased crop diversity would diversify and increase the effect of natural enemies and secondary metabolites, provide a complex canopy structure, increase yields, and reduce pest insect activity.

4:15

32.5 • Ecostacking: The way forward, Heikki MT Hokkanen, heikki.hokkanen@uef.fi, University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland; Ingeborg Menzler-Hokkanen, University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland

Despite great advances in IPM, global pesticide use has largely continued unaffected, with negative implications for farmer livelihoods, biodiversity conservation, and the human food systems. Recently, the whole concept of IPM has been challenged due to its ambiguity, inconsistencies in implementation, insufficient engagement of farmers, and lack of basic understanding of its ecological concepts. Ecostacking as an approach aims to stimulate the scientific community to develop, design, and implement integrated systems for optimised provision of ecosystem services and the use of plant protection tools, with focus on ecological, economic, and social sustainability of the integrated system.

33 • IPM of *Cannabis sativa*: Lessons Learned and Future Directions

Plaza Ballroom F

Recent legislation in the United States and around the world has legalized the production of hemp and/or cannabis. However, previous laws have prohibited agricultural research on the plant. Therefore, as this emerging industry is increasing worldwide, growers are left without a research-based integrated pest management plan. The sudden and rapid global increase in the production of this crop have left producers ill-equipped to manage the many pests that make cannabis and/or hemp their home. The goal of this session is to highlight the current research being conducted around the world and promote discussions on how to sustainably

grow this crop. Potential topics include the identification of knowledge gaps, insect, weed, or disease management successes and failures, challenges of researching a highly regulated crop, connecting and communicating with growers in an emerging industry, and developing international collaborations to move this crop into the future.

Organizer: Katelyn Kesheimer, kesheimer@auburn.edu, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL

3:00

33.1 • Priority Research Needs to Address Advancement of Integrated Pest Management Programs for Arthropod Pests of *Cannabis sativa* crops in North America, Whitney Cranshaw, Whitney.Cranshaw@ColoState.edu, Colorado State University, Fort Collins, CO

In the very short period that hemp and other *Cannabis sativa* crops have been legally grown in parts of the United States, arthropods associated with the crops have been able to be well described for most regions of North America. The information has subsequently allowed further development of components needed in Integrated Pest Management systems for several key pests of the crops, notably corn earworm (*Helicoverpa zea*) and hemp russet mite (*Aculops cannibicola*). At present pest management is presently most hindered by data gaps associated with arthropods that are strictly associated with *C. sativa* or have not had their association defined, and by limits on development of effective and crop-appropriate pesticides. A review of present key research/development needs are offered that involve Eurasian hemp borer, rice root aphid, hemp russet mite, and cannabis aphid.

3:15

33.2 • Small pest, big problem: Integrated Pest Management (IPM) strategies to manage hemp russet mite, Punya Nachappa, punya.nachappa@colostate.edu, Department of Agricultural Biology, Colorado State University, Fort Collins, CO; Chris Hayes, Olivia Carter, Whitney Cranshaw, Colorado State University, Fort Collins, CO

Hemp (*Cannabis sativa*) is quickly becoming a crop of agricultural importance in United States, yet pests associated with the crop and pest management needs are essentially undescribed. Among the most serious hemp pests is the hemp russet mite, *Aculops cannabicola*. Due in part to its minute size, hemp russet mite can go unrecognized by growers and the extent of its economic impact is likely underestimated. The current study is the first report of life history and the injury potential of the mite. We also evaluated the efficacy of biological control and chemical control in reducing mite populations.

3:30

33.3 • Landscape effects on the cannabis aphid, a vector of potato virus Y, Jacob Pitt, William.Pitt@colostate.edu, Department of Agricultural Biology, Colorado State University, Fort Collins, CO; Lisa Kairy, Department of Agricultural Biology, Colorado State University, Fort Collins, CO; Tess Christensen, Agro Engineering, Alamosa, CO; Punya Nachappa, Department of Agricultural Biology and Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO

Potato virus Y (PVY) poses a significant threat to crop production worldwide. The virus is vectored solely by aphids and is capable of infecting plants in many different families, including hemp. The goal of this study is to determine associations between aphid species, specifically the cannabis aphid, and PVY prevalence, and to then assess how crop diversity and percent cover of hemp in the landscape affect these relationships. Findings of our study can aid in development of disease mitigation strategies by identifying interactions between hemp, crop diversity, aphid vectors, and PVY prevalence.

3:45

33.4 • Industrial hemp in Northeastern Oregon: Developing integrated pest management programs, Tiziana Oppedisiano, tiziana.oppedisano@gmail.com, Hermiston Agricultural Research and Extension Center, Oregon State University, Corvallis, OR; Silvia I. Rondon, Hermiston Agricultural Research and Extension Center, Oregon State University, Hermiston, OR and Oregon Integrated Pest Management Center, Oregon State University, Corvallis, OR

Northeastern Oregon represents a growing region in terms of industrial hemp production per hectare. Pests commonly found on hemp in this region include wireworms, aphids, spider mites, corn earworm and beet leafhopper to name a few. The latter, causes damages vectoring *Beet Curly Top Virus* (BCTV). In 2021, we conducted a series of studies which included a general survey of pests in hemp, evaluation of the susceptibility of hemp varieties to corn earworm infestation, and evaluation of the efficacy of four organic insecticides against nymphs and adults of beet leafhopper and spider mites. All studies have helped us develop a better understanding of long-term pest management programs for the crop.

4:00

33.5 • Evaluation of fungicides against greenhouse hemp powdery mildew in Tennessee, Rufus Akinrinoloa, rakinrin@vols.utk.edu, Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN; Kimberly Gwinn, Toni Wang, Zachariah Hansen, University of Tennessee, Knoxville, TN

Hemp powdery mildew (*Golovinomyces ambrosiae*) is a common problem of greenhouse hemp in Tennessee. In four greenhouse trials, 15 commercial and 25 experimental fungicides were evaluated against powdery mildew on 'BaOx2' or 'Sweetened' hemp cultivars. Plants grown in 1-gallon pots were treated with fungicide treatments one day before or after inoculation with a powdery mildew conidial suspension ($2x10^5$ conidia/ml) and treated two more times at 7-day intervals. Disease data were collected weekly three times and compared with no-fungicide control plants. All of the treatments significantly reduced powdery mildew disease index by 55% to 100% compared to the control.

34 • Cotton Insect Management in Water-Deficit Production Scenarios

Plaza Ballroom E

This session assembles presentations on the topic of cotton insect pest management in water-deficit production systems. The presentations include the economics of the management of five insect pests of cotton in light of increased dryland acreages, irregular rain events, increased input cost, and market price uncertainty.

Organizer: Megha N. Parajulee, m-parajulee@tamu.edu, Texas A&M University AgriLife Research and Extension Center, Lubbock, TX

8:30

34.1 • Pest Monitoring is the Key to Successful IPM Program: A Case Study of Silverleaf Whitefly Management in Cotton and Vegetable Production, Apurba K. Barman, akbarman@ucanr.edu, University of California Cooperative Extension, Imperial County, Holtville, CA; Michael D. Toews, University of Georgia, Tifton, GA

Monitoring of insect pest populations is one of the cornerstones of successful integrated pest management programs. Information on insect population dynamics at temporal and spatial scale for a given area is critical to develop timely and location specific pest management strategies. A three-year monitoring study was conducted to document the spatio-temporal population dynamics of sweet potato whitefly, *Bemisia tabaci* in Georgia. We documented the time of the year when whitefly first become abundant as indicated by trap captures and when population declines significantly. Further, we were able to identify few locations within the sampling area of 24 counties in the southern part of Georgia. A study on available weed hosts of *B. tabaci* in the sampling area also provided information on the key weed species contributing to the abundance of whitefly. While weather conditions and availability of host plants, both cultivated and weeds, favor the high incidence of whitefly, it is possible to reduce the risk of whitefly incidence on major crops during summer and fall season by targeted management of key weed species and maintaining brief crop-free period in the winter.

9:00

34.2 • Management of Mid- and Late-Season Cotton Insects in Water-Deficit Production, Megha N. Parajulee, m-parajulee@tamu.edu, Texas A&M University AgriLife Research and Extension Center, Lubbock, TX; Dol. P. Dhakal, Abdul Hakeem, Katie L. Lewis, Suhas Vyavhare, Donna McCallister, Texas A&M AgriLife Research and Extension Center, Lubbock, Texas; Michael D. Toews, University of Georgia, Tifton, GA

The Texas High Plains is a semi-arid region with production agriculture supported by limited irrigation or rain-fed. As a result, the cropping system in this region is largely low-input and the producer decision-making in economically profitable input use is a challenge. The objective of this study was to quantify the impact of single versus multiple (sequential) pest infestations on cotton lint yield and fiber quality under three irrigation water regimes (water-deficit treatments). In 2018-2019, thrips and fleahoppers (early/mid-season) and thrips and *Lygus* (early/late season) were evaluated single versus sequential infestations each under two water-deficit (full irrigation and dryland) regimes, and three water regimes in 2020-2021, replicated four times. Water deficit conditions and insect infestations impacted crop growth profile as well as lint yield and fiber quality. In 2018 and 2019, lint yield was similar across all four treatment combinations under dryland condition while the sequential infestation of two pests (2018) and cotton fleahopper augmentation (2019) significantly reduced the lint yield compared to uninfested control under irrigated condition. In 2020, thrips and cotton fleahoppers significantly reduced lint yield in dryland and numerically lower yields were observed in irrigated treatments compared to uninfested control treatment. In 2021, thrips and thrips+fleahopper treatments significantly reduced lint yield compared to only fleahopper treatments in dryland, however, lint yield was similar across all insect treatments in low water and high water treatments, indicating the impact of drought conditions on modulating the effect of insect

pests as well as the plant's compensatory ability. The late season sequential infestations with Lygus bugs showed similar trend as observed in the early/mid-season pest sequence.

9:30

34.3 • Economics of Multiple Pest management in Water-Deficit Production Scenarios, Donna McCallister, donna.m.mitchell@ttu.edu, Department of Agricultural and Applied Economics, Texas Tech University, Lubbock, TX; Megha N. Parajulee, Texas A&M University AgriLife Research and Extension Center, Lubbock, TX; Michael D. Toews, University of Georgia, Tifton, GA

An economic analysis was performed to determine profitability for dryland, deficit, and fully irrigated treatments of cotton under thrips and cotton fleahopper pressure. Results indicated a decline in yield of 20%, 3%, and 28.7% compared to the uninfested control for dryland under thrips, fleahopper, and thrip and fleahopper pressure, respectively. In the deficit-irrigated scenario, yield declined 14%, 1.8%, and 8.3% compared to the control for thrips, fleahopper, and thrip and fleahopper pressure, respectively. In the full-irrigated scenario, cotton yield declined by 9%, 11.4%, and 24.6% compared to the control for the thrips, fleahopper, and thrip and fleahopper pressure, respectively. A partial budget analysis will include revenue and cost estimations.

35 • Managing Rodents Using Multiple Control Tactics

Plaza Ballroom F

Rodent control represents one of the pest control industry's most important markets, contributing to the bottom line of companies throughout North America and around the globe. And thanks to population growth, urbanization, and favorable environmental conditions, rodents are thriving. Against this backdrop of expanding rodent populations, it's more important than ever for Extension Specialists, Researchers, Public health Officials and Pest Management Professionals need to have a thorough understanding of the latest IPM techniques for managing these pervasive pests. No longer are trigger snap traps and rodent bait stations the only solution to rodent control. This session will cover some of the new technology being used as illustrated through result demonstration projects or cases studies on the research being done.

Organizer: Janet Hurley, jahurley@ag.tamu.edu, Texas A&M AgriLife Extension Service, Dallas, TX

8:30

35.1 • Welcome and Introduction to Session, Janet Hurley

8:35

35.2 • The Future of Rodent Management, Ed Dolshun, edolshun@catchmaster.com, AP&G/Catchmaster, Brooklyn, NY

This is an exciting time to be performing rodent control because of high-tech equipment such as sensors, trail cameras and changes in the equipment we use. However, for Extension Specialists, researchers, environmental health professionals, and PMPs they must first have a clear understanding of what causes drives and sustains pest invasions. In order to use this technology, we must first understand what we are dealing with and then how to use it to solve our most difficult rodent problems.

8:50

35.3 • Rats, rodenticides, and researching rats, Niamh Quinn, nmquinn@ucanr.edu, University of California Cooperative Extension, South Coast Research and Extension Center, Irvine, CA

The Southern California Urban Rodent Research Initiative (SCURRI) is a project researching urban rodent ecology and disease, their management, and the impact the management of rodents has on the environment. This session will cover how live trapping rodents has led to discoveries that could potentially change the dynamic of how we manage this nuisance animal. How these mammals have adapted and can transmit disease easily, will also be discussed.

9:05

35.4 • Exclusion Essentials: Keys to Successful Rodent Control, Matt Frye, mjf267@cornell.edu, NYS IPM Program Cornell University, Elmsford, NY

Most rodent problems in both commercial and residential accounts could be avoided by implementing a comprehensive exclusion program, but it requires a shared commitment between the PMP and the client. In this session participants will learn the secrets to preventing rodent problems before they begin by incorporating time-tested exclusion techniques into your rodent control program, including the use of sealants, door sweeps, and exclusion materials. In addition, attendees will learn how to conduct conducive condition inspections, enhance sanitation measures, and manage the surrounding landscape to prevent rodents from entering buildings.

9:20

35.5 • Using Biosecurity Dogs to Manage and Control Rodents, Megan Vick, megan@nrpdogs.com, Natural Resource Protection Dogs, Chesapeake, VA

Biological threats—whether invasive species of plants, animals and invertebrates or diseases— have unlimited potential to self-replicate, which makes them especially costly and dangerous. Dogs have a key role to play in "Biosecurity," whether through prevention, early detection, mapping infestations, or finding every last individual during eradication the role of dogs in rodent management is another tool. Building upon techniques from narcotics detection, cadaver detection, and search and rescue, we pioneered ways to use dogs' extraordinary sense of smell to protect wildlife and wild places. This session will cover a case study of rodent eradication for the Government of South Georgia & the South Sandwich Islands.

9:35

35.6 • Using Corteva ActiveSense system to measure rodent activity a look at data and how you use in IPM, Janet Hurley, jahurley@ag.tamu.edu, Texas A&M AgriLife Extension Service, Dallas, TX

In the age of new technology understanding the data and how that relates to an IPM program is essential. How do you use and train others on the how, whys, and benefits of using sensing technology for rodent management? Learning how the technology works is one portion, teaching PMPs, IPM coordinators, food safety managers and others to be observational biologists will need to shift so that the entire structure is pest free. Moving away from just checking bait stations and snap traps to offering IPM solutions.

9.50

35.7 • Mosquitoes, Rats and Flies–Oh My!, Claudia Riegel, criegel@nola.gov, City of New Orleans Mosquito, Termite and Rodent Control Board, New Orleans, LA

2021 saw two major hurricane events hit the City of New Orleans. Mosquitoes were not the main pest of these weather events, flies and rodents surfaced that required the team to change how they did vector management. In this session we will discuss a different approach to how to educate City leaders and the citizens so that rodents and flies did not become the main story after Hurricane Ida and Nick.

poster abstracts

P1 • A fresh perspective: Sysco's data-driven sustainability expansion

*Hannah Kasun[1], hkasun@ipminstitute.org, Sarah Laves[1], selaves@ipminstitute.org, and Shane Sampels[2]

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For over 15 years, Sysco has led the foodservice industry in environmental stewardship with canned and frozen fruits and vegetables. The company's program has centered on understanding current agricultural practices, promoting IPM initiatives and training to improve various facets of the supply chain. Beginning in 2003, Sysco implemented a grower survey focused on environmental questions, which has evolved into the annual Environmental Indicator Report (EIR). Since then, the EIR has tracked metrics that span pollinator habitat, soil health and resource conservation, while documenting inputs such as nutrients, water and pesticides avoided in the growing process. Using this annual report, Sysco recognizes where growers and suppliers have made impactful sustainable leaps though multi-year trends. The report asks growers to highlight success stories or challenges to help connect consumers to the realities of farm-level sustainability. This initiative has laid the groundwork for Sysco's next step: an expansion of sustainability into fresh produce across 350 Sysco Brand items. Sysco fresh produce suppliers will use EIR paired with the Sustainability Standard, a certification born in part from the partnership between Sysco and the IPM Institute of North America. Together, EIR and the Sustainability Standard will help Sysco track progress over time and continue to model environmental responsibility in supply chains.

P2 • Sustainable supply chains: Building a better apple at Honeybear Brands

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Honeybear Brands has been working with the IPM Institute of North America for over ten years to promote sustainability within their supply chain. Through this partnership, the TruEarth label was developed. TrueEarth is a certification for responsibly and sustainably grown fruit, requiring robust integrated pest management practice adoption to reduce pesticide use and risks over time. With over 400 TruEarth certified acres in 2021, Honeybear Brands' orchards are leading the way with sustainable practices. In 2020, Honeybear Brands expanded their sustainability initiatives to address sustainability priorities in packaging, food loss and waste, pollinator health and climate change, and committed to increase TruEarth acreage. Together with the IPM Institute's Sustainable Food Group, they developed SMART goals and metrics to annually track and report progress towards each commitment. Honeybear Brands uses a variety of metrics to track progress, such as utilization of refrigerants and electricity, pollinator habitat acres established and packaging material used. Honeybear Brands and Sustainable Food Group developed the metrics with input from various stakeholders, from growers to facility managers. From these efforts, the company is quickly progressing towards their sustainability goals and will continue to prioritize their values, environmental stewardship, and responsibility to consumers, along the way.

P3 • Online integrated pest management extension programming during the COVID-19 pandemic in South Carolina

*Tim B. Bryant, timb@clemson.edu, and Francis Reay-Jones

Clemson University, Pee Dee Research and Education Center, Florence, SC

The integrated pest management (IPM) program in South Carolina, funded by the USDA NIFA Crop Protection and Pest Management Extension Implementation Program (EIP) grant, is a statewide Extension implementation program tasked with improving producer knowledge about IPM strategies and increasing the adoption of IPM in field crops and specialty crops, in addition to promoting pollinator health. Traditionally, this program has relied heavily on in-person meetings, field days, trainings, and direct producer interactions. The COVID-19 pandemic introduced unique challenges for the program which has required a major shift in focus to online communications since March 2020. This has been an opportunity to substantially develop the online presence of the EIP program through the redesign of the Clemson IPM website, a more extensive use of social

media, creation of a Clemson IPM Newsletter, development of numerous online publications (including in the newly developed peer-reviewed Extension publication Land-Grant Press), development of IPM training videos, and development of a mobile application. In addition to the on-demand content listed above, numerous virtual training programs have been conducted, and an IPM open forum was hosted virtually in 2021 for all stakeholders in South Carolina to provide input for future programming. While there will eventually be a shift back to in-person programming, efforts will continue to maintain and improve the virtual presence of the program. While the pandemic presented unique challenges, it ultimately will strengthen the accessibility of the program moving forward by providing a range of online training programs to our stakeholders.

P4 • Evaluation of IPM online courses

*Tunyalee A. Martin, *Petr Kosina, pkosina@ucanr.edu, and Cheryl Reynolds*

University of California Agriculture and Natural Resources Statewide Integrated Pest Management Program, Davis, CA

As with most in Extension, the University of California Statewide Integrated Pest Management Program (UC IPM) extends science-based information via in-person meetings. In 2011, UC IPM delved into online courses with the goal of expanding our reach without losing the interactivity that can occur at in-person meetings and field days. Ten years later, UC IPM has 24 online courses. In 2020, online courses were taken 8,250 times and UC IPM reported 8,251 continuing education hours. Evaluations from UC IPM's online course participants show that these courses facilitate the adoption of IPM. Participants of online courses are surveyed to assess changes in knowledge and to improve the courses. Initial feedback from participants who took four of our newest courses on pesticides and pesticide safety show that 92% (458 responses) agreed and strongly agreed that their knowledge of the subject increased. A follow-up survey was sent to participants 3 to 6 months after the online course was taken. For the eight online course series focused on citrus pests, 65% of the respondents (77 responses) put what they learned into practice. Examples of behavior changes included those when monitoring ("Take my time when scouting as I now [am] more knowledgeable as to what I'm looking for."), targeted pesticide applications, ("By adding barrier treatments I was able to reduce the frequency of foliar spraying"), and improved timing of pesticides to ensure management success ("Timing based on day degrees").

P5 • Lessons learned from three years of organizing and facilitating IPM webinars

**Petr Kosina, pkosina@ucanr.edu, Cheryl Reynolds, Stephanie Parreira, and Tunyalee Martin*

University of California Agriculture and Natural Resources Statewide Integrated Pest Management Program, Davis, CA

In-person extension meetings are one of the common ways of extending new information from university experts to the clients in the field. While topics might be of interest for the audience in a broad geographical area, participation is usually limited to the audience within a reachable distance to the meeting venue. Presentations then need to be repeated in various locations, which puts an extra burden on presenters who spent many hours traveling to the meeting venues. In October 2018, the UC IPM program started the UC Ag Experts Talk webinar series to reach a broader audience and reduce the burden on presenters. Since then, we have facilitated more than 60 webinars lasting from 1 to 4 hours and helped many others who were starting with webinars in 2020 as the COVID-19 pandemic hit. We have worked with over 80 presenters with various levels of technology and presentation skills and helped them to deliver impactful presentations. Results of the feedback surveys implemented after each webinar indicate that 89% of respondents (n=2575) agree and strongly agree that the webinars were a good use of their time, 78% agree and strongly agree that they have gained new knowledge through webinars, and 63% of survey respondents (n=793) plan to implement at least one new technique, product, or practice they have learned during the webinars. Based on our successful webinar series we will present lessons learned from our experience such as the use of Zoom chat and polls to collect simple information or for knowledge checks throughout the webinar.

P6 • UC IPM diversity, equity, inclusion, and justice actions

*Tunyalee A. Martin[1], Elaine Lander[1], Stephanie Parreira[1], and *Whitney Brim-DeForest[2], wbrimdeforest@ucanr.edu*

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In 2020 racial equity issues were at the forefront in the news. That year, the University of California Statewide Integrated Pest Management Program (UC IPM) began their journey in earnest to learn and understand diversity, equity, inclusion, and justice (DEIJ) topics. A small DEIJ working group focused

on the goal to improve processes and policies and ensure UC IPM is diverse, equitable and inclusive. Activities included a breakout session at the annual planning meeting, time on monthly staff meeting agendas, a program-wide Intercultural Development Inventory (IDI), and a series of trainings led by the UC Davis Office of Diversity, Equity, and Inclusion. Initial conversations identified recruiting diverse candidates in hiring, hosting accessible trainings, and helping each other learn about microaggressions as priorities. The program-wide IDI assessment showed that our individual understandings formed a normal distribution along the IDI spectrum of complexity. Evaluation of the training series indicated 93% (58 responses) strongly and somewhat agreed that the content was applicable to their work and 95% (58 responses) strongly and somewhat agreed that the content was appropriate for their level of understanding. Evaluating success also includes understanding the barriers to success. One barrier is DEIJ activities are not specified in our position descriptions, so DEIJ work is in addition to our official duties. UC IPM anticipates continuing learning activities and redefining organizational culture to meet our goals.

