**Proposal title:** Soybean insect management (2021): Soybean aphid and Japanese beetle

**Final progress report**

Justification: Soybean production in Minnesota is now threatened by multiple invasive insect pests. The soybean aphid (*Aphis glycines*), continues to be the most damaging insect pest of soybean in the Midwest. However, the Japanese beetle (*Popillia japonica*) is spreading and causing increasing injury to soybean. Growers need information about how co-occurring insect pests affect soybean yield to make better informed management decisions. The Koch lab has advanced drone-based scouting for soybean aphid, but we must understand how co-infestation by other insects like Japanese beetle affect spectral reflectance of soybean canopies. This knowledge is essential for fully informed management decisions to avoid unnecessary insecticide inputs or incurring yield losses due to damaging infestations not being treated appropriately. Likewise, it is unclear how Japanese beetle feeding could affect efforts to use drone-based scouting for soybean aphid. The work proposed here continued (third year of a three-year project) our evaluation of the impact of combined infestation by these pests on soybean yield, quality and spectral reflectance of the soybean canopy.

**Proposal Objectives & Goal Statements**

* **Objective 1:** Assessing combined effects of Japanese beetle and soybean aphid on soybean
	+ **Goal 1:** Determine combined effects of Japanese beetle and soybean aphid on soybean yield and quality
	+ **Goal 2:** Determine effects of Japanese beetle feeding alone and in conjunction with soybean aphid on plant spectral reflectance

**Methods**

Experimental plots were set up during 2021 in the field in three locations in southern Minnesota where soybean aphid and Japanese beetle are likely to occur. In St. Paul and Rosemount, cages were used to manipulate pressure from aphids and Japanese beetles (treatments included: control, aphid infestation, Japanese beetle infestation, combined aphid and Japanese beetle infestation, artificial defoliation, and combined artificial defoliation and aphid infestation). In Rochester cages could not be used so we relied on ambient levels of aphids and beetles. However, the drought conditions adversely affected populations of both insects, so the experiment could not be completed at Rochester. Per plant aphid counts, visual defoliation, computer calculated defoliation, and hyperspectral measurements were taken of all plots over multiple weeks at each site. At crop maturity, we harvested the plots from St. Paul and Rosemount for yield comparisons.

**Results**

Defoliation was significantly higher in plants fed on by Japanese beetle (P < 0.05). Defoliation by Japanese beetle was most severe in the upper third canopy of soybean (P < 0.05). On average, upper canopy defoliation as high as 13.5% were observed, but total canopy defoliation of plants fed on by Japanese beetle ranged from 3.8 to 6.8%. Low levels of soybean aphid (~ 100 aphids/plant) did not affect yield or seed quality (P > 0.05). However, Japanese beetle defoliation reduced the weight of seeds (P < 0.05), but not the total yield (P > 0.05) and the number of seeds (P > 0.05). Additionally, intense defoliation (66%) decreased total yield (P < 0.05) and the number of seeds (P < 0.05). Japanese beetle and artificial defoliation were found to decrease near infra-red reflectance of soybean plants (P < 0.05). Near infra-red reflectance was previously identified as promising for the detection of soybean aphids. Thus, Japanese beetle defoliation higher than typical levels in the field and intense defoliation (66%) could affect the detection of soybean aphids with remote sensing. Management recommendations are currently being reviewed and changes will be disseminated through extension channels if needed.

While sampling the plots in St. Paul and Rosemount, we observed injury (leafmines) that we had not previously seen on soybean. We determined these were a new species feeding on soybean and published a paper documenting this and discussing its implications for soybean. The insect causing the leafmines is the caterpillar of a tiny moth called *Macrosaccus morrisella*.

**Challenges encountered**

Ambient levels of soybean aphid and Japanese beetle were extremely low in Rochester, due to the drought conditions. Therefore, we were unable to collect data from this location.

**Dissemination of data/information**

Results of this research and relevant information were presented in the 2021 Prairie Grains Conference and the North Central Branch Meeting. The reports of the new leafmining insect were published in a scientific journal (https://doi.org/10.1093/jipm/pmab038) and in an online entomology newsletter (https://entomologytoday.org/2021/12/15/macrosaccus-morrisella-leaf-mining-moth-new-pest-soybean/).

**Key benefits**

The findings resulted from this project helped advance the scientific knowledge on the combined effects of soybean aphid and Japanese beetle feeding on soybean. Additionally, the results will benefit growers by refining management recommendations for these two pests.