

Trap cropping: A simple, effective, and inexpensive organic IPM approach to manage cucumber beetles and squash bugs in cucurbit crops



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ABSTRACT The relative attractiveness of Blue Hubbard, Red Kuri Hubbard, and Buttercup squash plants (trap crop plants) to adult spotted cucumber beetle (*Diabrotica undecimpunctata howardii*), striped cucumber beetle (*Acalymma vittatum*), and squash bug (*Anasa tristis*) were evaluated using a comparative behavioral approach. In addition, the ability of trap crop plants to prevent pest numbers from exceeding economic thresholds in the cash crop was assessed. These insects have consistently been identified as the most damaging insect pests of cucurbits in areas of the US where the crops are grown and truly effective organic management approaches are lacking. Results indicate that all three squash varieties suppressed squash bugs from cash crops, but for spotted and striped cucumber beetles Red Kuri squash and Blue Hubbard squash performed best throughout the growing season. Therefore Red Kuri Hubbard and Blue Hubbard squash represent excellent trap crop plants to manage key insect pests of cucurbits in organic systems.

INTRODUCTION The concept of trap cropping fits into the ecological framework of habitat manipulation of an agro-ecosystem for the purpose of pest management (Shelton and Badenes-Perez, 2006). Trap crops function by delivering pest-behavior-modifying stimuli that attract the pest to the border areas thereby reducing – or even eliminating, pest numbers in the cash crop, resulting in a reduced or eliminated need for chemical application to the crop (Cook et al., 2007). Due to its high attractiveness to cucumber beetles and low susceptibility to bacterial wilt, Blue Hubbard squash has been shown to perform well as a perimeter trap crop for striped cucumber beetle, *Acalymma vittatum* (Coleoptera: Chrysomelidae), in summer squash (Pair, 1997), cantaloupe (Boucher and Durgy, 2004), and butternut squash (Cavanagh et al., 2009). Perimeter trap cropping, however, needs to be improved and adapted to the current size and conditions of organic farms, and tested against multiple pest species. This study aimed at assessing the attractiveness of Blue Hubbard, Red Kuri Hubbard, and Buttercup squash to adult spotted cucumber beetle, (*Diabrotica undecimpunctata howardii*) striped cucumber beetle, (*A. vittatum*, and squash bug (*Anasa tristis*) (Heteroptera: Coreidae), as well as the plant's ability to suppress pest numbers in various cash crops in multiple farms over several years.

METHODS

- Field studies were conducted at the Lincoln University (LU) George Washington Carver (2011-2014) and Alan T. Busby (2012-2014) certified-organic research farm, in Jefferson City, Missouri. Reported here are the approaches followed for the years 2012 and 2013.
- Trap crop transplants were grown in the greenhouse using soilless, peat based, potting media. All trap crop and cash crop seeds were certified organic and were purchased from Johnny's Selected Seeds.
- After field preparation, raised, plastic mulch-covered beds with drip irrigation were installed. In most cases, rows were 35 m long.
- 2012:** Evaluations were conducted in 16 small-scale plots. Each plot was randomly assigned one of the following treatments: (1) Red Kuri Hubbard squash, (2) Blue Hubbard squash, (3) Buttercup squash, and (4) control (no trap crop).

METHODS (cont'd.)

- Each treatment plot was replicated 4 times. Two trap crop plants of the assigned variety were planted in each of the outermost rows (1 and 6) of each sub-plot. The 4 inner rows in each replicate consisted of the cash crop, zucchini, for a total of 16 cash crop plants per replicated sub-plot (Fig. 2A).
- 2013:** Four 2-week old seedlings of the appropriate treatment (Blue Hubbard = BH, Red Kuri Hubbard = RK, or Buttercup = BC) were planted at each end of every row (Fig. 2B). The cash crop, Zephyr summer squash, was direct seeded at the same time at 18 inch intervals which resulted in about 65 plants per row. This resulted in a cash crop to trap crop ratio of ca. 8:1.
- For all evaluations, data were collected 3 times per week for 6-8 weeks. The number of insect pests (by species) was counted for all trap crops and randomly selected cash crop plants per row. All insects and egg masses were removed by hand from the field as they were counted.