P7 • Tactical Science Coordination Network: An effort to grow awareness and collaboration among biosecurity programs

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The Tactical Sciences Coordination Network (TSN) was instituted through USDA-NIFA-AFRI funding to improve coordination and leverage collaboration among a suite of programs that operate tactically and contribute to plant and animal biosecurity. The programs involved include the detection and diagnostics programs (National Plant Diagnostic Network—NPDN and National Animal Health Laboratory Network—NAHLN; the regulatory systems support programs (Minor Crop Pest Management—IR4, Food Animal Residue Analysis Database—FARAD, and Minor Use Animal Drugs Program—MUADP); and the deployment of new crop and animal production and protection technologies and management systems programs (Crop Protection and Pest Management—CPPM and Extension Disaster Education Network—EDEN). The project was initiated just before the pandemic, leading to a shift from planned in-person activities to virtual interactions. The expressed aim of the project is to address goals defined by NIFA from stakeholder listening sessions: improving effectiveness, efficiency, relationships and accountability. Initial goals were to identify shared concerns and to measure baseline data on familiarity among the programs. The first virtual meeting revealed that the programs shared concerns about communications, workforce development, lab standards, equipment obsolescence, surveillance, information technology, sustainability and industry relationships, and stakeholder input to NIFA. Data from larger surveys suggested that relationships exist in clusters among more like programs and some programs remain more isolated from others. Generally, plant-focused programs are better connected with other plant-focused programs, animal-focused programs are better connected with other animal-focused programs and regulatory-focused programs are better connected with other regulatory-focused programs.

P8 • Long-term impact of integrated pest management programs on pesticide use in North India

*Rajinder Peshin[1], rpeshin@rediffmail.com, Baljeet S. Hansra[2], Kuldeep Singh[3] Rakesh Nanda[1], Lovleesh Garg[3], and Rakesh Sharma[1]

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In India, integrated pest management (IPM) is a policy decision for pest management since 1985. IPM activities were intensified in the early 1900s. We conducted a field study to find out the long-term impact of IPM programs on achieving the primary objective of reducing pesticide use in cotton, rice and vegetable crops in the north Indian region of Jammu & Kashmir (J&K) and Punjab. The positive impact of the IPM observed were: i) development and adoption of bacterial leaf blight-resistant rice varieties in Punjab ii) negligible insecticide and fungicide use in rice cultivation in J& K, and iii) reduction in active ingredients of insecticides applied in cotton by ca. 66%. Rice crop in the subtropics of J&K, climatically similar to Punjab, by default is almost insecticide and fungicide-free. Since 2008, the pesticide use (a.i) and

applications in eggplant and okra have increased, and only the quantum of increase differs. Reduction in insecticide use by weight in cotton can be attributed to i) introduction of low volume pesticide and ii) cultivation of Bt cotton that has significantly reduced infestation of Helicoverpa armigera. The foremost factor affecting farmers' pesticide use decisions was that the pesticide industry through their sales outlets and outreach program is the main information source for pest management. To get IPM information to as many farmers for rationalizing and reducing pesticide use in agriculture, more extension needs to be done with mass media. In a vast country such as India, you cannot reach millions of farmers face-to-face.

P9 • "I See Dead Plants" podcast—Communicating IPM research to the public

*Edward Zaworski, zaworski@iastate.edu

Plant Pathology, Iowa State University, Ames, IA

The "I See Dead Plants" Podcast strives to educate the public in the area of integrated pest management (IPM). The focus is to make research and IPM related topics understandable to listeners from various backgrounds, levels of education, and professions. A majority of the content produced will be interview-style podcasts, having conversations with researchers about their work in pest management. This poster will illustrate how the podcast is made, future topics, where the podcast can be found, etc. The "I See Dead Plants" Podcast strives to educate the public in the area of integrated pest management (IPM), making unbiased, multi-state research and related topics accessible to listeners from a variety of different backgrounds, levels of education, and professions. With an estimated 80 million Americans alone tuning into a podcast every month, podcasting has rapidly expanded as a media phenomenon, connecting listeners to content produced by professionals and amateurs alike. "I See Dead Plants" seeks to bring integrated pest management to the forefront of this connection: breaking down the barriers between researchers and the public. The podcast's comprehensive interview-style dives into current focuses in research from their sources, providing important crop protection information to farmers, agribusiness, and educators. The poster illustrates the workings of the "I See Dead Plants" podcast, the creative minds behind the podcast, and possibilities for involvement.

P10 • New York State IPM Program's response to Spotted Lanternfly's arrival

Brian Eshenaur, bce1@cornell.edu

New York State Integrated Pest Management Program, Cornell University, Rochester, NY

After years of scouting and preparation, established populations of Spotted Lanternfly (SLF) (Lycorma delicatula) were confirmed in 2020. SLF was first confirmed on New York's Staten Island, quickly followed by locations in the lower Hudson Valley and isolated populations in Upstate NY. The NYS IPM program has a multi prong approach to help prevent damage from occurring to agriculture crops and to provide reliable information on this pest to NYS residents. With our partner institutions we coordinated strategies to reduce spread of SLF and minimize its impact. To share research data and news of sightings, NYSIPM established a Spotted Lanternfly Outreach Listserv and regularly scheduled Zoom meetings for Cornell Extension specialists, invasive species experts, and others. Over 100 individuals are currently on the listserv and many participate in monthly online meetings. Using numerous venues in 2020, our Spotted Lanternfly presentations reached over 400 educators and horticulture industry members. Due to the vulnerability of vineyards to damage by SLF, we established and maintain close communication with grape extension specialists. In turn, they provide outreach through their programming. In the first year of its arrival, we disseminated information through nine print and broadcast media services, made 51 social media posts with, a total of 34,707 views and 1,941 actions. New Yorkers' are becoming familiar with this invasive's potential for harm, and together we will continue to protect our environment—from backyards to vineyards.

P11 • IPM adoption perspectives from the regions: Barriers and recommendations

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Increased IPM adoption hinges not only on the future of innovative research, but also on the willingness of growers to adopt new IPM technologies. Adoption and diffusion of innovations can encounter many different challenges. By better understanding the barriers to IPM adoption, future research, extension, and education initiatives can

better target behavior change. This study sought to better understand the barriers facing IPM adoption from the perspective of state IPM coordinators. These professionals have the unique perspective of IPM on a state-wide basis. Overall, the participants ranked "high cost of practice" as the most critical barrier to IPM adoption. "Difficulty of implementation" and "lack of awareness" were also highly ranked as critical barriers to adoption. When asked about ways to increase IPM adoption, participants ranked "Improved cost-benefit analysis" as the most critically important. These findings demonstrate the importance of improved IPM economic cost-benefit analyses to accompany the promotion of new and existing IPM innovations. The need for more comprehensive extension and education programs is also demonstrated by these results.

P12 • University of Arizona Public Health IPM—Honoring and empowering tribal nations and indigenous peoples

*Shujuan Li[1], lucyli@email.arizona.edu, Dawn H. Gouge[1], Kathleen Walker[2], Kacey Ernst[3], Channah Rock[1], Alfred J. Fournier[1], Shaku Nair[1], Maureen Brophy[4], Peter C. Ellsworth[1], Trent Teegerstrom[5], Africa Dorame-Avalos[6], Irene Ruberto[7], and Heather Venkat[7]

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The University of Arizona Public Health IPM Team partnered with professionals and experts within the Native American communities in Arizona to promote Integrated Pest Management (IPM) as a solution to reduce pest-related public health threats. We responded to the needs of tribal communities on a wide range of public health related topics, including vectors such as mosquitoes and ticks. The majority of in-person educational events were organized and carried out on tribal lands. Multi-media outreach helped to maximize the impact of our education efforts. Across all training events, health and well-being of tribal community members were potentially improved by increasing awareness and knowledge of vector pests, public health pests, pesticide safety, and IPM practices in their environments. Nearly 950 tribal participants from 2019-2021 indicated up to an 80% increase in knowledge of pests and IPM topics following training events, and 100% agreed that they would use newly-learned IPM knowledge to empower their tribes to improve lives and communities by making better decisions about pest management. We engaged a variety of new underserved stakeholder communities challenged by pest issues, ultimately providing benefits from the implementation of sustainable IPM practices. The university experts, public health agencies and tribal groups involved in this program shared common goals to reduce environmental and human health risks for tribal members, and to enhance emergency preparedness within the communities. Tribal citizens and public health professionals have improved access to the latest scientific findings and best management practices to improve public and environmental health in tribal communities.

P13 • Pilot survey of dung beetles on cattle pastures in eastern New York

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New York State Integrated Pest Management, Cornell University, Geneva, NY

We conducted a pilot study to measure the species and diversity of dung beetles on two grazing beef and dairy farms in eastern New York. We also were testing the use of equipment designed to be a more effective way of collecting dung beetles than pitfall traps. Manure samples were collected weekly and placed into a modified berlese funnel and harvested beetles from May 1 to October 1. The total number of beetles caught were 1135. There were nine species of Scarabaeidae. Of these seven species were Aphidiini and two species were Onthophagini. The predominant species collected were Aphidiini. The following seven species of Aphidiini were collected : *Calamosternus granarius*, *Colobopterus erraticus*, Aphodius fimetarius, Otophorus haemorrhoidalis, Oscarinus rusicola, Teuchestes fossor, and Blackburneus stercorosus. We collected two species of Onthophagini that include Onthophagus taurus and Onthophagus hecate. This pilot survey is the precursor to a larger study we will conduct in 2022. We will sample on 10 farms across the state and compare the differences in dung beetle populations and species diversity with producers that use and do not use ivermectin and/or feed-through insecticides. We will also determine the life cycle time gaps of decreased dung beetle activity and possible opportunities for augmentation of certain species of dung beetles to fill those gaps as a means to recycle manure quickly to out compete horn, and face flies that are a major pest of cattle.

P14 • Evaluation of the USGA sand-based rootzone with various organic amendments for growing creeping bentgrass

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Addition of sphagnum peat as an organic amendment to sand-based rootzones has been recommended by the USGA when constructing golf greens. However, sphagnum peat can lead to environmental issues (wetland destruction) and agronomic issues (breakdown over time, hydrophobic soil, reduction in shear strength, etc.). Several other organic amendments (vermicompost, biochar, biosolids, etc.) are well known for their instrumental agronomic role as soil amendments in agriculture. A nursery green trial was established in September, 2015 at North Shore Country Club, Glenview, Illinois. The objective was to compare the substitution of the organic component in USGA's standard mix of 15% sphagnum peat (% vol), hereafter called A1. The experimental area consisted of 11 soil amendment(s) as treatments (A1, A2,... A11) in a CRD design and all were seeded with a 50%/50% blend of creeping bentgrass 'V8' plus '007' for turf establishment. Treatments were evaluated for root depth, visual quality, NDVI, dollar spot, nematodes, and silvery thread moss. Treatment A9 (5% biochar + 10% biosolids + 85% sand) had deeper roots than the USGA industry standard treatment. Treatments A9 and A5 (10% CarbonizPN soil enhancer + 90% sand) had higher NDVI and visual quality ratings than A1 on most dates rated. Other positive trends were observed. These results suggest certain organic amendments are viable alternatives to sphagnum peat in USGA spec golf greens.

P15 • Our beef with house flies: Understanding fly movement and behavior for risk assessment and improved fly management

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Despite their ability to transmit pathogens including antimicrobial resistant bacteria, house flies (*Musca domestica* L.) are most often considered simply as a nuisance pest in confined cattle operations. Consequently, assessments of their risk to animal health and proper management strategies are not well understood. A series of experiments investigated the risks associated with adult house flies moving bacteria within a cattle feeding operation, as well as utilizing adult fly feeding behaviors to improve management strategies. In our first study, adult house flies marked with pigmented powders were released from different points within a beef stocker unit. Positions of marked flies within the facility were recorded at multiple time intervals over 24 hours. Since most flies were observed on animal feed substrates, we performed two additional studies investigating house fly feeding behaviors in relation to cattle feed. In a second study, groups of adult female flies were released into cages with either roughage or concentrate feeds and observed for 30 minutes to record attraction to either feed type. Finally, we determined whether adult flies feeding on cattle feed mixed with diflubenzuron, a feedthrough insect growth regulator supplement, would affect viable egg production for female house flies. The results presented will provide information on 1) house fly movement within confined cattle feeding operations that might increase the risk of pathogen transmission, 2) attraction of house flies to different cattle feed types, and 3) whether fly preferences for cattle feed could be utilized for fly sterilization and control.

P16 • Handling invasive weeds in Migori county: An all-inclusive agenda for house holder food security

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In the recent past, there has been an influx of invasive weeds in Migori county, Kenya which has worsened the already bad food security issue. This has in part been as a result of climate change and improper weed management by stake holders. A variety of methods have been advanced to keep invasive weeds in check. Five main weed species that have been noted within the study area include dodder (*Cuscuta* spp), water hyacinth (*Eichhornia crassipes*), Santa Maria feverfew (*Parthenium hysterophorus*), cactus (Prickly pear) and striga (*Striga hermonthica*). These weeds, in addition with others and the changing climate have had a great impact on the elusive food security status in Kenya and Migori county in particular. A study was done in Migori couty to assess the perceptions of the people on the economic impacts of the above weeds mainly on food security and the methods used to control them. Guided questionnaires were administered by trained data collectors. Results showed that no one

method was effective for weed control. Of the sampled population, 35% reported a combination of various weed control methods including hand weeding, slashing, burning, allelopathy, crop rotation, pulling and use of chemicals for weed control. This population was able to report an increased crop yield by 43%. The study advocates for a combination of all the above methods for weed control.

P17 • Indirect effects of invasive insect management on forest insect biodiversity

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Numerous studies have highlighted declines in insect biodiversity due to climate change, habitat destruction, pesticides, and invasive species. Invasive species are arriving in novel habitats at accelerating rates and are the second largest threat to biodiversity. In agricultural systems, invasive insects disrupt established integrated pest management programs, as growers primarily rely on chemical control. Japanese beetle is an invasive insect species that recently established populations throughout the Midwest. Soybean growers manage this pest with 3-4 additional insecticide applications per season. Few studies have examined the effects of increased insecticides targeting invasive insects in adjacent natural ecosystems. In addition to non-target contact from pesticide drift, insects from natural habitats forage in agriculture crops and may experience negative effects from multiple insecticide applications. We investigate the effects of insecticide applications targeting Japanese beetle on forest insect biodiversity. Treatments consisted of soybean fields treated with three weekly insecticide applications and untreated control fields. We compared abundance and diversity of ground predators using pitfall traps and pollinators and natural enemies using sticky traps deployed throughout forest canopies. Samples were collected along 40 m transects from July through September. We found notable differences in species abundance and diversity among treatments.

P18 • Rot diseases on Michigan chestnuts: Pathogens, cultivar susceptibility and storage effect

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Brown rot, caused by *Gnomoniopsis smithogilvyi* (G.s.), is a pre- and post- harvest disease of chestnut. It is globally distributed and can cause losses of up to 91% of a grower's total harvest. Brown rot symptoms, characterized by soft, brown lesions on the kernel, increase over time in storage. To evaluate the effects of cold storage and host cultivar on symptom incidence and severity, three cultivars of chestnut in Michigan (cv. 'Colossal', 'Labor Day', and 'Benton Harbor') were evaluated for symptom incidence and severity at different time points after harvest in fall 2019 and 2020 using inoculated *G. smithogilvyi* and intact, untreated chestnuts (natural infection). In 2020, isolations were made from all chestnuts collected to identify other fungi that may also cause rot, and a subset of these were evaluated for pathogenicity on cv. 'Colossal' in fall 2021. Intact and inoculated cv 'Colossal' chestnuts exhibited the highest incidence and severity of symptoms. Chestnuts stored in the cold for 1-2 months exhibited lower symptom incidence and severity when compared to chestnuts left at room temperature. Fungi isolated from chestnuts were categorized into 17 morphological groups, with 2% of the 236 cultures isolated identified as *G. smithogilvyi* in 2020. These results indicate that brown rot symptoms in chestnut may be caused by more than a single fungal species and that cold storage suppresses symptom incidence and severity. Future research will focus on evaluation of fungicides for control of fungi associated with chestnut rot post- harvest.

P19 • Understanding pest biology and exploring monitoring options for Pacific flatheaded borer in walnut orchards in California

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Pacific flatheaded borer, *Chrysobothris mali* (Coleoptera: Buprestidae), is a resurging pest of walnuts, *Juglans regia*, in commercial orchards in California's Central Valley. The neonatal larvae bore into the wooded plant parts—twigs,

branches, limbs, and young tree trunks, and cause the dieback of the affected plant or plant parts. Reported as a problem of stressed weaker trees historically, flatheaded borer problem is being increasingly reported in, both young and mature, healthy walnut orchards for over five years. Since limited information is available regarding the biology and monitoring of this borer pest, we conducted studies to help understand the extent of the problem, determine pest phenology, and explore potential monitoring tools. Our study confirmed that Pacific flatheaded borer (PFB) is the primary species causing damage in California walnuts. Also, we found that the adult emergence occurs from May through July, with the peak activity in mid-June. In the last three years, we tested various trap designs and attractant types for monitoring PFB beetle activity. The findings and their implications are discussed. Future studies include generating more information on the biology of this pest and developing refined monitoring and management tools.

P20 • Improving in-row cultivation efficacy in carrots through seed selection and timing optimization

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Weed management in carrots is difficult due to their poor competitiveness and lack of effective herbicide options. We hypothesized that the efficacy and selectivity of early in-row mechanical cultivation could be improved through 1) use of large seed size fractions from a competitive cultivar ('Bolero'); and 2) development of a model to predict the optimal timing and type of in-row cultivation tools given different weed communities. In a field study, we evaluated the effects of three types of early in-row weed management (finger weeder, hilling disk or handweeding) and two carrot seed size fractions (large vs small seeds) on weed and crop survival and growth. We also collected height and root anchorage force data from carrots and five species of weeds at different early growth stages to parameterize a simple model of tool selectivity. In the field study, we found that larger seed size was correlated with greater carrot anchorage force and height but did not translate to improved tolerance to cultivation. A simple predictive model of selectivity based on our anchorage force and height data suggests that potential selectivity can be improved through 1) use of crop establishment strategies (including seed size selection) that increase carrot height or anchorage force relative to competing weeds; 2) tool choice and timing decisions based on weed species present. Future research will evaluate constraints and opportunities for practical application of these approaches for improving weed management in carrots and other vegetable crops.

P21 • Developing a degree-day model to predict overwintering carrot weevil emergence in Ohio parsley fields

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The carrot weevil (*Listronotus oregonensis*) causes significant crop losses to carrots, parsley, and celery in the Great Lakes regions of North America. To properly time insecticide applications targeting overwintering adults prior to oviposition, growers place monitoring traps on field edges throughout the Spring. However, a degree-day model based on cumulative trap catch may provide a less labor intensive, more reliable estimate of overwintering emergence. Although a degree day-model exists for carrot weevil in Nova Scotia, Canada, it is unclear if this model accurately describes weevil activity in Ohio. We used modified-Boivin traps to monitor overwintering weevils in Ohio parsley fields from April-June 2017-2019 and modeled adult emergence activity as a function of cumulative degree days ($CDD_{7.0\,°C}$). Emergence patterns varied between years and was influenced by presence of overwintered parsley in the field. In the absence of overwintered parsley (2017 and 2019), overwintering adults recruited to traps earlier and more quickly, with 50% cumulative emergence occurring at ~167 cumulative-degree days ($CDD_{7.0\,°C}$) and ~180 $CDD_{7.0\,°C}$, respectively. However, in the presence of overwintered parsley (2018), overwintering adults recruited to traps later and more slowly, with 50% cumulative emergence occurring at ~450 $CDD_{7.0\,°C}$. Our results support the Nova Scotia model, which estimates 50% adult emergence by 187 $CDD_{7.0\,°C}$, but also suggest that the utility of monitoring traps may be reduced by the presence of overwintered hosts.

P22 • Reevaluation of squash bug, *Anasa tristis*, thresholds in Virginia summer squash (*Cucurbita pepo*) systems

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The squash bug (Hemiptera: Coreidae), *Anasa tristis*, is a serious pest of cucurbit crops across the continental US, especially in summer squash (*Cucurbita pepo*) grown in Virginia. Using piercing sucking mouthparts, squash bug feeds on all above-ground portions of its host plant, often leading to leaf necrosis, marketable fruit loss, and even plant death. Although *A. tristis* nymphs contribute to much of the squash damage sustained throughout the growing season, current management actions are based on loosely established thresholds for only adult and egg mass life stages. Further, the nymphs are the most vulnerable stage to insecticides, and therefore are an important target for effective chemical IPM strategies. For this reason, our goal was to reevaluate squash bug life stage thresholds in Virginia summer squash and to identify squash bug densities that result in significant crop loss. In 2020 and 2021, we performed weekly egg mass, nymph, and adult counts for six to eight weeks in squash fields of at least 100 plants. Plants were randomly labeled as either "insect-free" plants (all egg mass and nymph stages were manually removed) or 'infested' plants (no *A. tristis* removed). Marketable and damaged fruit were also collected from each plant three times per week for three weeks. Insect count and fruit yield data were compared between infested and insect-free plants. Overall, our two-year study sheds new light on the relationship between *A. tristis* densities and marketable yield, offering squash growers valuable guidance through an IPM-focused lens.

P23 • Improving two-spotted spider mite management in high tunnel cucumbers

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High tunnels (HT) are a protected agriculture tool used among specialty crop farmers. The popularity of HTs falls on the low cost of construction and increased profitability by extending the growing season and protecting crops against extreme climatic conditions. Cucumber (*Cucumis sativa* L.) are well suited for HT production because of their vertical growth pattern allowing for space optimization and repeated flowering, offering multiple harvest opportunities. However, two-spotted spider mite (*Tetranychus urticae* Koch; TSSM) is one the primary pests of cucumbers in HT systems. TSSM sucks essential plant nutrients from the leaves, causing yellowed, mottling symptoms and eventual leaf death. TSSM often goes unnoticed by farmers until the damage is irreversible and the pest is difficult to control without conventional insecticides. Because there is inadequate knowledge of the TSSM behavior inside HTs, it is essential to evaluate the performance of this pest and possible management strategies optimized for HT systems. Here, we will present results from an experiment evaluating the susceptibility of cucumber cultivars bred for high tunnel production and the efficacy of biopesticides to manage TSSM. Cucumbers were grown in HTs across Indiana. Cultivar susceptibility was evaluated using the Horsfall-Barret scale across 10 varieties replicated within a single tunnel in a RCB design. Five commercially biopesticides (Bioceres, Insecticide's soup, Venerate, AzaGuard, Neem Oil) were evaluated in separate plantings of *Corinto* cv. in adjacent high tunnels. The information gained through this work can help growers select varieties that minimize TSSM damage and biopesticides that are efficacious at managing this damaging pest.

