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Focus on Insects: Snapshots of the Top 10 Research Articles in Agricultural Entomology

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Focus on insects: Snapshots of the top 10 research articles in agricultural entomology
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The scientific literature contains a wealth of new information on insect biology, ecology, behavior and management, but seldom does this research directly reach the crop advisor or agribusiness professional. During the last 12 months, numerous research papers have been published that may have relevance to crop production and management in Iowa. Articles were selected from the scientific journals Environmental Entomology or Journal of Economic Entomology. These journals are published bimonthly with Environmental Entomology focusing on the interaction of insects with the biological, chemical, and physical aspects of their environment, while Journal of Economic Entomology emphasizes articles on the economic significance of insects.

The objective of this presentation is to create awareness of this newly published research by briefly presenting an overview of the significant findings. Ten scientific papers were selected and the published abstracts are presented. At the end of each abstract is space for taking notes on the implications for pest management and crop protection in Iowa. Free PDFs of most papers can be accessed at http://www.entsoc.org/Pubs/Overview/index.htm.

#10 - Physiological response of glandular-haired alfalfa to potato leafhopper (Hemiptera: Cicadellidae) injury.

Plant tolerance to herbivory is a key approach for managing pests. In alfalfa, Medicago sativa, the potato leafhopper, Empoasca fabae, is a major pest as a result of the cascade of plant responses to piercing-sucking injury. To identify tolerance to its injury based on alfalfa physiology, experiments were conducted in the field and greenhouse. In our comparison of the response of field-grown alfalfa cultivars to standardized leafhopper densities, net photosynthesis and transpiration rates of 'Geneva' leaves were reduced by 18 and 21%, respectively, by leafhopper presence compared with a rate change of <1% of resistant 'EverGreen' leaves. Under greenhouse conditions, alfalfa clones varied in their level of gas exchange (net photosynthesis and transpiration) and stem elongation responses to leafhopper injury. For example, in the comparison of seven clones, net photosynthesis declined an average of 40.7% with leafhopper injury, although individual clones varied from 26.6 to 74.3% reduction. Internode elongation after 2 d was 60.3% less on injured stems compared with healthy stems, but again, the individual clones varied from 17.3 to 91.9%. In a time-course study of selected clones, clones varied in their level of injury just after and 3 d after insect removal. Gas exchange responses of all clones recovered by 7 d after cessation of injury. In a choice test, leafhoppers spent similar amounts of time on the susceptible clone and the most tolerant clone; however, their precise feeding behaviors were not measured. Thus, the variable response of clones to injury may be either true physiological tolerance or antixenosis from a change in feeding behavior. This study showed putative tolerance to leafhopper injury among alfalfa genotypes, suggesting that tolerance could be the basis for crop protection in alfalfa from potato leafhopper injury.
#9 Alfalfa living mulch advances biological control of soybean aphid.

Despite evidence for biological control in North America, outbreaks of the invasive soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), continue to occur on soybean (*Glycine max* L. Merr.). Our objectives were to determine whether natural enemies delay aphid establishment and limit subsequent population growth and whether biological control can be improved by altering the within-field habitat. We hypothesized that a living mulch would increase the abundance of the aphidophagous community in soybean and suppress *A. glycines* establishment and population growth. We measured natural enemy and *A. glycines* abundance in soybean grown with and without an alfalfa (*Medicago sativa* L.) living mulch. Soybean grown with an alfalfa living mulch had 45% more natural enemies and experienced a delay in *A. glycines* establishment that resulted in lower peak populations. From our experiments, we concluded that the current natural enemy community in Iowa can delay *A. glycines* establishment, and an increase in aphidophagous predator abundance lowered the rate of *A. glycines* population growth preventing economic populations (i.e., below the current economic threshold) from occurring. Incorporation of a living mulch had an unexpected impact on *A. glycines* population growth, lowering the aphids’ intrinsic rate of growth, thus providing a bottom-up suppression of *A. glycines*. We suggest future studies of living mulches or cover crops for *A. glycines* management should address both potential sources of suppression. Furthermore, our experience suggests that more consistent biological control of *A. glycines* may be possible with even partial resistance that slows but does not prevent reproduction.
three cone trap designs. Second, we examined the influence of the location of the large metal cone trap relative to a windbreak on the number of moths captured. Third, we examined the relationship between nightly mean air temperature, relative humidity, wind speed, precipitation, and the number of moths captured in large metal cone traps. The number of moths captured was significantly influenced by trap design, with large metal cone traps capturing the most moths. Wing and bucket traps were ineffective. Differences among trap captures were significant among trap locations relative to a windbreak. Under strong (>14 kph) or moderate (7 < 14 kph) wind speeds, traps located leeward of the windbreak captured the most moths, but when wind speeds were light (<7 kph), traps not associated with windbreaks captured the most moths. The multiple regression model fitted to the relationship between number of moths captured per Julian date and nightly weather patterns was significant. Nightly mean air temperature was the most influential parameter in the model, and its relationship with moth capture was positive.

