IPM in the 21st Century – Invasive Pests, Resistance, Environmental/Consumer Constraints and Demand

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ABSTRACT:

The availability of people trained in IPM will be critically important if the human population is able to successfully manage and survive the trials of the next 35 years. Our increasing population will demand higher food and fiber production than ever in history to feed and clothe a population predicted to reach 9 billion – a 28% increase – by 2050. Record-breaking crop production will be required on less land, with less water, with increasing pressure from invasive pest and resistant pests. It will demand the best of our technology and skilled IPM practitioners. Currently, the numbers of IPM practitioners and faculty training them are in decline. It is critically important that we reverse this trend.

INTRODUCTION:

Development of Field-specific IPM Systems in Southern Crops


Palmer amaranth

During most of the 20th Century, control of insect pests in intensely infested crops, such as cotton, was dependent on insecticides. From the 1920s through the 1960s insecticides were heavily used with applications based on calendar spray dates and crop phenology; and without regard to pest population levels or the density of natural enemies. By the 1950s and 1960s pest resistance, secondary pest resurgence, and environmental contamination had become problematic on farms where these crops were grown. Extension run IPM programs began in the late 1960s and early 1970s. They were accompanied by research programs which rediscovered the ecologically-based systems that predated the period of insecticide dependence, and further developed IPM tactics and systems. IPM programs quickly demonstrated the value of scouting and use of IPM practices. Grower adoption of scouting and ecologically-based pest management practices was rapid during the early 1980s and adoption resulted in reduced production costs, protection of crop yields and quality, and environmental protection. By 1983 an estimated 6.8 million acres of cotton were in private or university sponsored IPM programs. The cost of this scouting was estimated to be $14.3 million but the benefits were in excess of $133 million, a return of more than $9.30 per dollar invested (Smith 1983).

Newsom (1974) divided the history of cotton production into four periods; the pre-boll weevil era (before 1892), early boll weevil era (1892 to 1917), the calcium arsenate era (1917- 1945) and the synthetic organic insecticide era 1945-forward. Perkins (1980) later divided the synthetic organic insecticide era into the era of euphoria and the crisis of residues (1945-1955), the era of confusion environmental crisis and the beginning of new directions (1954-1972), and era of changing paradigms (1968 and beyond). Since 1996, it has become clear that yet another era has begun Allen (2014). Cotton and other field crops have entered the era of genetically modified crops and preventative, area-wide pest management.

Evolution of Preventative Management Technologies Deployed on an Areawide Basis

From the early 1990s through the early 2000s pest management in major field crops evolved from field-specific management practices (scouting, decision-making and treatment conducted on a field-by-field basis) to preventative technologies deployed on an areawide basis. Some of the preventive treatments were long duration (boll weevil and pink bollworm eradication). Others were combinations of controls bought in or on the seed and applied areawide on millions of acres. Examples were Bt transgenic (and other host plant resistance technologies), herbicide-resistant cultivars, insecticide seed treatments, preventative fungicides, and application of atoxigenic fungal pathogens (biocontrol) to competitively displace pathogenic fungi (aflatoxin). Growers quickly adopted these novel pest management technologies. Because of the control provided by these technologies, their ease of use and their cost; pest management evolved from field-specific scouting and control to preventative area-wide technologies purchased in or on the seed. And the demand for field-specific IPM practitioners and techniques declined.


boll weevil

RESULTS:

Preventive technologies applied areawide have had beneficial impacts on agriculture. The positive economic impact of boll weevil eradication in Texas between 1996 and 2012 has been $2.3 billion (McCorkle, 2012). Comparing the 14-year period pre-2000 to the 14-year period post-2000; adoption of combined technologies (primarily pest eradication, Bt transgenic crops and seed treatments) in cotton resulted in a 66% reduction in foliar insecticide use (Williams 1986 – 2014), and a 37% yield increase in Texas cotton fields (National Agricultural Statistics Service 1986-2014).

Not all of the effects of this change have beneficial, however. The human infrastructure available to conduct field-specific IPM has diminished as follows:

- Licensed consultants declined 28% in AR (2006-12) and 35% in LA (2005-11).
- Licensed commercial ground applicators down 6.9% (cumulative AL, AR, FL, GA, LA, MO, NC, OK, SC, TN and TX, 2005-11).
- Licensed aerial applicators down 11% (cumulative FL, GA, LA, SC, TN, TX and VA, 2005-11).
- Extension Entomologists down 33% (cumulative AL, AR, FL, GA, LA, MS, NC, OK, SC, TN and TX, 2007 -12).
- Longer duration case studies support these data and show larger reductions over 10 to 20-year periods of time.

Challenges of the 21st Century

Four major components will define the directions of IPM in the next generation. They are:

- Human population growth – projected to increase over 28 percent in the next 35 years.
- Invasive pests – intensity of damage and level of management needed.
- Pest resistance – extent and rapidity of loss of effectiveness of plant incorporated protectants (GMOs) and insecticides
- New technology – extent of development, labeling and deployment of effective new technologies

The continuing increase in travel and trade around the globe is fostering the spread of more and more invaders (Bright 1998). More than 450 non-native forest pests have become established in U.S. forest ecosystems and the pace of new introductions has increased (Aukema et al. 2011). Resistance to GMO-based management strategies and pesticides is occurring in a number of pests with still more beginning to adapt. The growth in the human population will demand that farmers produce more in the coming years than in all of history. Effective field-specific IPM systems and trained practitioners will be needed if these demands are to be met. Less water and fewer acres of productive soils will be available. There is an urgent need for colleges to train more IPM practitioners to work with farmers enabling them to produce at the unparalleled levels that will be needed.


sugarcane aphid

CONCLUSIONS:

The loss of field-field specific IPM capability is occurring at a time when the need for food and fiber is higher than at any other time in history and is expected to increase by 28% by 2050. Intensified global trade has greatly increased threats from invasive pests. In Texas the surge of invasive pests that are threatening agricultural production in recent years include: sugarcane aphid, Bermuda grass maggot, Old World bollworm, spotted winged drosophila, brown marmorated stink bug, bagrada bug and others. Invasive insect transmitted crop and human diseases have also increased, e.g. citrus greening, West Nile virus, chikungunya, dengue and others. And other pests are demonstrating their capacity to adapt and survive modern control technologies. Examples are herbicide resistant weeds, bollworm, fall armyworm, western corn rootworm and others. Our vulnerability has increased in the current era because we lack trained human resources to respond to pest outbreaks and breakthroughs. And, IPM expertise will take time to develop as fewer college instructors have field experience in IPM and fewer students are being prepared to address the pest management concerns.


bollworm

The multibillion dollar question is, ***"How will we respond to the challenges of protecting food and fiber to meet the needs of the growing human population in the next 35 years?"*** Will we be ready, or will we be caught unprepared?

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