Illinois Extension
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

2025 Applied Research Results
Field Crop Disease and Insect Management

Evaluations of insect and disease control tactics for corn, soybean, and wheat

Statewide surveys of corn and soybean pests

A digital copy of this guide can be obtained at go.illinois.edu/PestManagementResearchReport

College of Agricultural, Consumer, and Environmental Sciences

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Helpful links

Multi-state corn rootworm management information, including annual report of regional monitoring network: www.rootwormipm.org

University of Illinois Plant Clinic:
go.illinois.edu/plantclinic

Illinois Agronomy Handbook:
go.illinois.edu/agronomyhandbook

Regional moth trap network:
corn.ipmpipe.org/insects

Illinois Extension field crop production resources: go.illinois.edu/cropcentral

Previous editions of this report:
go.illinois.edu/pestmanagementresearchreport

Statewide Insect Survey Annual Summary – 2025

Kelly Estes

State Survey Coordinator, Illinois Cooperative Agriculture Pest Survey Program

University of Illinois

Illinois Natural History Survey

One of the most longstanding pest surveys, the Illinois statewide insect survey has occurred in fourteen of the last fifteen years (2011, 2013-2025). The goal of this survey is to estimate densities of common insect pests in corn and soybean cropping systems throughout the nine crop reporting districts in Illinois.

Survey methods have remained consistent throughout the years. Sampling occurs at the same time each year. Within each crop reporting district, 4-5 counties are surveyed, with 5 corn and 5 soybean fields sampled in each county. Within the soybean fields surveyed, 100 sweeps were performed on both the exterior of the field (outer 2 rows) and interior (at least 12 rows beyond the field edge) using a 38-cm (15-in) diameter sweep net. The insects collected in sweep samples were identified and counted to provide an estimate of the number of insects per 100 sweeps (Tables 1.1 and 1.2).

Insect populations in 2025 again varied greatly by species and locations across the state. It was not unusual to observe variation between fields in a county and counties within a crop reporting district. As a reminder, fields are randomly selected in this survey and pest management strategies are unknown. Other factors such as climate and recent weather events may also impact insect populations.

Once again, statewide, bean leaf beetle, grape colaspis and stink bug numbers were low. Grasshoppers, green cloverworm and soybean loopers were much more noticeable during the 2025 survey. Compared to 2024, numbers were higher in the southern two-thirds of the state with particularly high counts in the southernmost counties surveyed.

Statewide averages of Japanese beetle populations were once again on the rise (Table 1.3). Counts were higher or at similar levels in 8 of the 9 crop reporting districts. Warren, McDonough, and Peoria counties once again had the largest counts of Japanese beetles recording average counts of 186, 74, and 164 beetles per 100 sweeps. However, many counties along and north of IL-Route 16 consistently had Japanese beetles found in the fields sampled resulting in Northwest, Northeast, West, Central, East, and West Southwest district averages higher than the state average.

Dectes Stem Borer (Table 1.4) continues to be more noticeable in the southern third of Illinois, particularly Clinton, Washington, Marion, and Hamilton counties. Higher than average counts were found in Pike, Sangamon, and Macoupin counties compared to previous years with 2.8, 1.6, and 1.6 borers found per 100 sweeps.

Rootworm abundance is also an important part of this survey each year. Western corn rootworm numbers in soybeans were lower in every district with the exception of one (East) compared to 2024, but trends are still overall low (Table 1.5). That is also true for northern corn rootworm in soybeans. Warren and McDonough counties both had higher-than-average northern corn rootworm present (5.6 and 10.4 per 100 sweeps, respectively).

In addition to sweep samples in soybeans, cornfields were also sampled for rootworm by counting the number of beetles on 20 consecutive plants beyond the end rows of a given field. A beetle per plant average was then calculated for each field. Overall, western corn rootworm beetle populations continue to remain low in all areas of the state (Table 1.6).

Funding for survey activities was provided by the USDA National Institute of Food and Agriculture. This survey would not be possible without the hard work and contributions of many people, including Cooperative Agriculture Pest Survey Program interns.

Table 1.1. Average number of insects per 100 sweeps in the exterior of the field (2025).

District	Bean Leaf Beetle	Grape Colaspis	Japanese Beetle	Northern CRW	Southern CRW	Western CRW	Grasshopper	Cloverworm/ Loopers	Stink Bugs	Dectes Stem Borer
Northwest	0.00	0.00	27.20	0.50	0.00	0.10	1.10	0.30	0.10	0.00
Northeast	0.80	0.90	33.10	0.30	0.00	0.60	2.50	0.50	0.00	0.10
West	0.20	2.20	75.90	4.00	1.00	0.00	11.70	1.20	1.00	0.50
Central	0.80	0.60	55.70	1.00	0.20	0.30	1.90	3.40	0.50	0.10
East	3.60	2.80	27.30	0.00	0.30	0.60	5.40	2.00	0.30	0.00
West Southwest	0.80	4.96	32.56	0.00	1.04	0.00	4.56	1.92	0.24	1.20
East Southeast	0.00	1.40	3.50	0.00	0.60	0.00	0.40	6.90	0.60	0.00
Southwest	1.20	4.77	0.83	0.00	0.33	0.00	4.13	13.80	1.10	1.20
Southeast	0.50	1.30	1.20	0.00	0.10	0.00	1.80	6.20	0.60	1.00
STATE AVE	0.88	2.10	25.89	0.64	0.40	0.18	3.72	4.02	0.49	0.46

Table 1.2. Average number of insects per 100 sweeps in the interior of the field (2025).

District	Bean Leaf Beetle	Grape Colaspis	Japanese Beetle	Northern CRW	Southern CRW	Western CRW	Grasshopper	Cloverworm/ Loopers	Stink Bugs	Dectes Stem Borer
Northwest	0.10	0.00	15.80	0.10	0.00	0.70	1.30	0.30	0.00	0.20
Northeast	1.20	0.50	21.40	0.60	0.00	0.70	1.60	0.60	0.00	0.00
West	0.33	0.50	67.00	1.10	0.40	0.10	10.20	1.80	1.10	0.20
Central	0.50	0.70	26.70	0.20	0.00	0.70	1.35	3.73	0.30	0.00
East	4.30	4.00	28.00	0.10	0.10	0.20	2.40	2.90	0.30	0.00
West Southwest	0.48	2.80	19.92	0.00	0.32	0.00	2.16	1.84	0.56	0.88
East Southeast	0.30	1.60	3.50	0.00	0.10	0.00	2.20	9.80	0.10	0.00
Southwest	1.40	2.73	1.00	0.00	0.17	0.30	1.40	17.63	1.13	0.87
Southeast	0.80	1.30	0.60	0.00	0.00	0.10	1.00	6.20	0.60	0.40
STATE AVE	1.05	1.57	20.44	0.23	0.12	0.31	2.62	4.98	0.46	0.28

Table 1.3. Average number of Japanese beetles per 100 sweeps, 2011-2025.

District	2017	2018	2019	2020	2021	2022	2023	2024	2025
Northwest	54.00	175.10	52.64	67.10	119.80	48.40	8.48	30.80	27.20
Northeast	31.80	36.46	23.28	7.33	20.20	39.30	11.30	31.33	33.10
West	133.60	151.70	26.30	21.87	37.36	107.60	13.64	8.63	75.90
Central	10.00	30.60	17.52	15.90	6.00	7.50	14.96	10.55	55.70
East	2.70	25.40	51.30	9.40	7.20	10.50	19.10	8.40	27.30
West Southwest	20.80	85.34	20.24	11.90	12.60	25.20	23.68	22.50	32.60
East Southeast	4.40	27.53	10.60	15.70	4.80	9.76	43.04	5.20	3.50
Southwest	1.80	11.95	3.90	2.67	3.83	2.13	13.50	2.27	0.80
Southeast	0.40	12.96	3.34	13.73	3.27	4.60	2.10	1.47	1.20
STATE AVE	28.23	47.45	19.56	12.30	23.90	29.44	16.64	13.46	25.60

Table 1.4. Average number of Dectes Stem Borer in soybeans per 100 sweeps for each crop reporting district (2020-2025).

District	2019	2020	2021	2022	2023	2024	2025
Northwest	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northeast	0.00	0.00	0.00	0.00	0.00	0.00	0.10
West	0.00	0.67	0.00	0.00	0.00	0.30	0.50
Central	0.00	0.00	0.16	0.00	0.15	0.03	0.10
East	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West Southwest	0.16	0.20	0.20	0.00	0.08	0.00	1.20
East Southeast	0.10	0.00	0.40	0.08	0.08	0.20	0.00
Southwest	1.60	0.40	3.52	6.40	2.10	0.53	1.20
Southeast	2.54	0.40	2.50	2.30	4.40	0.53	1.00
STATE AVE	0.55	0.21	0.75	1.01	0.76	0.18	0.46

Table 1.5. Mean number of western corn rootworm beetles per 100 sweeps in soybean by crop reporting district and year (2011-2024).

District	2017		2018		2019		2020		2021		2022		2023		2024		2015	
	INT	EXT	INT	EXT	INT	EXT	INT	EXT	INT	EXT	INT	EXT	INT	EXT	INT	EXT	INT	EXT
Northwest	0.00	3.40	0.90	0.50	0.08	0.00	2.60	4.20	0.80	1.40	0.30	0.50	0.32	0.56	0.80	0.27	0.70	0.10
Northeast	0.00	0.40	0.13	5.30	0.00	0.08	0.80	1.20	1.00	2.20	1.20	1.00	1.00	0.60	0.70	3.20	0.70	0.60
West	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.10	0.00	0.48	0.16	0.70	1.30	0.10	0.00
Central	1.60	6.25	0.10	1.60	0.00	0.08	1.00	0.20	0.32	2.40	0.70	0.00	0.24	0.00	0.00	0.20	0.20	0.30
East	0.75	1.60	4.36	5.72	0.16	1.44	2.20	3.00	0.00	0.00	0.00	0.20	0.30	0.30	0.10	0.00	0.20	0.50
West Southwest	0.00	0.00	0.48	0.00	0.00	0.32	0.10	0.00	0.07	0.00	0.00	1.20	0.60	0.00	0.30	0.72	0.00	0.00
East Southeast	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.13	0.00	0.00	0.16	0.00	0.40	0.00	0.00	0.00	0.00	0.00
Southwest	0.00	0.00	0.00	0.10	0.00	0.00	0.27	0.13	0.00	0.00	0.00	0.00	0.00	0.10	0.27	0.00	0.30	0.00
Southeast	0.00	0.00	0.08	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.20	0.00	0.00	0.10	0.00	0.00	0.10	0.00
STATE AVE	0.28	1.29	0.64	1.68	0.02	0.24	0.61	0.72	0.24	0.67	0.33	0.25	0.35	0.24	0.34	0.55	0.31	0.18

INT: interior, EXT: exterior

Table 1.6. Mean number of western corn rootworm beetles per plant in corn by crop reporting district and year (2011-2024).

District	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Northwest	0.26	0.33	0.05	0.02	0.02	0.10	0.04	0.08	0.13	0.55	0.28	0.32	0.49*	0.14
Northeast	0.15	0.20	0.02	0.00	0.02	1.95	0.35	0.00	0.00	0.16	0.03	0.07	0.05*	0.06
West	0.01	0.10	0.10	0.01	0.00	0.75	0.00	0.00	0.00	0.03	0.02	0.16	0.38*	0.11
Central	0.35	0.37	0.37	0.02	0.05	0.30	0.12	0.12	0.03	0.08	0.03	0.01	0.00	0.02
East	0.31	0.81	0.81	0.01	0.01	0.40	0.02	0.12	0.05	0.05	0.03	0.02	0.00	0.03
West Southwest	0.01	0.20	0.20	0.00	0.01	0.70	0.35	0.52	0.01	0.03	0.01	0.18	0.01	0.00
East Southeast	0.02	0.01	0.01	0.00	0.00	0.00	0.03	0.05	0.01	0.00	0.03	0.02	0.00	0.01
Southwest	0.00	0.00	0.00	0.01	0.01	0.15	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Southeast	0.00	0.03	0.03	0.00	0.00	0.20	0.03	0.00	0.00	0.01	0.00	0.01	0.00	0.00
State Average	0.12	0.23	0.18	0.01	0.01	0.51	0.10	0.01	0.03	0.10	0.05	0.09	0.10	0.04

*Counts in 2024 reflect combined counts of western corn rootworm and northern corn rootworm averages.

University of Illinois Plant Clinic Agronomic Sample Summary – 2025

Diane Plewa, Esneider Mahecha, Alison Colgrove

The University of Illinois Plant Clinic received 2,465 samples in 2025. These samples include field crop, nursery, and ornamental plant samples, along with Amaranth weeds submitted for herbicide resistance screening, seed lots submitted to test for the presence of Palmer amaranth, soil samples submitted for vermiform nematode identification and SCN egg counts and typing, and seed screening to test for SCN resistance. Plant Clinic staff use a combination of traditional laboratory methods including incubation, culturing, microscopy, along with other techniques such as bioassays and serological and molecular assays for diagnosis and identification.

In 2025, a total of 1,915 field crop samples were received, approximately 78% of all Plant Clinic submissions. These included 1,236 soil samples for nematode identification and enumeration and 624 plant samples for pest and pathogen diagnosis. Additionally, Amaranth weed samples were submitted for herbicide resistance testing, and seed lots were analyzed for the presence of Palmer amaranth.

Among the 624 plant samples received, the distribution was as follows: 320 corn, 298 soybean, and 6 wheat. Samples were submitted from 53 counties in Illinois and 3 other states. The plant samples included field crop samples submitted by farmers, crop consultants, and researchers, as well as samples processed for phytosanitary certification.

The most frequently diagnosed corn diseases in 2025 were Northern corn leaf blight (61% confirmed), Common smut (24%), Gray leaf spot (23%), Southern corn leaf bight (23%), and Physoderma brown spot (23%). All of these are considered common corn diseases in the Midwest. Northern corn leaf blight was more common this year compared to last year (39% of samples in 2024). We saw less Common rust in 2025 and more Southern rust (19% and 14% of samples in 2025) compared to last year (44% and 4% of samples in 2024). The number of samples diagnosed with tar spot (Figure 2.1) was also much decreased from last year (8% in 2025 compared to 20% in 2024).

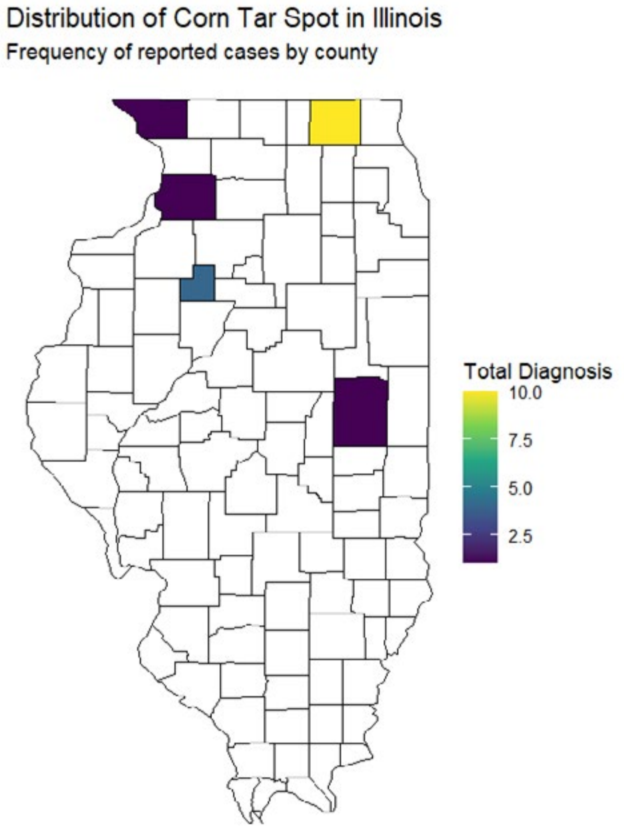

Figure 2.1. Frequency and distribution of corn tar spot diagnoses in 2025.

Of the soil samples submitted for corn vermiform nematode analysis, Spiral nematodes were the most frequently detected (90% of samples submitted), followed by Lesion (80%), Lance (59%), Dagger (20%), and Stunt (10%).

For soybean samples, the most common diseases diagnosed were Downy Mildew (53% of submitted samples), Sudden death syndrome (33%), Phytophthora Crown and Root Rot (25%), Frogeye leaf spot (24%), and

Red crown rot (18%; Figure 2.2). As with corn, these are common diseases frequently seen in Illinois. Sudden death syndrome was confirmed on more samples in 2025 compared to last year (19% of samples in 2024) along with an increase in Phytophthora (17% in 2024). Bacterial diseases, including bacterial blight, were less common this year compared to 2024 (10% of samples compared to 28%). Soybean Vein Necrosis Virus was also much decreased in 2025 (10% compared to 55% in 2024).

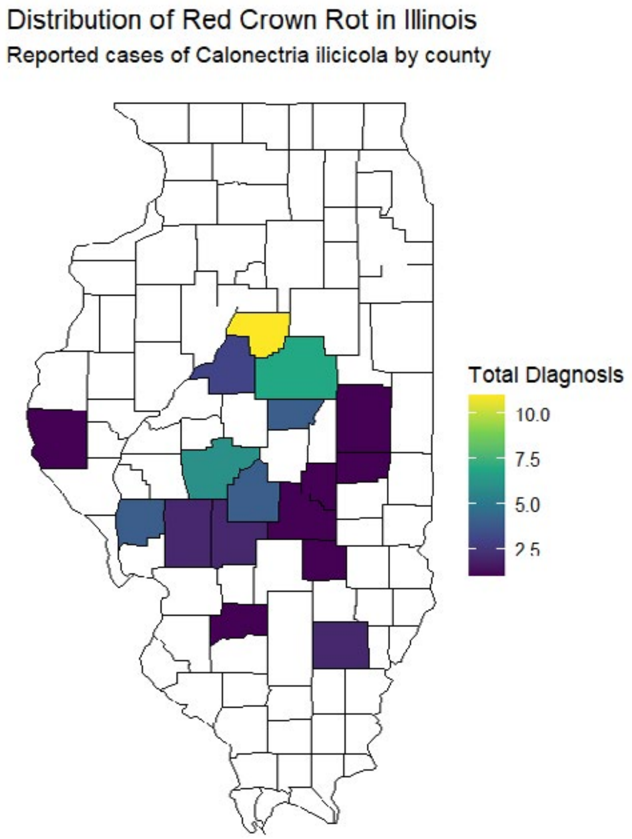

Figure 2.2. Frequency and distribution of red crown rot diagnoses in 2025.

We continue to see moderate to high numbers of SCN eggs found in fields across the state sufficient to cause yield loss. Yield loss is usually most severe on lighter, sandy soils, but drastic losses have been observed even in the heavy clay-loam soils typical of much of the soybean acreage in Illinois. SCN Type 2 is the most common in Illinois, though Type 1 is increasing in prevalence, continuing the trend seen in previous years. We recommend testing soil for SCN egg counts and continuing to monitor if moderate to high levels are found.

