Variability in response of corn earworm to insecticides on sweet corn over nine years in Ohio

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Abstract

Corn earworm is a key pest of sweet corn in Ohio, where it typically attacks late-season sweet corn after populations migrate into Ohio from the southern USA. Field trials were conducted on control of corn earworm by insecticides from 2007 through 2015, primarily due to concern that populations were becoming resistant to pyrethroids. The corn planting date was chosen so that corn began silking in mid-August when the corn earworm population was most likely to reach high density, as estimated by the number of moths caught in pheromone traps. Treatments every year included application with the maximum rate of lambda-cyhalothin and an untreated check, along with various other insecticides and transgenic hybrids. The expected trend of decreasing control by lambda-cyhalothrin and other pyrethroids was found only in years in which the corn earworm population was present at high density during silking. Results have been used to develop decision rules that incorporate population density in choosing an insecticide product as well as the intensity of the spray schedule.

Background

- Corn earworm ('CEW'):
  - *Helicoverpa zea*; Lepidoptera: Noctuidae
  - A pest of many crops
- Corn earworm in Ohio:
  - A key pest of sweet corn
  - Usually worst on late plantings
  - Does not overwinter well in Ohio in most years
  - Migrates from southern USA in late summer
- Other caterpillar pests in late sweet corn:
  - European corn borer ('ECB'), a resident species
    - *Ostrinia nubilalis*; Lepidoptera: Crambidae
  - Fall armyworm ('FAW'), a migratory species
    - *Spodoptera frugiperda*; Lepidoptera: Noctuidae
- CEW control by pyrethroid insecticides:
  - Efficacy excellent for 3 decades
  - Concern about control failures since early 2000s (Hutchison et al. 2007; Jacobson et al. 2009)
  - Conservative assumption: the CEW populations arriving in Ohio are likely to be tolerant of pyrethroids due to extensive exposure to these compounds in the southern USA
- Decision rule used for insecticide schedule:
  - Spray schedule determined by catch in pheromone trap and air temperature (Table 1)
- Objectives:
  - 1) evaluate efficacy of pyrethroids and alterative insecticides for control of CEW populations in Ohio
  - 2) Evaluate conditions that might explain year-to-year variability in efficacy

Table 1. Action thresholds during silking, based on pheromone traps for corn earworm (after Dively 1995)

Population category	Average number of moths per trap **per day**		Action
	Large metal Hartstack trap	Small nylon Scentry trap	
Negligible	<2	<0.2	No spray
Low	≥2 - 5	≥0.2 - 0.5	Spray every 6 days
Moderate	≥5 - 10	≥0.5 - 1	Spray every 5 days
High	≥10 - 50	≥1 - 13	Spray every 4 days
Very high	≥50	≥13	Spray every 3 days

Methods

- Each year, 2007 – 2015, at South Charleston, Ohio
- Pheromone trap for corn earworm
  - Lures: Hercon brand, changed every 2 weeks
  - Trap: large metal Hartstack trap (Figure 1)
  - Checked every 7 days in June-July, or 1-3 days in August
  - Critical 4-week period: 1 week before silking until harvest
- Field trials on insecticide efficacy :
  - Treatments
    - Lambda-cyhalothrin (Warrior) at maximum rate
    - Untreated check
    - Various alternative insecticides & transgenics
  - Randomized complete block design
  - 4 replicates
  - 'Providence' hybrid
  - Planted in late June so that silking began in mid August, which is typically when CEW arrives in Ohio
  - Plots 40 feet long by 4 rows wide
  - Sprays directed at center 2 rows per plot
  - 6 or 7 sprays, every 3 - 4 days, during silking
  - 1st spray when 25% of plants showing fresh silk
  - High-clearance boom sprayer (Figure 2)
  - Drop nozzles directed at silk zone
  - Spray volume:
    mean 31 gallons per acre (range 27 – 45)
  - Evaluate at harvest:
    mean 18 ears per plot (range 10-25 ears)
  - Analysis: ANOVA in SAS; mean separations by LSD

Figure 1. Pheromone trap.

Figure 2. High-clearance boom sprayer.

Results

- Large year-to-year difference in damage in untreated plots:
  - % of ears with no damage (Figure 3, red bars):
    - Heavy damage (0-9% clean ears) in 2007, 2009, 2010, 2014, 2015
    - Moderate damage (51-61% clean ears) in 2008, 2012, 2013
    - Light damage (82% clean ears) in 2011
  - Number of kernels damaged (Figure 4, red bars): same trend
- Large year-to-year difference in damage in plots treated with maximum rate of lambda-cyhalothrin:
  - % of ears with no damage (Figure 3, blue bars):
    - Excellent control (99% clean ears) in 2011 and 2013
    - Good control (94-96% clean ears) in 2008, 2009, 2012
    - Fair control (49-60% clean ears) in 2007 and 2010
    - Poor control (8-18% clean ears) in 2014 and 2015
  - Number of kernels damaged (Figure 4, blue bars): same trend
- Large year-to-year differences in corn earworm population as monitored by adults in pheromone trap (Figure 5)
  - Differences in overall number of moths caught
  - Difference in highest catch early versus late within silking period
- Corn earworm usually dominant but other species present (Figure 6)

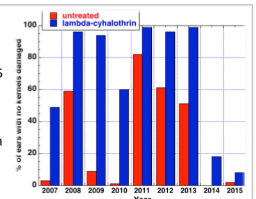


Figure 3. % of ears undamaged.

