# Evaluation of Soybean Aphid-resistant Soybean Lines

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## Introduction
The soybean aphid, *Aphis glycines*
(Hemiptera: Aphididae), is a consistent pest of
soybean in Iowa. Current management is
heavily reliant on the use of insecticides,
which can be expensive and time consuming
to apply. Soybean varieties resistant to the
aphid are available. These varieties primarily
include one resistance gene (*Rag1*) for
soybean aphid control. Varieties incorporating
two genes (*Rag1 + Rag2*) have recently
become available. We sought to compare
soybean lines susceptible to the soybean aphid
with lines carrying a single resistance gene
(*Rag1* **or** *Rag2*) and a line carrying two
resistance genes (*Rag1 + Rag2*). We evaluated
the lines based on aphid control and yield
protection.

## Materials and Methods
Plots were established at the Iowa State
University Northeast Research Farm in Floyd
County, Iowa. The treatments were arranged
in a split-plot design with four replicates.
Soybean line was the whole-plot factor and
insecticide was the split-plot factor. Four
experimental soybean lines were used for the
experiment. The lines were developed by the
soybean breeding program at Iowa State
University and were near-isogenic (BC$_1$,
sharing 75% genetic identity) for the soybean
aphid resistance genes *Rag1* and *Rag2*. The
four lines were termed 'susceptible,' *Rag1*,
*Rag2*, and *Rag1 + Rag2*. Each line was grown
free of insecticides to measure the aphid
control provided by each line and with foliar
insecticides in order to measure the yield
potential of each line. We were able to
measure yield loss due to aphid feeding for
each line by comparing the yield of the
insecticide-free treatment and insecticide
treatment.

Soybeans were planted in 30-in. rows using
conventional-tillage (fall chisel plow, spring
field cultivate) production practices on June
19. Each split-plot was six rows wide and 50
ft long. A foliar application of Warrior II CS®
was made to each insecticide treatment split-
plot when aphid populations reached 50
aphids/plant.

Soybean aphid populations were counted on
five plants/split-plot each week. Aphid
populations are reported as cumulative aphid
days (CAD), a summary statistic similar to
growing degree-days. Cumulative aphid days
measure the plant's exposure to aphids
throughout the season and have a strong
correlation to yield loss. Economic injury is
expected to occur around 5,200 CAD.

Plots were harvested on October 22. Yields
were determined by weighing grain from the
middle four rows of each split-plot with a
hopper that rested on a digital scale sensor
custom designed for the combine. Yields were
corrected to 13 percent moisture and reported
in bushels/acre. An analysis of variance
(ANOVA) was used to determine the effect of
soybean line on CAD (aphid control) and the
effects of soybean line and insecticide
treatment on yield. Means were separated
using a least significant difference test
(alpha=0.05) for the CAD data. A t-test was
used to test for yield differences between
insecticide treatments for each line
(alpha=0.05).

### Results and Discussion

Soybean aphid populations were high in 2013. On the susceptible line, aphid populations exceeded the economic injury by the end of August and peaked in the second week of September at ≈ 1,500 aphids/plant (Figure 1). Aphid populations for the single gene lines were reduced compared with the susceptible line, but still supported substantial aphid populations. Populations on the *Rag1 + Rag2* line never exceeded 10 aphids/plant.

Aphid populations varied significantly across the four soybean lines (soybean line P<0.0001). Cumulative aphid day data revealed significantly reduced aphid populations on the *Rag2* line compared with the susceptible line. The *Rag1* line, however, did not significantly reduce aphid populations. The *Rag1 + Rag2* line provided the greatest aphid population suppression, reducing CAD by >98 percent compared with the susceptible line (Figure 2).

The average yield in the insecticide treatment was 47 bushels/acre across the four soybean lines. Yield loss to soybean aphid did not occur equally across the four soybean lines (line × treatment P=0.05). The susceptible line experienced 18 percent yield loss, while the single gene lines experienced 7 percent yield loss (Figure 3). As expected from the low aphid populations present, the *Rag1 + Rag2* line did not lose any yield to aphids. Farmers who grow soybean aphid-resistant varieties still will need to scout for soybean aphid. We observed marginal protection against soybean aphid provided by single gene lines. These single gene lines still required an insecticide treatment to achieve optimal yield. Single gene resistance makes up the majority of commercially available soybean aphid-resistant varieties.

In the future, farmers may be able to purchase more varieties incorporating two soybean aphid-resistance genes. Two gene lines provide increased aphid population suppression and eliminated the need for foliar insecticides in our experiment. Iowa State University has produced the first commercially available varieties incorporating two soybean aphid resistance genes. We encourage farmers, especially organic farmers, interested in experimenting with soybean aphid-resistant varieties to try these varieties on their farm.