The Plant Clinic working with Dr. Nathan Schroeder and the Illinois Soybean Association (ISA) to provide Illinois soybean producers with SCN Egg Count analysis on their soil samples at no charge to them. Producers can contact freeSCNtesting@illinois.edu to receive a kit with sampling instructions and free shipping. Currently the project is funded through August 31, 2026. SCN egg counts (measured as the number of eggs per 100 cubic centimeters of soil) provide a snapshot of the status of SCN in a field and can help inform the producer's management plan. A low count indicates that the management plan is successfully incorporating best practices for SCN management, which should include rotation with a non-host (including corn or wheat), use of SCN resistant soybean varieties, as well as monitoring their SCN egg count. Because SCN is known to be prevalent in Illinois soybean fields and to cause significant yield losses especially at high levels, it is important for Illinois soybean farmers to test their fields to determine if they have a problem with SCN in their soybean fields and if their management plan should be re-evaluated.

On wheat samples, Anthracnose, Fusarium head blight, Sharp eyespot, Septoria leaf blotch, Bacterial leaf streak, and Stripe rust were confirmed.

Impact of *Sclerotinia sclerotiorum* Inoculation Timing on Soybean Disease Severity and Yield, Year 1

Esneider Mahecha, Diane Plewa

The Plant Clinic produces more than 5,000 pounds inoculum annually of different pathogens. Field inoculation is a common practice used to increase disease pressure, particularly for evaluating host resistance and fungicide efficacy under field conditions.

One of the inoculums we produce is white mold, caused by the fungal pathogen *Sclerotinia sclerotiorum.* White mold is a major disease affecting soybean production, leading to significant reductions in seed yield and weight. This year, in collaboration with the Smart Plant Pathology Laboratory under Dr. Boris Camiletti and Agustin Perez at the University of Illinois, we conducted field experiments in irrigated plots to improve our understanding of white mold inoculum performance and infection efficiency. Two inoculation methodologies were evaluated: applying sclerotia to the field at seedling stage and applying powdered inoculum at flowering (Figure 3.1).

The experiment was conducted in Urbana, Illinois, at a research station of the University of Illinois Urbana–Champaign. The seeding rate was 140,000 seeds per acre in irrigated plots. The study was arranged in a randomized complete block design (RCBD) with four replications (plots). Fungicide treatments consisted of a single application of prothioconazole (41%) at the R3–R4 growth stage, applied at a rate of 5 fl oz/A using a CO_2-powered backpack sprayer. Data were analyzed using ANOVA after checking normality assumptions, and means were compared using a post hoc Tukey test.

Overall, results from this year's experiments showed clear differences between inoculation strategies. Inoculation at the flowering stage resulted in significantly higher disease incidence measured by the number of infected plants per two treated rows compared to the seedling/soil inoculation method and the non-inoculated control (Figure 3.2). We infer from this finding that the presence of flowers, which serve as a primary nutrient source for Sclerotinia ascospores, represents the critical infection window for successful disease establishment. Disease severity was also evaluated. Despite high variability, plants inoculated at the flowering stage had overall higher disease severity ratings compared to both the soil inoculation at seedling and the non-inoculated control. This variability is probably driven by environmental factors, particularly the timing and intensity of irrigation pulses, which strongly influence sclerotia germination and apothecia development. Higher humidity in the field favors the germination of sclerotia.

The Inoculated in Flowering treatment shows the lowest median yield visually (Figure 3.3), but the high variability (long whiskers in the boxplot) prevented this from being statistically significant. The fungicide treatment did not significantly increase yield indicating it was not very effective at protecting the plant and preventing infection. This could be due to the timing of the fungicide application; due to scheduling and environmental pressure the fungicide was applied later than generally recommended for control of white mold. We plan to replicate this study in 2026.

In addition to white mold research, the Plant Clinic is actively developing and evaluating field inoculation methodologies for other economically important diseases. These efforts include work on northern corn leaf blight and gray leaf spot in corn, as well as *Phytophthora sojae* in soybean. Collectively, these studies aim to refine pathogen inoculum application techniques, improve consistency and reliability of disease establishment in field trials, and enhance the quality of data generated for research and extension purposes.

Figure 3.1. Powder inoculation at the flowering stage in soybean, applied to the two inner treated rows.

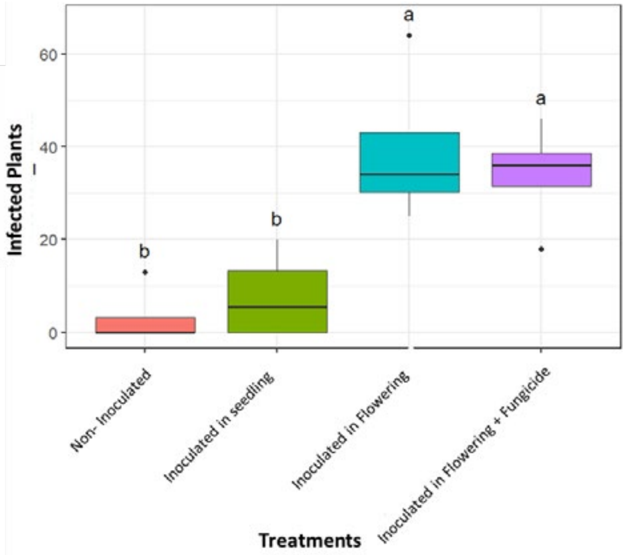

Figure 3.2. Effect of inoculation on the number of infected plants per row. (treatments with different letters are significantly different (P < 0.05). Inoculation during flowering is effective in establishing infection, and is superior to inoculating with sclerotia as seedlings. Both the Inoculated in Flowering and Inoculated in Flowering + Fungicide resulted in a significantly higher number of affected plants compared to Inoculated in seedling and the non-inoculated control.

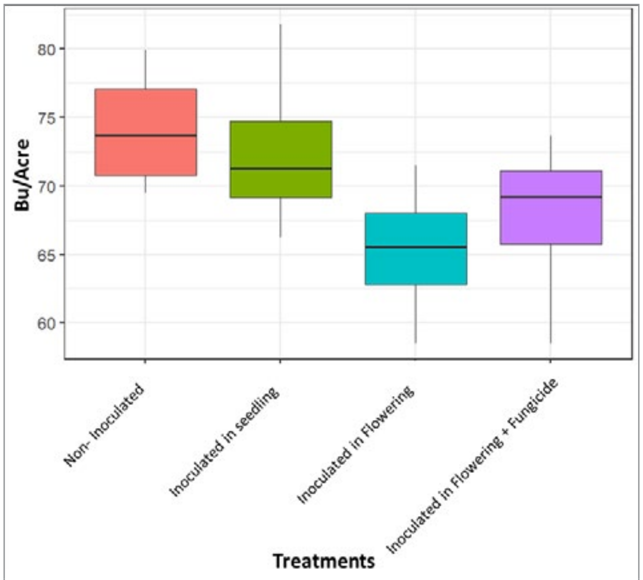

Figure 3.3. Effect of inoculation methods on yield. No significant differences were detected among treatments (P < 0.05). Although the differences were not statistically significant, treatments inoculated at the flowering stage showed yield reductions of 12.0% for the inoculated flowering treatment and 8.76% for the inoculated flowering + fungicide treatment compared with the non-treated control.

Efficacy of Fungicide Programs Against Tar Spot and Northern Corn Leaf Blight of Corn in Northwestern Illinois – 2025

Corn (*Zea mays*) *Phyllachora maydis*

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A trial was established at the Northwestern Illinois Agricultural R&D Center in Warren County, IL. The experiment was a randomized complete block design with six replications. Plots were 30 ft wide and 60 ft long, consisted of 12 rows, and the two center rows were used for evaluation. The previous crop was soybean. Standard practices for non-irrigated grain corn production in Illinois were followed. Corn hybrid ‘DK107-33RIB’ was planted in 30-in row spacing at a rate of 36,000 seeds/A on 17 May. Foliar applications were made at the R2 growth stage on 01 Aug. Fungicides were applied using an Agras T10 drone sprayer at 3 gal/A. Disease ratings were assessed on 20 Aug (R5). Tar spot and Northern corn leaf blight (NCLB) incidence and severity was visually assessed as a percentage (0-100%) of symptomatic leaf area at the ear leaf on 5 plants per plot and averaged for the statistical analysis. The two center rows of each plot were harvested on 25 Sep, and yields were adjusted to 15.5% moisture. All disease and yield data were analyzed in RStudio. Incidence data were analyzed using a generalized linear model, while severity data were analyzed with linear models. Means were calculated using the package ‘emmeans’ and compared with Tukey’s test (α=0.05).

In 2025, environmental conditions in northwestern Illinois were conducive to the development of both tar spot and NCLB; however, overall disease pressure was moderate (Table 4.1). Tar spot incidence reached 100% across all treatments, and no significant differences were detected among fungicide programs for disease incidence. In contrast, significant differences were observed for tar spot severity. The Priaxor plus generic propiconazole treatment resulted in the lowest tar spot severity, while Adastrio and the generic azoxystrobin plus propiconazole treatment exhibited the highest severity levels. Other fungicide programs provided intermediate levels of tar spot suppression and did not differ statistically from the non-treated control.

NCLB incidence was generally low to moderate across treatments and did not differ significantly among fungicide programs. One treatment (Priaxor plus generic propiconazole) resulted in zero NCLB incidence across all evaluated plants. Similarly, NCLB severity remained low overall, with no significant differences detected among treatments.

Grain yield was not significantly affected by fungicide program, with yields ranging from 229 to 253 bu/acre. These results indicate that, under the disease pressure observed in 2025, fungicide applications influenced tar spot severity but did not translate into statistically significant yield benefits.

Table 4.1. Effect of fungicide programs on tar spot and NCLB in northwestern Illinois, 2025.

Fungicide Program	Tar spot[y]		NCLB[y]		Yield[x]
Treatment, rate[z]	Incidence[w]	Severity[w]	Incidence[w]	Severity[w]	(bu/acre) [w]
Non treated	100 a	12.73 ab	13.33 a	0.3 a	244 a
Revytek 8 floz/a	100 a	12.78 ab	10 a	0.23 a	248 a
Veltyma 7 floz/a	100 a	9.11 ab	6.67 a	0.4333 a	236 a
Priaxor 8 floz/a + generic propiconazole 6.8 floz/a	100 a	6.26 a	0 a	0 a	248 a
Lucento 5 floz/a + generic azoxystrobin 5.8 floz/a	100 a	10.53 ab	3.33 a	0.1 a	229 a
Adastrio 8 floz/a	100 a	16.65 b	3.33 a	0.0167 a	236 a
Trivapro 13.7 floz/a	100 a	11.04 ab	26.67 a	1.35 a	239 a
Generic azoxystrobin + propiconazole 10.5 floz/a	100 a	16.5 b	16.67 a	0.8 a	253 a
Generic azoxystrobin 6 floz/a	100 a	7.13 ab	6.67 a	0.1667 a	246 a
p-value[w]	1	0.007	0.87	0.3	0.83

[z] Foliar applications were made at R2 on 01 Aug.

[y] Disease severity was visually assessed as the percentage (0-100%) of leaf area covered by stroma on 5 plants in each plot. The incidence was analyzed as proportion and converted to percentage.

[x] Yields were adjusted to 15.5% moisture and harvested on 25 Sep.

[w] Treatment mean values with the same letter are not significantly different based on Tukey's test (α=0.05).

Efficacy of Fungicide Programs Against Tar Spot and Southern Rust of Corn in Northwestern Illinois – 2025

Corn (*Zea mays*) *Phyllachora maydis*

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A trial was established at the Northwestern Illinois Agricultural R&D Center in Warren County, IL. The experiment was a randomized complete block design with six replications. Plots were 30 ft wide and 60 ft long, consisted of 12 rows, and the two center rows were used for evaluation. The previous crop was soybean. Standard practices for non-irrigated grain corn production in Illinois were followed. Corn hybrid 'DK107-33RIB' was planted in 30-in row spacing at a rate of 36,000 seeds/A on 15 May. Foliar applications were made at the R1 growth stage on 24 Jul. Fungicides were applied using an Agras T10 drone sprayer at 3 gal/A. Disease ratings were assessed on 20 Aug (R5). Disease severity was visually assessed as a percentage (0-100%) of symptomatic leaf area at the ear leaf on 5 plants per plot and averaged for the statistical analysis. The two center rows of each plot were harvested on 13 Oct, and yields were adjusted to 15.5% moisture. All disease and yield data were analyzed in RStudio. Incidence data were analyzed using a generalized linear model, while severity data were analyzed with linear models. Means were calculated using the package 'emmeans' and compared with Tukey's test ($\alpha=0.05$).

In 2025, environmental conditions in northwestern Illinois were favorable for the development of tar spot and southern rust, resulting in moderate to high disease pressure (Table 5.1). Tar spot incidence was uniformly high across treatments and did not differ significantly among fungicide programs. In contrast, significant differences were observed for tar spot severity. Headline AMP followed by Proline and Delaro Complete resulted in the lowest tar spot severity and differed significantly from the non-treated control. Proline alone, Headline AMP alone, and Miravis Neo provided intermediate suppression and did not differ statistically from either the non-treated control or the most effective treatments.

Southern rust incidence differed significantly among treatments. The non-treated control exhibited the highest incidence, while Headline AMP alone and Headline AMP followed by Proline resulted in the lowest southern rust incidence. Similarly, southern rust severity was significantly reduced by fungicide applications compared to the non-treated control. Headline AMP alone resulted in the lowest severity values, while the remaining fungicide programs provided intermediate control and did not differ statistically from one another. Grain yield tended to be higher in fungicide-treated plots compared to the non-treated control; however, these differences were not statistically significant.

Table 5.1. Effect of fungicide programs on tar spot and southern rust in northwestern Illinois, 2025.

Fungicide Program	Tar spot[y]		Southern rust[y]		Yield[x]
Treatment, rate[z]	Incidence[w]	Severity[w]	Incidence[w]	Severity[w]	(bu/acre) [w]
Non treated	100 a	4.46 b	66.7 b	1.03 b	178 a
HeadlineAMP 14.4 fl oz + Proline 5.7 fl oz	93.3 a	1.1 a	23.3 a	0.35 ab	196 a
Delaro Complete 8 fl oz	96.7 a	1.86 a	26.7 a	0.32 ab	195 a
Proline 5.7 fl oz	96.7 a	2.1 ab	46.7 ab	0.38 ab	184 a
HeadlineAMP 14.4 fl oz	100 a	2.14 ab	20 a	0.2 a	200 a
MiravisNeo 13.7 fl oz	100 a	2.99 ab	33.3 ab	0.34 ab	194 a
p-value[w]	0.94	<0.001	0.001	0.016	0.078

[z] Foliar applications were made at R1 on 24 Jul.

[y] Disease severity was visually assessed as the percentage (0-100%) of leaf area covered by stroma on 5 plants in each plot. The incidence was analyzed as proportion and converted to percentage.

[x] Yields were adjusted to 15.5% moisture and harvested on 13 Oct.

[w] Treatment mean values with the same letter are not significantly different based on Tukey's test (α=0.05).

Efficacy of Registered Seed Treatments Against Red Crown Rot of Soybean in Western Illinois – 2025

Soy (*Glycine max*) *Calonectria ilicicola*

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A field trial was established in a commercial soybean field in Pike County, IL, with a history of red crown rot (RCR) epidemics. The experiment followed a randomized complete block design with seven replications. Plots measured 10 ft wide by 20 ft long, consisted of four rows spaced 30 in apart, and only the two center rows were used for evaluation. The previous crop was corn, and standard practices for non-irrigated soybean production in Illinois were followed. Soybean variety XO3922E was planted on 28 May at a rate of 140,000 seeds per acre. Seed treatments included a base treatment ineffective against RCR, as well as Saltro (Syngenta), ILEVO (BASF), and CeraMax (Ceradis), applied at the rates described in Table 6.1. Disease ratings were collected every 10 days after the first detection of foliar symptoms. Foliar disease severity was assessed using a standardized 0 to 9 scale to calculate a disease severity index, which was used to estimate the area under the disease progress curve (AUDPC) for each plot. The two center rows were harvested on 03 Oct, and yield was adjusted to 13% moisture. All disease and yield data were analyzed in RStudio using linear models. Treatment means were estimated with the emmeans package and separated using Tukey test at $\alpha = 0.05$.

Saltro treatments were the most effective at suppressing RCR (Figure 6.1A). Plots treated with Saltro alone at both rates and with the Saltro + ILEVO combination had the lowest AUDPC values and were statistically similar to each other, indicating strong and consistent disease suppression. In contrast, CeraMax and ILEVO provided intermediate disease control, while the base treatment had the highest AUDPC and differed significantly from all Saltro treatments, confirming severe disease development in the absence of an effective RCR seed treatment. Yield trends closely mirrored disease suppression (Figure 6.1B). The highest yields, approximately 75 to 80 bu per acre, were obtained with Saltro alone and in combination with ILEVO, and these treatments yielded significantly more than the intermediate group. CeraMax and both ILEVO rates produced intermediate yields, around 45 to 55 bu per acre. The base treatment had the lowest yield, near 35 bu per acre, and differed significantly from all other treatments. Overall, treatments that provided the greatest RCR suppression, particularly Saltro alone or combined with ILEVO, resulted in the lowest disease levels and the highest soybean yields.

Table 6.1. Seed treatments and application rates used in the field trial.

Treatment	Application rate
Base	Metalaxyl (4 g AI/100 kg seed) + trifloxystrobin (5 g AI/100 kg seed) + imidacloprid (0.12 mg AI/seed)
ILEVO	0.15 mg AI/seed
ILEVO	0.25 mg AI/seed
Saltro	0.075 mg AI/seed
Saltro	0.15 mg AI/seed
Saltro + ILEVO	0.075 mg AI/seed + 0.075 mg AI/seed
CeraMax	160 ml/100 kg seed

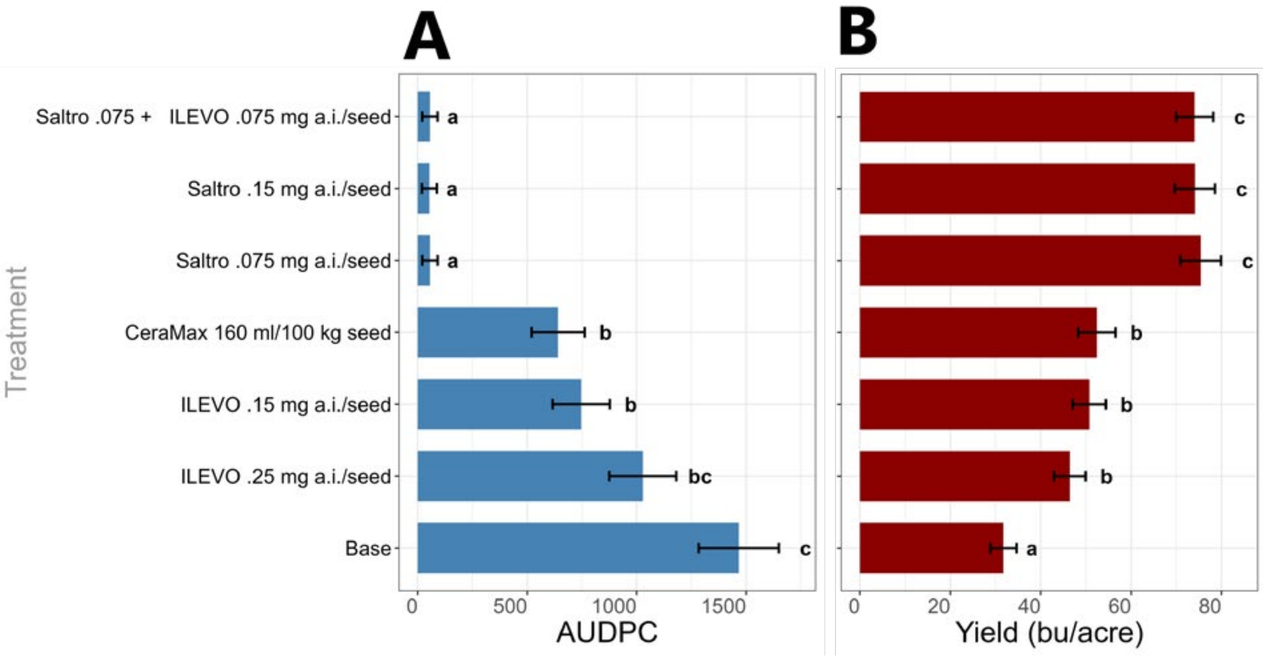

Figure 6.1. Effect of seed treatments on (A) RCR severity expressed as area under the disease progress curve (AUDPC) and (B) soybean yield in a commercial field in Pike County, IL. Bars represent mean values across seven replications. Treatments sharing the same letter within each panel are not significantly different according to Tukey test at α = 0.05.