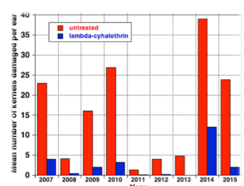


Figure 4. Number of kernels damaged.

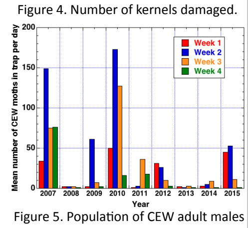


Figure 5. Population of CEW adult males in trap for 4 weeks before harvest.

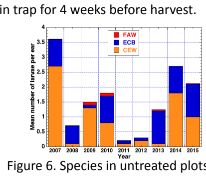
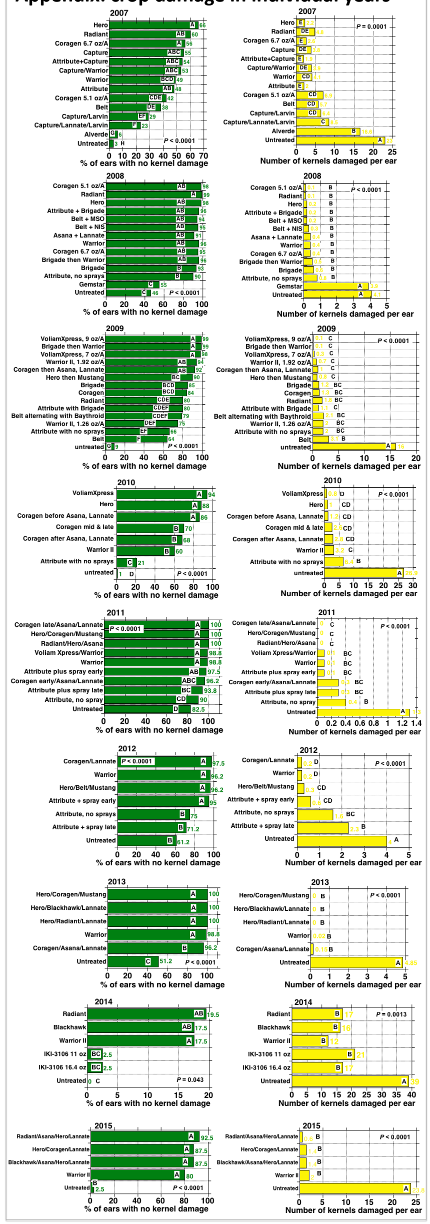


Figure 6. Species in untreated plots: CEW = corn earworm; ECB = European corn borer; FAW = fall armyworm.

Discussion

- Despite known occurrence of resistance to pyrethroids in populations of corn earworm in the midwestern USA (Hutchison et al. 2007; Jacobson et al. 2009), lambda-cyhalothrin did provide excellent efficacy in years when the population of corn earworm was low during the first two weeks of silking, even if the population rose to high levels during late silking, as in 2011, or if low throughout the silking period, as in 2013.
- Lambda-cyhalothrin was not able to provide good or excellent efficacy when the population of corn earworm was high or very high during silking, as in 2007, 2010, and 2015.
- An additional factor that is likely to affect the infestation of corn earworm in late plantings of sweet corn is the status of field corn development in the vicinity. In years in which field corn planting was delayed due to unfavorable weather, such as in 2011, and to a lesser extent in 2008 and 2009, then sweet corn is somewhat less vulnerable to infestation because the moths are spread out over many more acres of favorable hosts rather than settling on the relatively small acreage of late sweet corn.
- Sweet corn growers are strongly encouraged to use at least one pheromone trap per farm and to check it at least twice per week. Not only does the trap provide information on the optimal spray interval during the silking period, but the relative density of moths can be an indicator of whether pyrethroids would provide good control or whether choosing an alternative to pyrethroids is prudent during that week. Given the high cost of most of the alternative products, this option of continued use of pyrethroids can provide an economical plan to growers, at least in the near future.

Appendix: crop damage in individual years



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Acknowledgements

Farm assistance from Joe Davlin, A. J. Kropp, T. Mumford, B. Reeb, C. Renk.
Technical assistance from J. Schoenhals, R. M. Riedel, M. Griffith, J. Radl, D. Zirkle, E. Linkous, M. Dorner, A. Lord, J. Wells, J. Franzen, K. Dye, A. Philpott, E. Larue, M. Burleson, M. LaCount, B. Eisley, M. Martin, B. Bloetscher, G. Sutton, L. Tryon.
Products and/or support funding from Syngenta, Dow, FMC, ISK Biosciences, DuPont, Bayer, Certis.
Funding from the Ohio Vegetable and Small Fruit Research and Development Program.