P24 • The art of attraction: Evaluation of vittatalactone, an aggregation pheromone, as an attractant for western cucumber beetles and possible synergies with plant volatiles

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Two beetle species, the western striped cucumber beetle, *Acalymma trivittatum*, and western spotted cucumber beetle, *Diabrotica undecimpunctata undecimpunctata*, are challenging pests of cucurbits in northern California. Damage to fresh-market melons is especially problematic. Western striped cucumber beetle in particular scar fruit rinds, rendering fruit unmarketable. Current management strategies rely mostly on applications of broad-spectrum insecticides. Growers scout the fields, but use manual searching in the absence of

monitoring tools. Fortunately, an aggregation pheromone has been identified (vittatalactone) and synthesized for the striped cucumber beetle (*Acalymma vittatum*), the eastern cucmber beetle (Acalymma congener). We examined and evaluated the attractiveness of vittatalactone in the field to western cucumber beetles across two seasons (2020, 2021). This study was conducted on two organic farms in California's Sacramento Valley. In both years, we deployed clear sticky traps that were either baited with vittatalactone or unbaited (control). In addition, we tested how a commercial floral lure affected attraction when combined with the aggregation pheromone in 2020. Also, we tested how each lure alone or combined affected attraction in a factorial design in 2021. Vittatalactone was attractive to both species of cucumber beetles, although the effect depended on time of season and crop growth stage. The floral lure was also attractive, while the addition of the floral lure to vittatalactone created a synergized attraction. The highest captures appeared to be at the end of the season when crop was harvested. These findings showed that vittatalactone could be a useful monitoring tool or a component of an attract-and-kill management approach.

P25 • Row covers provide sustainable resiliency to cucurbit pests

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Cucurbit crops are of high economic value and grown extensively on large as well as small acreages throughout the Midwest. Cucurbit production suffers from a number of key insect pests and diseases that, when managed poorly, limit production in this region. This includes: squash bug, *Anasa tristis*; striped cucumber beetle, *Acalymma vittatum*; spotted cucumber beetle, *Diabrotica undecimpunctata howardi*; squash vine borer, *Melittia curcurbitae*; bacterial wilt, *Erwina tracheophila*; and yellow vine decline, *Serratia marcescens*. Cucumber beetles and squash bug also serve as primary vectors of bacterial wilt and yellow vine decline, respectively. Since 2009, mechanical exclusion research studies have been conducted at University of Kentucky for these pests and diseases to find practical IPM strategies for organic and conventional growers on small to moderate acreages. Working on research farms as well as with local producers, these continuing studies address insect vector, disease, pollination, and weed management under row covers with the goal to provide a sustainable, practical IPM system for cucurbit producers. Previous years' trials have explored general pest management, biological control of bacterial wilt, natural enemy enhancement, micro-environment changes, and soil health. Studies conducted during 2021 have investigated pollination strategies with larger areas under row covers in order to scale the system to commercial acreages, weed management through use of cover crops, and the efficacy of fungicides applied through woven row covers. Local producers experimenting with the system provide novel innovations, validation of research farm results, stakeholder feedback, and early adoption of the systems.

P26 • Burkhard spore traps coupled with qPCR detect *Pseudoperonospora cubensis* sporangia in Michigan fields

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Cucurbit downy mildew (CDM), incited by *Pseudoperonospora cubensis*, is a destructive disease for Michigan's pickling-cucumber industry. The pathogen arrives in the state annually via an influx of airborne sporangia. In collaboration with extension educators and growers, Burkard volumetric spore traps were placed in seven Michigan counties in 2021 as an early detection tool. The spore trap tape was removed weekly. One-half of the tape was split into lengths corresponding to a 24-hour time period, processed in a DNA extraction and a multiplex qPCR assay with primers and probes that detect and differentiate among *P. cubensis* clade 1 and 2 and *P. humuli*. *P. cubensis* clade 2 infects cucumbers while *P. humuli* infects hop. *P. humuli* sporangia occur earlier than the influx of *P. cubensis* clade 2 as *P. humuli* overwinters in Michigan while *P. cubensis* does not. A positive or negative for DNA of the pathogen(s) was recorded for each 24-hour period. The other half was examined using light microscopy, however, sporangia of *P. humuli* and *P. cubensis* cannot be differentiated by morphology. Early detection via qPCR reaction was verified using light microscopy. CDM was verified on cucumbers on 14 July. *P. cubensis* clade 1, which prefers pumpkin and squash, was detected only on October 11; infection of these crops was not observed. Weekly qPCR results across Michigan's cucumber production regions were communicated via the website veggies.msu.edu, extension articles, and other outreach activities. Monitoring airborne sporangia and scouting are used to alert growers and provide recommendations to initiate fungicide sprays.

P27 • Evaluating new fungicides with the TOMCAST forecasting model to limit *Stemphylium vesicarium* on asparagus fern

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Purple spot caused by *Stemphylium vesicarium* affects asparagus spears and fern. Michigan growers use the TOMCAST forecasting model to time sprays of mancozeb or chlorothalonil to protect the fern. Growers typically discontinue sprays in September as reduced temperatures limit purple spot disease development. Our primary objective was to determine whether fungicides not currently registered for use on asparagus are effective against purple spot when used in conjunction with TOMCAST. The secondary objective was to determine whether the fungicide program should be extended into the fall. Two trials were established in a grower's 'Millennium' asparagus field with four replicates arranged in a randomized complete block design; 20' treatment rows were separated by 5' buffers. Plots were visually assessed for foliar purple spot using a scale of 0 (no disease) to 10 (100% disease, defoliation). In the first trial, seven fungicides were compared to chlorothalonil. All treatments were significantly more effective than the control. The premixes of pydiflumetofen + fludioxonil and fluxapyroxad + pyraclostrobin were more effective than the others; pydiflumetofen + fludioxonil was most effective. In the second trial, fungicides were applied according to TOMCAST until September 2nd or October 6th. Plots treated with chlorothalonil through October 6th had significantly less disease than plots treated with chlorothalonil until September 2nd. Registration of new fungicides proven effective against purple spot could improve fern health and enhance the use of the TOMCAST forecasting model. Extending the fungicide program beyond early September could offer additional protection in years when warm temperatures persist.

P28 • Effects of micro-rates of 2,4-D and dicamba on lettuce

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Off-target herbicide injury from 2,4-D and dicamba is an increasingly common problem for specialty crop growers in the Midwest U.S. Lettuce (*Lactuca sativa* L.) is a common specialty crop grown in Nebraska, but proximity to corn and soybean production leaves growers vulnerable to crop injury and significant economic loss. The goal of this study was to quantify crop injury and yield loss in greenhouse and field grown lettuce after exposure to micro-rates of 2,4-D and dicamba. Sublethal doses were determined based on a percentage of the maximum labeled rate and ranged from 25% to 0.01%. Tested lettuce cultivars included 'Green Forest,' 'Vulcan,' and 'Allstar,' and each was sprayed at seedling and mature growth stages. Plant injury ratings were recorded every 4 days after herbicide application until harvest, when final dry/fresh weight yield was determined. Dose response curves were generated to determine effective dose (ED) values and to relate drift rates with crop injury and yield loss. All lettuce cultivars were highly susceptible to both herbicides but the maturity growth stage showed higher tolerance. All cultivars at the seedling stage showed injury and yield loss at rates above 0.4% 2,4-D (1066 g ae ha^{-1}) and 5% dicamba (560 g ae ha^{-1}). At maturity, rates above 2% 2,4-D and 10% dicamba showed severe injury which resulted 100% yield loss. Dicamba residue concentration on lettuce tissue was strongly correlated with application rate when analyzed within 7 days, but by 16 days after application the relationship was less consistent. These results confirm the susceptibility of lettuce to relatively low rates of 2,4-D and dicamba and highlight the importance of drift mitigation efforts in the Midwest U.S.

P29 • Evaluation of table beet varieties for resistance to rhizomania caused by beet necrotic yellow vein virus

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Rhizomania, caused by Beet Necrotic Yellow Vein Virus (BNYVV), is a devastating soil-borne disease of table and sugar beets. BNYVV is vectored by a fungal-like organism, *Polymyxa betae*, that is difficult to control and persists in soils for many years. Previously, methods were developed to describe symptomology and severity of rhizomania infection on sugar beets. As sugar and table beets exhibit different morphological changes when infected with BNYVV, a novel disease rating system was needed to assess rhizomania infection on table beet. Utilizing published methods and the U.S. Department of Agriculture's grades and standards for table beets, a new categorization system, with disease rating values from 0 (healthy) to 5 (severe disease), was developed. Our objective was to apply the new disease rating system to eight commercially available table beet varieties, six with genetically resistance to BNYVV and two that are susceptible. The method was applied to a field trial in a grower's field in Newaygo County, Michigan in 2021. The field contained naturally occurring inoculum of BNYVV-infected *P. betae*; the trial was established as a completely randomized block design. One day after harvest, the beets were visually assessed for disease symptoms. All varieties exhibited some level of disease. The rhizomania-susceptible varieties ('Red Ace', 'Boro') scored the highest mean ratings (>4.33), which was significantly higher than that for all other varieties included in the study. Varieties resistant to rhizomania obtained scores ranging from 2.38 ('Redval') to 3.03 ('Palau'), suggesting that genetic resistance may be a viable option for combatting rhizomania.

P30 • Toxicity of newer insecticides to adults of *Trichogramma chilonis* Ishii. (Hymenoptera: Trichogrammatidae) in tomato under greenhouse condition

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Biological control agents are the most promising strategies in integrated pest management programme. Among the several biocontrol agents successfully adopted in the pest management strategies, Trichogrammatid parasitoids are one of the most leading species of biocontrolagents with well-known attention for the management of lepidopteran pests throughout the world. *Trichogramma chilonis* is one of the common egg parasitoid augmentatively released inmany agricultural ecosystems, but its efficacy can be severely curtailed by synthetic pesticidal applications. Eight insecticides and two biopesticides were evaluated to check their compatibility with the *Trichogramma* parasitoid. Persistent toxicity studies revealed that chlorantraniliprole, *Metarhizium rileyi* and *Beauveria bassiana* are short lived by causing less than 30 per cent mortality at five days old residues. Whereas, chlorantraniliprole + lambda cyhalothrin, emamectin benzoate, spinetoram and imidacloprid were found as slightly persistent. Further, thiamethoxam + lambda-cyhalothrin, thiamethoxam and spinosad caused more than 30% mortality of parasitoids even to the 15 days old insecticide residues and they were classified as moderately persistent as per the IOBC classification. Tricho cards tied to the tomato plants sprayed with insecticides showed varied degree of parasitoid emergence showing more than 80% reduction in adult emergence in thiamethoxam + lambda-cyhalothrin, spinetoram and spinosadand found moderately harmful. Whereas chlorantraniliprole+ lambda-cyhalothrin found slightly harmful and imidacloprid, thiamethoxam, chlorantraniliprole, emamectin benzoate, *B. bassiana* and *M. rileyi* are harmless. The study advices the plant protectionists in avoiding one with detrimental effects on this hymenopteran wasp with appropriate timing of application that controls the pests without adversely affecting their natural enemies.

P31 • Assessment of active compounds of *Azadirachta indica* and *Cymbopogon citratus* for *Meloidogyne* infestation prevention

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Plant-parasitic nematodes are major threats to global food security. In horticultural crops, approximately 21.3% yield loss occurs due to nematode population only. More than 4100 species of plant parasitic nematodes are reported, out of this *Meloidogyne* species is prominent and worldwide in distribution. The utilization of harmful chemical pesticides to reduce the nematode population may cause acute and delayed health hazards and harmful impacts on the environment. Several phyto-nematicides are available but none of them can efficiently control to *Meloidogyne* spp. infestation. Thus there is a great need for an eco-friendly, highly efficient sustainable control measure for this pest. Therefore in the present study, to control the *Meloidogyne* infestation, leaf extract of *Azadirachta indica* and *Cymbopogon citratus* were analyzed. Organic compounds present in extracts were characterized. In vitro analysis was conducted using three concentrations over 100 individuals of 2nd juveniles stage. Mortality status of nematode population by counting the live and dead individuals after applying a 100 µl of extract was recorded at different time durations i.e.24h, 48h and 72h. Results indicated significant variability towards different concentrations and durations for both the extracts. GC-MS profile of *C. citratus* and *A.indica* revealed the presence of diverse types of compounds in varying quantities. In such a way active compounds present in *A. indica* and *C. citratus* will be screened out. These compound /s based formulation will be available for IPM programs, especially in horticultural crops to minimize infestation of *Meloidogyne* species.

P32 • Investigating the mechanism of natural repellents and miticides for *Tetranychus urticae* Koch using electrotarsogram and behavioral studies

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Tetranychus urticae Koch (two-spotted spider mite, TSSM) is an agriculture pest with a host range of over 1,100 species of plants. TSSM has developed resistance to a variety of synthetic chemical pesticides due to its high fecundity and short generation time. Plant essential oils (EOs) have been recognized as a novel natural source of pest control that have less or no detrimental impacts to the environment and human health. The present study focuses on assessing the efficiency of natural-based products developed by a Canadian company. One of the main products *(102*) is found effective to control TSSM. A novel electrophysiological approach was developed to record the electrophysiological response from TSSM. Both electrotarsogram technology and behavioural assays were used to identify TSSM repelling compounds. By using a Gas Chromatogram-Flame Ionization Detector (GC-FID) linked to an electrotarsographic detection (GC-ETD), we have recorded that TSSM is sensitive to eucalyptol, thymol, and linalool, which are terpenoids commonly found in EO mixtures. In addition, we have screened volatile organic compounds with different functional groups, and we found that TSSM are sensitive to a series of carboxylic acids and a series of aldehydes which are typically detected by ionotropic receptors. Finally, the project investigated alternative uses and potential non-target impacts of product 102 for acaracide use. Product 102 was also tested as a potential fungicide against *Botrytis cinerea* Persoon and *Cladosporium herbarum* Persoon. To investigate potential non-target impacts, acute contact toxicity tests were conducted using product 102 on *Bombus impatiens* Cresson.

P33 • Establishing the mating disruption mechanism for San Jose scale in apples

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Since its accidental introduction in 1870, San Jose scale (*Quadraspidiotus perniciosus*) (Comstock) has been a patchy pest in apple orchards across the United States. In recent years *Q. perniciosus* has re-emerged as a critical pest of Michigan apple orchards. This pest has become harder to

control due to increased restrictions in pesticides and the difficulty in timing sprays. In recent years mating disruption has been studied as a possible alternative to conventional control methods. The San Jose scale could be a good candidate for mating disruption because males fly short distances to find immobile females. ISOMATE dispensers primed with *Q. perniciosus* pheromone were deployed at increasing densities from 0 to 926 per Ha in 0.08 Ha orchard plots. Field trials were conducted during the 2020 and 2021 growing seasons. Results support the hypothesis that *Q. perniciosus* responds to increasing dispenser densities via competitive mating disruption.

P34 • Evaluation of novel kairomone-based lures for attracting male and female tortricid moths in apple orchards

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Apple orchards are often attacked by several tortricid (Lepidoptera) pests, e.g., codling moth (*Cydia pomonella*, CM) and oriental fruit moth (*Grapholita molesta*, OFM) that are either key or secondary pests directly damaging the fruit. Sex pheromone-based lures have been used to monitor male moth populations and to control pest species directly through mating disruption. Increased capture of moths of both sexes by addition of plant-volatiles to pheromones has been shown in many previous studies. In 2021, we evaluated kairomone-based lures for optimal capture of both sexes of individual and multiple species of tortricid moths and quantified whether the addition of an aromatic compound would increase moth response to the lures. The results show that, across the entire season, Megalure and TRE2267 were very attractive to OFM. Captures of CM were statistically similar in trap baited with CML2-P, Megalure and Megalure + TRE2265. The lure TRE2276 was very attractive to OFM but was less attractive to CM in comparison to pheromone lure and Megalure. The addition of TRE2265 to Megalure did not improve the captures of female CM as their numbers were similar in Megalure and Megalure + TRE2265, but it did increase the number of female OFM. The addition of an aromatic compound significantly increased the response of OFM, but not CM, to the lures. Results are expected to increase the effectiveness of commercial lures used for monitoring of tortricid moths in apple orchards in New England.

P35 • Multi-cultivar grafting: Evaluating a novel low-cost, grower-friendly approach to monitor key apple pests

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Among several early-season insect pests threatening apple production in Northeast USA, plum curculio (PC) is the most important fruit-damaging pest early in the season. Two additional early season pests are the tarnished plant bug (TPB) and European apple sawfly (EAS). As part of a long-term study that aims at manipulating insect pest behaviour through host plant preference, we quantified the attractiveness of trees grafted with multiple cultivars to PC, TPB, and EAS in various Massachusetts apple orchards. The main goal of the research is to develop a low cost and environment friendly monitoring (and potentially attract-and-kill) approach for early season insect pests without using expensive lures. We monitored PC activity using unbaited black pyramid traps deployed near grafted and non-grafted trees and installed white sticky cards on the same trees to monitor TPB and EAS. The trapping devices captured more TPB, EAS, and PC in grafted trees than in non-grafted trees. The number of PCs captured by pyramid traps in grafted trees was around thirteen percent greater than that recorded on non-grafted trees. Furthermore, more PC oviposition injury was observed on grafted trees relative to non-grafted. However, further work is needed over multiple years to determine whether multi-cultivar grafting can be used as a 'trap crop' approach to bring multiple pests to grafted trees.

P36 • Testing the efficacy of *Cydia pomonella* pheromone lures: A two state Study

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Codling moth (*Cydia pomonella*) management has become more difficult as growers lose access to chemical sprays due to resistance and regulatory changes. Sterile insect release (SIR) has been shown to be an effective control method for codling moth, which unlike chemical control, is both economically and environmentally sustainable. Monitoring wild moth populations with the use of pheromone and kairomone lures is an important part of this integrated pest management system. However, pests

respond to intraspecific chemical cue differently across different geographical regions. In this project, we compared the efficacy of six lures on the male and female catch in Michigan and Washington over a two-year period. We found that in Michigan in 2020 average weekly male and female catches across the season were not affected by lure type. In Washington in 2020 we saw a significant difference when comparing average weekly male moth capture and lure type, however there was no difference in female capture rates. Finally, in Michigan in 2021 we found similar results to Michigan in 2020 where there was no difference between the lures in average weekly capture. This research can help explain why techniques used in one region are not always transferable to others and will contribute to our understanding of CM pest management under climate change.

P37 • Fruit protective bags as a tool for valuable insights into a devastating fruit rot of wine grapes

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Covering fruit with wax paper bags has been a common practice for commercial fruit production in some developing countries, acting as a physical barrier for exclusion of pathogens and pests. In this study, the bags were used as a research tool to investigate the infection behavior of the grape ripe rot pathogen, *Colletotrichum*. Over three seasons and in two vineyards, clusters of ripe rot susceptible wine grape cultivars were covered with the bags at various phenological stages and for various durations of time. Concurrently, Vaseline-covered microscope slides were placed in the vineyard every 7-11 days throughout the season and spores of *C. acutatum* and *C. gloeosporioides* complexes were quantified with qPCR. At harvest, ripe rot severity was assessed, and *Colletotrichum* spp. were isolated from symptomatic clusters. In all seasons, clusters that were not bagged during the late season (post-veraison) had significantly higher ripe rot severity than those that were protected during the late season. *C. fioriniae* and *C. nymphaeae* (*C. acutatum* complex) and *C. aenigma* and *C. fructicola* (*C. gloeosporioides* complex) were isolated in each season, and C. fioriniae was the most frequently isolated species. The spore traps detected DNA of both species complexes throughout the 2019 and 2020 seasons. Although, spores were present throughout the season, only clusters exposed during the late season were severely infected. This indicated that the late season is a critical ripe rot management period and the use of this simple bagging tool was able to reveal new insights into an important pathogen.

P38 • Peppermint response to mesotrione and S-metolachlor applied post-harvest

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Dose-response greenhouse trials were conducted at the Purdue University Horticulture Greenhouses, West Lafayette, IN, in 2021 to determine peppermint tolerance to mestrione and S-metolachlor herbicides. The experimental unit consisted of a 20 cm polyethylene pot containing an established 'Redefined Murray Mitcham' peppermint plant. Treatments included five rates each of S-metolachlor (0, 1000, 2000, 3000, and 4000 g ai ha-1) and mesotrione (0, 105, 210, 420, and 840 g ai ha-1) applied the same day of a simulated harvest and one day after harvesting, respectively. Data collection included visual crop injury on a scale of 0% (no injury) to 100% (crop death), plant height, and aboveground biomass harvested 42 or 52 days after treatment (DAT) for S-metolachlor and mesotrione trials, respectivey. Fresh biomass samples were oven-dried at 60°C for three days to achieve shoot dry weight. At 14 and 28 DAT, as S-metolachlor rate increased from 1000 to 4000 g ha-1, peppermint height was reduced 29 to 67% and 8 to 38%, respectively, and visual crop injury (necrosis, stunting, and leaf distortion) increased from 35 to 70% and 1 to 40%, respectively. By 42 DAT, plants had recovered entirely, and shoot dry weight was not reduced at any of the rates applied. In contrast, at 52 DAT, as mesotrione rate increased from 105 to 840 g ha-1, peppermint plant height was reduced 12 to 79% and visual crop injury (bleaching, stunting, and leaf distortion) increased from 4 to 84%, resulting in a significant shoot dry weight reduction of 42 to 98%.

P39 • Multiple pest management: Understanding the relationship between onion thrips and weed pressure

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Onion thrips, *Thrips tabaci*, (Thysanoptera: Thripidae) and weeds are economically devastating pests in organic onion (*Allium cepa*) fields. Onions must compete with weeds for nutrients and be able to withstand defoliation from onion thrips feeding. Throughout the season, onion thrips and weeds are found simultaneously in onion fields. To develop an effective multiple pest management strategy, it is important to understand how pests interact with each other. The objective of our study was to determine the effect of weed pressure on onion thrips populations throughout the 2021 growing season in an organic onion field in Michigan. We monitored onion thrips populations in experimental plots and recorded weed pressure until weed pressure reached 100% in each plot. Once weed pressure reached 100%, we hand-weeded half the plots to determine the effect of weeding on onion thrips populations. Weed pressure in the early season did not affect onion thrips populations. However, plots that were hand-weeded had significantly more onion thrips than plots that were not weeded. Onion thrips are polyphagous pests, and weeds found within plots may provide an alternative food source for onion thrips, thus reducing the number of onion thrips found on onions. Yet, growers should be cautious of weed pressure within their fields, as weeds directly compete with onions, resulting in decreased yields. Growers will always battle multiple pests simultaneously, and this research provides insight into the relationship between two economically damaging pests. Understanding this relationship will be important to developing an effective multiple pest management strategy.