Patterns of Bt Corn Adoption in Some Illinois Counties – 2025

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Introduction

The western corn rootworm (*Diabrotica virgifera* LeConte, WCR) and northern corn rootworm (*Diabrotica barberi* Smith and Lawrence, NCR) are the most serious U.S.A. corn pests. Illinois abundance surveys documented widespread and potentially injurious rootworm populations from the mid-1960s through the early 2010s (Figure 7.1 and see Tinsley et al. 2018). Illinois corn growers have responded to corn rootworm threats with crop rotation, applying soil and/or broadcast insecticides, and more recently by adopting seed-based technologies (i.e., insecticidal seed treatments and/or Bt corn hybrids) or combinations of multiple tactics. Over the last 10-15 years, annual surveys by the Illinois Cooperative Agricultural Pest Survey (IL-CAPS) have documented sustained low WCR and NCR abundances, even in former rootworm “hot spots” (Figure 7.1). Broadscale adoption of effective single- and multi-trait “pyramided” Bt corn hybrids (beginning in 2003 and 2010, respectively) likely contributed to the Illinois rootworm suppression (along with weather and other practices) (Gray 2015, Tinsley et al. 2018). However, the subsequent growth of Bt resistance in Illinois WCR (and NCR) populations has not led to a rebound in overall rootworm abundance during the intervening decade.

From an integrated pest management perspective, persistently low WCR and NCR abundances present opportunities to plant non-Bt corn hybrids and thus avoid unnecessary selection for Bt resistance and the *ca*. $25/acre Bt technology premium for hybrids expressing Bt toxins (Ye et al. 2025). Growers are encouraged to monitor rootworm abundance in fields destined for corn planting during the following year. However, few growers scout for rootworm beetles before making rootworm management decisions.

Documenting adoption patterns of Bt corn hybrids may be helpful for understanding grower perception of rootworm risk relative to historical and current local rootworm abundances. While IL-CAPS annually collects county-level data on rootworm abundance, USDA-NASS public information on adoption of Bt corn hybrids (USDA-NASS 2025a,b; available at https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-united-states and https://croplandcros.scinet.usda.gov/) only provide statistics at the state level and those data are aggregated across Bt traits for below-ground (i.e., rootworm) and above-ground (caterpillar) pests. Lacking access to Bt adoption data at a scale reflecting grower perception of rootworm risk, we conducted a field-scale survey to document the proportion of cornfields in counties that expressed Bt traits targeting rootworm and caterpillar pests.

Previous small surveys in 13-23 contiguous cornfields NE of Urbana, Ill. (Champaign, Co.) were conducted to collect and test corn leaves for expression of Bt toxins that provide protection from larval rootworm feeding using toxin-specific test strips (QuickStix®, Envirologix, Inc. Portland, Maine). Annually testing fields in the same Champaign Co. area between 2015-2019 (all years of extremely low rootworm pressure) revealed that the planting of rootworm-protected Bt corn hybrids declined from 100% (2015) to 48% (2019). Though the geographical scope was limited to a few square miles, reduced adoption of rootworm-protected Bt corn hybrids over time suggested growers were reducing their reliance on Bt corn in response to low rootworm pressure. At the state level during the same period, adoption of Bt corn hybrids with rootworm + caterpillar protection had remained steady at ca. 90% since 2015 (USDA-NASS 2025a, https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-united-states).

During 2025, a similar survey was conducted to document Bt adoption in cornfields, but it was expanded to include multiple Illinois counties. Our goal was to document the proportion of cornfields planted with Bt corn hybrids expressing various *Cry* toxins that protect corn from belowground (corn rootworms, Order Coleoptera) and aboveground (caterpillars, Order Lepidoptera, e.g. European corn borer, ECB) pests. To provide a context to understand the local perceptions of rootworm risk, we examined historical rootworm abundance data from 1966-1984 Illinois corn rootworm surveys, IL-CAPS adult rootworm abundance data for 2024 (https://extension.illinois.edu/crops/field-crop-disease-and-insect-management-applied-research-report) and earlier years, as well as 2008-2023 data on county-level frequency of annual crop rotation (a practice that prevents the build-up of damaging rootworm populations)(USDA-NASS 2025b).

Methods

Leaf sampling

During June and July of 2025, corn leaves were collected from commercial cornfields in seven Illinois counties and tested to detect expression of the Bt *Cry* toxins that provide protection from caterpillar and rootworm pests in Bt corn hybrids.

Counties spanning the historical range of rootworm pest pressure from Central to Northwest Illinois were selected (Coles, DeWitt, Lee, Livingston, and Woodford), along with Champaign (location of our University of Illinois research laboratories and field plots) and Warren (location of a frequently visited UI Crop Sciences Research and Education Center farm) counties. Five or more starting locations per county were pre-selected before each sampling trip. Starting locations were selected to be at accessible, rural intersections that were broadly distributed within each county. During sampling, data about each intersection were recorded, including the location of corn, soybean, and other crops at the intersection, the road names/numbers, GPS coordinates, etc. A unique consecutive number was assigned to each cornfield and used to label plastic leaf collection bags. Each commercial cornfield at the intersection was briefly entered to collect two 15-20 cm long leaf tips/field from corn plants in widely separated rows (typically >12 rows apart). Multiple leaves were sampled to reduce the probability of choosing the leaf from a non-Bt ‘refuge” plant (present as 5% of the plants in most fields). Bagged leaves were stored in a cooler. Details about the presence of rootworm adults, information from corn variety signs along field margins, etc., were also recorded. The team then traveled to the next intersection and repeated the process until cornfields at 5 consecutive intersections separated by 1 mile had been sampled. The team then drove to the next starting location and repeated the process of sampling 5 consecutive intersections. Time permitting, additional starting locations were identified and sampled before returning to the laboratory. Champaign and Woodford counties were sampled on 3 and 2 different days, respectively; other counties were sampled on one day. Leaf samples stored at -10°C until processing.

Detection of Cry toxin expression

Two *ca*. 5 mm × 10 mm pieces of tissue from each leaf were placed in separate 1.5 ml Eppendorf tubes containing 1 ml of an Envirologix® QuickStix buffer and ground with a plastic pestle until the solution was green. Solutions were tested for Bt toxin expression using six different Envirologix® QuickStix lateral flow test strips specific for the detection of *Cry*1Ab or *Cry*1F caterpillar-specific toxins and *Cry*3Bb1, *Cry*34/*Cry*35Ab1 (recently renamed Gpp34/Tpp35Ab1), mCry3A, and eCry3.1Ab, four rootworm-specific toxins. During testing, two different QuickStix were placed back-to-back and inserted vertically into the sample tube. This was repeated with the remaining QuickStix in additional tubes. Each cornfield leaf was tested separately. Test results were read after 5-minutes.

The solution in the tubes is drawn up into the absorbent QuickStix where it interacts with antibodies specific for one of the Bt toxins that are bound to a matrix. If the specific toxin is present in the solution and binds to the specific antibodies, a color change is initiated resulting in the appearance of a red-line on the QuickStix, indicating a positive result for that toxin. If either leaf sample from a field tested positive for ≥1 caterpillar and/or ≥1 rootworm toxin, that field was judged to have been planted with a Bt corn hybrid that targeted those pests. If the 2nd leaf from a field growing a rootworm-protected Bt hybrid was positive only for caterpillar Bt toxins, it was presumed to have come from a non-rootworm Bt refuge plant. Uncommonly, leaves were negative for all tested *Cry* toxins. Those leaves were judged to be from non-Bt hybrids and were frequently retested to confirm the result. If one or both of the leaves from a pair were positive for caterpillar protection traits, but both negative for rootworm protection, the source field was classified as field lacking rootworm protection, but protected from caterpillar pests.

We tested for only some of the possible Bt toxins expressed in commercial corn hybrids. As such, the specific identity of a trait package (some of which express the same sets of Bt toxins) could not always be unambiguously identified. Furthermore, the RNAi mode of action is not based on the presence of toxic proteins and cannot be detected using Envirologix® QuickStix. Thus, an unknown proportion of leaves that were positive for both *Cry*3Bb1 and/or *Cry*34/*Cry*35Ab1 rootworm-specific toxins, also expressed the RNAi mode of action. RNAi expression can be confirmed via amplification with polymerase chain reaction (PCR) and detection/identification of RNA fragments, procedures beyond the scope of our sampling.

The presence of rootworm and/or caterpillar-specific Bt toxins in a leaf sample definitively identifies a leaf as being protected from rootworms or caterpillar pests, or both. The “Handy Bt Trait Table” was used as a reference to toxins expressed in Bt corn hybrids (DiFonzo, 2025). https://www.texasinsects.org/uploads/4/9/3/0/49304017/bttraittable_aug2025.pdf)

The proportion of corn acres in annual rotation

The USDA-NASS CroplandCROS website (USDA-NASS 2025b) is a source of detailed U.S. cropping data at the state, county and field level. We collected Illinois county-level data on the annual frequency of corn planting (“Corn Frequency Layer”) between 2008-2023. The proportion of total county acres that were planted with corn for 8 of 16 years was calculated and used as a measurement of highly consistent crop rotation frequency. An examination of the county Cropland Data Layer (also available at the CroplandCROS website), which details the acres of all crops for a given year, confirmed that the most frequently rotated field crops, corn and soybean, typically accounted for ca. >95% of all planted acres in a county.

Historical and current rootworm abundance surveys

As noted above, rootworm data from the 1966-1984 Illinois corn rootworm surveys and IL-CAPS adult rootworm survey data for 2024 and earlier years provided information on historical and current rootworm abundance at different spatial scales.

Results and Discussion

A total of 342 cornfields were sampled from seven Illinois counties during 9 days in June and July of 2025. Overall, the proportions of sampled cornfields that were planted with a hybrid expressing ≥1 Bt trait providing protection from rootworm or caterpillar pests were 0.535 ± 0.027 and 0.968 ± 0.010, respectively. This level of Bt adoption is generally consistent with aggregate data from USDA-NASS reporting that *ca*. 90% of Illinois corn hybrids express insect resistance traits for above and/or belowground pests (USDA-NASS 2025a).

The proportion of caterpillar-protected cornfields was not significantly different among counties ($F_{(6, 341)}$=1.496; P=0.1788) (Table 7.1). There were significant differences in the proportions of rootworm-protected cornfields among counties ($F_{(6, 341)}$=6.293; P<0.0001). The highest proportion of fields planted with rootworm-protected hybrids (0.816) was in Lee Co. (Northwest Ill.). Among the sampled counties, Lee Co. also had the lowest average 2008-2023 proportion of corn acres grown under a strict annual crop rotation with a non-host, like soybean. Since continuous corn cultivation is associated with higher local CRW abundance and a greater expected CRW threat, high proportions of rootworm-protected cornfields are unsurprising. The lowest average proportion of fields planted with rootworm-protected hybrids (0.310) was in Coles Co. (East-southeast Ill.). Coles Co. also had the highest average 2008-2023 proportion of cornfields that were planted in a strict annual crop rotation with soybean or another non-host plant. Unless there is significant rotation-resistant WCR egg-laying activity in soybean (a problem that has largely been absent for ≥10 years), areas with a preponderance of rotated corn acres can expect to experience lower CRW abundance and be at low risk of larval injury in corn. Low proportions of rootworm-protected hybrids under these circumstances are also unsurprising.

What is surprising is that no county sampled in 2025 had 2024 adult abundance/plant in corn (based on CAPS 2024 survey) that exceeded the 0.75-1.0 CRW/plant economic threshold associated with a future risk of economic rootworm injury in corn. Given low 2024 rootworm average abundance and parallel long-term low abundance trends (Figure 7.1), the measured Bt corn adoption patterns suggest Illinois growers are planting much more rootworm-protected Bt hybrids than necessary (Table 7.1).

Our sampling was done without any knowledge of the actual local rootworm abundance during the previous year. It is possible that the Bt corn hybrids planted in 2025 were justified based on 2024 field scouting or adult rootworm monitoring. However, given that we saw no evidence of active 2025 rootworm monitoring, it seems unlikely that rootworm monitoring was a common practice in 2024.

While there were significant differences in the proportion of rootworm Bt corn hybrids planted across Illinois counties (Table 7.1), there were no statistically significant relationships between those proportions and other metrics. The CRW/plant abundance in 2024 corn was a poor predictor of the 2025 rootworm Bt corn hybrid adoption proportions in a county ($F_{(1, 5)}$=0.425, P=0.543).

These data suggest that growers are not planting rootworm Bt corn hybrids in response to monitoring data or risk based on current rootworm abundance trends. Long-term average Illinois-CAPS WCR/plant data (Figure 7.1) and annual rootworm plant count data (see IL-CAPS 2025, and prior years) do not exceed even a fraction of the economic threshold for rootworm adult counts. Recent rootworm abundance is only a fraction of the historical average abundance (WCR+NCR/plant) between 1966-1984 (Figure 7.1). If the 2024 plant counts or the CRD average WCR/plant counts were at all representative of on-farm field monitoring results, planting rootworm Bt corn hybrids in 2025 would have been largely unnecessary in the sampled counties. The relationship between the long-term proportions of annually rotated corn acres/county and the proportion of rootworm Bt corn hybrids/county was also non-significant ($F_{(1, 5)}$=4.463, P=0.088), but thought-provoking. The trajectory of the observed response from just seven counties points toward more Bt adoption in counties where there are greater proportions of continuous corn acres, regardless of the measured rootworm abundance.

It is interesting to consider to what extent current Bt adoption reflects historical patterns of crop rotation vs. current local rootworm abundance. It is difficult to imagine how Bt adoption patterns align with low WCR abundance. Though imperfect, county-scale patterns of Bt corn hybrid adoption suggest that growers from some counties with historically low and high proportions of rotated corn acres are aware that their cultivation choices affect their vulnerability to future rootworm injury. Thus, in counties where annual rotation was historically less common, a greater proportion of fields are planted with rootworm Bt corn hybrids to address their vulnerability and *vice versa*. In this instance, the choice to plant a rootworm Bt corn hybrid seems more tied to “habit” and traditional/historical perceptions of risks associated with growing more or less continuous corn than they are rooted in current (low) beetle abundance.

The hypothesis that habits and the traditional practices related to rootworm risk play a more significant role in adoption of rootworm Bt corn hybrids than measurable rootworm abundance would benefit from additional data from a broader set of Illinois counties. In the future, it will be important to sample counties in SW and SE Illinois, where present rootworm abundances are not so different from some historical time periods. We should also sample more counties from NW and NE Illinois, where rootworm threats were high. In addition, we did not inspect fields to determine whether stubble/debris in the soil suggested they were rotated or continuous corn. This detail could have provided data on the current proportions of rotated vs. continuous corn in the sampled counties and whether adoption of rootworm Bt-protected hybrids is more common in continuous cornfields.

Perhaps long-standing efforts to increase grower awareness of rootworm injury and resistance have been *too* successful? Casting the rootworm as an endlessly formidable foe may have turned it into a pest “boogey-man” that constitutes an unacceptable risk wherever it may be present, regardless of its abundance. Growers may benefit from a refresher on the vulnerabilities of corn rootworm biology, the limitations of Bt technology, and the importance of adopting rootworm monitoring as the first step in their pest management decision-making process.

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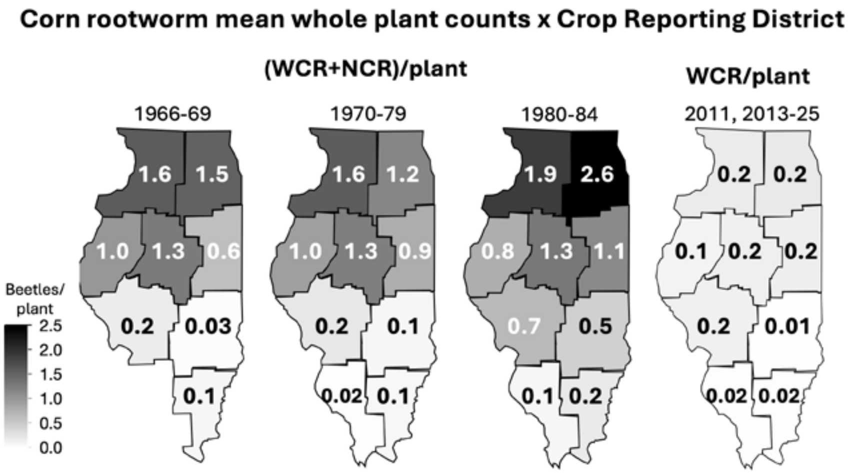

Figure 7.1. Mean corn rootworm whole plant counts in corn by Illinois Crop Reporting District (CRD). WCR+NCR/plant data from 1966-69 (n=875 fields), 1970-79 (n=3,492 fields), and 1980-84 (n=1,839 fields) data are pooled from annual county-level surveys conducted by the Entomology Extension Office (Petty et al. 1966-1984). WCR/plant data from 2011, 2013-2025 are pooled from annual county-level surveys conducted by the Illinois Cooperative Agricultural Pest Survey (Estes 2025).

Table 7.1. Proportion of annually rotated corn acres by Illinois county, 2024 county corn rootworm (WCR + NCR) adults/plant abundance in cornfields, 2025 proportions of corn hybrids in county cornfields expressing Bt caterpillar and Bt corn rootworm protection

Illinois county	Sampled fields[1]	2008-2024 Proportion of rotated corn acres[2]	2024 Mean CRW/ plant[3]	Mean proportion hybrids with caterpillar protection[4]	Mean proportion hybrids with corn rootworm protection[4]
Coles	29	0.563	0	0.931 a	0.310 c
DeWitt	34	0.535	0	0.971 a	0.559 abc
Champaign	107	0.531	0.11	0.991 a	0.421 c
Livingston	30	0.52	0	1.000 a	0.600 abc
Woodford	59	0.415	0.031	0.932 a	0.661 ab
Warren	34	0.377	0.113	1.000 a	0.382 bc
Lee	49	0.14	0.04	0.939 a	0.816 a

[1] Cornfields were sampled at 5 successive rural intersections along ≥5 transects per county.

[2] Rotated acres were planted to corn for 8 of 16 years (2008-2023). Source: USDA-NASS. CroplandCROS (2025b).

[3] 2024 IL-CAPS survey data. There were 5 cornfield samples per county. DeWitt Co. & Woodford Co. were not sampled in 2024. Survey data for adjacent sampled counties were pooled to generate extrapolated means for DeWitt (McLean + Macon) and Woodford (Peoria + LaSalle + Livingston + McLean + Tazewell) counties, respectively. The economic threshold for CRW/plant (1.0 – 0.75) was not exceeded by any county mean.

