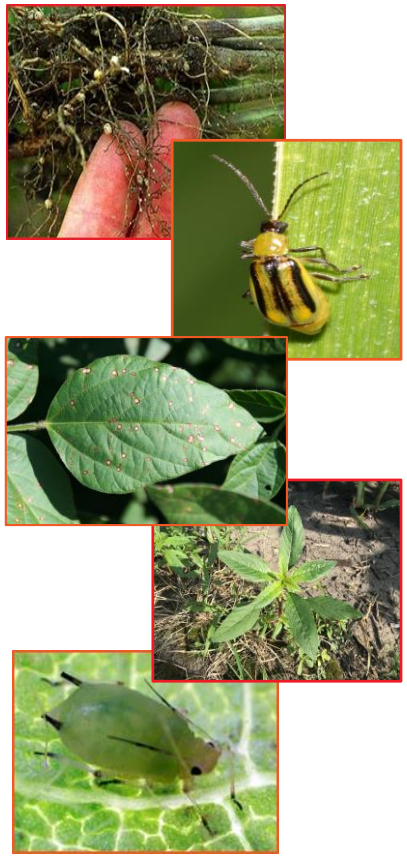
TRENDS IN PEST RESISTANCE: 2013 - 2021



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Trends in Pest Resistance: Western Corn Rootworm

Resistance to Cry3Bb1 and mCry3A corn in Iowa.

Cross-resistance identified between Cry3Bb1 and mCry3A corn.

2015 [a]

Resistance Management Practices:

Plant non-Bt refuges.

Rotate fields out of corn production to alternative crops such as soybean.

Rotate with non-rootworm Bt corn with a soil-applied insecticide.

Use corn pyramided with Cry34/35Ab1 and either Cry3Bb1 or mCry3A.

Cross-resistance among Cry3Bb1, mCry3A and eCry3.1Ab; three of the four Bt traits.

Incomplete resistance to Cry34/35Ab1 corn (the fourth Bt trait).

2016 [b]

Resistance Management Practices:

Plant non-Bt refuges.

Rotate fields out of corn production to alternative crops such as soybean.

Rotate with non-rootworm Bt corn with a soil-applied insecticide

Use corn pyramided with Cry34/35Ab12021 and either Cry3Bb1 or mCry3A.

Data suggest complete resistance to Cry34/35Ab1; appears to be increasing in magnitude.

There are western corn rootworm populations that possess resistance to all commercially available Bt; the challenge of managing western corn rootworm has become more difficult.

2021 [c]

Current Resistance Management Practices:

Rotate fields out of corn production to alternative crops such as soybean.

Rotate with non-rootworm Bt corn with a soil-applied insecticide. If resistance prevalent in surrounding fields, effectiveness of rotations increases if this practice widely adopted in the landscape.

RNAi trait pyramided with Cry3Bb1 and Cry34/35Ab1 will have limited durability in fields with rootworms resistant to the Bt traits due to evolution of RNAi resistance.

Trends in Pest Resistance: Soybean Aphid

Foliar insecticides were the primary management tactic.

Pyrethroids (e.g., λ-cyhalothrin) were the most common mode of action.

Good performance and yield protection was observed when using the economic threshold.

2001 – 2014 [d]

Poor performance and declining yields in commercial fields were first detected in Iowa and several other northcentral states.

Subpopulations have reduced susceptibility to bifenthrin and λ-cyhalothrin.

2015 – 2016 [e, f]

Pyrethroid-resistant aphids have mutations in the voltage-gated sodium channel and detoxification enzymes.

Pyrethroid-resistant aphids found in northwest and northcentral Iowa, even before a pyrethroid is applied.

2018 – 2021 [g, h, i]

Recommended Management Practices:

1) scout & apply insecticide when populations exceed the economic threshold,
2) assess efficacy 3 – 5 days after application, and
3) use a different mode of action if another application is needed.

Current Resistance Management Practices:

1) plant aphid-resistant varieties (note many are not herbicide-tolerant),
2) alternate modes of actions, and
3) spray single modes of action to delay cross resistance to other modes of action.

Trends in Pest Resistance: Pathogens

No confirmed reports of fungicide resistance for corn and soybean pathogens in Iowa.

QoI-resistant frogeye leaf spot, Cercospora sojina, in soybean documented in Illinois and Missouri.

2015 [q]

Resistance Management Practices:

Fungicide resistance management strategies include managing diseases using other strategies (e.g. resistant hybrids) and applying fungicides only when the risk of disease is elevated.

QoI-resistant strains of the frogeye leaf spot and Septoria brown spot pathogens documented in Iowa.

2018 [j, p]

Resistance Management Practices:

Crop rotation; planting of frogeye leaf spot-resistant cultivars; and application of fungicides with multiple modes of action

Fields should be scouted approximately two weeks after fungicide application to determine if the fungicide is working.

QoI-resistant strains of frogeye leaf spot and Septoria brown spot pathogens documented across all of Iowa on soybean displaying symptoms of infection. Using QoI fungicides as the primary control of these diseases is no longer viable.

Fungicide resistant strains of the Cercospora leaf blight pathogen have been found in the U.S., but has not yet been confirmed in Iowa, but a possibility..

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2020 [j, q]

Current Resistance Management Practices:

QoI. resistant strains can be managed effectively with other fungicide groups

Selecting a frogeye leaf spot-resistance cultivar and incorporating crop rotation with non-host crops can provide better control of the disease.