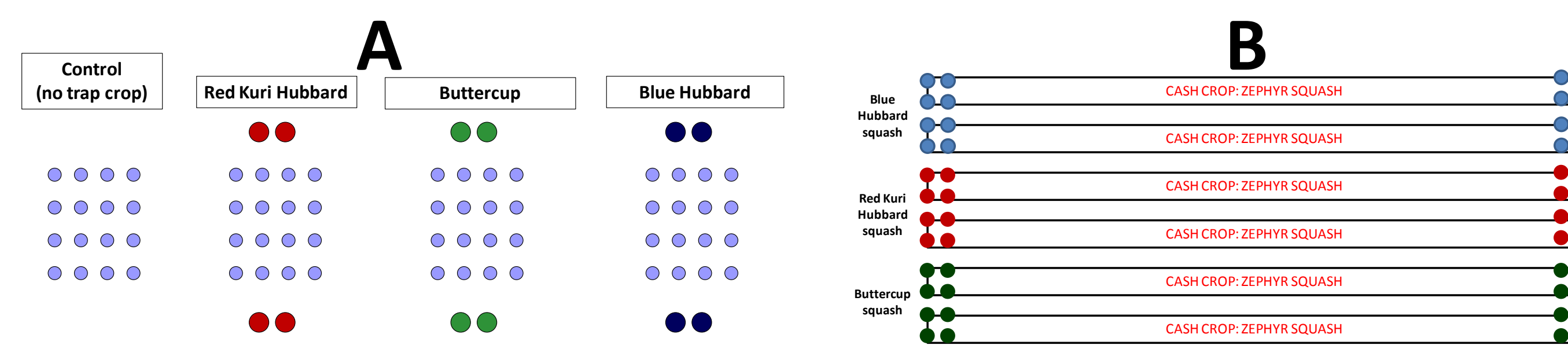


Fig. 2: Layout of the experimental plots used in the (A) 2012, and (B) 2013 field evaluations at two Lincoln University (LU) research farms in Jefferson City, Missouri.

RESULTS

- Overall, the most attractive trap crop for striped cucumber beetles was RK, but for spotted cucumber beetles both RK and BH were equivalent (Figs. 3 and 4).
- At both farms, all trap crops were equally effective at suppressing all three pest species from cash crops (Figs. 3, 4, and 5).