[4] Two leaves/field were tested for expression of Bt toxins targeting caterpillars (Cry1Ab and Cry1F) and rootworms (Cry3Bb1 and Gpp/Tpp34/35Ab1). Expression of ≥1 caterpillar or rootworm trait in one leaf was the criterion for designating that plants in a field had protection from a specific pest(s). Analyses of the proportions of caterpillar- and corn rootworm-positive Bt fields were via ANOVA, with mean separations via Tukey HSD; means bearing the same letter are not significantly different at a=0.05.

The Status of Illinois Western Corn Rootworm (*Diabrotica virgifera virgifera*, WCR) Resistance to Commercial Bt Corn Hybrids.

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Introduction

Two groups of Bt Cry toxins (i.e., the “Cry3” Bt toxins: Cry3Bb1, mCry3A, and eCry3.1Ab, and the Gpp34/Tpp35Ab1 toxins Bt toxin [formerly called Cry34/Cry35Ab1]) are commonly used to protect corn roots from corn rootworm larval injury. The two groups of Bt toxins represent the only two independent Bt modes of action that have been commercialized for rootworm management. As a consequence of repeated exposure to the same toxins, expressed singly or in pairs (“pyramided”) in commercial Bt corn hybrids, their efficacy against WCR larvae is now poor (Bt efficacy against NCR larvae is also declining, but at a slower rate) (Tabashnik et al. 2023). Illinois WCR populations are resistant to Cry3 Bt toxins. For example, compared to survival on non-Bt hybrids, practically 100% of WCR larvae survive in bioassays of hybrids expressing Cry3Bb1 as a single toxin. Larval survival and development times are no different among larvae exposed to hybrids expressing a “Cry3” toxin and those exposed to non-Bt hybrids. Illinois WCR susceptibility to the Gpp34/Tpp35Ab1 Bt toxin is declining, but it provides some useful efficacy. In recent years, compared to survival on non-Bt hybrids, 50%-60% of WCR larvae survive in bioassays of hybrids expressing Gpp34/Tpp35Ab1 as a single toxin.

Current Bt-based strategies to protect corn roots from rootworm larvae rely on corn hybrids that simultaneously express two different Bt toxins (i.e., Gpp34/Tpp35Ab1 and one of the Cry3 toxins). Hybrids that express two different toxins targeting the same pest are called “pyramided” hybrids. Dual expression of different toxins is a more robust strategy than the use of single toxin Bt corn hybrids because larval survival requires that they possess resistance to both toxins. Pyramiding Bt toxins is a strategy that allows a pair of single toxins to “work together” and provide more predictable efficacy. When there is resistance to one of the Bt toxins in a pyramided hybrid, product efficacy will depend solely on the efficacy of the other toxin. Such “functionally single-toxin corn hybrids” are more vulnerable to rapid resistance evolution. Because of poor Cry3 toxin efficacy around the Corn Belt, many pyramided Bt corn hybrids depend on the efficacy of Gpp34/Tpp35Ab1 to provide root protection.

Adding a novel, non-Bt-based, highly-effective mode-of-action against rootworms (i.e., RNA Interference or “RNAi”) to existing Bt toxin pyramids created Bt + RNAi hybrids that perform well against rootworm populations with varying levels of Bt resistance. Unlike Bt toxins, which target and kill the tiny 1st instar rootworm larvae by disrupting their digestive system, RNAi interferes with the production and supply of materials essential for processes within insect cells and can affect all larval instars. In SmartStax™ PRO hybrids, larvae are killed by interfering with the expression of the DvSnf7 gene. Over time, cell function is compromised, and the insect dies. However, just like Bt toxins (and any management tactic that kills pests), RNAi is still vulnerable to resistance. Recent lessons learned from studies of Bt resistance (Gassman 2021) identify repeated use of a toxin/mode of action year after year against the same population of pests and needless application of a tactic when it is not justified by the presence of an economic pest population.

Two field populations of western corn rootworm beetles (*Diabrotica virgifera virgifera*, WCR) were separately collected in 2024 from the University of Illinois Agricultural and Biological

Engineering Farm, Champaign, Illinois. (Champaign Co.). Eggs were collected from the populations and used to generate larvae that were used in standard bioassays to measure WCR resistance to Bt and RNAi traits expressed in commercial corn hybrids by assessing larval survival and development.

Methods

Insects

Two WCR populations were collected from the University of Illinois Agricultural and Biological Engineering Farm (Champaign Co.) during July 2024. While they were evaluated separately, the patterns of Bt resistance were similar, those data were pooled for the analyses and simplicity of presentation.

Procedures

Using the method of Gassmann et al. (2011), single plants of Bt and non-Bt corn hybrids (**Table 8.1**) were grown in 0.95 L plastic cups in a greenhouse until they were at the 5-6 leaf stage. Groups of n=10 newly emerged WCR larvae were transferred onto fine corn roots exposed around the base of each plant, larvae were added to twelve plants per hybrid. Treated plants were clipped to a height of 35 cm and held in a growth chamber at 25°C. After 17 days, the surviving larvae in each cup were extracted, counted, and their developmental stage was determined by measuring the width of their head capsules. Healthy, unstressed larvae should be in the 3rd instar (the final larval stage) after 17 days. The Illinois field populations were assayed along with Bt-susceptible WCR populations from the USDA. Sets of bioassays with Illinois and USDA WCR were repeated several times during the summer of 2025.

Results and Discussion

Proportion of WCR larval survival on Bt hybrids

There were no significant differences in the survival of WCR from Illinois field populations or Bt-susceptible USDA populations on hybrids that did not express any rootworm traits (Table 8.2). WCR survival on hybrids expressing a pyramid of the Cry3Bb1 + Gpp34/Tpp35Ab1 Bt toxins (i.e., SmartStax™ hybrids) was significantly greater among WCR field populations than the survival of Bt susceptible USDA WCR; however, elevated survival on the Bt pyramid was still significantly less than survival on hybrids lacking rootworm traits. This indicates that despite diminished susceptibility, the Bt pyramid retains some efficacy against the field population. If the proportion survival data are converted to corrected survival (by dividing survival on the Bt pyramid by survival on the non-Bt hybrid, .0.202/0.361) and converted to a percentage, we learn that 56% of larvae from the field population survived on the Bt pyramid. Given a history of declining susceptibility (and even resistance) to each of the component Bt toxins in the Cry3Bb1 + Gpp34/Tpp35Ab1 pyramid, significant larval survival is predictable. It is reasonable to assume that the larval mortality on the Bt toxin pyramid is a consequence of the efficacy of the Gpp34/Tpp35Ab1 toxin.

WCR survival on hybrids expressing a Bt + RNAi pyramid of the Cry3Bb1 + Gpp34/Tpp35Ab1 + DvSnf7 Bt toxins (i.e., SmartStax™ PRO hybrids) was significantly greater among WCR field populations than the survival of Bt-susceptible USDA WCR. As before, elevated survival on the Bt + RNAi pyramid was still significantly less than survival on hybrids lacking rootworm traits, indicating that even though there is evidence of diminished susceptibility, the Bt + RNAi pyramid retains significant efficacy against the field population. Calculating corrected survival data as before (0.114/0.361), we find that 32% of larvae from the field population survived on the Bt + RNAi pyramided hybrid. For this pyramid, lower corrected survival can be attributed to the presence of Bt + RNAi

Developmental rates of surviving larvae

While larval survival on Bt hybrids is the focus when measuring resistance, development rates among the survivor larvae can add to the understanding of resistance. If larval development has proceeded normally during bioassays, surviving WCR larvae recovered from hybrids that do not express rootworm protection traits in non-Bt corn hybrids at the end of the bioassay should mostly be in the 3rd (final larval) instar. This is the final mature feeding stage before larvae pupate in the soil before adult emergence. If a treatment negatively affects their development, fewer larvae may be present and/or a greater proportion of survivors may be underdeveloped. Slowed development among resistant and/or susceptible larvae is a common consequence of exposure to Bt toxins and other stressors. When larvae are fully resistant to Bt toxins, their development may proceed at a normal rate, and a high proportion of "typical" 3rd instars will be recovered at the end of the bioassay. It is common for a portion of the larvae that survive exposure to a Bt toxin to exhibit slowed development. This suggests that resistance is present, but that the larvae are not completely insensitive to the effects of the toxin.

Among surviving WCR larvae in the bioassays, the proportions of surviving 3rd instars were high and did not differ between the Illinois field populations and the Bt susceptible populations when tested on the non-Bt hybrids (Table 8.2). Those proportions were also significantly greater than all but the proportion of 3rd instars among field populations on the Bt + RNAi pyramid. The proportions of 3rd instars were numerically lower among Bt susceptible survivors of the Cry3Bb1 + Gpp34/Tpp35Ab1 Bt pyramid and the Bt + RNAi pyramid than among Illinois field population survivors from the same hybrids; however, the differences were not statistically significant (likely a consequence of low numbers of Bt susceptible population survivors from both hybrids). Though the statistical power was lacking to distinguish many differences, the patterns illustrate that survival on Bt doesn't mean larvae are not affected by the toxins/traits. However, surviving as a smaller larva that emerges later from on Bt or Bt +RNAi hybrids may not guarantee success. Developmental delays among survivors (which prolong larval exposure to soil pathogens and predators and may lead to later adult emergence that is out-of-sync with food resources or mating opportunities) may mean that they are less "fit", have shorter lives, and are less likely to mate and reproduce. Elevated larval survival accompanied by a high proportion of 3rd instar larvae among survivors on Bt or Bt + RNAi pyramids is an indication that a population is Bt resistant or nearly so. It is notable that among the n=54 survivors (recovered in n=29 replicates with survivors) from SmartStax PRO™ plants from Illinois field populations, over half (0.546) were third instars, indicating that many survivors had developed at a normal rate. If this is consistent among survivors of Bt + RNAI pyramids, it could mean that the survivors may escape penalties that might otherwise slow the development of resistance.

Summary and conclusions

Ongoing selection and Bt resistance limit growers' choices and options for corn hybrids that may prevent economic WCR injury. Recent periods of low to very low (non-economic) WCR abundance present growers with opportunities to forego the use of Bt or Bt + RNAi pyramids. Not only does this reduce input costs, but because larvae are not being exposed to and killed by Bt or Bt + RNAi, it relaxes selection for resistance. Thus, opting for non-Bt corn (or non-Bt corn with a soil insecticide) when the WCR threat is low can prolong the lifespan of traits that are indispensable when rootworm populations are high, and crop rotation is not an option. Paying attention to WCR (and NCR) abundance, using monitoring and thresholds to justify use of Bt (or any management tactic), and avoiding Bt hybrids that don't perform well will help prolong the efficacy of a declining number of traits on which most growers depend.

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Table 8.1. Bt corn hybrid information for seed used in 2025 single-plant, Bt-resistance bioassays of 2024 Illinois field-collected populations of western corn rootworm (WCR) (Diabrotica v. virgifera LeConte)

Corn hybrid	Hybrid type	Rootworm traits expressed	Seed source
DKC 111-33 RIB [a]	Pyramided Bt + RNAi	Cry3Bb1 + Gpp34/Tpp35Ab1 + DvSnf7	Bayer
DKC 110-10 RIB [b]	Pyramided Bt	Cry3Bb1 + Gpp34/Tpp35Ab1	Bayer
DKC 111-35 RIB [c]	non-Bt isoline	None	Bayer

[a] SmartStax™ PRO, seeds of the integrated refuge were not included in the biossays, [b] SmartStax™, seeds of the integrated refuge were not included in the biossays, [c] VT Double Pro

Table 8.2. Proportion larval survival and proportion 3rd instar larvae from single-plant, Bt-resistance bioassays conducted during 2025 on two Illinois populations of the western corn rootworm (WCR) (*Diabrotica v. virgifera LeConte*) collected in 2024 from open fields in Champaign Co.

Rootworm traits expressed	WCR test population	n	Proportion larval survival (mean ± SEM) [a]	n	Proportion 3rd instar larvae (mean ± SEM) [a]
Cry3Bb1 + Gpp34/Tpp35Ab1 + DvSnf7	Illinois field populations	49	0.114 ± 0.018 c	29	0.546 ± 0.084 ab
Cry3Bb1 + Gpp34/Tpp35Ab1 + DvSnf7	USDA Bt susceptible population	36	0.014 ± 0.006 d	5	0.200 ± 0.200 bc
Cry3Bb1 + Gpp34/Tpp35Ab1	Illinois field populations	47	0.202 ± 0.022 b	39	0.334 ± 0.064 bc
Cry3Bb1 + Gpp34/Tpp35Ab1	USDA Bt susceptible population	36	0.025 ± 0.010 d	7	0.000 ± 0.000 c
None	Illinois field populations	44	0.361 ± 0.033 a	41	0.778 ± 0.053 a
None	USDA Bt susceptible population	36	0.372 ± 0.029 a	35	0.615 ± 0.054 a

[a] Proportion WCR larval survival and proportion 3rd instar larvae were non-normal and were analyzed using the non-parametric Kruskal-Wallis test, with multiple comparisons performed using the Steel-Dwass method (a non-parametric version of Tukey's method that protects the overall a=0.05 error rate) (JMP Pro 18 (2025 SAS Institute)). Mean proportions sharing the same letter are not significantly different.

Frequency of Extended Egg Diapause in Illinois Northern Corn Rootworm Populations from Henry, Peoria, and Warren Counties.

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Introduction

Until 1964, the northern corn rootworm (*Diabroticia barberi* [Smith and Lawrence], NCR) was the only pest rootworm in Illinois. Shortly after its pest status was recognized, Illinois State Entomologist, Dr. Stephen A. Forbes cited the female's dependence on cornfields as an egg-laying site and the larval dependence on corn roots as food to propose annually rotating corn with another crop that would not support larval development ("a frequent change of crops" or crop rotation) to control the NCR (Forbes 1883, 1892). When the related western corn rootworm (WCR, *Diabrotica virgifera virgifera* LeConte) was discovered on sweetcorn in Colorado in 1909, its similar habits led to the suggestion that crop rotation was also the obvious remedy to manage the WCR (Gillette 1912). Annual crop rotation to control corn rootworms, an obvious remedy Forbes (1883) characterized as "too plain to require special comment", provided simple and reliable rootworm control.

Few people in 1883 would have imagined that annual crop rotation, a cultural control based on fundamental limits of rootworm biology, could be circumvented by the NCR. However, by the late 1920s, scientists in SW Illinois had observed that short (i.e., annual) rotations no longer reliably protected corn roots from NCR larvae (Bigger 1932). This was the first evidence of NCR resistance to crop rotation.

NCR egg diapause in field populations. After NCR eggs are laid in cornfield soil, they survive cold winter conditions in a state of arrested development called "diapause". Once springtime soil temperatures warm above *ca*. 50°F, the eggs resume development and predictably hatch during the spring/summer of the year after they were laid. Historically, a tiny proportion of NCR eggs were capable of extending the normal "1-year" diapause duration and remaining viable and unhatched in the soil during additional wintertime chill periods. This capacity for "extended diapause" (ED, also known as semivoltinism or prolonged diapause) was part of the natural variation present in NCR populations.

Decades after Bigger's initial report, Chiang (1965) described the phenomenon we now know as NCR "extended diapause" and referenced the earlier Bigger (1932) study. Working in Minnesota cornfields, Chaing (1965) showed that a "rather small" percentage (0.3%) of NCR eggs could survive through two winters and hatch. The relevance of Chiang's rather small percentage took on new significance when Krysan et al. (1984, 1986) studied the phenomenon and found up to 40% of NCR eggs could extend their normal 1-year diapause, remain unhatched at 25 °C during a simulated summer period, and later hatch after passing through a 2nd period of winter chill. They hypothesized that ED was a "bet-hedging strategy" adaptive for species in unpredictable host environments, such as annually rotated cornfields, where the larval host plant is present only every other year. In fact, proportions of NCR eggs expressing the ED phenotype were low (9%) where crop rotation was not practiced (Krysan et al. 1986). They argued that the phenomenon could explain the observations of Bigger (1932) and (Chiang 1965) and suggested that crop rotation may select for ED in NCR populations.

Levine et al. (1992a) conducted an extensive study of ED in Illinois NCR using 1985 and 1986 field-collected eggs from a set of counties that varied in their intensity of crop rotation from high to low. Levine et al. (1992a) documented that the proportion of NCR eggs expressing ED increased with the proportion of annually rotated corn acres in the county, with ED percentages ranging from 13.9% where rotation was uncommon, to 51.3% in areas where rotation predominated. Furthermore, Levine et al. (1992a) showed that small proportions of NCR eggs could survive 3-and even 4-year durations of extended diapause.

A 2008-2009 study of ED among Nebraska NCR documented significant geographic variation in the proportion of eggs that hatched the year after they were laid within and among locations (4.5% – 42.5%) (Geisert and Meinke, 2013). Nebraska sites with the lowest proportions of 1-year diapause eggs (and thus potentially the highest proportions of ED eggs) were located in areas with a history of higher adoption of annual crop rotation. This is consistent with the hypothesized role of crop rotation in selecting for ED. Their data showed that NCR ED in Nebraska could range from ca. 57% to >90%.

ED allows NCR to circumvent the control once provided by annual crop rotation. Where present, this NCR "rotation resistance" can force corn growers to protect both their continuous and first-year corn from NCR larval injury. In addition, uncertainty regarding the local proportion of ED in NCR eggs complicates the interpretation of adult trapping data. A year of high NCR abundance may generate enough normal and ED eggs that a field may be at risk of NCR injury for two (or more) subsequent years. Since 2021, Minnesota corn growers have faced escalating problems with NCR ED (Yang 2025). Minnesota has recently adjusted its NCR/plant economic thresholds to account for ED effects on subsequent populations (Yang 2025).

The challenge of NCR ED is further complicated by Bt resistance in some NCR populations. Calles -Torrez et al. (2019) first documented NCR resistance to multiple Bt toxins in North Dakota. Bt resistant NCR populations are present at other locations, including Illinois where we have previously documented declining NCR susceptibility to Bt (Spencer and Seiter 2024). ED is also present in WCR populations, but at extremely low rates (0.14%) (Levine et al. 1992b). The WCR overcame crop rotation by changing its behavior and laying eggs in corn and soybean fields (Levine et al. 2002, Spencer and Hughson 2023).

For an adaptation that was first documented in Illinois (Bigger 1932) and later studied in detail using Illinois populations (Levine et al. 1992), it is surprising that the Illinois status of NCR ED has not been revisited in nearly 40 years. To update information on the occurrence of ED and its potential impact on current management practices/challenges, we collected eggs from three NCR populations in 2023 and have monitored their hatching/viability during 2+ years of simulated field conditions. Exploring the relationship between current ED levels and historical use of crop rotation may help identify and predict Illinois locations likely to be challenged by NCR ED.

Methods

NCR population collection and handling

Illinois NCR beetle populations were collected in August 2023 from Henry, Peoria, and Warren counties and maintained in the laboratory. Eggs were collected from groups of 10 females and stored in Petri dishes on moist field soil. Eggs from 10 to 15 groups of females (typically 250-300 eggs/group) were collected from each population. In the fall, egg dishes were moved into cold storage for 6-7 months at 6°C (to simulate typical cold winter conditions) and held until summer 2024 when they were warmed to room temperature to stimulate resumption of development. At that time, the number of surviving eggs in each small group collection was counted and recorded as the Year 1 starting egg population. Future calculations were based on these starting populations. Egg hatch typically began approximately 15-20 days after eggs were warmed to room temperature and continued for ca. 1 month.