Trends in Pest Resistance: Soybean Cyst Nematode (SCN)

Soybean varieties resistant to SCN include PI8878, Peking and PI437654; evidence of SCN resistance to PI8878 in Iowa

2016 [b]

Resistance Management Practices:

Rotation of soybean varieties with different sources of resistance; chemical and biological options; cultural practices.

Substantial yield suppression from SCN seen in soybean varieties with resistance from PI 88788.

2021 [c]

Current Resistance Management Practices:

Grow soybean varieties with SCN resistance from the Peking source in rotation with varieties with good SCN resistance from PI 88788. .

Trends in Pest Resistance: Weeds

2013 [a,b,r]

Soybean fields surveyed in 2011, 2012, and 2013, documented 10 weed species with evolved resistance across herbicide site of action groups (HGs): 2 (ALS inhibitors), 5 (PSII inhibitors), 9 (glyphosate), 14 (PPO inhibitors), and 27 (HPPD inhibitors). Populations with multiple herbicide resistance were reported for giant foxtail, giant ragweed, and waterhemp.

For waterhemp populations sampled in 2013, 100%, 97%, 98%, 17%, and 28% had evolved resistance to HG 2, 5, 9, 14 and 27, respectively.

In 2013, 69% of the waterhemp populations demonstrated multiple resistance to three site of action groups, most commonly HGs 2, 5 and 9. Approximately 10% and 5% of the waterhemp populations demonstrated 4- and 5-way resistance, respectively.

2019 – 2020 [s, t, u, v]

Based on 2019 surveys, estimated percent of Iowa fields with waterhemp populations resistant to HG 2, 9, and 14 were >95%, >75% and >50%, respectively. Out of 75 waterhemp populations collected, approximately 25% had four-way multiple resistance to HGs 2, 5, 9 and 14. Five-way resistance including HG 27 was also reported.

At a 1X rate (field-use rate), approximately 10% of waterhemp populations treated with 2,4-D or dicamba had 30% of the plants survive, re-grow and produce seeds (personal communication, Prashant Jha Iowa State University).

Marestail populations in Iowa have developed resistance to glyphosate (HG 9) and ALS-inhibitor (HG 2) herbicides.

2021 [w]

Current Resistance Management Practices:

Utilize a two-pass layered residual herbicide program to add additional sites of action to the program. Scout fields after each application and especially late in the season to prevent seed production from survivors. Consider incorporating one or more non-chemical, complimentary tactics, including cereal rye cover crop, tillage, narrow row spacing, or higher soybean seeding rate to reduce selection pressure for development of herbicide resistance.

Trends in Pest Resistance: References

[a] https://www.ipm.iastate.edu/files/iprmp/resistance-meeting-background-materials.pdf

[b] https://www.ipm.iastate.edu/files/iprmp/resistance-management-conceptual-framework.pdf

[c] Gassmann 2021; https://www.mdpi.com/2075-4450/12/2/136

[d] Hodgson et al. 2012; https://doi.org/10.1603/IPM10016

[e] Hanson et al. 2017; https://doi.org/10.1093/jee/tox235

[f] Menger et al. 2020; https://doi.org/10.1093/jee/toz351

[g] Paula et al/ 2020; https://doi.org/10.1016/j.pestbp.2019.12.012

[h] Paula et al. 2021; https://doi.org/10.1127/entomologia/2021/1226

[i] Valmorbida et al. 2021; In press

[j] Neves, D.L., Wang, A., Weems, J.D., Kelly, H.M., Mueller, D.S., Farman, M., and Bradley, C.A. 2020. Identification of Septoria glycines isolates from soybean with resistance to quinone outside inhibitor fungicides. Plant Disease. In press.

[k] Hanson et al. 2017; https://doi.org/10.1093/jee/tox235

[l] Koch et al. 2018; https://doi.org/10.1093/jipm/pmy014

[m] Dean et al. 2019; https://store.extension.iastate.edu/product/15763

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[o] https://crops.extension.iastate.edu/cropnews/2021/11/substantial-yield-suppression-scn-seen soybean-varieties-resistance-pi-88788-2021)

[p] https://crops.extension.iastate.edu/cropnews/2018/02/frogeye-leaf-spot-fungicide-resistance-confirmed-iowa-soybean

[q] https://crops.extension.iastate.edu/cropnews/2020/01/instances-frogeye-leaf-spot-resistance qois-abundant-iowa

[r] Owen 2017; https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1262&context=icm

[s] https://crops.extension.iastate.edu/blog/prashant-jha-ramawatar-yadav/what%E2%80%99s-new-weed-control-corn-and-soybean-2021

[t] https://crops.extension.iastate.edu/cropnews/2021/01/herbicide-programs-waterhemp-control-soybean

[u] https://crops.extension.iastate.edu/blog/bob-hartzler-meaghan-anderson-prashant-jha/managing-herbicide-resistant-waterhemp-dicamba

[v] https://crops.extension.iastate.edu/cropnews/2021/02/2020-summary-herbicide-evaluations-marestail-horseweed-control-soybean

[w] https://crops.extension.iastate.edu/blog/prashant-jha-ramawatar-yadav/what%E2%80%99s-new-weed-control-corn-and-soybean-2021