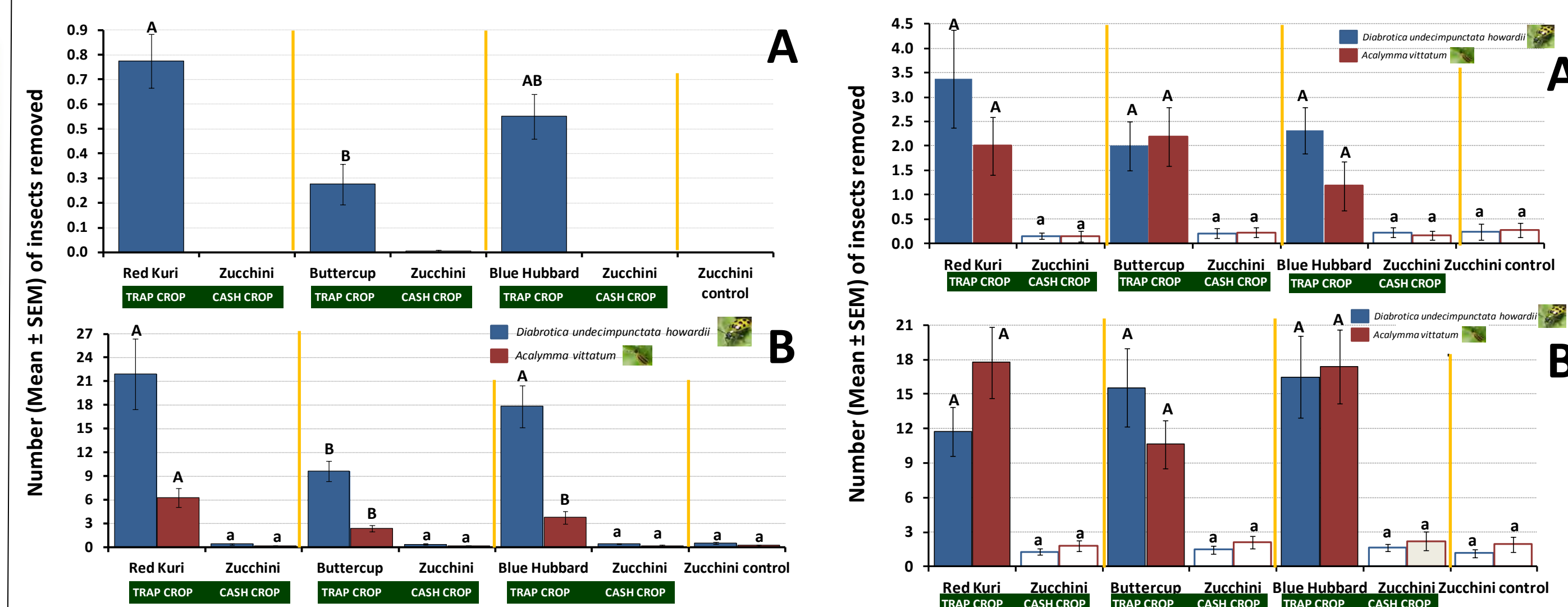


Fig. 3: Number of cucumber beetles in experimental plots at the LU Carver farm on (A) week 1, and (B) weeks 2-3 after transplanting during 2012.

For both figures (3 and 4): For each beetle species (blue: spotted, red: striped cucumber beetle), bars with same uppercase letters are not significantly different (ANOVA and Fisher-protected LSD tests, $P > 0.05$). Letters in lower case denote comparisons made across cash crops.

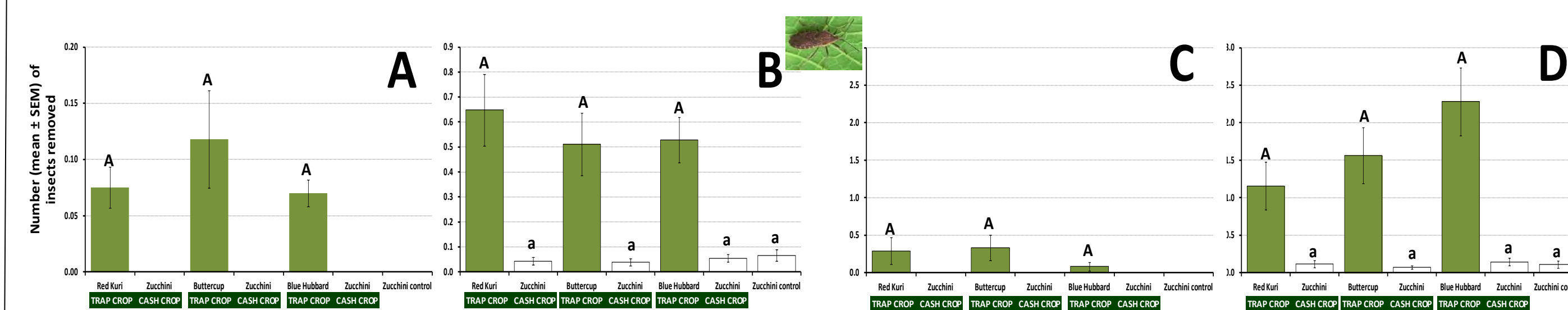


Fig. 4: Number of cucumber beetles in experimental plots at the LU organic Busby farm, weeks 1-3, and (C) LU organic Busby farm, weeks 1-2, and (D) LU organic Busby farm, weeks 3-4. Bars with same uppercase letters are not significantly different (ANOVA followed by Fisher-protected LSD tests, $P > 0.05$). Letters in lower case denote comparisons made across cash crops.