P40 • Production of heirloom tomatoes on grafted rootstocks was highly variable in open field production in California

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Heirloom tomatoes are a high value, significant income crop to organic producers in warm, inland climates in California. Though valuable, high yield variability from year to year is commonly reported. Reasons for this include sensitivity to heat stress, soilborne disease pressure, insect pressure, and poor water quality, among others. Vigorous rootstocks for grafting are often developed to address such pressures. Numerous studies have shown improved soilborne disease resistance, increased salt tolerance, changes in insect attractiveness or disease resistance in the scion, and changes in scion growth that affect overall health and productivity using improved rootstocks. Over four years, six field trials were conducted evaluating two scions—heirloom tomato cultivars Brandywine and Cherokee Purple, and six rootstocks—Maxifort, Multifort, DRO138TX, Estamino, Fortamino and Espartano. Compared to non-grafted plants, scions grafted onto rootstocks can increase yield by 86% or decrease yield by 58%. The yield ranking of the rootstocks compared to each other and to the control was highly variable over the four years. Rootstock effect on fruit size depended on the specific rootstock/scion combination. In conclusion, when grown under non-disease conditions in open-field production, grafting does not consistently improve heirloom tomato production. Future work in California could look to evaluate rootstocks to specifically manage current and anticipated stresses including soilborne disease pressure, early or late season high tunnel production, poor water quality, and reduced inputs.

P41 • Forty years of onion pest management: Advances and challenges

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An integrated pest management (IPM) program for onions (and carrots) began as a pilot project in the Holland Marsh, Ontario, Canada, in 1980. The IPM program has continued, with a few breaks, since that time. The main onion insect pests and diseases in 1980 were onion maggot (*Delia*

antigua), and Botrytis leaf blight (*Botryis squamosa*). Cutworms (Nocutidae) and onion thrips (*Thrips tabaci*) were considered occasional pests, as were disease onion downy mildew (*Personospora destructor*) and onion smut (*Urocystis cepulae*). Onion maggot flies were monitored with yellow sticky traps and damage was assessed in grower fields. Onion fly populations have decreased from highs of over 100 flies per trap per day in 1981, with most fields having over 20/trap/day. In 2020, the highest onion fly counts were 13/trap/day and most fields had less than 5/trap/day. Insecticide sprays were applied to control onion flies in the 1980's. Now seed treatments are used for onion maggot and onion smut. Onion thrips are scouted twice a week. The spray threshold was increased from one to three thrips per leaf, as the newer insecticides are more effective. In 2021 thrips counts were below the spray threshold throughout the season. Onion downy mildew remains sporadic and the DOWNCAST forecasting program is effective at determining disease risk and spray timing. Botrytis leaf blight is rare, even when the BotCAST forecasting program indicates favourable weather for Botrytis. The most widespread, and difficult to manage, disease is now Stemphylium leaf blight (*Stemphylium vesicarium*); pathogen is insensitive to many fungicides.

P42 • Is DOWNCAST an effective model for predicting onion downy mildew in Ontario, Canada?

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Onion downy mildew, caused by the Oomycete *Peronospora destructor*, is a highly destructive foliar disease of onion, but does not occur every year in the Holland Marsh, Ontario, Canada. Symptoms develop 10–14 days after infection and fungicides must be applied prior to infection to be effective. Disease forecasting is used to indicate when no fungicides are needed and to properly time protective fungicide applications when there is disease risk. The integrated pest management program uses DOWNCAST to predict the risk of sporulation and infection based on temperature, relative humidity, leaf wetness duration and temperature in the days after infection. Fungicide sprays are also recommended if downy mildew is found in the region. Spore trapping was added to detect sporangia of *P. destructor* in the air. Rotorod spore traps are assessed three times a week. From 2012 to 2021, the forecasting program was accurate in eight of the 10 years, including two years where there was no disease risk, and no disease was found. Most years downy mildew developed 14–17 days after sporangia were found. While mostly effective, DOWCAST can be improved with trapping of sporangia.

P43 • Western bean cutworm presence in Maine sweet corn

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The University of Maine Cooperative Extension sweet corn IPM program monitors major sweet corn pest species at volunteer farms throughout the southern region of the state, including corn earworm, fall armyworm and European corn borer. Based on data from the mid-Atlantic states, where western bean cutworm, *Striacosta albicosta* (Smith), has become an import pest of corn, we set up pheromone traps for western bean cutworm in 2012 at seven of our sites. Western bean cutworm moths were captured at four, with most sites catching three to four moths over the season, and one site catching eight. Traps were set out again in 2015 at six locations. Counts for the season ranged from zero to eight moths per site. From 2019 through 2021 we set out traps at more locations and have observed increases in moth counts each year, with counts reaching over 100 moths in a single week during 2021. Although populations were variable from site to site, the first captures tend to occur during the third week of July and peak around the second week of August. In comparison to other major pest species, western bean cutworm tends to arrive earlier than fall armyworm, but later than corn earworm. Counts drop later in August, while corn earworm and fall army worm counts are often still increasing. Trap monitoring data from Maine suggest that western bean cutworm may become an important pest of corn here, as it has in other parts of North America.

P44 • Irrigation as a potato IPM component: Balancing in-field observations and soil water metrics

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Irrigation is an inextricable component of potato integrated pest management (IPM) because it influences microclimate conditions that govern canopy free-moisture duration, soil oxygen, and other factors affecting canopy and tuber disease development. For instance, excessive irrigation exacerbates

potato early die, caused by *Verticillium dahliae*, and can result in tuber losses greater than 30 percent. However, IPM is not the impetus behind irrigation technology trends. Water scarcity and sustainability concerns are catalyzing a shift to irrigation underpinned by digital technologies. Digital technologies for better soil water estimation improve soil moisture budgets and irrigation scheduling and increase water use efficiency. However, soil moisture probes and allied technologies also enhance IPM by measuring where moisture accumulation and depletion are occurring in the soil profile at a single point location. Optimizing irrigation scheduling based on soil tensiometer measurements has been shown to reduce common scab (*Streptomyces scabies*) by 30 percent while preserving yield. Moreover, modern technologies allow growers to view data and manage irrigation from miles away, granting greater autonomy; however, this autonomy may negate the utility these technologies provide to IPM. Soil moisture data alone are insufficient to manage irrigation and its impact on IPM. For instance, free-moisture duration in the canopy cannot currently be gleaned from probe data. Consequently, growers need to check fields routinely to determine if irrigation frequency should be adjusted for proper canopy drying to mitigate disease. In short, soil moisture probes and allied technologies can support irrigation and IPM; however, they should augment rather than replace in-field observations.

P45 • Using spring-seeded grass cover crops to reduce herbicide inputs in plasticulture peppers

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The objective of this study is to evaluate the use of spring-seeded grass cover crops as an integrated weed management approach in a bell pepper plasticulture system. The study was conducted at the Central Maryland Research and Education Center in Upper Marlboro, MD and was arranged in a split-plot factorial design with four replications. Factor A (cover crop termination) consisted of clethodim, paraquat or no herbicide/rolled. Factor B (cover crop) consisted of: 1) cereal rye (*Secale cereale*), 2) spring oats (*Avena sativa*), 3) cereal rye + spring oats, or 4) no cover crop. Factor C (residual herbicide) consisted of a residual herbicide or no residual application. The residual herbicide treatment of s-metolachlor + fomesafen was applied within 24 hours following cover crop termination. Cover crops were seeded in the bare-ground area between plastic rows approximately 7 weeks before the peppers were transplanted and terminated 4 weeks after transplanting. Plots were evaluated for weed control and density, and crop yield. Cover crop presence, termination method and residual herbicide application influenced weed control and density. All cover crop plantings were able to significantly increase overall weed control compared to no cover crop. Spring oats plots averaged 94%, 74%, 60% and 55% weed control 1, 3, 5 and 8 weeks after cover crop termination (WATerm), respectively. Further, cover crops were able to decrease broadleaf weed density by 80%, 57%, 51% and 55% compared to no cover treatments 1, 3, 5 and 8 WATerm, respectively. Plots terminated with paraquat showed significantly better weed control compared to clethodim and rolled plots at all evaluation periods. Similarly, plots that received a residual herbicide application had significantly less weeds than plots without a residual at each evaluation period. Cover crop treatments had significantly greater pepper yield (no. of fruit and fruit weight) than the no cover crop treatment plots. The greatest yield was in the cereal rye + spring oats treatment which increased pepper yield by 98% compared to no cover crop plots.

P46 • Evaluation of alternative strategies for management of soilborne plant pathogens and nematodes

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Research into alternative methods to conventional soil fumigation has been increasing over the past decade due to growing concerns with fumigants on human health, soil health and the environment. One such alternative strategy is the regenerative soils program being evaluated by BioSafe Systems, herewith referred to as BRSP. BRSP is an integrated approach primarily aimed to reduce/control soil plant pathogen/nematode population and at the same time improve the overall soil health through boosting of beneficial soil microbiome and structure. Program involves biochemical (Peroxyacetic Acid; PAA) and *Bacillus* based biological components applied sequentially immediately prior to planting and during crop growing season. Lab and greenhouse assays with these components against important soilborne pathogens/nematodes such as *Fusarium*, *Verticillium*, *Phytophthora* and Root Knot Nematode and field

research in crops such as Peppers yielded promising results in terms of reducing the pathogen/nematode populations in the soil, plant infection severity and overall improvement in crop yields. Objective of this poster presentation is to discuss in detail the components of BRSP and research associated with the program.

P47 • Assessing the impact of Ruby-throated Hummingbird predation on spotted-wing Drosophila in raspberry

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Hummingbirds require arthropods in their diet and may consume over 2000 small insects, including Drosophilid flies, per day when fledging young. In New York State, we investigated the use of feeders to attract Ruby-throated Hummingbirds into raspberry fields to encourage predation of the spotted-wing Drosophila (SWD) with the goal of reducing fly populations and fruit infestation. Baited traps were used to assess fly populations and salt flotation was used to assess fruit infestation. Over four years (2015-2018), 81% of 266 hourly observations of hummingbird behavior found the birds were occupying the raspberry planting when utilizing the feeders, supporting opportunities for predation on the SWD flies. During some of the weeks when high numbers of hummingbirds were observed in the unsprayed research plots (2016-2018), the number of the SWD caught in traps and found in fruit were reduced ($p \leq 0.05$) in the area of the field with 62 feeders/hectare, compared to the area without feeders. In two commercial raspberry fields (2020), in the one with 151 feeders/hectare significant reductions ($p \leq 0.05$) in fruit infestation and trap catch was found in most weeks during the fruiting season compared to the field without feeders. No Ruby-throated Hummingbirds were observed in the commercial field without feeders. Hummingbirds may protect fruit against the SWD when encouraged with feeders to visit and occupy raspberry plantings. Encouraging hummingbirds in raspberry fields with feeders or with nectar-producing plants has the potential for contributing to the SWD IPM program and reducing the reliance on chemical management.

P48 • Faunistic records of arthropods associated with elderberry in Missouri

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Elderberry, *Sambucus nigra* subsp. *canadensis*, is a native shrub that grows abundantly in many parts of U.S. The crop has recently increased in importance because of the human health-benefitting attributes of its edible berries. Efforts to bring it to mainstream production are currently underway in the Midwest, and like most crops, a successful and sustainable elderberry production will depend on effective pest management that addresses key pests. A major step in developing an Integrated Pest Management (IPM) program is to identify the key pests and pest natural enemies in the cropping system. This study was conducted to determine the presence and abundance of arthropod pests and associated natural enemies with a goal of developing an IPM program for key arthropod pests in elderberry production in Missouri. Different sampling methods were used to collect arthropods in three elderberry farms. Overall, 80 insect, 12 spider, and 3 mite species were found during the 2020 and 2021 elderberry growing seasons. The most abundant insect pests were elderberry borer, green and brown stink bugs, aphids, sawflies, Japanese and June beetles, Jessie's bug, and tarnished plant bug. The most common insect natural enemies found were spined soldier bugs, assassin bugs, several dragonflies and damselflies, hover flies, robber flies, soldier beetles, and several ground beetles. The mite pests found were two-spotted mites and two unidentified species. Two unidentified **phytoseiid** predacious mites were found. The results are discussed based on importance of the arthropods in the development of IPM for elderberry production in Missouri.

P49 • Integrated management of strawberry black root rot complex in a perennial organic production system

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Black root rot complex and crown rot of strawberry caused by soil-borne fungi limit sustainable strawberry production in the northeastern United States especially in perennial systems encompassing both matted row and plasticulture. As pathogen population builds up over time in the rhizosphere and infect root system, feeder roots are pruned that diminishes nutrient and water uptake to stunt plant growth or cause death. Many organic and small growers who can't use chemical fumigants due to new regulations and potential health hazards need alternative management options. This study was conducted by growing strawberry plug plants on beneficial microbes-inoculated or regular planting mix followed by transplanting in fruiting field plots that either were bio-fumigated with mustard cover crop, anaerobically disinfested (ASD) or left untreated. Different combinations of plug plants and field plot treatments were used to determine efficacy of individual treatment or synergistic effect from combination treatment. Plug plants were transplanted in pretreated plastic mulched raised beds and grown following a typical organically-recommended production system. Plants grown on TerraGrow (TG)-inoculated planting mix showed enhanced plant vigor in fruiting field compared with non-treated plants. Weeds grew through planting holes were significantly suppressed in ASD plots compared with non-treated. Plants treated with TG had significantly ($P \leq 0.045$) higher fruit yield in both years and the difference was greater in the second year. Plant survival in treated plots were also significantly higher in the second year compared with non-treated control. Results indicated that alternative fumigation methods could provide soil-borne disease suppression and improve yield.

P50 • The invasive *Aspidiotus rigidus*: A continuing IPM challenge in the Philippines

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The infestation of *Aspidiotus rigidus* in coconut palms is the first record of insect infestation that caused a serious economic downturn to the Philippine coconut industry. Ten million palms were severely affected coaxing the government to spend nearly 100 million pesos to stem pest proliferation, spread and rehabilitate coconut farmlands. Pest management strategies employed included regulated pruning of mature infested fronds, use of biological control agents such as parasitoids and predators, trunk injection of neonicotinoids, issuance of government policies and rehabilitation of devastated coconut lands. Successes in lowering pest population was achieved in Luzon and Mindanao but new areas in the Visayas Region were found infested. Moreover, the pest reinvaded the world's coconut germplasm collection in Mindanao. Studies on the molecular profile of the pest provided proof that the northern and southern populations are different and this may have implications in the formulation of sustainable IPM for the pest.

P51

Not being presented

P52 • A decision support tool to track Spotted Lanternfly (*Lycorma delicatula*) development with a network of on-site real time microclimate data streams in the Eastern United States

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The invasive Spotted lanternfly (SLF) was first detected in 2014, and its range has since expanded from Southeast Pennsylvania (USA) to include a broad cross-section of the Eastern US, threatening Mid-Atlantic and Northeast grape industries. The risk of damage and crop loss in vineyards is high, but new research provides a pathway for producers to reasonably estimate onsite SLF development using the

Network for Environment and Weather Applications (NEWA) online decision support platform. New research-generated information was used as a framework for the development of a SLF life-stage tracking model to 1) demonstrate that a fully-functional digital resource can be quickly put up for an invasive pest in a way that is widely accessible to vineyard managers and producers; 2) remove the obstacle of digital infrastructure development that is likely to slow or otherwise derail the near- and medium-term efforts of researchers; and 3) maintain a framework that facilitates easy and userfriendly implementation of future advances in knowledge and understanding of SLF life history and biology. Growers and researchers can access this SLF resource free of charge and obtain model output from any of the 750+ physical weather stations linked to the NEWA platform at https://newa.cornell.edu. Users can save customized SLF model output with a secure NEWA profile account and quickly get started with NEWA SLF using Knowledge Base resources at **https://newa.zendesk.com/hc/en-us/articles/4410555358999**.

P53 • DDRP: A modeling tool to guide decision making for pest surveillance and management

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Invasive pests present a significant threat to agricultural production in the United States, yet decision support tools that can accurately predict where and when to expect pests have not yet been fully developed and utilized. Here we present our spatial modeling tool known as DDRP (Degree-Days, Risk, and Phenological event mapping), which was designed to provide regularly updated forecasts of the potential distribution (risk of establishment) and timing of seasonal activities (phenology) of pests. We highlight some of our previous modeling work on 15 high-risk pest insects for the USDA APHIS PPQ Cooperative Agricultural Pest Survey program (**http://uspest.org/CAPS**) including light brown apple moth (*Epiphyas postvittana*) and small tomato borer (*Neoleucinodes elegantalis*). We then present our plans to extend DDRP's capacity to model a wider range of agricultural biosecurity threats including weeds and plant pathogens, and to engage citizen scientists in contributing observations for forecast validation. This will include building and validating models for five invasive species that have major impacts on U.S. agricultural production systems including spotted lanternfly (*Lycorma delicatula*) and cheatgrass (*Bromus tectorum*). We will iteratively improve model products based on stakeholder input and work with the USA National Phenology Network to solicit ground-based observations for use in forecast validation. DDRP will help decision makers conduct surveillance and management operations in the right place at the right time, allowing for rapid and cost-effective detections and responses to biosecurity threats.

P54 • Digital epidemiology: Tool for timely phytosanitary decision making

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The use of information and communication technologies, the internet of things, machine learning, and digital platforms with a user interface for data acquisition, visualization and analysis becomes an opportunity to achieve efficient processes in the evidence-based phytosanitary decisions. The objective of this work was to develop digital epidemiology tools using free software with the ability to integrate Google Earth Engine (GEE), Web search trends, field monitors, and phytosanitary risk models. The web application was developed in the Django framework, which allowed to develop the Back End in Python for the use of the libraries and database to analyzed. Additionally, the visualization was carried out using three types of languages: HTML5, CSS3 and Javascript. An easy-to-use graphical interface for farmers has been created through web access and mobile app. This interface allows the simultaneous download of GEE products, data upload from monitors, and implementation of machine learning and traditional algorithms for the acquisition, optimization, and analysis of trends in web, as well as the visualization of the risk probability of different phytosanitary problems. With this digital epidemiology tool, it has been possible to improve the management of information and prioritization of samples as a basis for making phytosanitary decisions in rice cultivation in Colombia, with a lower environmental impact, efficiency, and the optimization of resources. Specifically, we have developed an open access platform for the visualization of risk in rice diseases and how farmers can develop early warning systems for their management.

P55 • Data science: The challenges and opportunities in integrated pest management in the digital age

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Currently, many data science tools have been identified and applied for the use of epidemiological analysis as a basis for decision-making by public health programs. The versatility of data science can be exploited and applied in risk management and incorporated into integrated pest management plans in agriculture, generating better information management for decision-making. The objective of this work was to apply data science tools for information management and its incorporation into integrated pest management programs in important tropical crops. Our work was based on the use of data science tools using automated workflow using free software for (i) acquisition, (ii) cleaning, (ii) organization, (iii) visualization and (iv) data analysis. The data was obtained from nearby and remote sensors, historical monitoring series, trends consulted on the web and social networks, free access data for climate, topographic, edaphic, spectral variables, among others. Our approach makes a rigorous selection of data analytics tools to responsible uses based on the knowledge of basic mathematical principles, implementation, and validation of algorithms in free software and development of easy-access visualization interfaces for the end users. The results were able to synthesize the information into reliable, stable, and informative indicators for making phytosanitary decisions in tropical cropping system.

P56 • Divided by water, united by need: Development of a best pest management report card for Puerto Rico & U.S. Virgin Islands' farmers

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Educating farmers and backyard gardeners living in tropical climates about viable pest prevention measures and best farming practices will help lead them to sustainability, better land stewardship, fewer problems, and ultimately less food importation. We are developing an Integrated Pest Management (IPM) on-farm score card with user-friendly metrics so stakeholders can be exposed to key tools and practices to strengthen and protect their farming systems and surrounding environment. They will be encouraged to adopt new techniques that are adapted for their systems. Educating farmers and introducing them to a wide variety of IPM practices will increase adoption, and we will gain a means to measure impact. Risks and hazards, benefits and limitations will be examined and built into the metrics. Interdependency of parts and other complementary features will be emphasized. As practices are acquired, extension personnel will track what is being implemented and record the practices that work well together over time.

P57 • Understanding pest and natural enemy populatons in urban gardens

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Urban agriculture in the form of urban gardening is becoming increasingly popular in response to the COVID-19 pandemic. More landscapes are being converted to this urban agroecosystem. Understanding what populations of natural enemies, beneficials, and herbivorous insects are in these urban gardens can increase the knowledge base and fill the gap around arthropod and invertebrate food web dynamics in these urban agriculture systems. In order to fill this knowledge gap, we examined 10 urban gardens across Tippecanoe and Montgomery County in Indiana over the course of June, July, and August in 2021. The gardens were surveyed during each month to identify natural enemies, pollinators, and pest communities associated with urban

gardens. Collection methods included spot identification, pitfall traps, and yellow sticky cards. Predation services were measured using sentinel prey items. Sentinel prey items included wheatgrass plants hosting bird cherry-oat aphid (*Rhopalosiphum padi*) populations, tomato plants hosting *Manduca sexta*, and corn earworm eggs (*Helicoverpa zea*) secured to cards. Working in urban garden systems with local landowners and growers can present unique challenges, but this work is crucial to develop integrated pest management strategies tailored to urban growing. Through understanding what populations of arthropods are present in urban garden systems and mapping their trophic interactions, we can begin to identify similarities and differences associated with growing foods in urban environments, and we can glean strategies from rural and commercial production systems as well as develop resources specific to urban needs. The results from the garden surveys from 2021 will be presented.

P58 • Rhizobacteria modulates the oviposition behavior of corn earworm in sweet corn

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Plant Growth-Promoting Rhizobacteria (PGPR) represents specific strains of root-colonizing bacteria that can elicit increased plant growth rates, suppress soil pathogens, and induce systemic resistance against plant diseases and insect herbivores. Little is known about the effect of PGPR on the oviposition preferences of female insects. Here we hypothesize that PGPR treatment of sweet corn (*Zea mays*) affects the oviposition behavior of corn earworm (*Helicoverpa zea*) and interferes with the feeding behavior of its immatures. To test this hypothesis, sweet corn plants treated with two blends, a single strain, and the untreated control were used in the no-choice oviposition preference test. Blend 5 consists of PGPR strains AP 209 and AP 136, whereas Blend 8 consists of three strains AP 136, 218, and AP 219, and single strain AP136 were used in the experiment. The corn earworm exhibited reduced oviposition on sweet corn plants treated with select PGPR (*Bacillus* spp.) strains compared to untreated plants. Moreover, the leaf area damage inflected by the larvae was higher in untreated corn plants when compared with the PGPR-treated plants. Interestingly, there was reduced leaf area damage on the single strain treated plants, but there were high number of eggs were laid. When this single strain blended with other strain showed both a reduced number of eggs laid by the female corn earworm moths and less leaf area damage inflected by the larvae. These preliminary findings reveal that the treatment of plants with rhizobacteria may induce significant physiological changes with potential ramifications for plant-insect interactions.

