



Soybean aphid-resistant soybean varieties for Iowa

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The soybean aphid is an economically damaging pest throughout much of the North Central United States. Soybean aphids are capable of reaching densities of over 1,000 per plant in the field and can reduce soybean yields by 14–40 percent. Since its discovery in North America in 2000, economically damaging populations have developed in parts of Iowa, particularly northern counties.

Aphid-resistant soybean varieties are a new management tool for farmers. These varieties incorporate one or more genes conferring resistance to the soybean aphid. At least four genes have been identified: *Rag1*, *Rag2*, *Rag3*, and *rag4*. These genes suppress aphid growth and reproduction. This causes aphid populations to develop much slower than when feeding on susceptible plants, often preventing them from reaching economically damaging levels.

All soybean aphid resistance genes are naturally occurring and were not produced through genetic engineering. Therefore, no requirements to plant a refuge exist, and the genes are compatible with organic production systems.

What should one consider when choosing a soybean aphid-resistant variety?

Yield potential: The most important characteristic to consider for seed selection is the yield potential of the variety. Host plant resistant varieties are developed to suppress insects and diseases in order to protect yield. Growers should consult variety trials for information on the relative performance of soybean varieties and select seed that is well suited for their growing conditions (e.g., soil type, relative maturity, etc.).

Other pests: Farmers should consider all pest challenges in their field when choosing a variety, including other insects, nematodes, diseases, and weeds. The soybean cyst nematode (SCN), brown stem rot, phytophthora root rot, sudden death syndrome, white mold, and many other diseases can reduce yield. Several of the varieties listed in this publication contain resistance to several of these pests. Specifically, if your field contains

SCN, an SCN-resistant variety is strongly encouraged because it is the most effective and reliable management tool. Farmers should consult Iowa State University (ISU) Extension publications for more information on SCN-resistant varieties.

What effect do aphid-resistant varieties have on the soybean aphid?

Soybean aphid-resistant varieties slow the rate at which soybean aphid populations increase. The resistant plants will not be aphid free, but they will have fewer aphids than susceptible plants. Since aphids are capable of reaching economically damaging levels and resistant aphid biotypes exist, farmers should still regularly scout fields planted regardless of seed selection (i.e., susceptible or resistant varieties) and use foliar insecticides when populations exceed the economic threshold.



Resistant and susceptible soybeans grown side by side. Sooty mold growing on the honeydew left by aphids makes the susceptible soybeans appear blackened.

When should growers consider using soybean aphid-resistant varieties?

We are not able to predict if a soybean aphid outbreak will occur before planting. Therefore, ISU entomologists recommend Iowa farmers to consider planting soybean aphid-resistant varieties if any of the statements apply for their production:

1. Fields located north of Interstate 80, especially northeast or northwest Iowa. Soybean aphid outbreaks are more common in the northern half of Iowa. This is especially true for farmers in northeastern Iowa who experience significantly earlier spring colonization by aphids due to their proximity to dense buckthorn stands. Spring and summer colonization in northern Iowa is more common, and farmers will likely see yield protection benefits from incorporating aphid-resistant varieties.
2. Farms that have fields sprayed for soybean aphid two out of the last four years. The premium for soybean aphid-resistant seed is lower than the cost of insecticidal seed treatments or most foliar insecticides. Therefore, if

insecticides are sprayed in half of the years soybean is grown, it would be more cost effective to grow a soybean aphid-resistant variety.

3. Farms with organic soybean production. Organic soybean producers have a limited number of tools for effectively managing soybean aphids. Therefore, if a farmer is planning on producing organic soybeans, we recommend the use of soybean aphid-resistant varieties. This is especially true for organic producers with fields in the northern half of the state.

4. Farmers interested in minimizing chemical inputs for broader integrated pest management and reducing overall input costs. Growers interested in adopting a more diversified approach to pest management on their farm should consider soybean aphid-resistant varieties. These varieties can reduce the need for chemical inputs, especially later in the season (R3 or later). If a grower were trying to avoid chemical applications at that point in the season, a soybean aphid-resistant variety would be a valuable management tool.