Developing larvae are visible through the eggshell *ca*. 1 week before the eggs hatch. Egg dishes were checked every few days for larvae. Eggs that did not hatch, but remained creamy white in color, with no evident larval development, were gently grouped in one area of the egg dish. Other eggs that collapsed, had larvae that failed to emerge, or were killed by disease, etc., were counted and removed from the dishes as they were discovered. Larvae (or their empty eggshells) were tallied as they were discovered. When emergence ceased, the remaining healthy, intact eggs (i.e., potential ≥2-year diapause eggs) were recovered, counted, and placed into fresh Petri dishes of soil. In late October 2024, those eggs were returned to 6°C cold conditions and held until summer 2025, when their dishes were again returned to room temperature to stimulate hatch. Observation of development and hatch of 2-year extended diapause eggs, and recovery of unhatched eggs proceeded as in 2024. In late September 2025, the remaining intact NCR eggs (i.e., potential ≥3-year extended diapause eggs) were recovered, counted, placed into fresh Petri dishes of 80-mesh soil, and returned to the cold chamber. They will be moved to room temperature to stimulate hatching in summer 2026.

The proportions of NCR eggs that expressed a 1-year (normal) diapause, a 2-year extended diapause, and a potential 3-year extended diapause were calculated using the methods of Geisert and Meinke (2013). The proportion of 1-year diapause eggs is the number of eggs that hatched after the first cold period, divided by the total number of intact eggs that survived it. The proportion of 2-year extended diapause eggs is the number of eggs that hatched in Year 2 (from those that did not hatch during Year 1), divided by the total number of intact eggs that survived the first cold period. The proportion of *potential* 3-year extended diapause eggs is the number of remaining intact undeveloped eggs that did not hatch in Year 2, divided by the total number of intact eggs that survived the first cold period.

Proportion of corn acres in annual rotation

The USDA-NASS CroplandCROS website (USDA-NASS 2025b) is a source of detailed U.S. cropping data at the state, county, and field level. We collected Illinois county-level data on the annual frequency of corn planting using the “Corn Frequency Layer” data from 2008-2023 (Figure 9.1). The proportion of total county acres that were planted with corn for 8 of 16 years was calculated and depicted on the Illinois map to illustrate the relative intensity of crop rotation across the landscape. The proportion of annually rotated corn acres is hypothesized to determine the intensity of selection for ED. In areas where crop rotation predominates, higher proportions of NCR eggs are expected to express ED. An examination of the county Cropland Data Layer (also available at the CroplandCROS website), which details the acres of all crops for a given year, confirmed that the most frequently rotated field crops, corn and soybean, typically accounted for ca. >95% of all planted acres in a county.

Historical NCR ED data

To facilitate comparison with prior research, 1986 population data from Levine et al. (1992a) are included in Table 9.1. However, we have used Geisert and Meinke (2013) methods to re-calculate the ED values found in Table 4 of Levine et al. (1992a). In that table, Levine et al. (1992a) calculated ED based on the total number of eggs that hatched over the course of the >4-year experiment. Because the Levine et al. (1992a) method excluded eggs that later died or were lost, the value of ED is inflated. Geisert and Meinke (2013) base calculations on the Year 1 starting egg population and account for eggs from that starting population that were lost or died in later years. In addition, we have chosen to present the proportion of rotated corn based on accessible 2008-2023 data from USDA-NASS

(2025) rather than use the Levine et al. (1992a) Table 4 calculation of percent rotational corn, which was based on a 3-year time window from the 1980s.

Results and Discussion

ED was present in NCR eggs from all three counties. In each population, the greatest proportion of NCR eggs expressed a normal 1-year diapause (Table 9.1). That proportion was significantly lower among Peoria Co. eggs than among eggs from either Warren Co. or Henry Co. The proportion of eggs expressing a 2-year ED was significantly higher among the Peoria Co. eggs than among eggs from either Henry Co. or Warren Co. Among the counties, Peoria Co. had the highest proportion of rotated corn acres, a circumstance consistent with the highest proportion of ED eggs. Based on the presence of apparently healthy, unhatched eggs from each population at the end of the 2025 emergence period, we were able to calculate the proportions of potential ≥3-year extended diapause eggs. The small proportions of NCR eggs that may express 3-year ED will be examined next summer. There was no significant county-level difference among those proportions of 2023-collected eggs that may express a 3-year ED in 2026.

Levine et al. (1992a) originally reported a range of ED (combining proportions for 2-year and 3-year ED) that ranged from 0.139 to 0.513. Applying the Geisert and Meinke (2013) revised calculation of ED to the Levine et al. (1992a) data compresses the ED range to 0.126 to 0.317. The revised Levine et al. (1992a) ED range is comparable to the range we measured, 0.169 (Warren Co.) to 0.340 (Peoria Co.), among the 2023 populations.

The proportion of annual crop rotation in the counties sampled by Levine et al. (1992a) represented a broader historical range of crop rotation proportions than those sampled in 2023 (Figure 9.1). Collecting additional NCR populations from counties with histories of both higher and lower crop rotation adoption rates will be important to determine if ED is tracking selection pressure imposed by greater or lesser adoption of crop rotation.

ED illustrates how selection, imposed by a management practice, acting on genetic variation in a population, changed pest biology in a way that allowed the NCR to overcome a management tool. ED makes it difficult to forecast the future risk of economic injury in corn because the number of eggs in the soil that will hatch and potentially yield larvae is uncertain year-to-year. ED becomes a management concern in fields where NCR populations are abundant. Under these circumstances, the potential for a sizable proportion of the NCR eggs laid during the growing season to hatch 2 years later may put first-year corn at risk from NCR larval injury.

While ED makes NCR monitoring more challenging, it may also be slowing the rate of NCR Bt resistance evolution. Because a significant proportion of the individuals in a NCR population take more than one year (some as long as 3 or 4 years) to complete their lifecycle, there are sub-groups within the population that are not exposed to Bt (or other management tactics) every year. Lengthening the time between generations (and exposure to Bt, insecticides, and crop rotation) slows selection and resistance evolution. Tabashnik et al. (2023) reported that the number of years between commercialization of Cry3Bb1 and Gpp/Tpp34/35Ab1 toxins and the first documentation of NCR field resistance to those toxins was nearly twice that for the WCR (a species with a 1-year lifecycle and rare occurrence of ED). As a result, NCR populations are not currently as resistant to Bt toxins as WCR populations. We conducted Bt resistance bioassays with these NCR looking at their survival on corn hybrids expressing a Cry3Bb1 + Gpp/Tpp34/35Ab1 pyramid of Bt toxins (e.g., SmartStax™) and hybrids expressing both Bt toxins and the RNAi mode of action (e.g., SmartStax™ PRO). We found that 27% of NCR larvae survived on the Bt pyramid and just 2%

survived on Bt + RNAi hybrids. These survival rates are just half of the survival percentages for WCR on the same hybrids (56% and 4%, respectively). This two-fold difference between NCR vs. WCR larval survival on Bt corn hybrids suggests the two species' populations are not experiencing the same Bt selection pressures (despite co-existing in the same fields) and further supports the presence of significant ED among Illinois NCR populations.

Growing Bt resistance in local rootworm populations limits growers' options for hybrids that offer reliable protection from economic rootworm injury in corn. The presence of ED in the local NCR populations adds a further complication. In fields where NCR are locally abundant, ED makes it difficult to predict how current NCR abundance may translate into potential injury in subsequent continuous or rotated cornfields. While there are no easy solutions to this problem, surveying adult NCR (and WCR) populations and consulting economic thresholds (ETs) should be the first step in the decision-making process regarding the appropriateness of planting Bt corn hybrid in continuous or rotated cornfields or just rotating a field to soybeans.

Rotating rootworm-infested cornfields to soybeans remains a very effective (and recommended) tactic to reduce rootworm pressure. Regardless of their resistance to crop rotation or Bt hybrids, any rootworm larvae emerging from eggs that hatch in soybean fields will die. Period. The presence of ED NCR eggs that will not hatch until the following growing season adds uncertainty to the interpretation of NCR abundance. The risk to 1st-year corn posed by NCR ED depends on how many larvae may be present and the prevalence of ED among the local NCR population. Our data show that ED is still present in Illinois and may result in *ca.* 17% of eggs (in Henry Co.) to *ca.* 34% of NCR eggs (in Peoria Co.) hatching two or more years after they were laid. Given that commercial corn hybrids still provide good efficacy against NCR, selecting a Bt + RNAi corn hybrid for a first-year cornfield threatened by NCR ED is a reasonable approach to manage that risk.

Given the generally low NCR abundance across Illinois Crop Reporting Districts (see Chapter 1 of this report for details), the risk from NCR ED will be confined to limited areas where NCR are locally more abundant. Selecting the appropriate response to NCR (and WCR) risks depends on awareness of rootworm abundance. There is no substitute for surveying rootworm pressure in your fields.

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Table 9.1. Proportions of NCR eggs expressing a 1, 2, or 3 year diapause from populations collected from Illinois counties with divergent histories of annual crop rotation adoption.

Illinois county[1]	Adult NCR sample year[2]	2008-2023 Proportion of rotated corn acres[3]	Mean ± SEM Proportion NCR eggs with 1-year diapause[4,5]	Mean ± SEM Proportion NCR eggs with 2-year extended diapause[6]	Mean ± SEM Proportion NCR eggs with 3-year extended diapause[7,8]
Ogle	1986	0.134	0.786	0.108	0.018
Will	1986	0.27	0.348	0.287	0.051
Kendall	1986	0.278	0.577	0.178	0.033
Warren (n=9)	2023	0.348	0.627 ± 0.035 a	0.151 ± 0.027 b	0.018 ± 0.004 a
Henry (n=8)	2023	0.352	0.662 ± 0.019 a	0.220 ± 0.018 b	0.032 ± 0.006 a
Marshall	1986	0.357	0.507	0.214	0.017
Peoria (n=13)	2023	0.377	0.510 ± 0.028 b	0.309 ± 0.024 a	0.031 ± 0.007 a
Champaign	1986	0.531	0.531	0.267	0.05

[1] Illinois counties where egg-laying northern corn rootworm (NCR) adults were collected. The number of diapause study replicate egg dishes for 2023 populations is indicated.

[2] 1986 Illinois NCR population data are from Levine et al. (1992a)

[3] Rotated acres were planted to corn for 8 of 16 years (2008-2023). USDA-NASS. CroplandCROS (2025b).

[4] Proportion of the original NCR egg population that hatched after experiencing one simulated winter cold period, a normal "1-year diapause".

[5] Comparison of the proportion of eggs in diapause among counties was via ANOVA, with mean separations via Tukey HSD; means bearing the same letter are not significantly different at $\alpha=0.05$.

[6] Proportion of the original NCR egg population that hatched after experiencing two simulated winter cold periods, "2-year extended diapause".

[7] Proportion of the original NCR egg population that hatched after experiencing three simulated winter cold periods, "3-year extended diapause". The proportions for eggs from 2023 populations is an estimate based on the proportion of remaining healthy, unhatched eggs that were returned to cold storage in late September 2025.

[8] Among 2023-collected populations, the values are the potential proportions of 3-year extended diapause eggs; any egg mortality occurring before eggs hatch in 2026 will reduce these values.

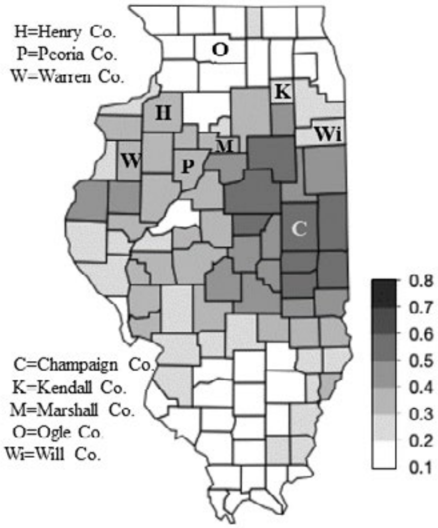

Figure 9.1. Proportion of Illinois county corn acres rotated during 8 of 16 years (2008-2023). The counties sampled by Levine et al. (1992a) in 1986 and by Spencer and Seiter in 2023 are listed and indicated on the map with abbreviations.

Standard Evaluation of Soil Insecticides and Bt Traits for Corn Rootworm Control, Urbana – 2025

Location: University of Illinois Agricultural and Biological Engineering Farm, Urbana, IL (40.0704, -88.21093)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To assess the performance of Bt trait packages and seed treatments with and without a soil insecticide for control of corn rootworm (particularly western corn rootworm, *Diabrotica virgifera virgifera*) larval damage.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 12 treatments. The experimental units were plots of corn (Table 10.1) that were 4 rows wide and 30 ft. long with 5 ft. of unplanted alley separating plots vertically. Treatments (Table 2) were four different corn rootworm trait packages (Trecepta, SmartStax, SmartStax PRO, VT4 PRO), with and without insecticide or treated with a higher rate of an insecticide seed treatment. Plant stands were assessed on 23 May (growth stage V3), and 11 June 2025 (growth stage V6). Larval corn rootworm damage was rated on 17 July 2025 (R2) by digging 5 root masses per plot from rows 1 and 4, removing all soil using an electric high-pressure water sprayer, and rating damage using the 0-3 Node-injury scale. Percent lodging was estimated for each plot on 19 September 2025 (R6). Yields were assessed for each plot on 13 October 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Percent consistency of root ratings for each plot was set equal to the percentage of roots that were given a node-injury rating of less than 0.25. Weights per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Consistency and lodging are reported as percentages but were analyzed as proportions. Plant stand, root injury rating, proportion consistency, proportion gooseneck lodging, proportion stalk lodging, and yield were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable) where treatment was considered a fixed effect and replicate block was considered a random effect.

Summary

This site experienced moderate corn rootworm feeding pressure, with average node-injury scores of 1.43 in the untreated plots. Of the insecticides we tested on non-rootworm traited corn, Aztec HC and Index reduced corn rootworm injury and lodging compared with the untreated plots. Of the trait packages we examined, only SmartStax Pro reduced corn rootworm injury when used without an insecticide. The addition of Aztec HC reduced corn rootworm injury when applied to both SmartStax and SmartStax Pro.

Funding

Project funding and seed were provided by Wyffels.

Acknowledgements:

We thank Tim Lecher (Farm Manager) for assisting with planting and plot maintenance, academic hourly Grayce Montano and Will Foulke, graduate student Yony Callohuari Quispe, and undergraduate students Sarah Rodriguez, Jason Ballard, Alex Riley, and Brad

Vandercar for assisting with plot maintenance and data collection. In addition, we thank Dr. Joseph Spencer (Illinois Natural History Survey) and his undergraduate research assistants for their help with root damage assessments.

Table 10.1. Plot information.

Input	Value
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Drummer silty clay loam/Brenton silt loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	34,500 seeds per acre
Planting date	April 28 2025
Emergence date	May 9 2025
Pre-emerge herbicide	32% UAN (200 lb/ac), Harness Xtra (2 qt/ac) [a]
Post-emerge herbicide	Acuron (3 qt/ac) [b]
Plot size	4 rows (10 ft) wide by 30 ft long, 5 ft unplanted alleys

[a] Bayer CropScience, St. Louis, MO; [b] Syngenta Crop Protection, Greensboro, NC

Table 10.2. Corn rootworm treatments

Trt	Treatment	Variety	Corn rootworm traits	Insecticide	Seed Treatment
1	Trecepta [a]	W7485 [b]	None	None	Cruiser 250
2	Trecepta + Aztec HC [c]	W7485	None	Aztec HC (1.63 lb/a)	Cruiser 250
3	Trecepta + Index [c]	W7485	None	Index 2.8 CS (12.5 fl oz/a)	Cruiser 250
4	Trecepta + Capture LFR [d]	W7485	None	Capture LFR (17 fl oz/a)	Cruiser 250
5	Trecepta + Cruiser 1250 [e]	W7485	None	None	Cruiser 1250
6	Trecepta + BioWake Prime [c]	W7485	None	None	Cruiser 250
7	VT4Pro [a]	EXP104 [b]	Cry3Bb1 + dvSnf7	None	Cruiser 250
8	VT4Pro + Cruiser 1250	EXP104	Cry3Bb1 + dvSnf7	None	Cruiser 1250
9	SmartStax Pro [a]	W7499 [b]	Cry3Bb1 + Gpp34/Tpp35Ab1 [f] + dvSnf7	None	Cruiser 250
10	SmartStax Pro + Aztec HC	W7499	Cry3Bb1 + Gpp34/Tpp35Ab1 + dvSnf7	Aztec HC (1.63 lb/a)	Cruiser 250
11	SmartStax [a]	W7878 [b]	Cry3Bb1 + Gpp34/Tpp35Ab1	None	Cruiser 250
12	SmartStax + Aztec HC	W7878	Cry3Bb1 + Gpp34/Tpp35Ab1	Aztec HC (1.63 lb/a)	Cruiser 250

[a] Bayer CropScience, St. Louis, MO; [b] Wyffels Hybrids Inc., Geneseo, IL; [c] AMVAC Chemical Corporation, Newport Beach, CA; [d] FMC Corporation, Philadelphia, PA; [e] Syngenta Crop Protection, Greensboro, NC; [f] Gpp34/Tpp35Ab1 was formerly known as Cry34/35Ab1, originally released as “Herculex Rootworm.”

Table 10.3. Generalized linear mixed model statistics. Probability distribution is given in parentheses after each dependent variable.

Dependent Variable	Date	df (numerator, denominator)	F	P
Plant stand (lognormal) [a]	23 May	11, 33	2.19	0.041
Plant stand (lognormal)	11 June	11, 33	1.69	0.120
Root injury rating (gamma) [a]	17 July	11, 33	31.30	< 0.001
Proportion consistency (normal) [a]	17 July	11, 33	17.11	< 0.001
Proportion root lodging (normal) [a]	19 Sept.	11, 33	3.14	0.005
Proportion stalk lodging (normal)	19 Sept.	11, 33	0.73	0.705
Yield (lognormal)	13 Oct.	11, 33	1.82	0.091

[a] Effect is significant at $\alpha = 0.05$.

