Role of insecticidal seed treatments and refuge for managing soybean aphid virulence
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ABSTRACT
Aphid-resistant soybean varieties with Rag (Resistance to *Aphis glycines*) genes are promising tools for the management of soybean aphid. Intriguingly, there are soybean aphid populations that can overcome such genetic resistance (i.e. virulent aphids) and cause yield losses. Previous research suggests refuge with aphid-susceptible soybean has the potential to control virulent aphid populations, but it is not clear whether it can reverse the proliferation of virulent aphid populations. Seed treatment has shown improvement of soybean aphid control on Rag soybean. To date, however, it is unknown whether refuge strategy and seed treatment combined could improve soybean aphid virulence management.

Therefore we evaluated aphid virulence management by planting refuge soybean in a 1:3 ratio of aphid-susceptible:Rag-soybean ratio. Seed treatment was applied to either the aphid-susceptible and/or Rag-soybean. All soybean plants were infested with both avirulent (i.e. biotype 1) and virulent (i.e. biotype 4) soybean aphids. Seven days after infestation, we counted the number of aphids of each biotype present. We found that untreated refuge with treated Rag-soybean could provide control over soybean aphid virulence.

INTRODUCTION

- The soybean aphid (*Aphis glycines*) Hemiptera: Aphididae, is one of the most important pests of soybean in North America (Ragsdale et al., 2011).
- Soybean host plant resistance by Rag genes provides control over virulent aphid populations (i.e. biotype 1).
- Virulent soybean aphid populations, such as the biotype 4, can overcome protection by Rag genes, cause declines in yield and threat the durability of Rag soybean (Varenhorst et al., 2015).
- The use of aphid-resistant refuge (Wenger et al., 2014) and seed treatment on Rag soybean (McCarrick and O’Neal, 2013) have shown promising control of virulent aphids.
- Our goal was to evaluate whether refuge strategy in combination with insecticidal seed treatment can manage virulent soybean aphid.
- We hypothesized that treating only the Rag-soybean and not the refuge, biotype 4 population will be lower than biotype 1.

MATERIALS AND METHODS
Treatments evaluated
- The aphid-susceptible soybean refuge (variety Wyandot) and Rag-soybean (variety IA3027RA12) were planted under greenhouse controlled conditions in a 1:3 ratio (Fig 1).
- We evaluated four treatments where the aphid-susceptible and/or the Rag-soybean were seed treated (in pink, Fig 1) or remained untreated (in black, Fig 1).
- We used CruiserMaxx Vibe (Syngenta®) for seed treatment at a rate of 95 mL per 100 pounds of seed.

RESULTS

![Figure 1](image1.png)

**Fig. 1.** Example of a pot planted with an aphid-susceptible soybean (refuge) and three Rag-soybeans. **S** Sagittal view of the four treatments tested where aphid-susceptible (Sus) and Rag-soybean (Rag) in pink represent those plants grown from insecticide-treated seeds, or from untreated seeds, in black.

Aphid infestation
- We infested soybean with aphids at 7, 14, 21, 28, 35, and 42 days after planting (DAP).
- Each plant was infested with 4 biotype 1 and 4 biotype 4 adult soybean aphids.
- At day 7 after infestation, aphids were counted and genotyped with molecular makers.
- For statistical analysis, the aphid count from all 4 plants within the same pot were considered as the experimental unit.

Biotype molecular genotyping
- Extraction of DNA using the Epicenter® QuickExtract kit.
- DNA was amplified via conventional PCR and biotype-specific primers.
- Amplification was digested with Msl enzyme and electrophoresed on a 3% agarose gel for 150 min at 75 mV.
- 83 bp, 57 bp, and 95 bp bands at 78 bp, 95 and 153 bp bands at

![Figure 2](image2.png)

**Fig. 2.** Total number of aphids (SEM) of biotype 1 (black line-circles) and biotype 4 (red line-squares) per experimental unit at 7, 14, 21, 28, 35, and 42 DAP. Asterisks represent significant difference between biotype counts within the same DAP/time point (Tukey’s HSD, α = 0.05).

DISCUSSION

**Treatment 1**
- Biotype 4 population was higher than biotype 1 at all time points, suggesting that refuge strategy without seed treatment might not control soybean aphid virulence (Fig 2A). Similar conclusions were obtained by Wenger et al., 2014.

**Treatment 2**
- As we hypothesized, biotype 1 population was over biotype 4 at almost all time points (Fig 2B). This trend might be related to the insecticidal seed treatment on Rag soybean (where biotype 4 has higher fitness) and the untreated aphid-susceptible soybean (where biotype 1 proliferates) (see Varenhorst et al., 2015 for fitness costs of aphid biotypes).

**Treatment 3**
- The larger population of biotype 4 over biotype 1 at all time points (Fig 2C) was probably due to the suppressing effect of seed treatment effects on the aphid-susceptible soybean (where biotype 1 has higher fitness) (see Varenhorst et al., 2015).

**Treatment 4**
- Aphid population of both biotypes along all time points was notably lower than other treatments (Fig 2D). This suggests that a full treatment of all plants (aphid-susceptible and Rag) could lower total aphid population, but it may not support the control of virulence.

CONCLUSIONS AND IMPACT
- Performing selective seed treatment application to Rag soybean in combination with untreated aphid-susceptible soybean refuge can be a promising tool for the control of soybean aphid virulence.

FUTURE DIRECTIONS
- Perform experiments under field conditions.

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LITERATURE CITED