Additional Resources:

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Email: ewh@iastate.edu; Twitter: @ErinWHodgson

Lab website: <http://www.ent.iastate.edu/soybeanresearch/content/extension>

Matt O'Neal, associate professor and chair of Sustainable Agriculture Graduate Program

Email: oneal@iastate.edu

Soybean Pest Podcast: <http://bit.ly/1UjOHvq>

Erika Rodbell, graduate student

Email: erodbell@iastate.edu

Integrated Crop Management Website:

-<http://crops.extension.iastate.edu/>

-ICM News, ICM Blog, Crops Twitter feed, Calender and Events, contact info

ISU Extension and Outreach Publication Store:

-<http://store.extension.iastate.edu/>

-Getting to Know the Insects (primer for youth and new agronomists)

-Soybean Aphid Efficacy Evaluations; Field Crop Insects Compendium; Soybean Aphid Field Guide

ISU Plant Insect Diagnostic Laboratory: <http://www.ent.iastate.edu/pidc/>



ON-FARM TESTING OF APHID RESISTANT SOYBEANS IN IOWA

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INTRODUCTION

In the North Central United States the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), is an economically damaging insect pest of soybean (*Glycine max* L.). Host plant resistance conferred by soybean aphid resistance genes (*Rag*) is an effective management tool to suppress aphid populations. Despite their high efficacy, farmer adoption of aphid resistant varieties is low, perhaps because of their limited commercial availability. Furthermore, the value of aphid resistant varieties in a farm setting is unclear. We conducted on-farm experiments in northern Iowa to evaluate the efficacy of aphid-resistant (*Rag1 + Rag2*) varieties from university and commercial sources and compare yield.

OBJECTIVES

1. Determine the on-farm efficacy of an aphid-resistant gene pyramid.
2. Compare yields of aphid-resistant and aphid-susceptible varieties, which may influence farmer adoption rates of aphid-resistant varieties.

METHODS

Hypothesis: Aphid-resistant soybean varieties will have fewer aphids than aphid-susceptible varieties.

We conducted this experiment on 3 farms and 1 Iowa State University Research Farm in Iowa in 2017 (Fig. 1).

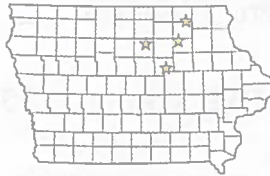


Figure 1. Farm location in northern Iowa.

Table 1. Seed treatment variety information.

Treatment	Variety	Soybean Aphid Tolerance	Herbicide Tolerance	Maturity Group
Farmer's Choice	Stonebridge 3045LF; Emerge e2162; Viking 2155N	Susceptible	Conventional*	2.1
ISU (Iowa State University)	IA 2102	Susceptible	Conventional	2.7
ISU	IA 2112 RA12	Resistant **	Conventional	2.7
Commercially Available	Viking 2188AT12N	Resistant **	Conventional	2.1

*Conventional indicates no herbicide tolerance. **Aphid resistance was conferred from a combination of the *Rag1* and *Rag2* genes.

Data Collection: At each location, aphid populations were estimated by counting all aphids on 30 plants per variety, weekly from June 20-August 9, 2017. Plants were randomly selected by moving in a zig-zag pattern through each variety. Aphid populations converted to cumulative aphid days as a measure of seasonal aphid exposure.

Hypothesis: Resistant varieties do not cause yield drag and should protect yield in high aphid pressure environments.

If aphid-resistant varieties, containing *Rag1 + Rag2* are associated with yield drag, farmers may be less likely to cultivate soybean aphid resistant varieties. If a yield drag is associated with *Rag* genes, then yield will be higher on the susceptible varieties in the absence of large aphid populations. Three of the participating farmers shared yield data from the four soybean varieties.



2017 soybean harvest at one of the participating farms.

Aphid populations on aphid-resistant soybean varieties were significantly less than on aphid-susceptible varieties.