Table 10.4. Mean (± Standard error [SE]) stand in number of plants per 17.5 ft. of row. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	23 May 2025 (V3)	6 June 2025 (V6)
1	Trecepta	37.1 ± 0.7 ab	36.3 ± 0.5 a
2	Trecepta + Aztec HC	35.9 ± 0.2 ab	36.5 ± 0.5 a
3	Trecepta + Index	33.4 ± 2.2 c	33.1 ± 2.4 a
4	Trecepta + Capture LFR	36.8 ± 0.7 ab	36.4 ± 0.5 a
5	Trecepta + Cruiser 1250	37.8 ± 0.6 a	37.0 ± 0.6 a
6	Trecepta + BioWake Prime	34.8 ± 1.3 bc	34.9 ± 1.0 a
7	VT4Pro	36.3 ± 0.5 ab	35.9 ± 0.3 a
8	VT4Pro + Cruiser 1250	35.6 ± 0.3 abc	35.8 ± 0.4 a
9	SmartStax Pro	37.1 ± 0.4 ab	36.6 ± 0.5 a
10	SmartStax Pro + Aztec HC	37.5 ± 0.7 a	36.9 ± 0.5 a
11	SmartStax	35.3 ± 0.8 abc	35.1 ± 1.0 a
12	SmartStax + Aztec HC	37.1 ± 0.5 ab	35.6 ± 0.4 a

Table 10.5. Mean (± SE) node-injury rating (0-3 scale) of corn rootworm larval feeding injury. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	17 July 2025 (R3)
1	Trecepta	1.43 ± 0.19 a
2	Trecepta + Aztec HC	0.10 ± 0.03 cd
3	Trecepta + Index	0.03 ± 0.01 ef
4	Trecepta + Capture LFR	0.93 ± 0.15 ab
5	Trecepta + Cruiser 1250	0.90 ± 0.15 ab
6	Trecepta + BioWake Prime	1.45 ± 0.25 a
7	VT4Pro	1.06 ± 0.21 ab
8	VT4Pro + Cruiser 1250	0.52 ± 0.15 b
9	SmartStax Pro	0.14 ± 0.05 c
10	SmartStax Pro + Aztec HC	0.02 ± 0.01 f
11	SmartStax	0.88 ± 0.16 ab
12	SmartStax + Aztec HC	0.06 ± 0.02 de

Table 10.6. Mean (± SE) percentage of roots with a node-injury rating (0-3 scale) of less than 0.25. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	17 July 2025 (R3)
1	Trecepta	5 ± 5 c
2	Trecepta + Aztec HC	85 ± 10 ^{a}
3	Trecepta + Index	100 ± 0 ^{a}
4	Trecepta + Capture LFR	25 ± 13 ^{c}
5	Trecepta + Cruiser 1250	15 ± 10 ^{c}
6	Trecepta + BioWake Prime	15 ± 5 ^{c}
7	VT4Pro	20 ± 12 ^{c}
8	VT4Pro + Cruiser 1250	55 ± 17 ^{b}
9	SmartStax Pro	85 ± 10 ^{a}
10	SmartStax Pro + Aztec HC	100 ± 0 ^{a}
11	SmartStax	25 ± 10 ^{c}
12	SmartStax + Aztec HC	95 ± 5 ^{a}

Table 10.7. Mean (± SE) percent root lodging (“goosenecked” lodging) per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Trecepta	12 ± 6 b
2	Trecepta + Aztec HC	0 ± 0 c
3	Trecepta + Index	0 ± 0 c
4	Trecepta + Capture LFR	0 ± 0 bc
5	Trecepta + Cruiser 1250	1 ± 1 bc
6	Trecepta + BioWake Prime	25 ± 13 a
7	VT4Pro	8 ± 3 bc
8	VT4Pro + Cruiser 1250	1 ± 0 bc
9	SmartStax Pro	1 ± 1 bc
10	SmartStax Pro + Aztec HC	0 ± 0 c
11	SmartStax	5 ± 3 bc
12	SmartStax + Aztec HC	2 ± 1 bc

Table 10.8. Mean (± SE) percent stalk lodging per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Trecepta	0 ± 0 a
2	Trecepta + Aztec HC	0 ± 0 a
3	Trecepta + Index	0 ± 0 a
4	Trecepta + Capture LFR	0 ± 0 a
5	Trecepta + Cruiser 1250	0 ± 0 a
6	Trecepta + BioWake Prime	0 ± 0 a
7	VT4Pro	0 ± 0 a
8	VT4Pro + Cruiser 1250	0 ± 0 a
9	SmartStax Pro	0 ± 0 a
10	SmartStax Pro + Aztec HC	0 ± 0 a
11	SmartStax	0 ± 0 a
12	SmartStax + Aztec HC	0 ± 0 a

Table 10.9. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	13 October 2025 (R6)
1	Trecepta	194 ± 17 a
2	Trecepta + Aztec HC	208 ± 14 a
3	Trecepta + Index	202 ± 21 a
4	Trecepta + Capture LFR	203 ± 8 a
5	Trecepta + Cruiser 1250	194 ± 21 a
6	Trecepta + BioWake Prime	178 ± 23 a
7	VT4Pro	184 ± 15 a
8	VT4Pro + Cruiser 1250	188 ± 15 a
9	SmartStax Pro	222 ± 12 a
10	SmartStax Pro + Aztec HC	251 ± 10 a
11	SmartStax	213 ± 17 a
12	SmartStax + Aztec HC	204 ± 17 a

Standard Evaluation of Soil Insecticides and Bt Traits for Corn Rootworm Control, Monmouth – 2025

Location: University of Illinois Northwestern Illinois Agricultural Research and Demonstration Center, Monmouth, IL (40.935285, -90.725937)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To assess the performance of Bt trait packages and seed treatments with and without a soil insecticide for control of corn rootworm (particularly western corn rootworm, *Diabrotica virgifera virgifera*) larval damage.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 12 treatments. The experimental units were plots of corn (Table 11.1) that were 4 rows wide and 30 ft. long with 5 ft. of unplanted alley separating plots vertically. Treatments (Table 11.2) were four different corn rootworm trait packages (Trecepta, SmartStax, SmartStax PRO, VT4 PRO), with and without insecticide or treated with a higher rate of an insecticide seed treatment. Plant stands were assessed on 28 May 2025 (growth stage V3). Larval corn rootworm damage was rated on 21 July 2025 (R2) by digging 5 root masses per plot from rows 1 and 4, removing all soil using an electric high-pressure water sprayer, and rating damage using the 0-3 Node-injury scale. Percent lodging was estimated for each plot on 12 September 2025 (R6). Yields were assessed for each plot on 19 September 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Percent consistency of root ratings for each plot was set equal to the percentage of roots that were given a node-injury rating of less than 0.25. Weights per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Consistency and lodging are reported as percentages but were analyzed as proportions. Plant stand, root injury rating, proportion consistency, proportion stalk lodging, and yield were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable) where treatment was considered a fixed effect and replicate block was considered a random effect.

Summary

Node-injury ratings, percent consistency, and yields were all impacted by treatment; the rootworm pressure at this site was low to moderate, with node-injury ratings averaging 0.76 in the untreated plots. All of the rootworm trait packages tested reduced node-injury ratings relative to the non-traited control plots at this site; SmartStax Pro resulted in the lowest node-injury scores when no insecticide was applied, while SmartStax and SmartStax Pro had equivalently low node-injury scores when treated with Aztec. When left without insecticide, both SmartStax and VT4Pro had greater pruning than SmartStax Pro. Among the soil insecticides we tested, Aztec HC, Index, and Capture LFR reduced node-injury scores relative to the untreated plots. Effects on yield reflected differences in yield potential of the hybrids in addition to differences in rootworm control.

Funding

Project funding and seed were provided by Wyffels.

Acknowledgements

We thank Tim Lecher (Farm Manager) for assisting with planting and plot maintenance, academic hourly Grayce Montano and Will Foulke, graduate student Yony Callohuari Quispe, and undergraduate students Sarah Rodriguez, Jason Ballard, Alex Riley, and Brad Vandercar for assisting with plot maintenance and data collection. In addition, we thank Dr. Joseph Spencer (Illinois Natural History Survey) and his undergraduate research assistants for their help with root damage assessments.

Table 11.1. Plot information

Input	Value
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Muscatune silt loam/Osco silt loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	34,500 seeds per acre
Planting date	May 7 2025
Emergence date	May 14 2025
Pre-emerge herbicide	Harness Xtra 2.5 qts/a [a]
Post-emerge herbicide	Option 1.5 oz/a [a]
Plot size	4 rows (10 ft) wide by 30 ft long, 5 ft unplanted alleys

[a] Bayer CropScience, St. Louis, MO.

Table 11.2. Corn rootworm treatments

Trt	Treatment	Variety	Corn rootworm traits	Insecticide	Seed Treatment
1	Trecepta [a]	W7485 [b]	None	None	Cruiser 250
2	Trecepta + Aztec HC [c]	W7485	None	Aztec HC (1.63 lb/a)	Cruiser 250
3	Trecepta + Index [c]	W7485	None	Index 2.8 CS (12.5 fl oz/a)	Cruiser 250
4	Trecepta + Capture LFR [d]	W7485	None	Capture LFR (17 fl oz/a)	Cruiser 250
5	Trecepta + Cruiser 1250 [e]	W7485	None	None	Cruiser 1250
6	Trecepta + BioWake Prime [c]	W7485	None	None	Cruiser 250
7	VT4Pro [a]	EXP104 [b]	Cry3Bb1 + dvSnf7	None	Cruiser 250
8	VT4Pro + Cruiser 1250	EXP104	Cry3Bb1 + dvSnf7	None	Cruiser 1250
9	SmartStax Pro [a]	W7499 [b]	Cry3Bb1 + Gpp34/Tpp35Ab1 f + dvSnf7	None	Cruiser 250
10	SmartStax Pro + Aztec HC	W7499	Cry3Bb1 + Gpp34/Tpp35Ab1 + dvSnf7	Aztec HC (1.63 lb/a)	Cruiser 250
11	SmartStax [a]	W7878 [b]	Cry3Bb1 + Gpp34/Tpp35Ab1	None	Cruiser 250
12	SmartStax + Aztec HC	W7878	Cry3Bb1 + Gpp34/Tpp35Ab1	Aztec HC (1.63 lb/a)	Cruiser 250

[a] Bayer CropScience, St. Louis, MO; [b] Wyffels Hybrids, Inc., Geneseo, IL; [c] AMVAC Chemical Corporation, Newport Beach, CA; [d] FMC Corporation, Philadelphia, PA; [e] Syngenta Crop Protection, Greensboro, NC; [f] Gpp34/Tpp35Ab1 was formerly known as Cry34/35Ab1, originally released as “Herculex Rootworm.”

Table 11.3. Generalized linear mixed model statistics. Probability distribution is listed in parentheses for each response variable.

Dependent Variable	Date	df (numerator, denominator)	*F*	*P*
Plant stand (lognormal)	28 May	11, 33	1.30	0.269
Root injury rating (gamma) [a]	21 July	11, 33	17.86	< 0.001
Proportion consistency (normal) [a]	21 July	11, 33	6.25	< 0.001
Proportion root lodging (normal)	12 Sept.	11, 33	0.95	0.512
Proportion stalk lodging (normal)	12 Sept.	11, 33	1.49	0.182
Yield (lognormal) [a]	19 Sept.	11, 33	2.43	0.024

[a] Effect is significant at α = 0.05

Table 11.4. Mean (± Standard error [SE]) stand in number of plants per 17.5 ft. of row. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	28 May 2025 (V3)
1	Trecepta	37.4 ± 0.8 a
2	Trecepta + Aztec HC	34.5 ± 0.7 a
3	Trecepta + Index	35.6 ± 0.5 a
4	Trecepta + Capture LFR	36.4 ± 0.9 a
5	Trecepta + Cruiser 1250	35.8 ± 1.0 a
6	Trecepta + BioWake Prime	35.4 ± 0.6 a
7	VT4Pro	35.8 ± 0.5 a
8	VT4Pro + Cruiser 1250	35.0 ± 1.1 a
9	SmartStax Pro	36.9 ± 0.7 a
10	SmartStax Pro + Aztec HC	36.1 ± 0.8 a
11	SmartStax	35.5 ± 0.8 a
12	SmartStax + Aztec HC	36.0 ± 0.7 a

Table 11.5. Mean (± SE) node-injury rating (0-3 scale) of corn rootworm larval feeding injury. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	21 July 2025 (R2)
1	Trecepta	0.76 ± 0.18 a
2	Trecepta + Aztec HC	0.12 ± 0.05 cde
3	Trecepta + Index	0.12 ± 0.04 de
4	Trecepta + Capture LFR	0.17 ± 0.06 cde
5	Trecepta + Cruiser 1250	0.61 ± 0.15 ab
6	Trecepta + BioWake Prime	0.80 ± 0.17 a
7	VT4Pro	0.24 ± 0.06 bcd
8	VT4Pro + Cruiser 1250	0.31 ± 0.12 bcd
9	SmartStax Pro	0.10 ± 0.04 e
10	SmartStax Pro + Aztec HC	0.02 ± 0.01 f
11	SmartStax	0.31 ± 0.09 bc
12	SmartStax + Aztec HC	0.02 ± 0.01 f

Table 11.6. Mean (± SE) percentage of roots with a node-injury rating (0-3 scale) of less than 0.25. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	21 July 2025 (R2)
1	Trecepta	40 ± 14 cd
2	Trecepta + Aztec HC	90 ± 6 ab
3	Trecepta + Index	90 ± 10 ab
4	Trecepta + Capture LFR	85 ± 10 ab
5	Trecepta + Cruiser 1250	40 ± 8 cd
6	Trecepta + BioWake Prime	30 ± 19 d
7	VT4Pro	65 ± 13 bc
8	VT4Pro + Cruiser 1250	70 ± 17 b
9	SmartStax Pro	80 ± 14 ab
10	SmartStax Pro + Aztec HC	100 ± 0 a
11	SmartStax	65 ± 17 bc
12	SmartStax + Aztec HC	100 ± 0 a

Table 11.7. Mean (± SE) percent root lodging per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	12 September 2025 (R6)
1	Trecepta	0 ± 0 a
2	Trecepta + Aztec HC	0 ± 0 a
3	Trecepta + Index	0 ± 0 a
4	Trecepta + Capture LFR	0 ± 0 a
5	Trecepta + Cruiser 1250	0 ± 0 a
6	Trecepta + BioWake Prime	0 ± 0 a
7	VT4Pro	0 ± 0 a
8	VT4Pro + Cruiser 1250	0 ± 0 a
9	SmartStax Pro	0 ± 0 a
10	SmartStax Pro + Aztec HC	0 ± 0 a
11	SmartStax	1 ± 1 a
12	SmartStax + Aztec HC	0 ± 0 a

Table 11.8. Mean (± SE) percent stalk lodging per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	12 September 2025 (R6)
1	Trecepta	0 ± 0 a
2	Trecepta + Aztec HC	1 ± 1 a
3	Trecepta + Index	1 ± 0 a
4	Trecepta + Capture LFR	1 ± 1 a
5	Trecepta + Cruiser 1250	0 ± 0 a
6	Trecepta + BioWake Prime	1 ± 0 a
7	VT4Pro	2 ± 1 a
8	VT4Pro + Cruiser 1250	0 ± 0 a
9	SmartStax Pro	1 ± 0 a
10	SmartStax Pro + Aztec HC	1 ± 0 a
11	SmartStax	0 ± 0 a
12	SmartStax + Aztec HC	1 ± 1 a

Table 11.9. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05)

Trt	Treatment	19 September 2025 (R6)
1	Trecepta	229 ± 4 abc
2	Trecepta + Aztec HC	223 ± 1 bcd
3	Trecepta + Index	220 ± 4 cd
4	Trecepta + Capture LFR	231 ± 5 abc
5	Trecepta + Cruiser 1250	224 ± 6 bcd
6	Trecepta + BioWake Prime	223 ± 3 bcd
7	VT4Pro	229 ± 7 abc
8	VT4Pro + Cruiser 1250	230 ± 6 abc
9	SmartStax Pro	240 ± 8 a
10	SmartStax Pro + Aztec HC	236 ± 7 ab
11	SmartStax	211 ± 3 d
12	SmartStax + Aztec HC	221 ± 4 cd

Evaluation of in-furrow insecticides for corn rootworm control – 2025

Location: University of Illinois Agricultural and Biological Engineering Farm, Urbana, IL (40.070669, -88.210978)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To evaluate the performance of in-furrow soil-applied insecticides for control of corn rootworm (particularly western corn rootworm, *Diabrotica virgifera virgifera*) larval damage on a non-CRW Bt hybrid with low insecticide seed treatment.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 7 treatments. The experimental units were plots of corn (Table 12.1) that were 4 rows wide and 30 ft. long with 5 ft. of unplanted alley separating plots vertically. Treatments (Table 12.2) were liquid or granular soil insecticides applied in-furrow at planting, along with an untreated control. Plant stands were assessed on 15 May (growth stage V2), 23 May (growth stage V3), and 11 June 2025 (growth stage V6). Larval corn rootworm damage was rated on 18 July 2025 (R2) by digging 5 root masses per plot from rows 1 and 4, removing all soil using an electric high-pressure water sprayer, and rating damage using the 0-3 Node-injury scale. Percent lodging was estimated for each plot on 19 September 2025 (R6). Yields were assessed for each plot on 13 October 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Percent consistency of root ratings for each plot was set equal to the percentage of roots that were given a node-injury rating of less than 0.25. Weights per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Consistency and lodging are reported as percentages but were analyzed as proportions. Plant stand (lognormal), root injury rating (gamma), proportion consistency (normal), proportion gooseneck lodging (normal), proportion stalk lodging (normal) and yield (lognormal) were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable) where treatment was considered a fixed effect and replicate block was considered a random effect.

Summary

All insecticides we tested reduced root injury relative to the untreated control. Index resulted in the least amount of pruning, followed by Force 6.5G and AMV2619B. AMV1205 resulted in lower root injury than Nurizma, and could not be distinguished from Force 6.5G or AMV2619B. Percent consistency followed a similar pattern. Root lodging was reduced by all insecticide treatments relative to the untreated control. Yield, stand, and stalk lodging were not affected by treatment.

Funding

Project funding and insecticide materials for testing were provided by AMVAC. Seed was provided by Wyffels.

Acknowledgements

We thank Tim Lecher (Farm Manager) for assisting with planting and plot maintenance, academic hourly Grayce Montano and Will Foulke, graduate student Yony Callohuari Quispe, and undergraduate students Sarah Rodriguez, Jason Ballard, Alex Riley, and Brad Vandercar for assisting with plot maintenance and data collection. In addition, we thank Dr. Joseph Spencer (Illinois Natural History Survey) and his undergraduate research assistants for their help with root damage assessments.

Table 12.1. Plot information

Variety	W7485 Trecepta [a]
Seed Treatment	Cruiser 250 [b]
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Drummer silty clay loam/Brenton silt loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	34,500 seeds per acre
Planting date	April 29th 2025
Emergence date	May 10th 2025
Herbicide	Pre-emerge: 32% UAN (200 lb/ac), Harness Xtra [c] (2 qt/ac)
Herbicide	Post-emerge: Acuron[b] (3 qt/ac)
Plot size	4 rows (10 ft) wide by 30 ft long, 5 ft unplanted alleys

[a] Wyffels Hybrids, Geneseo, IL; [b] Syngenta Crop Protection, Greensboro, NC; [c] Bayer CropScience, St. Louis, MO

Table 12.2. Corn rootworm treatments

Trt	Treatment	Insecticide
1	Untreated	n/a
2	Force 6.5 G [a] (1.8 oz/1,000 row-ft)	6.5% Tefluthrin, granule
3	AMV1205 [b] (3 oz/1,000 row-ft)	pre-commercial
4	AMV1377 [b] (3 oz/1,000 row-ft)	pre-commercial
5	AMV2619B [b] (0.7 oz/1,000 row-ft)	pre-commercial
6	Index 2.8 Cs [b] (0.72 oz/1,000 row-ft)	clorethoxyfos (25.8%) + bifenthrin (4.2%), 2.8 lbs active ingredient (AI) per gallon, capsule suspension
7	Nurizma 2.5L [c] (0.058 oz/1,000 row-ft)	broflanilide, 2.5 lbs AI per gallon, suspension concentrate(SC)

[a] Syngenta Crop Protection, Greensboro, NC; [b] AMVAC Chemical Corporation, Los Angeles, CA; [c] BASF Corporation, Research Triangle Park, NC.

Table 12.3. Generalized linear mixed model statistics. Probability distribution is listed in parentheses after each dependent variable.