RESULTS (cont'd.)

- In 2013, RK was 6.7 – 11 times more attractive than the cash crop to spotted cucumber beetles (Fig. 6A) and 2.4 – 23 times more attractive than the cash crop to striped cucumber beetles (Fig. 6B).
- BH was 6.7 – 11 times more attractive than the cash crop to spotted beetles and 2.4 – 23 times more attractive than the cash crop to striped beetles (Fig. 6A,B).

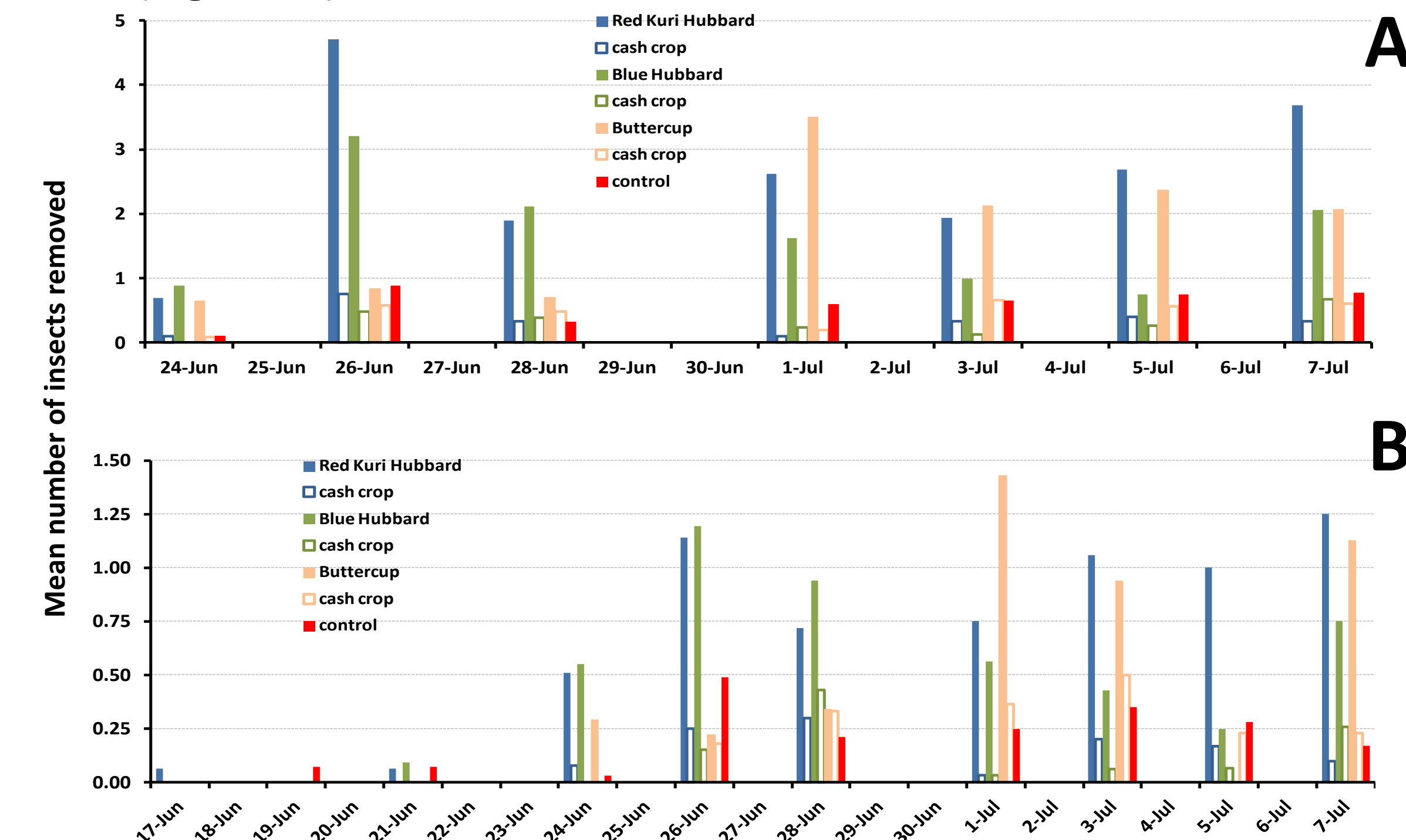


Fig. 6: Occurrence of (A) spotted cucumber beetles, and (B) striped cucumber beetles on trap crop and cash crop plants in experimental plots at the LU Carver farm in 2013.

ON-FARM RESEARCH

- Seven farmer cooperators, including a NCR-SARE FR grant recipient, have adopted the trap cropping approach in their vegetable farms. Four of these farms are certified organic. AZERA™ insecticide (pyrethrins + azadirachtin) has been their method of choice for killing insects on trap crop plants.