P59 • Utilizing Integrated Pest and Pollinator Management Strategies to Improve Plant Production in Community Gardens

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Urban gardens often forgo the use of chemical pesticides for the sake of public health and the risk to pollinators but are challenged with detrimental pest outbreaks. Implementation of Integrated Pollinator and Pest Management (IPPM) was utilized to survey insect pests and pollinators in urban community gardens of Grant County, IN. Floral resources outside of vegetable crops needed to sustain pollinators and beneficial insects are lacking within urban community garden settings. Introduction of native plants into urban community garden is thought to attract beneficial insects; however, very little data exists on these interactions within the urban garden setting. A Before-After-Control-Impact framework was used to understand the impact that pollinator gardens established within urban community settings have on beneficial insect populations. Pollinator communities were assessed before pollinator gardens were established, assessed after garden establishment and compared to un-disturbed control patches. Pan and pitfall traps, sweep netting, sticky tape and active scouting were used to assess the initial pollinator and pest insect populations at all of the garden sites. Of the eight urban community gardens, four were selected to feature native plant pollinator gardens including Curfman's Community Garden, Boots Street Community Garden, 38th Street Alliance Garden, and Greenacres Community Garden. Initial survey results in all gardens yielded several insect pests including white fly (Aleyrodidae), leafhoppers (Cicadellidae), aphids (Aphidoidea). Among present pollinator species, several bee (Anthophila) and wasp (Vespidae) were observed.

P60 • Regional IPM Centers: Our shared mission and what it means

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The mission of the Regional IPM Centers is to champion the development and adoption of integrated pest management, the science of managing pests while protecting people, the environment and economy. Each Center engages broadly with stakeholders to identify and address regional pest priorities in agriculture, communities and natural areas. This infographic highlights the shared mission of the four Regional IPM Centers. The Centers are a valuable resource to the IPM Enterprise and our mission statement encompasses the diversity of IPM by highlighting important impacts. Illustrations expand on our mission by using examples of center operations, the services we offer, and IPM in general. Examples include what it means to manage pests, how IPM protects people, the environment, and boosts the economy, as well as specific examples of stakeholder engagement. Also included are the three areas mentioned in the mission including agriculture, communities, and natural areas. All of these aspects highlight the IPM Centers, the importance and scope of IPM, and potential for future collaborations.

P61 • NIFA awarded 77 Crop Protection and Pest Management proposals worth $19.79M

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The Crop Protection and Pest Management Program is one of the biggest programs that NIFA administers. Within CPPM are Applied Research and Development Program (ARDP), Extension Implementation Program (EIP), and the Regional Coordination Program (RCP) areas. The CPPM grant awards are given to meritorious projects that enhance the development, adoption, and implementation of innovative, ecologically-based, sustainable Integrated Pest Management (IPM) technologies, tactics, and strategies that address IPM priorities to ensure food security and effective response to other major societal pest management challenges. The impact of the funded research is enhanced by the establishment of communication networks to ensure active stakeholder participation in the setting of the regional, state and national priorities. The data we present in this Infographic poster is gleaned from our internal-use database, GMRA (Grants Management Reporting Application). After a stringent review process, 77 proposals were funded in the amount of $19.79 M in FY2021. Research proposals covering at least 42 specific commodities were submitted to ARDP program area alone. Topics of recurring submissions are on pollinator health and agricultural commodities such as soybean, corn, cotton, and tomatoes. We utilized Lingo3G Clustering Workbench for data visualization. This poster displays FY2021 metrics of all CPPM funded applications complemented with text cluster infographics of our RFA versus submitted projects. We will continue to refine our RFA and review processes to serve our stakeholders more effectively.

P62 • Effective educational tactics using common outcomes from IPM and the pesticide safety education program

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The IPM-Pesticide Safety Education (IPM-PSE) Collaboration Team is a national team of pest management educators dedicated to engaging stakeholders in the value of IPM

and PSE educational programming. The Team is supported by a US EPA cooperative agreement with Michigan State University. The Team sponsored two Focused Discussion sessions at a National Workshop in July, 2021. These two sessions brought together practitioners from both IPM and PSE to recognize that both programs are after the same outcomes and impacts for pest management, and that ultimately, their diverse yet complementary expertise strengthens those efforts. IPM and PSE are currently collaborating in six focus areas: 1) National Stakeholder Team IPM Working Group, 2) USDA Regional IPM Centers, 3) National Association of Landscape Professionals, 4) Pesticide Environmental Stewardship Website, 5) National IPM Coordinating Committee, and 6) School IPM Workgroup. The IPM-PSE Collaboration Team, through the focused discussions and other activities, have accomplished expanded awareness of and identified the diversity of IPM sites, programs and practitioners, as well as common goals and areas of work in the overlap between IPM outreach and PSE.

P63 • Eco-based pest management: "Push-pull" technology and companion planting in organic vegetables

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Sweetpotato whitefly, thrips and aphids are major insect pests in vegetable crops. The use of "push-pull" technology (PPT) and companion planting is a cultural control method, which may mitigate damage by these insect pests. "Push" crops repel pests away and "pull" crops draw them into trap crops, both components influencing behavior of the pest. Leafy greens were planted in late fall 2019 through winter 2020 in a tropical screenhouse at the Florida Research and Extension Center, Quincy, Florida. In this study, the "push" component of the PPT included potted repellent plants of mustard (var. red giant, caliente), arugula (var. nemat) and society garlic. "Pull" components evaluated included green leaf volatiles (GLV) such as leaf acetate because preliminary laboratory and greenhouse studies showed it is attractive to whiteflies. Additionally, flowering plants, such as marigold (var. French marigold), sweet alyssum and potted basil (var. African blue) were placed on the edges of the screenhouse to attract beneficial insects (as opposed to 'pull' factors on pests). Commercial "preda-lure" were placed near the basil plants. Population densities of insects throughout the season were monitored by taking weekly samples of sticky traps. Preliminary results indicate that sweetpotato whiteflies, aphids and thrips were common at relatively low populations. The pest's natural enemies collected were mainly lacewing and whitefly parasites, *Encarsia* spp. and *Eretmocerus* spp. In general, the eco-based pest management strategy of combining the "push" strategy of the PPT combined with "pull" of companion planting may control major insect pests of organic vegetables in enclosed structures.

P64 • Holistic biodiversity assessment of eight fruit and vegetable farms in western Michigan

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There is growing recognition that above- and below-ground biodiversity provides critical services to food and agriculture, including pest management, nutrient cycling, pollination, and system-level resilience. Gerber/Nestlé is a member of One Planet Business for Biodiversity (OP2B), a collective industry effort that aims to transform agricultural supply chains to maintain and enhance biodiversity. Scaling up regenerative agriculture practices is one of OP2B's main focus areas. To this end, Gerber/ Nestlé collected baseline above- and below-ground biodiversity data on eight fruit and vegetable farms in June—August 2021. Farms were selected and paired by crop, production practices (progressive/regenerative or conventional) and region. Soil samples were collected from each farm and submitted for soil microbiome analysis to measure below-ground biodiversity. Relevant beneficial insect groups were identified, and biweekly monitoring was conducted to measure above-ground biodiversity. Qualitative comparisons were drawn between pairs of farms to understand the potential influence of production practices on biodiversity indicators. Progressive/regenerative farms tended to have the same or higher soil microbial biodiversity and functionality than conventional farms, while production practices were not consistently correlated with insect species richness and evenness. These data will serve as a baseline by which to measure biodiversity indicators over time and to examine the effect of changes in production practices.

P65 • Pepper weevil (*Anthonomus eugenii*) infestations and their control in U.S. North Central region

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Pepper weevil has become an emerging pest in the North Central region of the United States. Unmarketable or damaged peppers are usually disposed of into cull fields. These disposed peppers have the potential to carry pepper weevil furthering the cycle of infestations. Adult pepper weevils emerge from these disposed peppers to infest clean cropping fields. This extension-based infographic aims to disseminate information to pepper farmers about best practices on how to prevent and/or manage pepper weevil infestations and give insight into the infestation cycle.

P66 • California rice, the "Environmental Crop"—Integrated strategies for pest management in a unique rice production system

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California rice systems are a unique production environment due to continuous annual flooding in combination with aerial seeding and chemical application practices. Many growers are incentivized to apply winter flooding to their fields to provide habitat for migratory bird species. These birds have been found to eat over-wintering insects and some weed seeds, and assist in incorporation of post-harvest rice straw which reduces the need for excess nitrogen fertilizers in the spring. Weedy rice (Oryza sativa f. spontanea) a conspecific of cultivated rice (Oryza sativa), is difficult to control in California rice cropping systems due to a lack of chemical control options and minimal crop rotation away from flooded rice. Research outcomes suggest that deep tillage (>5 cm) in combination with deep flooding (>15 cm) is a possible option for managing the weedy rice seedbank and reduce seed viability over time for those accessions with low seed dormancy. This is an over-wintering management strategy that is easily achieved with the winter flooding incentives program. Aerial seeding practices are also unique; they provide the opportunity for flooding pre-planting which reduces the prevalence of some weed species as well as insect issues associated with early rice growth. Aerial chemical applications are also beneficial because they do not allow for equipment contamination and movement of pests and diseases across the field. Here we present an ecologically-focused approach to rice production and the pest management benefits that present themselves in this environment.

P67 • Monitoring southwestern corn borer flights with pheromone traps in conventional field corn in Arkansas

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Southwestern corn borer is an important pest of non-Bt field corn in Arkansas. Monitoring for this pest is key to proper management and can be accomplished utilizing pheromone traps. In the absence of a monitoring program, growers often make prophylactic applications of an insecticide to prevent infestations. These applications can be costly, often averaging about $29/acre, but are not necessary if the pest is not present. County agents deployed southwestern corn borer traps in non-gmofield corn areas to monitor for this pest as a part of the Arkansas IPM program. Traps were checked weekly with updates reported to local growers and the state IPM coordinator utilizing the FarmDog program. Statewide numbers were graphed utilizing ARCGIS and posted weekly on the University of Arkansas System Division of Agriculture Cooperative Extension Service Row Crop Blog. Treatable populations were detected yearly in only 3 counties representing approximately 6,000 acres. In all other areas with large non-gmo acreage treatable levels of this pest were not reached. This translated to a total savings of $29/acre on 35,000 acres (>$1,000,000 total). This also reduced the amount of insecticide being applied to the environment by 2330lbs of active ingredient. The Arkansas IPM Trapping Program provides producers with a weekly update on SWCB populations. This data allows more information during the decision making process. This program can potentially limit or eliminate the need for costly pesticide applications and aid growers in making timely applications when needed, ensuring maximum profitability.

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P68 • IPM Strategic Plans for Ornamental Nurseries

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Oregon IPM Center (formerly the Integrated Plant Protection Center) at Oregon State University produces Integrated Pest Management Strategic Plans (IPMSPs) for Oregon's agricultural industries to identify critical IPM needs for research, regulation, and education. Oregon IPM Center worked with the Northwest Nursery Crop Research Center, USDA-ARS Horticultural Crops Research Center (Corvallis, OR) to develop an IPMSP aimed at identifying these critical needs for Oregon's ornamental nurseries and evaluate current IPM practices. Greenhouse and nursery are currently Oregon's top agricultural commodity, valued at $1.18 billion in 2020. The IPMSP workgroup consisted of 27 members representing university research and extension, wholesale and production nurseries, and state and federal regulatory agencies. The IPMSP identified key pests (insects, weeds, and pathogens) for different sectors of the industry, best integrated pest management practices, and multiple critical needs for IPM. Top priority critical needs for IPM included: education about BMPs or IPM practices for new or emerging pests, education about the implementation and utilization of natural enemies, research into new IPM strategies to control thrips and aphids, and the development of action thresholds for ornamental production pests. IPMSPs produced by the Oregon IPM Center are published through Oregon State University Extension Publications. This project was funded by the Northwest Nursery Crop Research Center, USDA-ARS.

P69 • Oregon IPM Center at Oregon State University

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The Oregon Integrated Pest Management Center (OIPMC), based at Oregon State University, promotes Integrated Pest Management (IPM) for Oregon and the Northwest region in agriculture and non-agricultural sectors. Our IPM Strategic Plans bring together farmers, researchers, and IPM experts to determine critical IPM needs. Crop Pest Losses Impact Assessments are intensive surveys that collect crucial economic data on seasonal pest pressure and production costs, and benefits of new technologies. Since 2019 we published IPMSPs and CPLIAs for seven commodities, with four more scheduled for 2022. OIPMC leads the Statewide IPM Committee, a working group designed to incorporate IPM into pest management by Oregon's public agencies. We host an annual IPM Research and Extension Summit at Oregon State University for the 100+ faculty working in IPM. We also producing a monthly newsletter and participate in IPM-related activities and events across the state. OIPMC manages USPest.org, a weather and climate driven support tool for pest managers nationwide. Users can access over 140 pest phenology models using 29,000 weather stations to predict local pest activity. Our new platform, DDRP (*Degree-Days, Risk, and Phenological event mapping*) helps detect new invasive pest threats and optimize monitoring and management actions. VegNet, a long-standing pest activity alert service for vegetable and specialty seed crops offers weekly reports of regional insect pest activity and how it relates to pressure within fields. A wide array of growers, home gardeners, industry professionals, and Extension agents use these tools to make informed pest management decisions.

P70 • From corpses to the farm: How forensic entomology can assist agriculture

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Animal remains, including human bodies, provide nutrients and protection to several insect species. This ecological interaction allows the estimation of the time when a corpse was colonized by insects, which can then be used as evidence to legal proceedings. Forensic entomology is often related with fields of medical entomology, taxonomy, and forensic pathology. In this infographic, we attempt to: 1) demonstrate the important role forensic entomology plays on the study of the insect diversity for agricultural and veterinary purposes, 2) show how forensic entomology studies allow the monitoring of insects that have the potential to benefit or harm food and animal production, and 3) provide insights on the importance of forensic studies to generate information related to decomposers and their role in the return of organic matter to the soil. In 2018, the first forensic entomology research projects in Zamorano University, Honduras were conducted in order to understand the diversity of insects that decompose animal carcasses. As a result of these projects, Zamorano University has established partnerships with the Forensic Biology Laboratory at the Medicolegal and Forensic Sciences Center

in Tegucigalpa, Honduras for further research collaborations with the objective to promote the growth of forensic entomology as a science in developing countries.

P71 • IPM crop survey in North Dakota

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Insects and diseases attack North Dakota's field crops, potentially causing economic losses in yield and quality, and blocking exports each year. Farmers need up-to-date data on the occurrence, distribution and severity of endemic and invasive pests that may rob them of yield and export markets. The NDSU Extension Integrated Pest Management (IPM) Crop Survey Program trains six to eight field scouts or insect trappers on pest problems of wheat, barley, soybean and sunflower. Scouts survey for endemic and invasive pests documenting their occurrence and severity, and helping farmers stay informed about pest problems. When economic pests are found, farmers are encouraged to use an IPM approach. IPM survey data/maps provide near real-time pest information to North Dakota producers and others in agriculture to assist with scouting and pest management decisions. Near real-time maps and data were made available to all stakeholders via the IPM website, NDSU Extension *Crop and Pest Report* newsletter, *Crop and Pest Report* website & Facebook page, and Extension meetings and field days. The NDSU Extension IPM Crop Survey helps farmers use IPM strategies for management of crop pests, and promotes the judicious use of pesticides for economic and environmental sustainability. This infographic summarizes outcomes and selected impacts of the IPM Crop Survey.

P72 • Integrated herbicide-resistant weed management practices: Current and future technologies

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Herbicides are primarily used for controlling weeds in commercial agronomic cropping systems in the United States. Widespread adoption of herbicide-resistant crops revolutionized weed control, making it easy, effective, and economical for growers. However, overuse of herbicides such as glyphosate led to glyphosate-resistance weeds due to repeated applications and selection pressure. Moreover, weeds are rapidly evolving resistance to multiple herbicides. Reducing the evolution of herbicide resistance requires the adoption of integrated weed management (IWM) practices. Currently, diversified weed management tactics such as field scouting, planting in weed-free fields, reducing selection pressure using multiple herbicide mechanisms of action at labeled rates and recommended weed growth stage, cultural practices suppressing weeds with crop competitiveness, mechanical and biological methods are recommended, and slowly increasing adoption. Advancing technology is another major component of IWM that is gaining momentum and providing modern technologies for effective weed control in near future. Sensor-based and image-analysis technologies such as unmanned aerial vehicles (UAV) or drones, remote sensing, robotics, and machine vision-guided precision sprayers will help in weed scouting, detection, mapping, and site-specific automated control. Using heat as flame weeding and electrocution/electric shock can control early-established and escaped weeds, respectively. Weed seed destruction techniques reduce weed seed banks and are becoming popular. Crop improvement such as stacked herbicide resistance, along with other advanced genetics techniques such as RNAi technology and gene editing will serve as new tools for weed control. Management of herbicide-resistant weeds is challenging, however, equally evolving nonconventional, unprecedented, and unanticipated weed control solutions incorporating the IWM principle hold a promising future.

P73 • Floral resources enhance fecundity, but not flight activity, in specialized aphid predator, *Hippodamia convergens*

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Adult aphid predators disperse across the landscape seasonally in search of patchily distributed and temporally variable prey aggregations. However, flight is energetically costly, consuming resources that could be invested in reproduction. *Hippodamia convergens* is an important aphid predator in North American cereal crops and other

agricultural systems. Floral resource consumption can enhance adult survival during periods of low prey availability and may improve reproductive success. We tested how an omnivorous adult diet containing floral resources interacts with body size to influence reproduction and flight behavior compared to a prey-only diet. Small and large beetles were produced by controlling larval access to food—3h daily access versus 24h *ad libitum* access. Reproductive performance was tracked for 18 days, and female flight activity was assayed via 3h bouts of tethered flight. Diet composition and body size interacted to influence preoviposition period, with large prey-only treatments delaying oviposition the longest. The omnivorous diet improved 18 d fecundity relative to a prey-only diet, but egg fertility was unaffected. Females flew up to 7 km in 6h, but neither body size nor diet influenced flight distance, suggesting that all treatments generated energy reserves sufficient to power flights of short duration. However, pre-reproductive females flew > 60% further than they did post-reproduction, likely due to the energetic costs of oviposition. Thus, access to pollen and nectar increased reproductive success and altered oviposition patterns in *H. convergens*, indicating the importance of floral resources in the agricultural landscape to conservation of this predator and its biological control services.

P74 • Feeding preference and mortality of *Osmia lignaria* bees exposed to two novel insecticides

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Two novel insecticides, sulfoxaflor and flupyradifurone, were recently registered and approved for use against sucking pests and have been effective against neonicotinoid-resistant insects. Both sulfoxaflor and flupyradifurone are approved for applications during bloom time, however, which increases the risk that foraging pollinators could be exposed to higher doses of the insecticides. Most research into the effects of pesticides on bee health has focused on honey bees (*Apis mellifera*). Because non-Apis bees can differ in their response to pesticide exposure, it is important to study the effects of novel pesticides on solitary bee species, as well. An important pollinator in North America is the blue orchard bee (*Osmia lignaria*), a native solitary species that is managed for its efficient pollination of fruit trees and vegetable crops. In this study, we exposed *O. lignaria* to doses of sulfoxaflor and flupyradifurone equal to or below the field use concentrations, in order to calculate the LD50 values of these insecticides. Both insecticides increased the mortality of *O. lignaria* at all doses for the female and at high doses for the males. Additionally, we evaluated preferences of *O. lignaria* for food containing low or high doses of these insecticides or no insecticides, but found little avoidance or preference behavior. Females avoided high doses of flupyradifurone, but did not seem to detect any other pesticide or dose.

P75

Not being presented

P76

Not being presented

P77 • MSU Enviroweather: Providing weather-based IPM solutions through alliances with Michigan agriculture

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It is evident to growers, researchers and crop production stakeholders that weather plays a significant role in agriculture. Insect and crop development are dependent on temperature, and periods when moisture is high due to precipitation and/or relative humidity are key to the cycles of disease development. Although many relationships between weather, crop production and pest management have been studied and predictive models developed to aid crop production, this type of information may not be easily accessed or presented clearly so that it can be used by growers for decision making.

Michigan State University's Enviroweather program is a free online resource that provides Michigan growers, farm managers, crop scouts and consultants with access to local weather information and a suite of weather-based tools to help manage a wide variety of crops. Available models include weather summaries, models that predict insect, disease and crop development and water-use tools. The inception, growth and application development for the Enviroweather network has been directed by the needs and priorities outlined by agricultural industries and commodity groups in Michigan. Of equal importance is the willingness of these agricultural stakeholders to provide in-kind and financial support for network operations and improvements. A survey of tree fruit growers in Michigan showed on average 0.3 to 0.5 fewer insecticide or fungicide applications as a result of using Enviroweather for each pest, per grower per year. Growers also reported increases of more than

5% in both crop yield and quality. Collectively, the use of Enviroweather-based information for Michigan apple and cherry was estimated to be more than $1.7 million dollars. Specific examples of how university, industry and governmental partners work together to provide critical IPM services to growers in our region are included in this presentation. This includes the addition and modification of weather stations to measure low level temperature inversions to guide frost protection and herbicide applications, and the development of need-based predictive models such as the Spotted wing Drosophila (SWD) Model for tart cherries, one of Enviroweather's newest applications.

P78

Not being presented

P79 • Regenerative agriculture: Benefits, barriers and call to action

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Agriculture is the largest single user of fresh water, the leading source of water pollution and soil erosion, and an important contributor to greenhouse gas emissions and biodiversity decline. Farmers, scientists and other agriculture leaders have suggested that regenerative agriculture is one way to help prevent these negative environmental and social impacts. Regenerative agriculture includes practices from around the world and draws from traditional and indigenous methods. Key principles and practices include minimizing soil disturbance by reducing tillage, using fewer inputs, keeping living roots in the soil, maintaining cover on soil year-round, maximizing biodiversity above and below ground through crop rotation and crop diversity and carefully integrating livestock. When evaluating the success of a system, this technique requires an outcomes-based approach and a paradigm shift, changing the focus from yield and stand-alone practices, to profits and holistic farm management. This approach can positively impact many areas such as soil health, water and air quality, carbon sequestration, biodiversity, pest management, climate and weather resilience, carbon sequestration, and farm profitability. Despite the many proven benefits, there are also barriers to regenerative agriculture. These can include a lack of a clear definition, limited technical and financial support and a lack of consumer understanding, among other challenges. Agricultural retailers, farmers, consumers and companies in the value chain can address these barriers to accelerate adoption of regenerative agriculture. This support from a diverse group of stakeholders is critical to effectively and systematically advance regenerative agriculture as one solution for some of today's most pressing challenges.