### Acknowledgements

Figure 1. Soybean aphid populations exceeded the economic injury level (650 aphids/plant) on the susceptible and *Rag1* lines. Aphid populations remained below the economic injury level on the *Rag2* line, but still reached substantial populations. Aphid populations never exceeded 10 aphids/plant on the *Rag1 + Rag2* line.
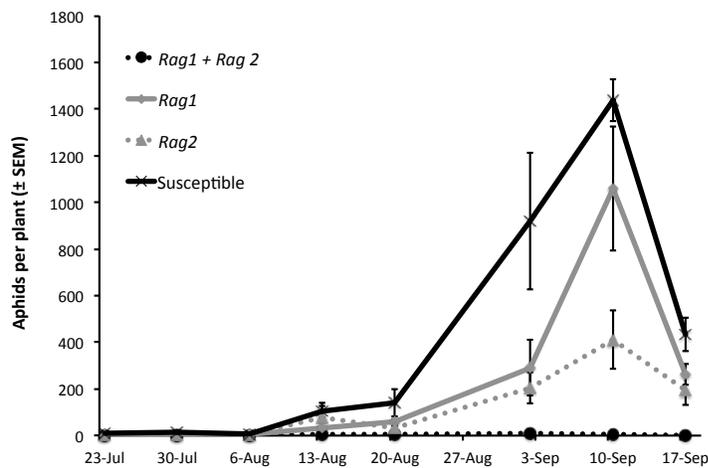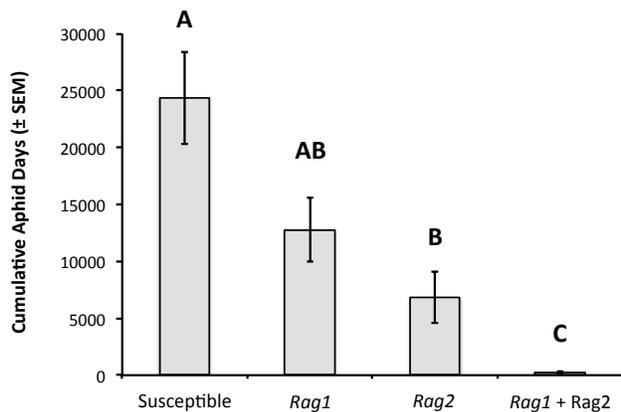
**Figure 1. Soybean aphid populations throughout the 2013 experiment.**

Figure 2. Cumulative aphid days (CAD) are a measure of the plant's seasonal exposure to aphids and have a strong correlation to yield. We expect yield loss to occur around 5,200 CAD. Therefore, soybean lines are desired that maintain aphid populations below this level. Letters above bars represent significant differences among soybean lines at $P<0.05$.
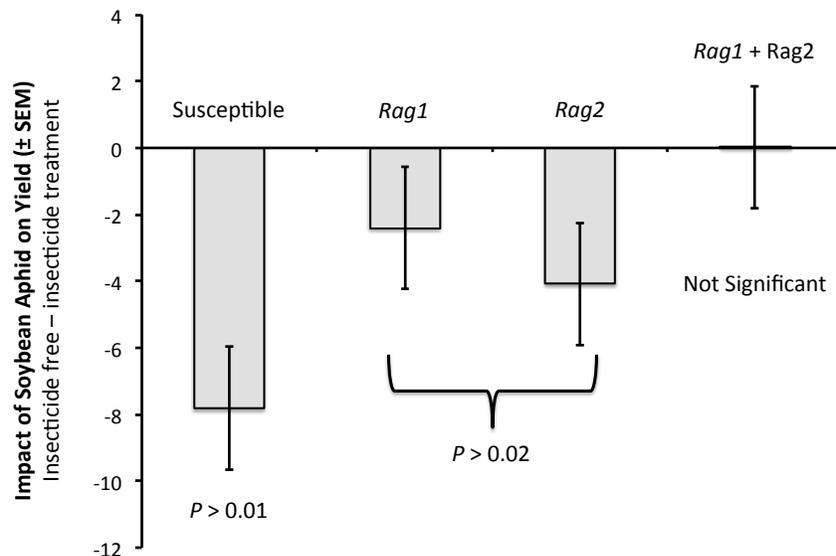
**Figure 2. Cumulative aphid days across the four soybean lines.**

Figure 3. The impact of soybean aphids on yield for each line was measured as the difference in yield between the insecticide-free and insecticide treatments. Yield of the insecticide treatment averaged 47 bu/acre across the four soybean lines. A *t*-test was used to determine differences among the insecticide free and insecticide treatment for each line. Only the *Rag1 + Rag2* line did not lose yield to soybean aphids.

**Figure 3. Impact of soybean aphid on yield of the four soybean lines.**