Dependent Variable	Date	df (numerator, denominator)	*F*	*P*
Plant stand (lognormal)	15 May	6, 18	1.41	0.264
Plant stand (lognormal)	23 May	6, 18	1.01	0.450
Plant stand (lognormal)	11 June	6, 18	0.23	0.961
Root injury rating (gamma) [a]	18 July	6, 18	27.78	< 0.001
Proportion consistency (normal) [a]	18 July	6, 18	12.69	< 0.001
Proportion root lodging (normal) [a]	19 Sept.	6, 18	6.84	0.001
Proportion stalk lodging (normal)	19 Sept.	6, 18	0.83	0.560
Yield (lognormal) [a]	13 Oct.	6, 18	2.16	0.096

[a] Effect is significant at $\alpha = 0.05$.

Table 12.4. Mean (± Standard error [SE]) stand in number of plants per 17.5 ft. of row. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	15 May 2025 (V2)	23 May 2025 (V3)	11 June 2025 (V6)
1	Untreated	35.6 ± 0.6 a	36.4 ± 0.6 a	36.3 ± 0.6 a
2	Force 6.5 G	37.0 ± 0.5 a	36.5 ± 0.4 a	35.8 ± 0.3 a
3	AMV1205	36.5 ± 0.5 a	36.4 ± 0.4 a	35.8 ± 0.5 a
4	AMV1377	36.4 ± 0.5 a	35.9 ± 0.4 a	35.8 ± 0.5 a
5	AMV2619B	35.9 ± 0.4 a	36.1 ± 0.4 a	35.8 ± 0.6 a
6	Index 2.8 CS	37.5 ± 0.7 a	36.6 ± 0.4 a	36.3 ± 0.6 a
7	Nurizma 2.5L	36.5 ± 0.6 a	35.1 ± 0.5 a	35.9 ± 0.5 a

Table 12.5. Mean (± SE) node-injury rating (0-3 scale) of corn rootworm larval feeding damage. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	18 July 2025 (R2)
1	Untreated	1.85 ± 0.18 a
2	Force 6.5 G	0.23 ± 0.04 d
3	AMV1205	0.36 ± 0.11 cd
4	AMV1377	0.58 ± 0.12 bc
5	AMV2619B	0.28 ± 0.06 d
6	Index 2.8 CS	0.05 ± 0.02 e
7	Nurizma 2.5L	0.75 ± 0.15 b

Table 12.6. Mean (± SE) percentage of roots with a node-injury rating (0-3 scale) of less than 0.25. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	18 July 2025 (R2)
1	Untreated	0 ± 0 d
2	Force 6.5 G	60 ± 0 b
3	AMV1205	50 ± 17 bc
4	AMV1377	30 ± 10 c
5	AMV2619B	60 ± 8 b
6	Index 2.8 CS	95 ± 5 a
7	Nurizma 2.5L	25 ± 5 cd

Table 12.7. Mean (± SE) percent root lodging (“goosenecked” lodging) per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Untreated	8 ± 3 a
2	Force 6.5 G	0 ± 0 b
3	AMV1205	1 ± 1 b
4	AMV1377	1 ± 1 b
5	AMV2619B	0 ± 0 b
6	Index 2.8 CS	0 ± 0 b
7	Nurizma 2.5L	1 ± 1 b

Table 12.8. Mean (± SE) percent stalk lodging per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Untreated	0 ± 0 a
2	Force 6.5 G	0 ± 0 a
3	AMV1205	0 ± 0 a
4	AMV1377	0 ± 0 a
5	AMV2619B	0 ± 0 a
6	Index 2.8 CS	0 ± 0 a
7	Nurizma 2.5L	0 ± 0 a

Table 12.9. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	13 October 2025 (R6)
1	Untreated	196 ± 19 a
2	Force 6.5 G	215 ± 11 a
3	AMV1205	212 ± 6 a
4	AMV1377	214 ± 2 a
5	AMV2619B	233 ± 9 a
6	Index 2.8 CS	223 ± 12 a
7	Nurizma 2.5L	213 ± 11 a

Different Rates of Poncho (clothianidin) for Control of Corn Rootworm Larvae

Location: University of Illinois Agricultural and Biological Engineering Farm, Urbana, IL (40.07065, -88.21211)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To evaluate the performance of several rates of Poncho 600 for control of corn rootworm (particularly western corn rootworm, *Diabrotica virgifera virgifera*) larval damage in a non-CRW Bt corn hybrid.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 4 treatments. The experimental units were plots of corn (Table 13.1) that were 4 rows wide and 30 ft. long with 5 ft. of unplanted alley separating plots vertically. Treatments (Tabe 13.2) were three different rates of Poncho 600, as well as a fungicide-only control on a non-CRW Bt corn hybrid. Plant stands were assessed on 15 May 2025 (growth stage V2), 23 May 2025 (growth stage V3), and 11 June 2025 (growth stage V5). Plot vigor was assessed on 6 June 2025 (growth stage V6) using a 1-9 scale where 9 is best. Larval corn rootworm damage was rated on 14 July 2025 (R2) by digging 5 root masses per plot from rows 1 and 4, removing all soil using an electric high-pressure water sprayer, and rating damage using the 0-3 Node-injury scale. Percent lodging was estimated for each plot on 19 September 2025 (R6). Yields were assessed for each plot on 13 October 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Percent consistency of root ratings for each plot was set equal to the percentage of roots that were given a node-injury rating of less than 0.25. Weights per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Consistency and lodging are reported as percentages but were analyzed as proportions. Plant stand, plot vigor, root injury rating, proportion consistency, proportion root lodging, proportion stalk lodging, and yield were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable in Table 3) where treatment was considered a fixed effect and replicate block was considered a random effect.

Summary

None of the response variables we assessed were affected by treatment, though there was a trend for lower node-injury scores where a seed-applied insecticide was used. Corn rootworm pressure in this trial was moderate, with node-injury scores averaging 1.49 in the untreated plots.

Funding

Project funding and treated seed for this trial were provided by BASF.

Acknowledgements

We thank Tim Lecher (Farm Manager) for assisting with planting and plot maintenance, academic hourly Grayce Montano and Will Foulke, graduate student Yony Callohuari Quispe, and undergraduate students Sarah Rodriguez, Jason Ballard, Alex Riley, and Brad Vandercar for assisting with plot maintenance and data collection. In addition, we thank Dr. Joseph Spencer (Illinois Natural History Survey) and his undergraduate research assistants for their help with root damage assessments.

Table 13.1. Plot information

Variety	Becks 5994 VT2P [a]
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Drummer silt loam/Brenton silt loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	34,500 seeds per acre
Planting date	April 28th 2025
Emergence date	May 9th 2025
Pre-emerge herbicide	32% UAN (200 lb/ac), Harness Xtra (2 qt/ac) [b]
Post-emerge herbicide	Acuron (3 qt/ac) [c]
Plot size	4 rows (10 ft) wide by 30 ft long, 5 ft unplanted alleys

[a] Beck's Hybrids, Atlanta, IN; [b] Bayer CropScience, St. Louis, MO; [c] Syngenta Crop Protection, Greensboro, NC

Table 13.2. Corn rootworm treatments

Trt	Treatment a
1	Untreated
2	Poncho 600, 0.25 clothianidin per seed
3	Poncho 600, 0.5 mg clothianidin per seed
4	Poncho 600, 1.25 mg clothianidin per seed

[a] Treated seed was provided by BASF

Table 13.3. Generalized linear mixed model statistics.

Dependent Variable	Date	df (numerator, denominator)	F	P
Plant stand (lognormal)	15 May	3, 9	1.46	0.289
Plant stand (lognormal)	23 May	3, 9	0.34	0.795
Plant stand (lognormal)	11 June	3, 9	0.95	0.458
Vigor (lognormal)	6 June	3, 9	0.60	0.629
Root injury rating (gamma)	14 July	3, 9	1.39	0.308
Proportion consistency (normal)	14 July	3, 9	1.24	0.350
Proportion root lodging (normal)	19 Sept.	3, 9	0.23	0.875
Proportion stalk lodging (normal)	19 Sept.	3, 9	1.00	0.436
Yield (lognormal)	13 Oct.	3, 9	1.19	0.369

Table 13.4. Mean (± Standard error [SE]) stand in number of plants per 17.5 ft. of row. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	15 May 2025 (V2)	23 May 2025 (V3)	11 June 2025 (V6)
1	Untreated	36.1 ± 0.4 a	35.4 ± 0.8 a	35.9 ± 0.2 a
2	Poncho 600 (0.25 mg a.i. per seed)	35.9 ± 0.5 a	35.8 ± 0.3 a	35.1 ± 0.5 a
3	Poncho 600 (0.5 mg a.i. per seed)	34.0 ± 1.1 a	35.1 ± 0.4 a	34.4 ± 1.1 a
4	Poncho 600 (1.25 mg a.i. per seed)	35.6 ± 0.6 a	35.3 ± 0.4 a	35.4 ± 0.6 a

Table 13.5. Mean (± SE) qualitative plot vigor on a 1-9 scale, where 9 is best. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	6 June 2025 (V6)
1	Untreated	7.0 ± 0.0 a
2	Poncho 600 (0.25 mg a.i. per seed)	6.8 ± 0.3 a
3	Poncho 600 (0.5 mg a.i. per seed)	6.8 ± 0.3 a
4	Poncho 600 (1.25 mg a.i. per seed)	7.0 ± 0.4 a

Table 13.6. Mean (± SE) node-injury rating (0-3 scale) of corn rootworm larval feeding damage. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	14 July 2025 (R2)
1	Untreated	1.49 ± 0.23 a
2	Poncho 600 (0.25 mg a.i. per seed)	0.99 ± 0.18 a
3	Poncho 600 (0.5 mg a.i. per seed)	0.87 ± 0.13 a
4	Poncho 600 (1.25 mg a.i. per seed)	0.90 ± 0.20 a

Table 13.7. Mean (± SE) percentage of roots with a node-injury rating (0-3 scale) of less than 0.25. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	14 July 2025 (R2)
1	Untreated	10 ± 6 a
2	Poncho 600 (0.25 mg a.i. per seed)	30 ± 13 a
3	Poncho 600 (0.5 mg a.i. per seed)	15 ± 10 a
4	Poncho 600 (1.25 mg a.i. per seed)	35 ± 24 a

Table 13.8. Mean (± SE) percent root lodging (“goosenecked” lodging) per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Untreated	18 ± 11 a
2	Poncho 600 (0.25 mg a.i. per seed)	19 ± 11 a
3	Poncho 600 (0.5 mg a.i. per seed)	8 ± 5 a
4	Poncho 600 (1.25 mg a.i. per seed)	13 ± 12 a

Table 13.9. Mean (± SE) percent stalk lodging per plot. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	19 September 2025 (R6)
1	Untreated	0 ± 0 a
2	Poncho 600 (0.25 mg a.i. per seed)	0 ± 0 a
3	Poncho 600 (0.5 mg a.i. per seed)	0 ± 0 a
4	Poncho 600 (1.25 mg a.i. per seed)	0 ± 0 a

Table 13.10. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	13 October 2025 (R6)
1	Untreated	168 ± 5 a
2	Poncho 600 (0.25 mg a.i. per seed)	166 ± 12 a
3	Poncho 600 (0.5 mg a.i. per seed)	185 ± 21 a
4	Poncho 600 (1.25 mg a.i. per seed)	196 ± 17 a

Evaluation of MBI-306 and Capture LFR Applied In-Furrow Using 10-34-0 Starter Fertilizer for Control of Corn Rootworm – 2025

Location: University of Illinois Agricultural and Biological Engineering Farm, Urbana, IL (40.07080, -88.21085)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To assess the performance of MBI-306 for control of corn rootworm (particularly western corn rootworm, *Diabrotica virgifera virgifera*) larval damage.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 3 treatments. The experimental units were plots of corn (Table 14.1) that were 4 rows wide and 30 ft. long with 5 ft. of unplanted alley separating plots vertically. Treatments (Table 14.2) were soil insecticides applied in-furrow using liquid starter fertilizer (10-34-0) as a carrier. Plant stands were assessed on 30 May (growth stage V2), and 27 June 2025 (growth stage V6). Larval corn rootworm damage was rated on 18 July 2025 (R1) by digging 5 root masses per plot from rows 1 and 4, removing all soil using an electric high-pressure water sprayer, and rating damage using the 0-3 Node-injury scale. Percent lodging was estimated for each plot on 19 September 2025 (R6). Yields were assessed for each plot on 13 October 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Percent consistency of root ratings for each plot was set equal to the percentage of roots that were given a node-injury rating of less than 0.25. Weights per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Consistency and lodging are reported as percentages but were analyzed as proportions. Plant stand, root injury rating, proportion consistency, and yield were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable in Table 3) where treatment was considered a fixed effect and replicate block was considered a random effect. Because no root or stalk lodging was observed in any of the plots, these data were not analyzed or displayed.

Summary

Capture LFR resulted in lower node-injury ratings than MBI-306 applied in liquid fertilizer, which failed to reduce node-injury ratings relative to the untreated plots. Overall root injury was low, and yield was not affected by our treatments.

Funding

Project funding and insecticide materials were provided by Pro Farm Group. Additional material was provided by FMC Corporation. Seed was provided by Wyffels.

Acknowledgements

We thank Tim Lecher (Farm Manager) for assisting with planting and plot maintenance, academic hourly Grayce Montano and Will Foulke, graduate student Yony Callohuari Quispe, and undergraduate students Sarah Rodriguez, Jason Ballard, Alex Riley, and Brad Vandercar for assisting with plot maintenance and data collection. In addition, we thank Dr. Joseph Spencer (Illinois Natural History Survey) and his undergraduate research assistants for their help with root damage assessments.

Table 14.1. Plot information.

Variety	W7485 Trecepta [a]
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Brenton silt loam/Drummer silty clay loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	34,600 seeds per acre
Planting date	May 13 2025
Emergence date	May 19 2025
Pre-emerge herbicide	32% UAN (200 lb N/ac), Harness Xtra (2 qt/ac) [b]
Post-emerge herbicide	Acuron (3 qt/ac) [c]
Plot size	4 rows (10 ft) wide by 30 ft long, 5 ft unplanted alleys

[a] Wyffels Hybrids Inc., Geneseo, IL; [b] Bayer CropScience, St. Louis, MO; [c] Syngenta Crop Protection, Greensboro, NC

Table 14.2. Corn rootworm treatments.

Trt	Treatment
1	Untreated
2	Capture LFR (17 fl oz/a), 1.5 lb bifenthrin per gallon, suspension concentrate
3	MBI-306 (20 fl oz/a), pre-commercial

[a] FMC Corporation, Philadelphia, PA; b Pro Farm Group, Davis, CA

Table 14.3. Generalized linear mixed model statistics. Probability distribution of each response variable is listed in parentheses.

Dependent Variable	Date	df (numerator, denominator)	*F*	*P*
Plant stand (lognormal)	30 May	2, 6	0.31	0.748
Plant stand (lognormal)	27 June	2, 6	0.27	0.773
Root injury rating (gamma) [a]	18 July	2, 6	10.38	0.011
Proportion consistency (normal) [a]	18 July	2, 6	5.46	0.045
Proportion root lodging (normal)	19 Sept.	N/A	N/A	N/A
Proportion stalk lodging (normal)	19 Sept.	N/A	N/A	N/A
Yield (lognormal)	13 Oct.	2, 6	3.20	0.113

[a] Effect is significant at α = 0.05

Table 14.4. Mean (± Standard error [SE]) stand in number of plants per 17.5 ft. of row. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	30 May 2025 (V2)	27 June 2025 (V6)
1	Untreated	38.3 ± 0.5 a	37.5 ± 0.5 a
2	Capture LFR (17 fl oz/a)	38.6 ± 0.5 a	37.1 ± 0.7 a
3	MBI-306 (20 fl oz/a)	38.0 ± 0.7 a	37.8 ± 0.5 a

Table 14.5. Mean (± SE) node-injury rating (0-3 scale) of corn rootworm larval feeding injury. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	18 July 2025 (R1)
1	Untreated	0.31 ± 0.08 b
2	Capture LFR (17 fl oz/a)	0.16 ± 0.05 b
3	MBI-306 (20 fl oz/a)	0.77 ± 0.15 a

Table 14.6. Mean (± SE) percentage of roots with a node-injury rating (0-3 scale) of less than 0.25. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	18 July 2025 (R1)
1	Untreated	70 ± 17 a
2	Capture LFR (17 fl oz/a)	75 ± 5 a
3	MBI-306 (20 fl oz/a)	25 ± 10 b

Table 14.7. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	13 October 2025 (R6)
1	Untreated	222 ± 4 a
2	Capture LFR (17 fl oz/a)	243 ± 8 a
3	MBI-306 (20 fl oz/a)	231 ± 5 a

Evaluation of Insecticides for Control of Corn Rootworm Adults – 2025

Location: University of Illinois Agricultural and Biological Engineering Farm, Urbana, IL (40.070185, -88.210065)

Study directors: Nicholas Seiter and Ashley Decker

Objective: To assess the performance of Asana with and without synergists for control of corn rootworm adults (*Diabrotica virgifera virgifera*) during corn pollination.

Materials and Methods

Field experiments were established in a randomized complete block design with 4 replicate blocks and 6 treatments. The experimental units were plots of corn (Table 15.1) that were 4 rows wide and 20 ft. long with 5 ft. of unplanted alley separating plots vertically. The treatments (Table 15.2) were different pesticide-rate combinations applied on 30 July 2025 (corn stage R1) using a CO2-powered backpack sprayer with an extended-height 10-foot wide spray boom (Table 15.1). Population densities of western corn rootworm adults were measured on 29 July (pre-application count), 1 August (2 days post-application), 6 August (7 days post-application), and 13 August (14 days post-application) by examining 10 consecutive plants per plot for corn rootworm beetles and other silk-inhabiting insects. (Note: all other insects were present at only low densities; only results for western corn rootworm are reported here). Yields were assessed for each plot on 13 October 2025 by harvesting rows 2 and 3 using a small-plot combine (Massey Ferguson 8XP, Kincaid Equipment, Haven, KS) with a built-in weight and moisture monitor (HarvestMaster, Logan, UT).

Data Analysis

Weights of harvested corn per plot were corrected to a standard weight at 15.5% moisture, then converted to bushels per acre using the standard bushel weight of 56 pounds. Adult counts per 10 plants and yield in bushels per acre were analyzed separately using a generalized linear mixed model (PROC GLIMMIX, SAS version 9.4, SAS Institute, Cary, NC; probability distribution indicated in parentheses for each response variable in Table 15.3) where treatment was considered a fixed effect and replicate block was considered a random effect.

Summary

All insecticides tested reduced corn rootworm beetle counts at 2- and 7-days post-application. By 14 days post-application, the two rates of Asana with no synergist still had counts that were lower than the untreated plots. Corn rootworm populations remained well below economic thresholds for silk feeding insects throughout the experiment, and the treatments did not affect corn yields.

Funding

Project funding and insecticide materials for testing were provided by Valent; additional insecticide materials were provided by FMC Corporation.

Acknowledgements

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Table 15.1. Plot information.

Variety	DKC099-11 VT Double Pro RIB [a]
Seed Treatment	Cruiser 250
Previous crop	Trap crop: late-planted, non-Bt field corn inter-seeded with pumpkins
Soil type	Brenton silt loam
Tillage	Conventional
Row spacing	30 inches
Seeding Rate	35,000 seeds per acre
Planting date	2-Jun-25
Emergence date	N/A
Pre-emerge herbicide	32% UAN (200 lb/ac), Harness Xtra [a] (2 qt/ac)
Post-emerge herbicide	Acuron [b] (3 qt/ac)
Plot size	4 rows (10 ft) wide by 20 ft long, 5 ft alleys, 2 rows unsprayed border between plots

[a] Bayer CropScience, St. Louis, MO; [b] Syngenta Crop Protection, Greensboro, NC

Table 15.2. Experimental treatments.