P80 • Building capacity for effective IPM implementation

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A myriad of national and international issues challenge the economic and environmental sustainability of global plant production systems. The adoption of increased technology, including IPM technology, will be essential to address many of these challenges, but improvement in sustainability will require a greater emphasis on systems level solutions. However, there is a shortage of broadly trained field professionals who understand the complex interactions affecting plant production systems and are capable of comprehensively diagnosing problems and managing production systems. In recent decades, calls for building increased capacity in agriculture have cited the need for more comprehensive graduate educational programs that increase the breadth and depth of knowledge necessary to deal with increasingly complex plant production systems. Therefore, building the capacity of agricultural professionals will require increased emphasis on systems and cross-disciplinary education and experiences. The Doctor of Plant Health (DPH) Program at the University of Nebraska–Lincoln, and the Doctor of Plant Medicine (DPM) Program at the University of Florida are interdisciplinary professional programs designed to educate high-level practitioners capable of managing across entire plant productive systems. Because of their interdisciplinary perspective, these plant doctors seek holistic approaches to forming and implementing sustainable integrated management strategies in complex plant systems. Graduates from the DPH Program all readily found employment opportunities in various sectors of agriculture ranging from consulting and applied research to agribusiness and extension. These plant doctors provide critical capacity toward solving the grand challenges in agriculture as we move into the future.

P81 • Potatoes to turfgrass: Promoting Extension's IPM initiative across the North-Central East coast of Florida

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Increasing the sustainability, profitability and competitiveness of agricultural and horticultural enterprises is a high-priority initiative of University of Florida IFAS (UF/IFAS) Extension and is outlined within the Florida Extension Roadmap. This roadmap specifies the important issues that guide UF/IFAS Extension agents in program development and delivery and defines an IPM Priority Working Group (PWG) to support the initiative. Specific PWG objectives include (1) increase development and adoption of IPM systems and (2) enhance pest identification and disease diagnostic services. As a UF/IFAS Extension Agent and a former IPM PWG lead, I have developed and delivered programs that promote the IPM initiative since 2014, from predominantly agricultural extension programs directed at large-scale vegetable producers in St. Johns County to turfgrass management professionals in Brevard County. Select program outcomes over seven years include the enhanced identification of potato seed soft-rot pathogens by farmers, adoption of insect and mite IPM methods by golf course superintendents and sports turf managers, and the development of a plant disease diagnostics triage lab in the Tri-County Agricultural Area. Since opening in the Fall of 2018, more than 150 plant samples have been processed, saving growers time and $6,000 in lab processing fees. Resulting recommendations have been made for more than 1,250 acres of high-dollar fruit and vegetable production. These programs, among others, were used to reach Extension's IPM objectives, and the outcomes and impacts of these programs across a variety of Florida's production systems will be presented.

P82 • Promoting integrated pest management in Big Sky country: Meeting the diverse needs of the Montana population

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Diverse sectors of the Montana economy depend on research-based integrated pest management (IPM) information. While agriculture is the largest segment of Montana's economy, the state's growing urban population has increased the demand for community IPM information. The Montana State University Extension IPM Program is supported by an interdisciplinary team of 11 specialists who provide critical, up to date IPM information to reduce health and environmental risk from weed, disease, and arthropod pest management. To meet the diverse needs of the Montana population, our program focuses on IPM implementation in agronomic crops, urban communities, and specialty crops in addition to supporting diagnostic facilities, delivering IPM education to pesticide applicators, and IPM for pollinator health. Our audience includes farmers, ranchers, home- and landowners, agricultural professionals, pesticide applicators, tribal communities, state and federal organizations, and private businesses. Our specialists work together to develop and communicate IPM information using various communication channels, such as workshops, grower meetings, fact sheets, videos, online resources, and traditional and social media to reach our audiences. The impacts of our program are documented through continuous evaluation. For example, the economic impact of the Schutter Diagnostic Laboratory on the state through diagnostic services amounted to $14.9 million from 2018 through 2020. This impact, in addition to those generated by our other IPM program areas, demonstrate the need for and success of IPM-based outreach and IPM implementation in Montana.

P83 • Better protected cowpea creates more business opportunities for women in West Africa

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Purdue Improved Crop Storage (PICS) bags have been proven effective for safe storage of cowpeas. They keep the cowpeas safe from insect damage and complete destruction; and avoid the use of chemicals that have severe health impacts. PICS bags also have a financial benefit, which is the focus of this poster. Street food vendors are critical entrepreneurs in the economies of developing countries. In West Africa women use cowpeas for two important products: dan wake and kosai. These popular "fast food" products are prepared and purchased regularly by people from all classes of society.This poster reports the results of research evaluating the increased profitability afforded street food vendors from using PICS bags to store cowpeas. Currently women purchase cowpeas every day. Our research examines the scenario of women purchasing cowpeas at harvest when prices are lowest, storing in PICS bags and using the cowpeas throughout the year. The economic benefits arise from the lower input prices for cowpea. Results reveal significant gains for the women entrepreneurs. Currently, the typical annual income for dan wake and kosai vendors respectively is 3526 U.S. dollars (USD) and 2860 USD, with both their revenue and cost of goods sold varying by market fluctuations and weather. We assume prices of other ingredients follow market trends, the women purchase all cowpeas at harvest (at the 10th percentile price) and use PICS bags for storage. The annual income for dan wake and kosai vendors respectively is then 3903 USD and 3177 USD. This represents very significant income in developing countries where most people earn under 2 USD per day.

P84 • Factors impacting soybean disease management decisions in Nebraska

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Fungicide resistance is a growing concern in Nebraska. Widespread Group 11 QoI (formerly Strobilurin) fungicide resistance in *Cercospora sojina*, causing frogeye leaf spot, was recently studied in the state, yet little is known about how the decision to apply foliar fungicides is made. To address this, we designed a survey to assess perceived importance of soybean diseases, reasons for foliar fungicide applications, and to identify the sources of information used. This was a 10-question survey with multiple-choice and short answer responses. Participants were recruited at University Extension row crop meetings. Results of 755 participants' responses from 78 counties represent soybean producers (81%), farm managers (1%), agriculture business representatives (8%), crop consultants (5%), Extension employees (1%) and others (4%). More than half (66%) of participants used or recommended foliar fungicides for soybean in the last 5 years. A few respondents (3.2%) mentioned using foliar fungicides for perceived plant health benefits. Factors that influenced application decisions were disease severity (34%), fungicide cost (31%), and crop market value (27%). The most cited source of information used to make disease management decisions was recommendations from the local agricultural co-operative service providers (50%) followed by University Extension (22%). Collectively, these results suggest that Extension programs should continue to appeal to a broad audience and consider how to better target co-operative service providers if we are to promote more sustainable use of fungicides and integrated disease management strategies.

P85

Not being presented

P86 • Distribution and management of soybean cyst nematode, *Heterodera glycines*, in soybean and dry bean fields in New York State

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Soybean Cyst Nematode (SCN), *Heterodera glycines*, is a plant-parasitic roundworm that is a major pest of soybeans and considered the pest of greatest economic concern. It has multiple hosts including dry beans and can cause comparable damage in dry beans. Typical aboveground symptoms are stunting of plants in irregular patches throughout the field, yellowing and wilting. However, yield loss can occur without obvious aboveground symptoms. Rotating away from a known host to something like corn has shown to decrease SCN levels by 50% the following year. Other management options include cleaning equipment before moving from a known SCN field to another field, planting resistant varieties or using seed treatments. The only way to know for sure that SCN is in a field and at what level is to take a soil sample. In 2017 only one county in NY, Cayuga, was known to be positive for SCN. In 2020, after surveying over 100 soybean fields, that number increased to 29 counties. In 2020 a preliminary survey was conducted in dry bean fields. Of the 8 fields sampled three were positive for SCN. We now know that SCN is present throughout NY in both soybean and dry bean fields. These results as well as those from the 2021 field season will be presented.

P87 • Integrated management of sudden death syndrome (SDS)—A disease of soybean caused by *Fusarium virguliforme*

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Field experiments were conducted in Illinois, Indiana, Iowa, Michigan, Wisconsin and Ontario, Canada in 2019 and 2020 to evaluate the integration of host resistance, seed treatment and seeding rates on sudden death syndrome (SDS) root rot, foliar symptoms which is caused by *Fusarium virguliforme* and yield. Seeds of a susceptible and partially resistant SDS variety were treated with either an industry standard base, base + fluopyram (ILEVO), and base + pydiflumetofen (Saltro) seed treatments. Three planting rates were tested (110,000 and 140,000, and 170,000 seeds/a). Overall, seed treatment with ILeVO and Saltro both reduced SDS foliar disease index. Saltro and ILEVO differed in reduction of foliar SDS symptoms (43.2% for ILEVO and 24.3% for Saltro). Yield did not statistically differ between seed treatments. ILEVO reduced root rot around 10%, but Saltro was not different from base. Seeding rate had no effect on foliar SDS symptoms but the highest seeding rate had increased root rot in 2019 and more yield both years. Performance of resistant cultivars was inconsistent across both years. In 2019, resistant cultivars reduced root rot by 8.9%, however in 2020, resistant cultivars had more root rot than the susceptible cultivar. Also, foliar SDS disease index was only reduced by the resistant cultivar in 2020. Integrating seed treatment, host resistance, and adequate seeding rates helped maximize yield in fields with SDS.

P88 • Peanut and nematode response to rotation sequence, cultivar, and chemicals applied at planting

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Crop sequence, cultivar, and nematicide or fumigation can affect plant parasitic nematodes and peanut yield. Populations of nematodes in soil and peanut yield were determined when the cultivars Bailey II and TifNV High O/L were treated with imidacloprid or imidacloprid plus fluopyram in the seed furrow at planting or metam sodium

was injected in soil 2 weeks prior to planting followed by imidacloprid at planting within ten different cropping sequences. Cropping sequences included continuous peanut and peanut planted at different intervals in combination with corn, cotton, and soybean over a seven year period of time. Main effects of rotation, cultivar, and chemical treatment were significant for peanut yield and populations of lesion, root knot, and stunt nematodes. The interaction of rotation by cultivar by chemical treatment was not significant for peanut yield or nematode population while the interaction of cultivar and chemical treatment was significant for lesion and stunt nematodes. Fewer nematodes were observed when the sequence between peanut plantings was increased or when soybean was not included in the rotation. Pooled over rotation sequence, lesion, root knot, and stunt nematode populations were lower for TifNV High O/L than Bailey II. Pod yield was greater for TifNU High O/L than Bailey II. Metam sodium was generally more effective in reducing populations of nematodes than fluopyram; fluopyram reduced nematodes in some cases more than the imidacloprid control. These results demonstrate the relative effectiveness of cultural practices including rotation and cultivar compared with chemical controls applied at planting.

P89

Not being presented

P90 • Crop rotation for rice systems in California: Baseline assessment of barriers and opportunities

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For California rice production systems, weed management challenges, and herbicide resistant weed species are a major threat to the long-term sustainability of California rice production systems. While crop rotations represent an IPM tool for weed management, rotations are limited in the Sacramento Valley due to the prevailing notion that heavy clay soils restrict the production of crops other than rice. However, little research has investigated the decision-making process and experiences of growers to understand current rotation practices and barriers to adoption. Interviews with rice growers (n=42) showed that perceived benefits depended on the type of operation. Roughly 47% of the growers interviewed were considered rice only growers. Twenty-eight percent were considered to rotate using conventional methods and another 24% were considered organic producers. Growers who rotated with conventional methods identified multiple benefits including weed management, soil health, economics, conservation, and input reductions. However, rice-only growers discussed rice land conservation and weed management as leading potential benefits, while most organic growers identified soil health and weed management alone. Although poor soil drainage was a dominant limitation mentioned by all growers, logistics for switching to other crops, profitability, limited market access, and limited resources such as production contracts, equipment, labor, and experience all pose additional challenges. In response, a multi-stakeholder California Rice IPM work group was recently established to address multiple economic and biophysical constraints.

P91 • Comparison of aerial and chemigation insecticide applications for western bean cutworm management

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Western bean cutworm (WBC) is an insect pest that can cause severe damage on corn ears by larval feeding. Inadequate insecticide application may lead to failures WBC control in corn. Exposing this moth to sublethal dosages may cause insecticide resistance. Thus, good coverage of treated plants should be the goal of pesticide applications. Most growers apply insecticides by airplane in intensive corn production, but spray coverage is not uniform. However, some growers apply insecticides by irrigation system (chemigation), but there is limited information for chemigation efficacy, particularly against this pest. Therefore, the goal of this study was to determine which application method would provide better insecticide efficacy for WBC management. Experiments were conducted in a spray chamber where first, second and third instars of WBC were exposed to the highest and lowest label rates of Brigade

(bifenthrin) and Prevathon (chlorantraniliprole). Carrier volume for aerial application was 2 gallons per acre, while for chemigation was 0.25 ac-in. After spraying, 20 neonates or 10 second/third instars were transferred to each Petri dish (four replicates per treatment). Mortality was recorded 16 and 24 hours after infestation. Larvae that did not move for at least body length after gentle prodding with a paintbrush, were considered dead. Overall, results showed that areal application provided better WBC control than chemigation. Within chemigation, Prevathon treatments were effective at both rates for all instars, while the high rate of Brigade provided better control than the low rate. However, Brigade treatments are not effective as they used to be.

P92 • Agronomic and pesticide decisions for managing ear rots, mycotoxins and quality in Michigan corn silage

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Toxic secondary metabolites, mycotoxins, accumulate in corn silage due to ear rot infections caused by *Fusarium*, *Aspergillus* and *Penicillium* spp. and cause yield and quality losses. Lately, increase in ear-damaging insect flight and favorable environment in the Great Lakes region have intensified infections. A survey across Michigan confirmed presence of at least 10 mycotoxins. Therefore, exploring strategies involving agronomic and pesticide decisions to manage insects, ear rots, mycotoxin accumulation, and silage quality is crucial. Multi-location field trials were conducted across Michigan from 2019-21 to study role of planting date (from late April to early June), seeding rate (from 70,000 to 115,000 seed ha-1), hybrid selection (with variable insect protection traits), and fungicide application in pest management. Planting date trials showed that planting corn between late-April to early-May can help escape highest insect and disease pressure when corn is silking (susceptible stage) and had highest yield (17.5 Mg ha-1), forage digestibility (20% higher than other plantings), and milk yield, thus, indicating better quality. Insect damage seemed to increase with increasing seeding rate and a quadratic relation was observed between seeding rate and silage yield. Results show that the use of hybrids with dual insect protection trait (against Western Bean Cutworm, WBC; and European Corn Borer, ECB) had 80-90% lower ear damage (both insect and ear rot) and mycotoxin concentration than hybrids without any insect protection trait. Fungicide was seen to reduce ear rots and mycotoxins (50-70% reduction) under low pressure (<20% incidence). Hybrid selection and fungicide did not seem to improve the yield and quality. Overall, it was seen that a combination of strategies can help escape reduce ear damage, reduce mycotoxin quality, and improve dry yield and quality.

P93 • The effects of planting population and nitrogen fertility on severity of tar spot of corn

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Tar spot, caused by the fungus *Phyllachora maydis*, is a foliar disease of corn (*Zea mays*) recently introduced to the US. Tar spot was first identified in the US in 2015 and is now affecting corn production across the Midwest with its range expanding each year. In 2019 and 2020, separate field studies were conducted to determine the relationships between nitrogen (N) application rate, planting population and tar spot to better understand how to manage this new disease and help growers reduce yield losses. Nitrogen fertility and planting population are known to influence disease dynamics in several different pathosystems. Nitrogen fertilization can increase disease susceptibility by altering host physiology, biochemistry, and increasing vegetative growth. Planting population can affect disease susceptibility by increasing resource competition and can alter the canopy microclimate, potentially changing the favorability of the environment for infection by fungal pathogens. Disease severity data were collected from five site years for N application rate trials and seven site years for planting population trials from across Michigan. Nitrogen application rate was found to have no significant effect on disease severity at any locations. Plant density was found to have a significant effect on disease severity at multiple locations across both years with higher plant densities resulting in lower disease severity. Hybrid susceptibility had a consistent significant effect on disease severity demonstrating the importance of using resistant hybrids. The yield data analysis suggested than an integrated approach using high plant densities of a partially resistant hybrid best protects against yield losses.

P94 • Phenotyping hessian fly resistance using spectral and surface model drone maps

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Hessian fly, *Mayetiola destructor* (Say) (Diptera: Cecidomyiidae), is an endemic pest reducing wheat yield in most of the world, excluding Australia. The most effective strategy for managing the damage potential of Hessian fly (HF) infestations is to leverage genetic resistance in wheat cultivars. There are over 30 genes that attribute to HF resistance, and there are multiple biotypes of HF. The variety of wheat and HF genetics lead to a complex problem of developing cultivars that maintain reliable resistance while providing favorable features to producers such as disease resistance, drought tolerance, and high yields. Wheat breeders have the responsibility of testing thousands of varieties to identify suitable cultivars to bring to market. Conventionally, HF resistance or susceptibility is scored manually, which is a time-intensive task. We propose using spectral and surface model data collected from drone-based imagery to increase the efficiency of evaluating HF resistance under field conditions. In Fall 2020, we planted susceptible and resistant varieties and we manually infested these cultivars in a randomized block field experiment. Susceptible wheat varieties responded to HF pressure by changing color and were stunted compared to resistant varieties. Both signals were identified in the drone imagery we collected throughout the growing season. This proposed approach of classifying wheat using remotely sensed data could help improve phenotyping and increase the availability of new HF resistant wheat varieties.

P95 • Integrated effect of row spacing and herbicide programs for control of multiple herbicide-resistant Palmer amaranth in corn

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Multiple herbicide-resistant Palmer amaranth is among the most troublesome summer annual broadleaf weeds across the mid-south, southeastern, and north-central United States. It has evolved resistance to number of herbicide sites of action. Agronomic and weed management strategies are required that can alleviate the evolution and spread of multiple herbicide-resistant weeds. Integration of narrow row spacing with herbicide application might augment herbicide efficacy for the management of multiple herbicide-resistant Palmer amaranth. The objectives of this study were to determine the effects of row spacing and herbicide programs for management of ALS-inhibitors, atrazine, and glyphosate-resistant Palmer amaranth in glyphosate/glufosinate-resistant corn. Field experiments were conducted during the summer 2020 and 2021 in a grower's field infested with ALS-inhibitors/atrazine/ glyphosate-resistant Palmer amaranth near Carleton, NE. With 76cm row spacing, Flufenacet/isoxaflutole/ thiencarbazone-methyl fb Glufosinate and Glufosinate fb diglycolamine salt of 3,6-dichloro-o-anisic acid/tembotrione provided 95% to 99% season long- control of ALS inhibitors/ atrazine/ glyphosate -resistant Palmer amaranth. Whereas, with 38cm row spacing, Acetochlor/flumetsulam/ clopyralid fb Glufosinate provided 95% to 99% season long- control of ALS inhibitors/ atrazine/ glyphosate -resistant Palmer amaranth. However, Acetochlor/mesotrione fb Glufosinate performed better in multiple resistant palmer control at both 38 and 76cm row spacing. The results of this research illustrate that integrated approach is available for season long control of multiple herbicide resistant Palmer amaranth in glyphosate/glufosinate-resistant corn.

P96 • Koch's postulate of *Macrophomina phaseolina* on hemp and crops in rotation

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Industrial hemp (*Cannabis sativa ssp. sativa*) production in Missouri was a relatively new addition to the 2021 growing season. As a result, fifteen new sample submissions for hemp disease diagnosis were submitted to the MU Plant Diagnostic Clinic. Of note, putative samples of charcoal rot (*Macrophomina phaseolina*) were received in the summer of 2021. The objectives of this study were to: i) test isolates

of *Macrophomina phaseolina* recovered from industrial hemp samples for pathogenicity on other hemp varieties using Koch's Postulates and ii) determine if this charcoal rot pathogen is pathogenic toward corn and soybean. Four hemp varieties were grown in a sterilized silt loam for three weeks. Plants were inoculated with *M. phaseolina* on colonized toothpicks that were gently rubbed onto stem tissue. For six weeks, plants were monitored weekly for charcoal rot symptoms. Symptoms resembling charcoal rot were present on inoculated plants and not control plants. Isolates resembling *M. phaseolina* in culture were recovered from symptomatic plants. DNA was extracted and the rDNA ITS region was PCR amplified with the ITS 1/4 primer set. The ITS region was sequenced and compared to similar sequences with BLAST analysis of Genbank. Recovered isolates showed closest sequence similarity (100%) to *M. phaseolina* accession number OK127887.1. To test pathogenicity, pre-germinated corn and soybean seedlings were planted into pots with *M. phaseolina* infested soil and monitored weekly for 12 weeks. Understanding hemp diseases, and how they relate to field crops will assist in creating cultural and chemical management strategies in future seasons.

P97 • Evaluating an attract-and-kill tactic for Japanese beetle

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Japanese beetle is an invasive insect that feeds on over 300 host plant species including wild shrubs, hardwoods, and several agricultural commodities, often resulting in severe economic damage. Field crop growers in the Midwest spray three to four insecticide applications per season to control Japanese beetle which may have non-target effects on pollinators and natural enemies. To mitigate these non-target effects, we evaluated an attract-and-kill strategy using insecticidal nets in soybean. Attract-and-kill treatments consisted of 76 m of insecticidal net placed along a single field border baited with pheromone lures. Attract-and-kill treatments were compared with grower standard treatments (insecticide sprays) and non-treated negative controls. We quantified Japanese beetle abundance, defoliation, seed damage, and species diversity. To quantify Japanese beetle movement towards insecticidal nets, we protein marked soybean fields with milk solution and the surrounding natural habitat with egg solution. We collected arthropods throughout the attract-and-kill fields and used enzyme-linked immunosorbent assays to quantify insect movement between habitats. Attract-and-kill treatments provided equal protection against defoliation when compared with insecticide applications and untreated controls. Attract-and-kill treatments had higher seed quality compared to the insecticide treatments, perhaps due reduced non-target effects on natural enemies. Surprisingly, there was little insect movement between soybean fields and the surrounding natural habitats.

P98 • Identification of early and extra-early maturing tropical maize inbred lines with multiple disease resistance for use in sub-Saharan Africa

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Maize, a staple for millions across sub-Saharan Africa (SSA), faces major biotic constraints affecting production and safety of the crop. These include northern corn leaf blight (NCLB), southern corn leaf blight (SCLB), Curvularia leaf spot (CLS), and aflatoxin contamination by *Exserohilum turcicum*, *Bipolaris maydis*, *Curvularia lunata*, and *Aspergillus flavus*, respectively. Farmers in SSA would benefit tremendously if high yielding maize hybrids with multiple disease resistance (MDR) are developed and commercialized. Forty-nine early-maturing (90-95 d to physiological maturity (PM), EM) and 55 extra-early-maturing (80-85 d to PM, EEM) inbreds developed by the Maize Improvement Program of the International Institute of Tropical Agriculture were found to be resistant to NCLB in field evaluations conducted in multiple agro-ecologies of Nigeria during 2017 and 2018. From each maturity group, 30 NCLB resistant inbreds were evaluated for resistance to SCLB and CLS using a detached leaf assay, and to kernel rot and aflatoxin contamination using a kernel screening assay. Seven EM and six EEM maize inbreds were found to be highly resistant to the three foliar pathogens, while 10 inbreds combined resistance to the foliar pathogens and supported significantly ($P < 0.05$) less aflatoxin accumulation than other inbreds. Inbreds possessing MDR should be tested extensively in hybrid combinations and commercialized. Adoption of maize hybrids with MDR would (i) increase maize production, and (ii) reduce losses caused by aflatoxin contamination. Overall, planting of EM and EEM maize hybrids with MDR would contribute to food security, reduced aflatoxin exposure, and increased incomes of maize farmers in SSA.