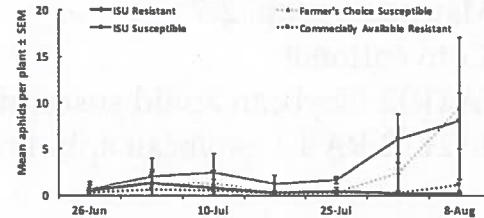


Figure 3. Aphid abundance \pm standard error of the mean (SEM) across all locations (n=4). Solid lines indicate Iowa State University varieties. Grey lines indicate aphid-susceptible varieties and black lines indicate aphid-resistant varieties. Note, the economic threshold for soybean aphids is 250 aphids per plant [2].

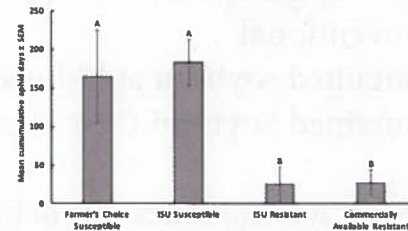


Figure 4. Seasonal exposure of aphids (CAD) \pm SEM across all locations (n=4). Note CAD is far below the economic injury level of 5,560 [1]. Different letters indicate significant differences between treatments (p<0.05).

Soybean varieties from ISU yield the highest regardless of aphid populations.

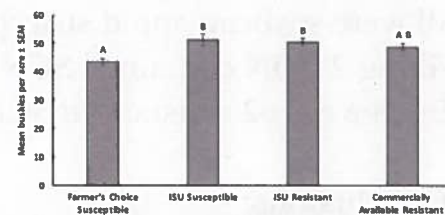


Figure 5. If aphid-resistant varieties, containing *Rag1 + Rag2* are associated with yield drag, farmers may be less likely to cultivate soybean aphid resistant varieties. If a yield drag is associated with *Rag* genes, then yield will be higher on the susceptible varieties in the absence of large aphid populations. Three of the participating farmers shared yield data from the four soybean varieties

RESULTS AND CONCLUSIONS

- Aphid populations were low and did not exceed economic threshold (Fig. 3).
- Despite these low populations, aphid-resistant varieties were efficacious when compared to aphid-susceptible varieties (Figs. 3, 4).
- Varieties chosen by farmers were aphid-susceptible, yielded less than the other varieties, but were not significantly different from the commercially-available resistant variety (Fig. 5). These yield differences were likely due to genetic differences among the varieties (Fig. 3).
- We observed no evidence of yield drag caused by pyramiding *Rag1 + Rag2* (Fig. 5).

12 Hodgson, E. 2017. Sustainable Management Plan for soybean aphid. Proceedings of the 27th annual integrated crop management conference. Source: <http://dx.doi.org/10.1017/procicmip.2017.11>
 13 Hodgson, E. 2017. Sustainable Management Plan for soybean aphid. Proceedings of the 27th annual integrated crop management conference. Source: <http://dx.doi.org/10.1017/procicmip.2017.11>

Objectives:

1. Determine the on-farm efficacy of an aphid-resistant gene pyramid.
2. Compare yields of aphid-resistant and aphid-susceptible varieties, which may influence farmer adoption rates of aphid-resistant varieties.

Seed Cultivars:

1. Iowa State University cultivars IA2102 and IA2112 RA 12:
 - Maturity group: 2.7
 - Conventional
 - IA2102 (soybean aphid susceptible): lacked *Rag*-genes
 - IA2112 RA 12 (soybean aphid resistant): contained *Rag1+2* genes
2. Commercially available resistant (Viking 2188AT12N):
 - Maturity group: 2.1
 - Conventional
 - Contained soybean aphid resistant *Rag1+2* genes
 - Contained Soybean Cyst Nematode (SCN) resistant gene PI88788
3. Farmer's Choice Cultivars (Stonebridge 3045LF; Emerge e2162; Viking 2155N):
 - Maturity group: 2.1
 - Conventional
 - All were soybean aphid susceptible
 - Viking 2155N contained SCN resistant gene PI88788
 - Emerge e2162 resistant to SCN

General Conclusions:

1. IA2102 generated similar cumulative aphid days (a cultivar's season-long exposure to aphids) as the farmer's choice cultivars, which were both significantly higher than the aphid resistant cultivars (IA 2112 RA 12 and Viking 2188AT12N) (Fig. 4).
2. We observed no evidence of yield drag caused by pyramiding *Rag1+2* genes (Fig. 5).