- Fig. 7 illustrates the level of season-long insect pest suppression achieved at the EarthDance organic farm by planting BH squash in 2 perimeter rows.

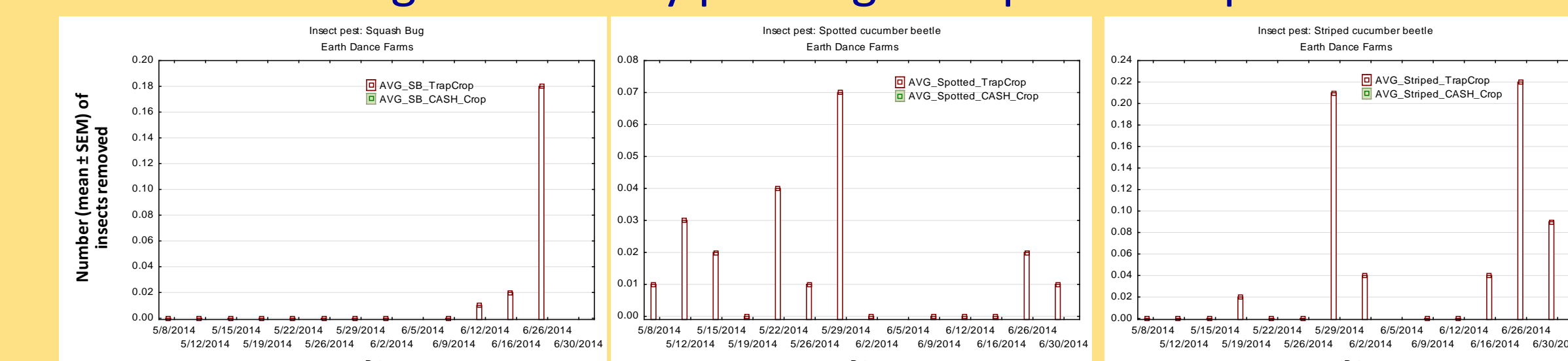


Fig. 7: Season-long evaluation of Blue Hubbard squash as trap crop to suppress key insect pests from the cash crops at EarthDance Farms (Ferguson, MO). Website: <http://www.earthdancefarms.org>.

- For one conventional farmer that now practices Integrated Pest Management, use of trap cropping has saved him about \$ 400 per acre in labor, pesticide, and fuel, per growing season. He has not sprayed his cash crops for 3 years in a row.

CONCLUSIONS

- Trap cropping is an effective IPM tool for organic cucurbit growers.
- BH, RK, and BC are all attractive trap crop varieties to cucurbit pests.
- Cucurbit trap cropping is effective at suppressing pests in the cash crop with as few as 11 % of the total plants being trap crops.

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