P99 • IPM in potatoes: Predicting phenology of four hemipteran pests in the lower Columbia Basin

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Several hemipterans such as *Circulifer tenellus*, *Lygus* spp., *Myzus persicae*, and *Macrosiphum euphorbiae* affect potatoes, causing direct foliage damage or vectoring plant pathogens. Environmental factors can drive the population dynamics of these pests, thus contributing to their establishment. Degree-days models based on temperature analysis have been developed to measure the movement of pests in the agroecosystem in response to accumulated daily temperatures. Moreover, host plant phenology can contribute to determining pests' spreading. In this study, we monitored weekly the seasonal population dynamics of *C. tenellus*, *Lygus* spp., *M. persicae*, and *M. euphorbiae* throughout potato growing seasons in 37 commercial fields located in the lower Columbia Basin (OR, USA). Using a multi-year dataset, we developed phenology models of each pest based on temperature (accumulated degree-days, DD) and potato growing stage (potato days, PD). Temperature-mediated population growth models suggest that *C. tenellus* and *Lygus* spp. are the first pests to colonize the potato crop fields. In contrast, *M. persicae* and *M. euphorbiae* populations increased more gradually throughout the season. Our results suggest strong effects of DD on predicting variation in cumulative emergence for these four pest species. Moreover, they show a pattern of inconsistency between pests' emergence and calendar days through the years. Results from PD models suggest that PD can be helpful in timing scouting transmitted-pathogens outbreaks due to those hemipteran pests. Both models provide integrated pest management tools to potato growers for predicting pest timing and pairing that with strategic chemical applications.

P100 • Integrating environmental sensing and molecular pathogen detection methods for developing a risk prediction model on powdery scab in potato

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Powdery scab caused by the plasmodiophorid *Spongospora subterranea* (*Ss*) is an increasingly important soilborne disease of potato in most potato growing regions globally. Infection by *Ss* can also transmit potato mop-top virus, an emerging pathogen that limits sales and export of seed and fresh potato. Management strategies for *Ss* and the virus are limited due to the lack of effective chemical control and resistant cultivars. Integrating open-source environmental sensor technology, to identify factors that affect powdery scab development, with a quantitative PCR assay, to monitor *Ss* soil inoculum changes during the growing season, can aid in developing a disease forecasting model. Trials were conducted in 16 naturally *Ss*-infested fields in Colorado, North Dakota, Oregon, and Maine. Within each field, sensor units that measure air temperature, relative humidity, soil temperature and moisture were installed in four different locations, and soils were sampled prior to planting and monthly after planting until harvest to determine *Ss* population sizes. Soil chemical properties, potato cultivar, cropping histories, and chemical applications were recorded for each field location. Roots and tubers were sampled for root gall and powdery scab assessment. Significant variation of *Ss* population sizes and root gall formation were observed within and among fields. These variations seem to be attributed to a combination of differences of initial soil inoculum, soil texture and temperature, potato cultivar, and chemical inputs. Currently, we are in the process of analyzing and constructing time series models for forecasting *Ss* population size and powdery scab disease development.

P101 • What's in Spud Soil? Findings from Soil Functional Analysis

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Soil DNA sequencing technology is a powerful tool for in depth understanding of soil microbiome, biodiversity, and overall soil health. Technology has great utility in sustainable soils research programs to assess impact of various soil treatment programs on natural soil bacterial and fungal populations and their associated functions. In summer of 2021, a small plot study was conducted in a commercial Potato field to assess the impact of fumigant alternative treatment programs on soil microbiome, Verticillium Wilt control and yield/grade of potatoes. Soil samples for microbiome analysis were collected early in the season (Before and immediately after planting) in various treatments including Fumigant check and Untreated plots. Genetic analysis yielded interesting results in terms of biodiversity in various treatments with over 500 different species belonging to various Bacterial and fungal phyla identified. Interesting insights into soil nutritional status through microbial mobilization were also observed in certain study treatments. Objective of this poster presentation is to discuss in detail the findings from this soil functional analysis.

P102 • How are pest management issues and farmer's practices evolving over time?

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Since 2003, farmers attending private pesticide applicator recertification workshops in Minnesota have been asked through an Integrated Pest Management (IPM) Assessment about the pest management issues they face and strategies they are using or willing to use. Turning Technologies, LLC ResponseCards were used to collect response data, although online delivery in 2021 led to the collection of data through Zoom and Qualtrics. The large sample size each year (e.g. n=1,033 in 2021) provides a valuable snapshot over time of farmer practices and the issues farmers face, particularly around pesticide-resistance. Herbicide-resistance continues to be a significant challenge in weed control, especially in waterhemp (*Amaranthus tuberculatus*) and giant ragweed (*Ambrosia trifida*) with 67% and 33% reporting resistance in these species in 2021, respectively. Glyphosate resistance was most reported (76% of respondents averaged over 2017 to 2021). To help manage weeds, in 2021 51% of respondents indicated they rotated herbicide-resistant traits the previous year compared to 7% in 2017, although reported use of all non-chemical strategies increased during this time. Soybean aphid is a major pest in soybean, and use of the economic threshold (e.g. 250 aphids per plant, aphids on at least 80% of plants, and the population increasing), ranged from 59% (2017) to 78% (2021), although 46% (2018) to 18% (2021) believed the threshold is too high (so they spray earlier). The IPM Assessment has been a useful teaching tool and the information has helped guide research and educational efforts.

P103 • Can a soil insecticide plus Bt corn effectively manage resistant western corn rootworms in Nebraska?

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The western corn rootworm (WCR), *Diabrotica virgifera virgifera* LeConte is an economically important pest across the United States Corn Belt. Transgenic hybrids expressing *Bacillus thuringiensis* Berliner (Bt) proteins are the primary management tactic used to manage WCR abundance and feeding injury in continuous corn production systems. In areas where WCR field-evolved resistance to Bt proteins is an emerging issue, some farmers are applying soil insecticides with Bt pyramids (i.e., 2+ rootworm-active traits) to reduce root injury. Further information is needed to determine if this practice can provide short-term management value and/or optimize longer-term resistance management strategies. To address this, replicated field trials containing a non-Bt hybrid and Bt pyramid (SmartStax®) with and without a soil insecticide (Aztec 4.67G) were planted in commercial cornfields across northeast Nebraska in 2020 and 2021. Single-plant bioassays were conducted on F_1 progeny to characterize resistance to SmartStax®. WCR emergence, root injury, and yield were evaluated in each plot. Bioassays indicate that incomplete resistance to SmartStax® is relatively common in northeast Nebraska. To date, with current levels of resistance to SmartStax®, data suggest that the combination of SmartStax® + Aztec 4.67G does not provide enhanced root protection or increase yield compared to SmartStax®. However, a significant reduction in adult emergence was observed when SmartStax® +

Aztec 4.67G was cultivated, which may impact population dynamics in continuous cornfields and help manage WCR densities over time.

P104 • Successful integrated pest management minimizes the economic impact of *Diatraea saccharalis* (Lepidoptera: Crambidae) on the Louisiana sugarcane industry

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The sugarcane borer, *Diatraea saccharalis* (F.) (Lepidoptera Crambidae), is the primary pest of sugarcane, Saccharum spp., in Louisiana. Recent evidence suggests an integrated pest management (IPM) program has reduced the sugarcase borer impact. Spring infestation levels and insecticide usage have declined substantially in the past 20 years, but the level of control achieved has not been assessed across the industry. The level of *D. saccharalis* injury present at harvest was recorded from billet samples from five sugar mills from 2017–2019. These results were used to estimate direct and indirect revenue losses from *D. saccharalis* on the Louisiana sugarcane industry. Insecticide use records were used to estimate control costs and determine total economic impact. The mean percentage of bored internodes (injury at harvest) was 1.1, 0.3, and 1.7% for 2017, 2018, and 2019, respectively. Direct losses from reduced sugar yield averaged US$4.6 million across years. Indirect losses across years accounted for US$3.0 million and $463,000 for insecticidal control costs and reduced milling efficiency, respectively. The total economic impact of *D. saccharalis* averaged $8.0 million annually during the three-year study period. This study demonstrates the efficacy of pest management implementation in reducing *D. saccharalis* injury and highlights the value of IPM. Our findings provide new support for the emergence of *D. saccharalis* management in the Louisiana sugarcane industry as a modern IPM success story.

P105 • Development of a dynamic action threshold for sugarcane aphids in sorghum

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The invasive sugarcane aphid (*Melanaphis sacchari*) is a critically important pest of sorghum production since 2013. Insecticides are currently the only means of suppressing sugarcane aphids in sorghum. There is an urgent need to explore and integrate additional, non-chemical management tactics that will maintain profitability of sorghum production regardless of insecticide efficacy. Previous work suggested that natural enemies (predators and parasitoid wasps) were capable of suppressing sugarcane aphids under certain conditions. To directly incorporate natural enemies into sugarcane aphid IPM, we conducted a series of greenhouse and field experiments to develop and test a dynamic action threshold that accounts for the suppressive effects of predators as well as plant resistance. We report the results of this work and discuss the strengths and limitations of deploying a dynamic action threshold to help reduce the use of insecticides.

P106 • Management of the sugarcane rust mite (Actinedida: Eriophyidae) using foliar miticides

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Sugarcane is grown on approximately 400,000 acres of organic and mineral soils in the Everglades Agricultural Area of Florida. While most arthropods feeding on sugarcane are not considered serious economic pests, the sugarcane rust mite (SRM), *Abacarus sacchari*, now poses as a potential threat to this important cropping system. To assist sugarcane growers with managing this pest, a series of small-plot miticide trials were implemented to determine the efficacy of miticides in reducing SRM populations infesting sugarcane . Four miticide trials were conducted from 2017-2019. Miticides (Agri-Mek, Torac, and Oberon) were assessed using small-plot trials imbedded within commercial sugarcane fields by examining the top visible dewlap (TVD)+1 and TVD+3 for SRM injury over the course of several weeks following application. All miticides significantly reduced SRM injury by at least 50% from 12 to 19 days

after treatment (DAT) and 16 to 51 DAT in 2017 and 2018, respectively. Differences in SRM injury were not detected in 2019. In addition, differences in sugarcane yield parameters (weight, Brix) were not detected among treatments in all years. Results from these miticide trials aim to provide data necessary for the registration of chemical products in order to increase the number of SRM management tools available to Florida sugarcane growers.

P107 • Image classification of sugarcane aphid densities using deep convolutional neural networks

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Developing automation technologies for pest monitoring is crucial for the long-term and low-cost production of crops. Since 2013, sugarcane aphid (SCA) *Melanaphis sacchari* (Zehntner) has caused significant yield loss across the sorghum growing region in the U.S. Adequate management of SCA depends on monitoring the pest and spraying insecticides once the infestation reaches an economic threshold. However, scouting this pest is time-consuming and inefficient in lower-value crops like sorghum. To assist pest monitoring, we propose using computer vision models to automatically classify SCA's infestation on leaves according to images of different density levels. We used a total of 5,048 images collected during field scouting, and we evaluated the performance of four models: Inception v3, DenseNet 121, Resnet 50, and Xception. We trained the models to classify aphid densities into 6 classes: no aphids (0 SCA/leaf), no threat (1-10, 11-39 SCA/leaf), and consider using insecticide (40-125, 126-500, and >500 SCA/leaf) to manage SCA in field conditions. Among these models, Inception v3 and Xception showed an overall accuracy score of 86%. The models correctly classified aphids as above or below threshold density 95% of the time. In the future, the methodology developed and the models tested in this study can be used in mobile applications or remote sensing technologies to assist sorghum growers and researchers to automate scouting SCA in sorghum fields.

P108 • Aptness of indigenous natural products against pulse beetle, *Callosobruchus chinensis* l. (Bruchidae: Coleoptera) in mung bean

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Pulse beetle, *Calosobruchus chinensis* is a destructive pest of mung bean in storage. It starts damaging pulses in the field and is carried to the storage structures. In mung bean, 50-58% losses in seed weight have been recorded due to severe attack of this pest. The studies were done to determine aptness of ethanolic extract of leaves of eight plants and extracted oils of seeds of five plants against *C. chinensis* in stored mung bean. Pulse beetle culture was maintained to conduct insect bioassays in the laboratory. The insecticidal effect of extracts and oils was determined by different parameters like, number of eggs per grain, number of holes per grain, percentage reduction of F_1 adults emerged, percentage inhibition rate, percent weight loss of grains and adult mortality. The results showed that all the tested plant extracts were effective against PB as compared to control. Plant extract of *W. somnifera* was the best in reducing fecundity 0.41 eggs per grain. The beetles made minimum number of holes (0.13) per grain in treated grains with extract of *T. terrestris.* The most effective plant extract was *S. marianum* in reducing number of F_1 adults (3) emerged of PB. The maximum inhibition (94.83%) of F_1 adults was seen in *W. somnifera* treated grain. The minimum weight loss of 4.62% of mung bean grains was recorded in *W. somnifera* treated grains. The plant seed oil of *S. marianum* was the best in the reduction of number of eggs 0.35per grain, number of holes 0.10 per grain, number of F_1 adults 2.1 emerged, and percent weight loss 6.58 of mung bean grains. This seed oil also provided the highest adult mortality 5.66, 8.6 and 9 after 24, 48 and 72 hours, respectively and maximum inhibition 96.76% in emergence of F_1 adults of PB. The plant seed oils of *E. prostrate* and *A. modesta* were the least effective against PB. The outcomes of this study included safe and effective control measures and brought forward effective IPM strategies for this economic pest.

P109 • Development of a disease management program for the new *Brassica* bioenergy feedstock crop, carinata

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Carinata [Ethiopian mustard, *Brassica carinata*] is a potential non-food oilseed (NFOS) bioenergy feedstock crop for the southeastern United States. Sclerotinia stem rot (*Sclerotinia sclerotiorum*) and Alternaria black spot (*Alternaria brassicae*) are possible yield-limiting diseases in a carinata production system. Incidence of the former disease has exceeded 40% in selected cultivar and fungicide screening trials with yield reductions up to 25% in Alabama and Florida. Management of the above diseases will require a combination of crop rotation along with disease resistant cultivars and selected fungicide inputs. Carinata entries in field screening studies have demonstrated significant differences in Sclerotinia stem rot incidence, so cultivars exhibiting effective disease resistance along with desirable agronomic characteristics should be available. Row spacing (7 vs 14 inch) does not influence Sclerotinia stem rot incidence or severity, or even yield; however, fungicide inputs significantly reduced disease and increased carinata yield. While differences among product chemistries in fungicide efficacy for the control of Sclerotinia stem rot have been observed, a two-application program has not been shown to provide improved disease control compared to a one-application program of a given fungicide. However, application timing is critical. Fungicide programs initiated after petal fall typically provided less effective control of Sclerotinia stem rot compared with programs initiated during early flowering before petals begin to fall. Overall, management of the above diseases in carinata will require a combination of crop rotation along with disease resistant cultivars and selected fungicide inputs, while minimizing input costs will be critical for profitable carinata production.

P110 • Impact of climate change on biodiversity of mycoflora associated with maize grains sampled from all over Egypt

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Seed-borne fungi cause yield and quality losses of maize and threaten food security. Climate change directly influence crop diseases, and their hosts, decreasing crop yields and increasing numbers of people at risk of hunger. In order to better protect the maize crop and secure food supply in Egypt, investigations on occurrence and diversity of the seed-borne mycoflora in maize were conducted at 200 local sites from all 25 maize-cultivating governorates in Egypt. In total, two hundred samples of maize grains from 200 villages were collected in 2020 and stored at 4°C. They were subsequently screened for their seed-borne mycoflora. A total of 23 genera and 40 species of fungi were recovered from the seed samples using a deep-freezing blotter method. The genera identified were: *Absidia, Alternaria, Arthrobotrys, Aspergillus, Bipolaris, Cephalosporium, Cladosporium, Curvularia, Epicoccum, Fusarium, Geotrichum, Melanospora, Mucor, Nigrospora, Penicillium, Phomopsis, Rhizoctonia, Rhizopus, Stemphylium, Trichoderma, Trichothecium, Ulocladium, and Ustilago*. Among the 23 genera, 4 genera of seed-borne fungi consisting of 9 species and 23 strains that are known to be plant pathogens were tested for their pathogenicity and transmission on maize seedlings. *Fusarium verticillioides* was the most frequent and was recovered from almost all samples. A washing test was done for all maize grain samples to detect the common smut fungus *Ustilago maydis*. Pathogenicity tests showed that *Bipolaris maydis*, *F. verticillioides*, *F. incarnatum*, *F. proliferatum*, followed by *Acremonium strictum*, caused high percentages of rotted seeds and seedling mortality. Transmission studies showed that *F. verticillioides*, *B. maydis*, *A. flavus* and *A. niger* were transmitted to the germinating maize seeds. These results are vital for guiding research priorities for developing future strategies for managing these diseases.

P111 • Biointensive management of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize

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Fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is native to tropical and subtropical regions of the Americas and is the key pest of maize in tropical regions. It is a highly polyphagous insect pest that attacks more than 80 plant species including maize, sorghum, millet, sugarcane and vegetable crops. Maize is the main crop affected by FAW in India, which has been reported during July 2018 from Karnataka. It has become a serious pest on maize and within a short time of its invasion; the pest infestation was enormous (6.00 to 100 %) on maize. Investigations were carried out both under laboratory and field condition to evaluate the pest control efficacy of different biorational against Fall armyworm (FAW), *S. frugiperda* at the University of Agricultural Sciences, Dharwad (Karnataka-India). *Metarhizium rileyi* (Farlow) Samson, significantly reduced the FAW and stood superior over other products with 83.33 and 73.57 per cent reduction in larval population under laboratory and field conditions, respectively. Among the botanicals, Vitex+cow urine, GCK and NSKE recorded 46.67, 63.33 and 66.67 per cent reduction in larval population respectively at 72 hours after treatment under laboratory. In field condition, at 7 days after spray, the same treatments registered 56.59, 54.56 and 67.28 per cent reduction in larval population respectively. It was concluded that *Metarhizium rileyi* (2g/lt), NSKE (5%), GCK(5%) and Vitex+cow urine(5%) can be included in integrated management practices as an eco friendly strategy to curb the menace of Fall armyworm in maize.

P112 • Integrated waterhemp management in corn and soybean of New York, USA

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Herbicide resistant weeds severely threaten the viability of agriculture in New York. Growers report yield losses of 20% and 50% in corn and soybeans, respectively. We provided education and resources to limit the spread of these weeds in New York. We also conducted research trials to demonstrate methods to control the most widespread and threatening of these species, herbicide resistant waterhemp (*Amaranthus tuberculatus*). Our results showed that a diversified approach incorporating several herbicides and/or alternative tactics is most cost-effective. In corn, herbicide programs that included at least two of the following WSSA groups 4, 14, 15, 19, 27, or inter-row cultivation were very effective. Interseeding annual ryegrass in corn fields where waterhemp has established is not recommended, but Callisto provided acceptable control of waterhemp while not injuring the annual ryegrass. In soybean, herbicide programs that included at least two of the following WSSA groups 4, 14, 15, or cultivation were very effective. We also found that cereal rye (*Secale cereale*) residue can provide up to 87% control of waterhemp, which, if used in conjunction with a moderately effective herbicide program, could provide excellent control. Seedbank modelling showed that control at 95%, 98%, or 100% would cause waterhemp emergence to increase, maintain, or decrease over time, respectively. We were able to reach an estimated 600+ farms with our programming and 97% (n=336) of evaluation respondents indicated their intention to change their practices as a result of our project, providing an estimated net benefit of over $600,000. Furthermore, though waterhemp had quickly spread to 13 counties in New York, since the first year of our outreach it has not been reported in any new counties.

P113 • The Glance-N-Go™ Sampling System: A presence-absence, sequential sampling system for scouting greenbug, sorghum aphid, and sorghum headworms

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The Southern Great Plains of the U.S. (Kansas, Oklahoma, Texas) grow more than 4.41 million hectares of winter wheat worth $2.5 billion annually, and 2.48 million hectares of grain sorghum worth $ 1.59 billion annually. Each crop is host to several insect pests that can cause severe yield loss. The greenbug, *Schizaphis graminum* (Rondani) is a serious pest of winter wheat. The sorghum aphid, *Melanaphis sorghi* (Theobald) (also referred to as the sugarcane aphid, *Melanaphis sacchari* (Zehntner)) and the sorghum headworm complex (corn earworm, *Helicoverpa zea* (Boddie) and fall armyworm, *Spodoptera frugiperda* (J.E. Smith)) are major pests of grain sorghum. Dynamic economic thresholds and binomial sequential sampling systems have been developed for these pests and have been or are being incorporated into a suite of Glance-N-Go™ smart phone apps that allow the user to rapidly determine if an economic threshold has been exceeded. The Glance-N-Go app for greenbug accounts for greenbug thresholds and the activity of the primary greenbug natural enemy parasitoid *Lysiphlebus testaceipes* Cresson. On-going research is evaluating the seasonal dynamics, within-field distribution, and impact of natural enemies of the sorghum aphid so their impact can be included into the Glance-N-Go app for sorghum aphid. A revised version of the Glance-N-Go app for sorghum headworm complex is being developed and will be evaluated during the summer of 2022. A description of the apps, a set of user directions, and a summary of data collected from their in-field performance and efficiency will be presented.

P114 • Integrated pest management of cotton in New Mexico: Will okra leaf cotton reduce *Helicoverpa zea* populations in semi-arid environments with developing resistance to Bt cottons

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Changes in crop microclimate can impact insect populations. Standard upland cotton (*Gossypium hirsutum*) typically has large leaves that provide shade, potentially lowering the canopy temperature and increasing the relative humidity particularly in semi-arid environments. Lower temperatures and higher relative humidity could allow increased survival of pests, like the cotton bollworm, *Helicoverpa zea* (Boddie). Field trials were conducted in New Mexico to determine if okra leaf cotton could help control bollworm populations as resistance to Bt cotton becomes a more widespread issue. Predator populations might also be affected by changes in microclimate. *H. zea* egg hatch was recorded in an open canopy okra-leaf variety (UA107), and a closed canopy (DP1845B3XF) variety with standard leaves. Clusters of 30-60 bollworm eggs were placed on leaf surfaces at mid and upper canopies in okra leaf and standard leaf cotton varieties. Egg clusters were retrieved after 48 hours and examined under a microscope to record predation and larval hatch at 48, 72, and 96 hours. Air temperature and relative humidity were recorded with HOBO dataloggers. There was significantly lower egg hatch in okra leaf cotton 31% vs 54% mean hatch in standard cotton. However, there were no significant differences in relative humidity or temperature to explain lower egg hatch rates. In 2021, this trial was repeated with additional treatments to evaluate the impact of solar radiation that might explain lower hatch rates in okra leaf canopies.