Implications: ________________________________

#7 Decline of soybean aphid (Homoptera: Aphididae) egg populations from autumn to spring on the primary host, Rhamnus cathartica.

Soybean aphid, *Aphis glycines* Matsumura (Homoptera: Aphididae), is a severe pest of soybeans in North America. Soybean aphid populations cycle between a secondary summer host, where populations reproduce parthenogenetically and a primary host, where populations overwinter as eggs. In North America, the secondary host is soybean, and the primary hosts are *Rhamnus cathartica* L. (Rhamnaceae) and *R. alnifolia* L’Her. A location with abundant populations of soybean aphid on *R. cathartica* was identified near Guelph, Ontario, Canada, in October 2004, and eggs on trees were counted at multiple sites within that location each autumn and spring over the next 2 yr. Dynamics of naturally occurring soybean aphid populations on the primary host were assessed with respect to (1) decline of overwintering eggs from autumn to spring, (2) development of spring populations on *R. cathartica*, and (3) development of soybean aphid populations on soybean immediately adjacent to overwintering sites. Counts of aphid eggs declined by approx. 70% between autumn and spring sampling periods in 2004-2005. Significant differences in counts of aphid eggs relative to sampling height were observed in the canopy of *R. cathartica*. No edge effects were observed in the development of soybean aphid populations in soybeans adjacent to overwintering sites in this study. Very few eggs were collected at the same study location in the autumn of 2005, and no aphid eggs were collected from samples taken in the spring of 2006. Egg counts taken in the autumn of 2006 were intermediate in number relative to counts taken in the autumn of 2004 and 2005.

Implications: ________________________________

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#6 Development of soybean aphid (Homoptera: Aphididae) on its primary overwintering host, Rhamnus cathartica.
Thermally dependent development of soybean aphid (Aphis glycines Matsumura) and common buckthorn (Rhamnus cathartica L.) were examined in growth chambers in spring 2005. Models based on ambient air temperatures for all development events were developed. Adjusted models were developed to account for heat units acquired because of solar radiation. These models were tested at field sites in Guelph and Ridgetown, Ontario, Canada. It was found that egg hatch of aphids and bud swell of buckthorn coincided at low temperatures in growth chambers and in the field. Development thresholds of 9 and 10°C were acquired for bud swell and egg hatch, respectively. Models based on ambient air temperatures were poor predictors of bud swell and egg hatch in the field, but models adjusted for solar radiation predicted these events just 1-4 d before they were observed at both sites. The results obtained have broad application for predicting aphid hatch on a regional basis.
Implications: ______________________

#5 - No-choice preference of Cerotoma trifurcata (Coleoptera: Chrysomelidae) to potential host plants of bean pod mottle virus (Comoviridae) in Iowa.
To better understand the naturally occurring host range of Bean pod mottle virus (family Comoviridae, genus Comovirus, BPMV) and its principal vector Cerotoma trifurcata (Förster) (Coleoptera: Chrysomelidae), 18 field-collected perennial plant species were tested for the presence of BPMV. By using no-choice assays, we determined the preference of these plants by bean leaf beetle, by measuring their level of herbivory relative to soybean, Glycine max (L.). New food hosts for adult bean leaf beetles include Lespedeza capitata (Michaux), Lotus corniculatus L., Trifolium alexandrinum L., Trifolium ambiguum Bieberstein, and Trifolium incarnatum L. Desmodium illinoense Gray is discovered as a new naturally occurring host for BPMV.
Implications: ______________________

#4 - Response of ground beetle (Coleoptera: Carabidae) field populations to four years of Lepidoptera-specific Bt corn production.
Pitfall traps were used to monitor populations of ground beetles (Coleoptera: Carabidae) in plots
of corn grown in continuous cultivation during a 4-yr period (2000-2003). Treatments included transgenic corn expressing a Bt Cry protein with efficacy specific against Lepidoptera (Bt), conventional corn grown with insecticide application (I), and the same conventional cultivar grown without insecticide application (NI). Mixed-model analyses of variance were performed on pitfall captures of beetles combined across weeks to give seasonal sums. Effects of corn treatment were not detected (P >0.05) on total beetle abundance or species richness in any year. Effects of corn treatment on individual taxa were detected (P <0.05) for 3 of the 39 species-by-year combinations examined. Effects of near significance (P <0.08) were detected for an additional two species. In 2001, captures of Amara farcta Leconte and Harpalus amputatus Say were lower in Bt plots than in I or NI plots. In 2003, captures of Amara apricaria (Paykull) and Amara carinata (Leconte) were higher in Bt plots than in I or NI plots. Also in 2003, captures of Poecilus scitulus Leconte were higher in I plots than in Bt or NI plots. These patterns were not repeated among years. Results of this study indicate that cultivation of Lepidoptera-specific Bt corn in southern Alberta does not appreciably affect ground beetle populations.