Trt	Treatment
1	Untreated
2	Asana XL [a], 0.66 lbs esfenvalerate per gal, emulsible concentrate [EC], 5.8 fl oz/a
3	Asana XL 9.6 fl oz/a
4	Asana XL 5.8 fl oz/a + Exponent Synergist [a] , piperonyl butoxide (91.3%), 8 fl oz/a
5	Asana XL 5.8 fl oz/a + Reform [b], piperonyl butoxide (91.3%), 8 fl oz/a
6	Steward EC [c], 1.25 lb indoxacarb per gal EC, 10 fl oz/a

[a] Valent USA Corporation, Walnut Creek, CA; [b] Loveland Products Inc., Greeley, CO; [c] FMC Corporation, Philadelphia, PA

Table 15.3. Generalized linear mixed model statistics. Probability distribution is listed in parentheses after each dependent variable.

Dependent Variable	Date	df (numerator, denominator)	*F*	*P*
Beetle count (normal)	29 July	5, 15	0.72	0.617
Beetle count (normal) [a]	1 Aug.	5, 15	11.42	< 0.001
Beetle count (normal) [a]	6 Aug.	5, 15	8.54	0.001
Beetle count (normal) [a]	13 Aug.	5, 15	2.96	0.047
Yield (lognormal)	13 Oct.	5, 15	0.86	0.530

[a] Effect is significant at α = 0.05.

Table 15.4. Mean (± Standard error [SE]) number of western corn rootworm beetles per 10 plants at 4 sampling dates. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	29 July 2025 (pre-application)	1 August 2025 (2 DAA)	6 August (7 DAA)	13 August 2025 (14 DAA)
1	Untreated	10.3 ± 3.4 a	18.5 ± 4.8 a	8.3 ± 1.7 a	5.5 ± 2.0 a
2	Asana XL (5.8 fl oz/a)	9.3 ± 3.0 a	2.0 ± 1.7 b	1.8 ± 0.5 c	2.0 ± 0.6 bc
3	Asana XL (9.6 fl oz/a)	11.0 ± 4.3 a	1.3 ± 0.6 b	2.5 ± 1.0 bc	0.0 ± 0.0 c
4	Asana XL (5.8 fl oz/a) + Exponent (8 fl oz/a)	11.5 ± 3.4 a	0.3 ± 0.3 b	2.0 ± 0.4 bc	3.8 ± 1.5 ab
5	Asana XL (5.8 fl oz/a) + Reform (8 fl oz/a)	7.8 ± 0.8 a	0.8 ± 0.3 b	2.0 ± 0.4 bc	3.8 ± 1.0 ab
6	Steward (10 fl oz/a)	15.5 ± 3.4 a	0.8 ± 0.5 b	4.5 ± 1.0 b	2.3 ± 0.8 abc

Table 15.5. Mean (± SE) corn yield in bushels per acre, corrected to 15.5% moisture. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Trt	Treatment	13 October 2025 (R6)
1	Untreated	216 ± 9 a
2	Asana XL (5.8 fl oz/a)	205 ± 15 a
3	Asana XL (9.6 fl oz/a)	209 ± 12 a
4	Asana XL (5.8 fl oz/a) + Exponent (8 fl oz/a)	211 ± 10 a
5	Asana XL (5.8 fl oz/a) + Reform (8 fl oz/a)	198 ± 16 a
6	Steward (10 fl oz/a)	208 ± 5 a

Assessing insect pest effects on yield and ROI of pest control inputs – 2025

Study directors: Nicholas Seiter and Ashley Decker

Locations:

University of Illinois Orr Agricultural Research and Demonstration Center, Baylis, IL (39.790219, -90.827412)

University of Illinois Crop Sciences Research and Education Center, Champaign, IL (40.045759, -88.233149)

University of Illinois Northwestern Illinois Research and Demonstration Center, Monmouth, IL (40.933305, -90.726045)

Illinois Extension Ewing Demonstration Center, Ewing, IL (38.095240, -88.844603)

Four commercial farms near Gibson City, La Harpe, Pittsburg, and Boody, IL

Objective: To assess how often insecticides applied to soybean seed or to the canopy at R3 and/or R5 result in protected yield.

Materials and Methods

Field experiments were established as a randomized complete block design with 3 or 4 replicate blocks and 2 or 5 treatments. The experimental units were plots of soybeans (Table 1) that were at least 30 ft wide and 80 ft. long. The treatments (Table 2) were different combinations of insecticides applied either as a seed treatment (imidacloprid at 0.091 mg active ingredient per seed) or as a broadcast application to the foliage at beginning pod formation (growth stage R3) or beginning seed formation (R5). Two of the locations (Urbana and Monmouth) included an additional treatment where an insecticide would be applied if an economic threshold was reached; however, no thresholds were reached at either location, making these in effect additional insecticide-free plots. Broadcast applications used at each site were as follows: Warrior II Zeon at 1.96 fl oz/a (2.08 lb lambda-cyhalothrin per gallon, Syngenta Crop Protection, Greensboro, NC) was used for all treatment applications at Champaign, Monmouth, Ewing, Baylis, Boody, and Gibson City; Bifen 2EC Select at 6.4 fl oz/a (2 lb bifenthrin per gallon, Prime Source LLC, Middlesex, NC) was used for the R5 application at Pittsburg; and Fastac CS at 3.8 fl oz/a (0.83 lb alpha-cypermethrin per gallon, BASF Corporation, Research Triangle Park, NC) was used for the R3 application at La Harpe. At research farm locations (Table 2), plant stands and insect injury were assessed by counting the number of total plants and injured plants in a 17’ 5” section of row until the crop canopy was tall enough to sample using a sweep net (approximately 20-inches high). Subsequently, sweep-net insect counts were taken approximately every other week until beginning maturity (R7) by sweeping a 15-inch diameter net through the canopy 25 times per plot, taking at least one full step between each sweep. All insects collected from each sweep-net sample were stored in a resealable plastic bag and brought back to the lab, where they were frozen until they could be processed. Sample processing consisted of identifying and counting all insect specimens, including pests, beneficial insects, and non-economically important species. When applicable, the percent of the canopy defoliated by insect feeding was visually estimated during stand and/or sweep net evaluations. Experiments conducted on commercial farms were sampled fewer times for insect pests (once before and once after applications were made) using similar methods. Plots were harvested using either a 2-row plot combine with built-in weighing system (Baylis, Champaign, Monmouth, Ewing) or using a commercial-scale combine with a yield monitor (Gibson City, La Harpe, Pittsburg).

Data Analysis

Weights per plot were corrected to 13% moisture, then converted to bushels per acre using the standard bushel weight of 60 pounds. Insect counts and yield were analyzed separately using a generalized linear mixed model where treatment was considered a fixed effect and replicate block was considered a random effect. Additionally, yields from the research farm sites were subjected to a separate, compiled analysis where treatment was considered a fixed effect and year, site (nested within year), and replicate block (nested within site-year combination) were considered random effects.

Summary

Over the first two years of this study, insect and defoliation assessments have not exceeded an economic threshold for any pest at any of our locations (14 site-years). Yield was impacted (Table 3) by our treatments at two locations in 2025 of the seven for which we had replicated yield data (see individual site descriptions below); when a combined analysis was conducted across locations, yields were not affected by insecticide treatment (Table 4). Insect counts and injury assessments overall were low in 2025 and were rarely impacted by our insecticide treatments; only those counts and injury assessments that were impacted by treatment are displayed (see individual site descriptions below).

Urbana

We missed a planned R3 insecticide application, which altered the treatment arrangement for this location. The R5 application was made using a ground rig, unlike the other research farm sites. Bean leaf beetles reached high densities towards the end of the season, which were dramatically reduced wherever an R5 insecticide application was made (Table 5). Green cloverworms, which were present at much lower densities, were also reduced by this application (Table 6). Yields, however, were not similarly affected by the insecticide treatment. While this site included a "spray at threshold" treatment, no threshold was reached, therefore these plots were effectively an additional no-insecticide control.

Monmouth

Insect counts at this site were relatively low. While Japanese beetles were slightly elevated when we began sampling the plots (up to 7.5 beetles per 25 sweeps), they were greatly reduced by the time our first foliar insecticides were applied at R3. As a result, none of our experimental treatments had an impact on Japanese beetle counts. While yields were impacted by our treatments, it did not follow a logical pattern; for example, the "spray at threshold" treatments (which were not sprayed) had reduced yields compared with the no-insecticide control plots (which were within the highest-yielding group of treatments; Table 4). We do not have a clear explanation for why we saw statistical differences, though we suspect based on the small effect size and the nature of the separation among treatments that this was a result of random chance. (A risk when many individual trials are analyzed separately, which is one reason we repeat these trials over multiple seasons and sites and conduct multi-location analyses).

Baylis

The proportion of plants injured by insects was reduced where an insecticide seed treatment was used at the second of four stand evaluations (Table 7); however, stand itself was not affected, and no other differences in insect counts or injury were observed among treatments at this site. Sweep net sampling revealed low insect counts throughout the season, and yields were not affected by the insecticide treatments (Table 4).

Ewing

Following a regional trend, this site was challenged by poor weather conditions throughout the season (including saturated soils early and alternating drought/downpours throughout the summer), and yield potential was abnormally low (Table 4). Stand, insect counts, and injury assessments were low throughout the season and were not affected by treatment. Yields were affected by treatment, with the plots treated with a combination of insecticide seed treatment, R3 application, and R5 application outyielding both the untreated plots and the plots that received only an R5 application (Table 4). However, the statistical test was barely significant (Table 3, note the test is considered significant if the P-value is less than 0.05; in this case it was 0.0479), and the yield impacts did not follow a logical order based on treatment type (e.g., an R5 application was the numerically lowest treatment, while adding that application to an R3 application and a seed treatment resulted in the highest yields). This location should be interpreted in the context of the overall poor condition of the soybeans at this site.

Boody

The experimental treatment at this site was an R5 foliar application of a pyrethroid insecticide (applied using a drone) compared with untreated plots. Insect counts were relatively low; there was a numerical reduction in bean leaf beetles in the R5-treated plots, but it was not statistically significant, and the population density was only 7.8 beetles per 25 sweeps in the untreated plots (see counts at Urbana and Gibson City for comparison, Table 5). Yield information was not collected from all plots.

Gibson City

The experimental treatment at this site was an R5 foliar application of a pyrethroid insecticide (applied using a drone) that followed an earlier application at R3 by ground rig, while the control plots were only treated at R3. Bean leaf beetles reached elevated levels late in the season and were reduced by the R5 application to the treated plots (Table 5). However, there was no corresponding impact on soybean yields, which were impacted by a late drought (Table 8).

La Harpe

The experimental treatment at this site was the addition of an insecticide to an R3 fungicide application (applied using a drone) compared with plots that only received the fungicide. Insect counts were low throughout the course of the experiment, and as a result were not impacted by treatment. Yields also were not impacted by treatment, though there was a trend for slightly lower yields where the insecticide was added (Table 8).

Pittsburg

The experimental treatment at this site was an R5 foliar application of a pyrethroid insecticide that followed an earlier R3 application, while the control plots were only treated at R3. (All applications were made using a drone). Insect counts were very low throughout the course of the experiment, and yields were not impacted by the R5 foliar application (Table 8).

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Table 16.1. Agronomic information

Location	Number of replicates	Soybean variety	Planting date	Seeding rate	Plot size (ft)	Tillage
Urbana	4	LGS3216E3 [a]	4-Jun	130,000	40 × 80	Conventional
Monmouth	4	LGS3216E3	15-May	150,000	30 × 80	Conventional
Orr	4	LGS3216E3	16-Apr	145,000	30 × 95	Conventional
Ewing	3	LGS3216E3	4-Jun	143,000	30 × 90	No-till
Gibson City	4	GH3415E3 [b]	29-Apr	140,000	75 × 1,500	No-till
La Harpe	4	P35Z76E [c]	19-Apr	142,000	70 × 950 ft	No-till
Pittsburg	4	AG39XF3 [d]	15-May	155,000	40 × 1,500	Minimal tillage
Boody	4	36R32 [e]	17-Apr	125,000	70 × 1,500	No-till

[a] LG Seeds, AgReliant Genetics LLC, Westfield, IN; [b] Golden Harvest, Syngenta Seeds, LLC, Durham, NC; [c] Pioneer, Corteva Agriscience, Johnston, IA [d] Asgrow Soybean Seed, Bayer CropScience, St. Louis, MO. [e] Stine Seed Company, Adel, IA.

Table 16.2. Experimental design and treatment arrangement by site.

Location	Farm type (application method)	Treatments
Urbana	Research (ground rig)	No insecticide (x 2); Insecticide seed treatment; IST + R5; Spray at threshold (not reached)
Monmouth	Research (drone)	No insecticide; Insecticide seed treatment; R3 foliar application; R5 foliar application; IST + R3 + R5; Spray at threshold (not reached)
Orr	Research (drone)	No insecticide; Insecticide seed treatment; R3 foliar application; R5 foliar application; IST + R3 + R5
Ewing	Research (drone)	No insecticide; Insecticide seed treatment; R3 foliar application; R5 foliar application; IST + R3 + R5
Gibson City	Commercial (drone)	R3 foliar application; R3 + R5
La Harpe	Commercial (drone)	No insecticide; R3 foliar application
Pittsburg	Commercial (drone)	R3 foliar application; R3 + R5
Boody	Commercial (drone)	No insecticide: R5 foliar application

Table 16.3. Generalized linear mixed model statistics.

Response variable	Date	df (numerator, denominator)	*F*	*P*
Yield - Combined, 2024-2025 (lognormal)	N/A	4, 84	1.38	0.249
Yield - Urbana (lognormal)	9-Oct	4, 16	1.44	0.2676
Yield - Monmouth (lognormal)	2-Oct	5, 15	3.53	0.0263 [a]
Yield - Orr (lognormal)	26-Sep	4, 12	1.81	0.1922
Yield - Ewing (lognormal)	16-Oct	4, 8	3.91	0.0479 [a]
Yield - Gibson City (lognormal)	29-Sep	1, 3	0.33	0.6039
Yield - La Harpe (lognormal)	3-Oct	1, 3	9.93	0.0512
Yield - Pittsburg (lognormal)	3-Oct	1, 2	0.05	0.8439
Proportion injured plants - Orr (normal)	27-May	1, 15	9.18	0.0084 [a]
Bean leaf beetle - Urbana (normal)	26-Aug	4, 16	25.02	< 0.0001 [a]
Bean leaf beetle - Urbana (normal)	8-Sep	4, 16	6.86	0.0020 [a]
Green cloverworm - Urbana (normal)	26-Aug	4, 16	4.33	0.0146 [a]
Green cloverworm - Urbana (normal)	8-Sep	4, 16	6.12	0.0035 [a]

[a] Effect is significant ($\alpha = 0.05$)

Table 16.4. Yield in mean (± standard error [SE]) bushels per acre at 13% moisture for each individual site, as well as analyzed across trials for the sites located at research centers which had the full complement of experimental treatments. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Treatment	Compiled [a]	Ewing	Monmouth	Orr	Urbana
No insecticide	57.0 ± 3.1 a	26.6 ± 0.8 b	68.4 ± 1.7 a	61.0 ± 0.7 a	45.4 ± 2.4 a
Insecticide seed treatment	56.5 ± 2.9 a	29.3 ± 1.3 ab	66.9 ± 1.3 ab	62.0 ± 2.1 a	48.0 ± 3.4 a
R3 application	57.5 ± 3.0 a	29.3 ± 2.2 ab	65.7 ± 0.8 b	64.2 ± 1.3 a	N/A
R5 application	55.3 ± 3.2 a	25.1 ± 0.5 b	69.0 ± 0.8 a	59.4 ± 1.0 a	54.4 ± 3.0 a
IST + R3 + R5	56.6 ± 2.7 a	32.0 ± 1.2 a	65.4 ± 1.3 b	59.5 ± 2.1 a	N/A
Spray at threshold [b]	N/A	N/A	66.0 ± 1.1 b	N/A	49.3 ± 1.5 a
IST + R5	N/A	N/A	N/A	N/A	49.4 ± 3.2 a

[a] Includes the 6 site-years at research stations where the 5 “core” treatments were included; omitted are Orr 2024 (R5 application was too low, damaged plots) and Urbana 2025 (R3 application was missed). [b] No thresholds were reached at either of the two locations that included this treatment, therefore these plots were not sprayed.

Table 16.5. Mean (± SE) number of bean leaf beetles per 25 sweeps at the Urbana (two sampling dates) and Gibson City (one sampling date) field experiments in 2025. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Treatment	Urbana 26 Aug.	Urbana 8 Sept.	Gibson City 28 Aug.
No insecticide	73.0 ± 5.6 b	39.5 ± 6.6 a	N/A
Insecticide seed treatment	100.3 ± 12.5 a	41.8 ± 12.1 a	N/A
R5 application	0.8 ± 0.8 c	2.5 ± 0.5 b	N/A
Spray at threshold	79.8 ± 21.3 ab	29.5 ± 7.7 a	N/A
IST + R5	0.0 ± 0.0 c	1.8 ± 0.8 b	N/A
R3 application	N/A	N/A	120.3 ± 31.1 a
R3 + R5	N/A	N/A	20.8 ± 6.4 b

Table 16.6. Mean (± SE) number of green cloverworm larvae per 25 sweeps at the Urbana (two sampling dates) field experiment in 2025. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Treatment	Urbana 26 Aug.	Urbana 8 Sept.
No insecticide	2.5 ± 0.5 a	3.6 ± 0.8 a
Insecticide seed treatment	3.0 ± 0.9 a	2.8 ± 0.5 ab
R5 application	0.3 ± 0.3 b	0.0 ± 0.0 c
Spray at threshold	3.3 ± 1.0 a	1.5 ± 0.3 bc
IST + R5	0.3 ± 0.3 b	0.0 ± 0.0 c

Table 16.7. Mean plant stand per 17 ft. 5 in. of row (a 1/1,000th-acre sample) and proportion of plants injured by insects for a single sampling date, 27 May 2025 (soybean stage V3) at the Baylis field experiment. This was one of four stand assessments conducted between 16 May and 19 June at this site. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Seed treatment	plant stand	proportion of plants injured
Fungicide-only [a]	88.6 ± 2.2 a	0.27 ± 0.03 a
Fungicide + insecticide [b]	86.1 ± 1.7 a	0.18 ± 0.01 b

[a] Fungicide base was Obvius Plus (fluxapyroxad, pyraclostrobin, metalaxyl, thiophanate-methyl, BASF Corporation, Research Triangle Park, NC) applied at 1.30 oz/cwt; [b] Insecticide was imidacloprid applied at 0.091 mg active ingredient per seed (Senator 600 FS, Nufarm Americas Inc., Alsip, IL applied at 1.36 oz/cwt)

Table 16.8. Yield in mean (± SE) bushels per acre at 13% moisture for each commercial farm site. Means followed by the same letter within a column are not different based on the Fisher method of least significant difference (α = 0.05).

Treatment	La Harpe	Gibson City	Pittsburg
No insecticide	66.7 ± 0.8 a	N/A	N/A
R3 application	65.0 ± 0.3 a	63.2 ± 3.7 a	52.8 ± 2.1 a
R3 + R5	N/A	63.6 ± 2.8 a	52.9 ± 2.6 a

Modified April 2026