P115 • Establishing the integrated pest management (IPM) and pesticide reduction information system and their applications in Taiwan

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The integrated pest management (IPM) and pesticide reduction information system have been established and applied in agriculture to inquire information of the approved chemical and biological pesticides, friendly materials, and other alternative methods to manage the pest in crop preservation. They can be easily operated by agriculture personnel and experts through the access of mobile devices. The IPM and pesticide reduction information system supplies electronic plant protection and pest control calendars, which contains information on crop cultivation and pest management linked to the diagnosis data of pests (insects, pathogens, weeds) in crop production fields, assisting farmers to further understand the main symptoms or signs of infected crops. The system additionally helps farmers select the risk-reduced pesticides with low toxicity or shorter Pre-Harvest Intervals. On account of the establishment, farmers can inquire the use of biopesticides in crop protection, biopesticide licenses, and even the information of the nearby biopesticide vendors. The IPM and pesticide reduction information system could promote new agricultural integrated management concepts, reduce the use of chemical pesticides, implement good agricultural practices, and achieve safe production goals.

P116 • Whitefly resistance management: Time and space refugia in cross-commodity systems of Arizona and California

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Insecticides are central for control of whiteflies (*Bemisia argentifolii* = *B. tabaci* MEAM1); however, this pest has frequently evolved resistances. Chemical control is available for whiteflies in Arizona and California's cross-commodity agricultural communities. Research and development costs affiliated with the production and marketing of new chemistries are continuously increasing. Diversifying practices and not overly relying on available chemistries allows us to actively manage refugia. To curtail chemical resistances in whiteflies, resistance management programs are a necessary component of an Integrated Pest Management (IPM) plan. Insecticide Resistance Management relies on what are known as the "first principles": 1) Limit use of chemistry to the lowest practical level, 2) Diversify modes of action used, and 3) Partition chemistry through space or time to reduce selection pressures in certain crops or times; all a part of refuge management. Available section-level application records of whitefly control chemistries from 2013-2017 were used in developing insights into local and regional usage patterns. Records were evaluated through periods of time (cropping seasons and whitefly development) and space (treated ag-acres, total ag-acres, total acreage of ag and non-ag). Practitioners often will diversify and limit chemistry use, but the decisions they make are often based only on what they know about actions taken on their farms. This local scale knowledge of refugia may not be adequate to achieve cross-commodity resistance management. Determining the relationships between both local and regional chemical use patterns in whitefly crops over time and space allows us to improve our ability to proactively manage resistance.

P117 • Plant to plant communication in response to *Helicoverpa zea* herbivory

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Plants produce volatile organic compounds (VOCs) by sensing the environmental stimuli, molecular patterns, and in response to insect herbivory. These cues are perceived by plants and generate the intra/intercellular/ inter-plant signals resulting in communication within and between plants. It was found that the *Helicoverpa zea* herbivory in plants (soybean, tomato, maize) causes higher emission of VOCs which may trigger defenses in neighboring plants. This suggest that inter-plant signaling may result in

communication between plants without physical contact in response to *Helicoverpa zea* herbivory. Additional experiments will be presented showing plant to plant communication in response to *Helicoverpa zea* herbivory in maize resulting in changes in physiology and metabolism of neighboring maize plants to improve fitness against herbivory. This technique could be applied to improve integrated crop management under field conditions.

P118 • Integrating short and long term risk models for boxwood blight

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Boxwood blight, caused by the ascomycete fungus, *Calonectria pseudonaviculata* (Cps) is an invasive disease of boxwood (*Buxus* spp.) and related genera (*Sarcococca*, *Pachysandra*, others) in the family Buxaceae. We present several models that can be used at varying spatial and temporal scales to predict Cps infection and outbreak risk, along with climatic suitability for long-term establishment risk, based upon climate and weather data. A short-term infection risk model has been available since 2014, with numerous updates, that uses hourly temperature and moisture data to predict risk at weather station locations. This model can be run at single sites using a web page integrated with 150 other pest, crop, and plant disease models, at uspest.org. A new mobile-adapted app version has recently been updated with email notification "push" capabilities, according to schedules of their selection. A wide-area synoptic version of the model is updated online daily, which provides a regional-to-national view of current, forecast, and past infection risk levels. We also developed a new spatialized, daily weather data-driven model that integrates short term infection risk predictions, which were calibrated based upon the hourly weather-driven models, with long term infection risk, based on climatic suitability. These climatic suitability models include the process-based CLIMEX platform, and an ensemble of correlative risk models, which were all developed using global Cps occurrence data. This model, an expansion of the published DDRP platform, provides stakeholders with short and long term estimates of both when and where boxwood blight is likely to cause disease in boxwood plantings, whether in nurseries or landscape settings.

P119 • Effects of drought treatments on arthropod populations in floral hemp over the reproductive cycle

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Drought is an abiotic stressor that can exacerbate biotic stresses, such as arthropods, which can lead to economic damage in crops. Hemp (*Cannabis sativa*) production was federally legalized 2018 but there is limited research on the relationship of arthropods and drought in hemp. Prior research shows significant increases in secondary metabolites, such as delta-9-Tetrahydrocannabinol and cannabidiol (CBD), in insect infested hemp. However, minimal information is known about the effect of drought on arthropod populations in abiotically stressed hemp. Therefore, the objective of this study was to determine how arthropod populations on hemp are affected by increasing drought severities across two phenotypically different hemp cultivars. Greenhouse trials were conducted in Zirconia, NC in the summer and fall of 2021. Foliar and soil arthropods were sampled in two cultivars across seven drought intensities. Drought intensities ranged from early, extreme drought to well-watered control treatments. Pots were measured daily to ensure correct soil water content. All arthropods were identified at the order level and analyzed with a two-way ANOVA on each sample date and a repeated measures ANOVA across all sample dates. We did not find any significant differences in arthropod populations between the two cultivars or drought severities, however some orders showed significant population changes over the hemp flowering period. These findings demonstrate the importance of understanding the relationship between abiotic and biotic stressors in a hemp greenhouse system. These data can be incorporated into comprehensive integrated pest management plans for producers.

P120 • Phytotoxicity of tolerant exempt pesticides on *Cannabis sativa* L. hemp transplants

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This study was performed to demonstrate the safety of five tolerance exempt pesticides that are commonly used in hemp production. Treatments of Zerotol® 2.0 , M-Pede®, Ultra-Pure™ Oil, Neem Oil Extract, and Thuricide BT Caterpillar were applied a 1, 2, and 4 times the recommended label rate with a second application 7 days later. Twenty-four hours after treatments were applied, phytotoxicity damage ratings were recorded. Plant height was recorded at 7 and 14 days after initial treatment. Each treatment was compared to the control with Dunnett's Test. Zerotol® and M-Pede® at 4 times the label rate were the only treatments different than the control in phytotoxicity. M-Pede at 4 times the label rate was the only treatment that demonstrated a difference in plant height when compared to the control. Other trends may become more evident in future studies that utilize clones. All products were similar to the control at the label rate.

P121 • Effect of plant extract *Ruta graveolens* against green peach aphid, *Myzus persicae*, at Biskra oasis, Algeria

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The green peach aphid, *Myzus persicae* (Hemiptera: Aphididae), is one of the most damaging insect pests of greenhouse crops , and has been causing considerable damage in Biskra oasis. To minimize the side effect of chemical use against *M. persicae*, a study was conducted at Oasis of Biskra, by applying plant extract of common rue, *Ruta graveolens* (Sapindales, Rutaceae) Extracts were sprayed on the first, second and sixth day of the week. Different extracts were used; seed extract and dry leaf extract, with three concentrations (0.25, 0.5, 0,7 ml/ml). Extracts were tested on different larval stages and adults in the laboratory and greenhouse, during the autumn and winter period of years 2020-2021. Results showed that the mortality is related to the type and concentration of extracts, especially on nymphal stages. The highest cumulative nymphal mortality was found 72 hours after spraying the seed extract, with 83% nymphal mortality under laboratory conditions and 70% mortality under greenhouse. for adult, 70% mortality under laboratory conditions and 45% mortality under greenhouse.

P122 • Developing sampling plans to estimate Asiatic garden beetle damage in commercial mint

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The Asiatic garden beetle (AGB) *Maladera castanea* Arrow has become a serious pest of commercial mint fields in Indiana. The larval (grub) stage feeds on mint roots, causing stunting and even plant death when feeding damage is severe, but the relationship between grub density and yield loss is unclear. We evaluated several sampling approaches over the course of the spring and fall of 2021 to optimize sampling intensity, characterize the grub species complex associated with mint, and resolve relationships between grub density and plant performance. Based on field level estimates of mean:variance ratios provided by the different sampling approaches, the best estimates of grub density, and below- and above-ground plant biomass were provided by randomly selecting and sampling 30, 0.25m^2 quadrats within a 0.2 ha grid composed of 64 total cells (0.003 ha/cell). White grub populations in the 3 mint fields were composed of 91% AGB, 8% Japanese beetle *Popillia japonica*, and 1% Masked chafer *Cyclocephala* spp. Grub densities were significantly higher per cell in the fall (10.67±6.16) compared to the spring (1.66±0.96), and although there was no discernible relationship between grub density and plant performance during the spring, plant performance decreased significantly with increasing grub density during the fall. Results to date provide a reliable sampling protocol for examining relationships between grub density and plant performance in mint, and indicate that post-harvest, late summer and fall grub populations may represent a more important management consideration than overwintered, spring populations.

P123

Not being presented

P124 • Management of Phytophthora root rot using biofumigation for field grown boxwood

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Phytophthora nicotianae is a soilborne pathogen with a wide host range including several woody ornamental crops. Phytophthora root rot caused by *P. nicotianae* is one of the major limitations faced by nursery growers to boxwood production. Crops with fumigation properties can be grown, mulched or incorporated in soil prior to cropping to manage soilborne pathogens. These crops contain compound glucosinolates (GSLs) which are converted to isothiocyanates upon maceration and these isothiocyanates are highly toxic to pests. In this study, we evaluated the efficacy of different biofumigants combined with solarization for the control of boxwood Phytophthora root rot. Field experiment was conducted at the TSUNRC, McMinnville, TN in 2020. Ground beds were artificially inoculated with *P. nicotianae*, biofumigants were seeded, incorporated at flowering stage, and then solarized for a month. Inoculated/non-biofumigated non-covered, non-inoculated/non-biofumigated non-covered plots were used as controls. Treatments were yellow mustard "Mustard Mustard", turnips "Purple top forage", arugula "Astro", mighty mustard "Pacific Gold", dwarf essex rape, amara mustard, oriental mustard, biofumigant DOMINUS, mustard meal and only solarization. All treatments significantly reduced Phytophthora root rot disease severity compared to the inoculated, non-biofumigated, non-solarized control. Treatments such as yellow mustard, amara mustard, oriental mustard, argula, and mighty mustard resulted in lower Phytophthora root rot severity compared to the inoculated, non-biofumigated, non-solarized control. Plants grown in mustard meal and non-inoculated, non-treated plots had a higher increase in height compared to the inoculated, non-biofumigated, non-solarized control. Average width increase, total plant weight, and total root weight were not significantly different among treatments.

P125 • Evaluation of fungicides at different application intervals in the management of boxwood blight in an IPM program

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Boxwood blight, caused by *Calonectria pseudonaviculata*, is an important disease of boxwood (*Buxus* spp.) that can infect all plant growth stages and result severe defoliation. Fungal spores produced by this pathogen can be splash-dispersed to a shorter distance via rain and irrigation water while the movement of the infected plants is a major source for longer distance disease transmission. In this current study, six different commercial fungicides at low and high application rates were tested at different application intervals for their effectiveness to reduce infections by boxwood blight. Treatments were drenched or spray applied to boxwood 'Green Velvet' rooted cuttings and inoculated with the conidial suspension of *C. pseudonaviculata*. When the disease severity and defoliation in the boxwood plants were measured two months after fungicide application, moderate disease pressure (30.8% disease severity and 21.7% defoliation) was recorded with the non-treated, inoculated control plants. Daconil Weatherstik (22 fl oz/100 gal) and KleenGrow (0.25 fl oz/1 gal) sprayed alone or in combination at every 14-day interval were significantly more effective in reducing both disease severity and defoliation in boxwood plants when compared to the inoculated control. Broadform, Medallion, Pageant Intrinsic, and Terraguard were also significantly effective in reducing the disease severity. Early and accurate diagnosis of this disease is the most successful approach to preventing the disease spread and implementing disease control strategies. In combination with other management strategies such as sanitation and use of resistant cultivars, application of these fungicides in a rotation plan can be effective in managing boxwood blight.

P126 • Assessment of physiological changes to monitor pests and diseases of container-grown flowering dogwoods in drought condition

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Flowering dogwoods (*Cornus florida* L.) are drought sensitive ornamental crops. Infestation of pests and pathogens increases when the flowering dogwoods are exposed to stress conditions. To assess the physiological changes induced due to drought, a study was conducted in an outdoor setting in a randomized complete block design. The irrigation treatments were applied at 125%, 25%, and 10% of their daily water usage for control, moderate, and severe drought, respectively. Physiological parameters like Normalized Difference Vegetative Index (NDVI) and mid-day leaf moisture potential (ψ) were collected every week whereas morphological data such as plant growth data, total and fresh root biomass were collected during the start and end of the study. NDVI was also collected from Unmanned Aerial Vehicle (UAV) mounted Sentera single sensor NDVI camera and was correlated with the hand-held NDVI for ground truthing. In the study, no significant differences were observed for plant total and fresh root biomass among the treatments whereas controls had the greater height and width. NDVI was significantly higher in controls in 7th, 14th, 21st, and 27th day as compared to other treatments. The correlation between hand-held NDVI and UAV NDVI were 91%, 93%, 84%, and 88% for respective weeks. No significant difference was observed on 7th day for ψ but were significantly higher for controls on 14th, 21st and 27th day. This study will provide useful information to understand crop physiology and monitor pests and diseases in abiotic stress conditions using UAVs and imaging sensors.

P127 • Cover crop usage for the sustainable management of soilborne diseases in woody ornamental nursery production system

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The woody ornamental nursery industry has been greatly impacted by soilborne diseases leading to significant economic losses. Cover crop usage, which has been extensively explored in small fruit, vegetable, and row crop systems, could be a potential tool in suppressing soilborne diseases in woody ornamental nursery production. Field experiment was conducted to explore the role of a cover crop on soilborne disease suppressiveness in woody ornamental nursery production systems. Soils from red maple (*Acer rubrum* L.) plantations grown with and without cover crop [crimson clover (*Trifolium incarnatum* L.)] were sampled following the senescence of the cover crop. Greenhouse bioassays were conducted in a completely randomized design using red maple cuttings on inoculated (with *Rhizoctonia solani*, *Phytopythium vexans* or *Phytophthora nicotianae*) and non-inoculated field soils and replicated ten times (N=80). Plant height, total plant and root fresh weight were measured and plant roots were assessed for disease severity using a scale of 0 to 100 % roots damaged. Also, soil samples from cover crop fields were analyzed for soil health parameters. Results showed that cover crop usage significantly reduced root rot disease severity in maple plants. Plants grown in cover cropped soil had higher total plant and root fresh weight. Soil organic matter, soil nitrogen and bacterial pseudomonad populations were higher in cover cropped soil than non-cover cropped. There were no significant differences in plant height within the treatments. Our results suggest that cover crop can reduce root rot disease by improving plant growth and soil properties. Thus, implementation of cover crop usage may improve field woody ornamental production efficiency by reducing pressure from soilborne diseases.

P128 • Changes in IPM adoption by Utah's fruit industry

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The Utah IPM Program has offered educational services and conducted research in fruit IPM for almost 35 years. Fruit industry surveys conducted in 1996, 2003, 2010, and 2017 provide feedback on our work regarding an assessment of IPM use, grower perceptions and needs, and impacts over time. The trend from 1996 to 2017 is that more growers are using more IPM practices. The greatest jump has been from 2003 to 2017, with a 330% increase in growers using 13 or more IPM practices, and a 70% decrease in the number of

growers using no practices at all. Monitoring, one of the most important IPM practices, was found to have the greatest improvement in 2010 survey. To dive deeper into the IPM impacts, we developed an IPM score for each individual survey submitted in 2010 and 2017 (which were identical surveys). Each survey-score then fell into a low, medium, or high IPM category. Most scores for both surveys fell in the low IPM category, followed by medium, and then high. This scoring system, however, did reveal positive shifts in the percentage of growers within each category. For example, from 2010 to 2017, the number of producers falling in the medium IPM category increased by 62%, and the number of producers falling in the high IPM category more than tripled (from 2% in 2010 to 9% in 2017).

P129 • The fight against fire blight to protect Utah's pome fruit industry

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The most pressing plant disease that Utah's apple and pear producers face is fire blight. Fire blight is a bacterial disease that primarily causes blossom infections in Utah. The bacteria spread from the flowers to shoots, branches and trunks, causing localized cankers and sometimes tree death. The most effective preventive option is to spray an antibiotic called streptomycin, but most growers in Utah cannot use it due to resistance. Alternative antibiotics are not as effective when used alone, but results could be improved by incorporating biological products. After the second year of this three-year study conducted on a USU research farm in Kaysville, UT, we have identified two of seven organic products that have significantly prevented infection of flowers. Fire blight is also an issue later in the season. Summer pruning of infections is a recommended practice, but can sometimes be ineffective or actually spread the disease. We therefore also tested the use of Actigard to prevent bacterial spread within the tree after pruning. On trees treated with Actigard, 4% of the cut branches started growing fire blight again but the fire blight infection did not spread into large branches or the stem. On water-treated trees, 9% of branches started growing fire blight, and three of those infections spread into large branches or into the main stem. A third year of testing will be conducted in 2022, but these positive and significant initial results have been shared with over 85 apple and pear producers.

P130 • IPM in action: Restoration of Lords Park, Elgin, IL

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In 2021, Midwest Grows Green's (MGG) Technical Assistance Program (TAP) transitioned a portion of the City of Elgin's historic Lords Park away from synthetic pesticides and fertilizers using IPM principles (see bit.ly/MGGassistance). TAP's soil scientist Vytas Pabedinskas visited a 1.6 acre turfgrass stand at Lords Park to extract soil samples, assess the turf quality, measure the soil compaction and identify weed and pest pressure. MGG and Pabedinskas incorporated data from this site inventory into a three-year sustainable land management plan that prioritized restoring the soil on the site's east and west slopes. The slopes contained rocky, compacted and thin soil that inhibited grass growth and caused excess water runoff into the basin between the slopes. MGG and Elgin broke through the rocky soil layer with a rake and topdressed the slopes with 120 cubic yards of compost in September 2021. MGG observed dense turfgrass growth on the slopes by late October. This project demonstrates the ability of IPM and natural lawn care to improve plant performance with limited synthetic inputs.

P131 • Putting the "I" back in IPM: Using carbon monoxide to reduce rodenticide use at the Washington Monument grounds

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The National Mall and Memorial Parks (NAMA), an urban National Park, manages approximately 1000 acres in the District of Columbia. One of the focal points at the National Mall is the Washington Monument. The Washington Monument grounds are highly visited, contain abundant food sources (trash and litter), and provide green space in the city which is harborage for Norway rats (*Ratus norvegicus*). Norway rats are widely distributed throughout the United States and are especially dense in urban areas. In 2017, NAMA contracted the District of Columbia Department of Health to conduct rat abatement on its property, utilizing Chlorophacinone (Rozol®) and/or Diphacinone (Ditrac®). However, while effective in keeping population levels in

check, these products have significant collateral effects on non-target wildlife and potential human health risks. In November 2020, NAMA began treating the Washington Monument grounds primarily with carbon monoxide (BurrowRx®). From November 2018–September 2019 and November 2019–September 2020, 397 and 362 burrows were treated respectively with 24.8lbs and 22.6lbs of rodenticide. In comparison, from November 2020–September 2021, 375 burrows were treated with 14.4lbs of rodenticide. Our project demonstrated significant reductions in the use of anticoagulant rodenticides when incorporating carbon monoxide. The National Mall and Memorial Parks will be expanding the use of carbon monoxide for rat abatement to other focal locations.

P132 • A success story of community online learning about ticks, tick-borne diseases and integrated tick management

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Ticks and tick-borne diseases (TBDs) pose a major public health risk to people, pets and livestock. Annually, TBDs account for approximately 75% of all vector-borne diseases reported to the Centers for Disease Control and Prevention (U.S. Department of Health & Human Services 2020). The North Central region of the U.S. is habitat for seven different tick species which collectively transmit 10 different known TBDs. Recently, the invasive Asian longhorned tick was discovered in Missouri and Ohio. Each of the 12 states within the region has at least three confirmed species of ticks, a fact which reinforces the urgent need to proactively mitigate the threat of TBDs. To address this, the Public Tick IPM Working Group (WG) hosted an online Tick Academy in September 2021. The event enabled us to distribute Integrated Tick Management (ITM) information to a broader audience with a deeper collective experience. The three-day Tick Academy attracted 132 public health professionals, land managers and WG members (representing 3 countries and 28 states) whose active dialog focused on tick life cycles, species identification and best management practices. We administered and analyzed a 10-item online assessment of subject matter knowledge before and after the event. The results (n=65) showed a 19% increase in overall knowledge of ticks and TBDs. Additionally, tick identification skills improved by 18% and knowledge of TBDs increased by 16%. Our story suggests that collaborative learning among ITM stakeholders may increase the urgency of global responses to emerging tick species and the potential threat of unknown TBDs.

P133 • Creating a network to support urban growers

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Urban agriculture enterprises, particularly within the North Central region, have established themselves as viable niche business ventures at a time of shrinking Extension budgets and limited staff resources in urban centers. Often persons engaged in urban agriculture enterprises are new and beginning farmers, non-English speakers, and are from historically underserved populations. These operators/workers are often coming to the field without baseline experience with specialty crop production and/or pest management issues. The farms are usually considered "micro-scale" with production limitations due to small production areas and working capital. Although urban farms tend to be smaller with diverse cropping systems, pests can be just as problematic as on larger scale farms. Pest pressure, along with limited pest management knowledge and options often leads to lower yield and profit. In order to serve the needs of the urban agriculture community (including for-profit farmers, ag-related social enterprises, and community gardeners) the Great Lakes Urban Agriculture IPM Working Group was formed in 2016. Outputs of the GLUA WG include annual network and educational exchange meetings, on-farm test plots and a series of vegetable pest post cards.

P134 • Managing Agricultural Drainage Ditches to Improve Conservation Biological Control

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Conservation biological control provides an alternative for a sustainable approach to managing pests by enhancing natural enemies through providing their ecological needs. To date, little research has been conducted on the natural enemies found in agricultural drainage ditches in farm fields. Here, we attempt to demonstrate the value of ditch management to improve conservation biological control for farmers. Three studies were conducted. Our results indicates that the ditch habitats may provide valuable ecosystem services to producers by enhancing natural enemies of pests and increasing their biological control.

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map of meeting space

Plaza Building: Concourse Level