Implications: ____________________________ 

#3 – Effects of Bacillus thuringiensis transgenic corn on corn earworm and fall armyworm (Lepidoptera: Noctuidae) densities.

We examined 17 pairs of near-isogenic hybrids of Bacillus thuringiensis (Bt) (176, Mon810, and Bt11) and non-Bt corn, Zea mays L., to examine the effects of Bt on larval densities of Helicoverpa zea (Boddie) and Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae) during 2 yr. During ear formation, instar densities of H. zea and S. frugiperda were recorded for each hybrid. We found that H. zea first, second, and fifth instar densities were each affected by Mon810 and Bt11 Bt corn but not by 176 corn. Surprisingly, first and second instars were found in higher numbers on ears of Mon810 and Bt11 corn than on non-Bt corn. Densities of third and fourth instars were equal on Bt and non-Bt hybrids, whereas densities of fifth instars were lower on Bt plants. S. frugiperda larval densities were only affected during 1 yr when second, and fourth to sixth instars were lower on ears of Mon810 and Bt11 hybrids compared with their non-Bt counterparts. Two likely explanations for early instar H. zea densities being higher on Bt corn than non-Bt corn are that 1) Bt toxins delay development, creating a greater abundance of early instars that eventually die, and 2) reduced survival of H. zea to later instars on Bt corn decreased the normal asymmetric cannibalism or H. zea-S. frugiperda intraguild predation of late instars on early instars. Either explanation could explain why differences between Bt and non-Bt plants were greater for H. zea than S. frugiperda, because H. zea is more strongly affected by Bt toxins and more cannibalistic.

Implications: ____________________________
#2 - Population dynamics of a western corn rootworm (Coleoptera: Chrysomelidae) variant in east central Illinois commercial maize and soybean fields.

Three on-farm sites in Iroquois County, IL, each containing an adjacent 16.2-ha commercial production maize, Zea mays L., and soybean, Glycine max (L.) Merr., field, were monitored for western corn rootworm, Diabrotica virgifera virgifera LeConte (Coleoptera: Chrysomelidae), adults from June through September 1999-2001. Mean captures of D. v. virgifera adults as measured with Pherocon AM yellow sticky traps were significantly greater in maize than in soybean. Overall mean numbers of D. v. virgifera adults captured with vial traps were significantly greater in soybean than in maize. Emergence cage data revealed that after 50% emergence of D. v. virgifera adults occurred, peak captures of D. v. virgifera adults occurred in maize as measured with vial and Pherocon AM traps. After maize reached the R2 (blister stage, 10-14 d after silking) stage of development and 90% emergence of D. v. virgifera adults had occurred, peak captures of D. v. virgifera adults were observed in soybean by using vial and Pherocon AM traps. Also, after maize reached the R2 stage of development, numbers of females significantly increased in soybean and decreased in maize. Captures of female D. v. virgifera adults frequently exceeded published economic thresholds in soybean, regardless of trap type used. Estimated survival of variant D. v. virgifera (egg to adult) in these commercial rotated maize fields was 10.7 and 9.4% from 1999 to 2000 and from 2000 to 2001, respectively. This compares with nonvariant D. v. virgifera survival estimates in continuous maize production systems in Iowa of 6.7 and 11% from 1983 to 1984 and from 1984 to 1985, respectively.

Implications: ______________________

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#1 Economic threshold for soybean aphid (Hemiptera: Aphididae).

Soybean aphid, Aphis glycines Matsumura (Hemiptera: Aphididae), reached damaging levels in 2003 and 2005 in soybean, Glycine max (L.) Merrill, in most northern U.S. states and Canadian provinces, and it has become one of the most important pests of soybean throughout the North Central region. A common experimental protocol was adopted by participants in six states who provided data from 19 yield-loss experiments conducted over a 3-year period. Population doubling times for field populations of soybean aphid averaged 6.8 d ± 0.8 d (mean ± SEM). The average economic threshold (ET) over all control costs, market values, and yield was 273 ± 38 (mean ± 95% confidence interval [CI], range 111-567) aphids per plant. This ET provides a 7-day lead time before aphid populations are expected to exceed the economic injury level (EIL) of 674 ± 95 (mean ± 95% CI, range 275-1,399) aphids per plant. Peak aphid density in 18 of the 19 location-years occurred during soybean growth stages R3 (beginning pod formation) to R5 (full size pod) with a single data set having aphid populations peaking at R6 (full size green
seed). The ET developed here is strongly supported through soybean growth stage R5. Setting an ET at lower aphid densities increases the risk to producers by treating an aphid population that is growing too slowly to exceed the EIL in 7 days, eliminates generalist predators, and exposes a larger portion of the soybean aphid population to selection by insecticides, which could lead to development of insecticide resistance.

Implications: ________________________________

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