Seed coat impacts on soybean plant trait expression and fitness

DEPARTMENT OF ENTOMOLOGY

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INTRODUCTION

Seed coats are combinations of chemicals commonly applied to crop seed before planting. Coat contents may alter the biotic and abiotic conditions around a seedling, with goal to increase plant fitness by preventing potential early season damage[1]. However, many ecological interactions are altered simultaneously through seed coat use and their overall link to plant fitness outcomes may be context-dependent. Here, we examine whether the ecological conditions created by seed coats:

1) Alter early season insect damage
2) Change soybean trait expression and plant fitness
3) Vary in impact across a gradient of environmental conditions

METHODS

We tracked plants grown from both treated and untreated seeds to measure the impacts of seed coats on plant development and fitness. While coat formulas vary, ours contained:

- Metalaxyl, fluxapyroxad, pyraclostrobin (fungicides)
- Imidacloprid (insecticide)
- Tioxazafen (nematicide)
- Flavonoids (to encourage rhizobial growth)

We tested soybeans over a gradient of environmental conditions (Figure 1). Data were analyzed using a linear mixed model (LMM) in R with a random effect structure including plot intercept[2]. Data were log-transformed to meet model assumptions (stippling, seed biomass).

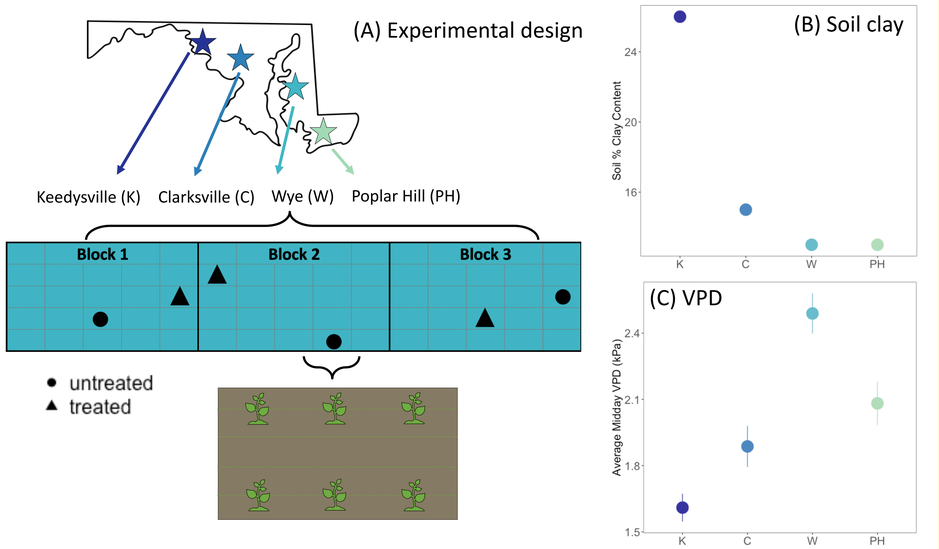

Figure 1. Soybeans were planted in a randomized block design at 4 farms across Maryland (A). Western sites had higher soil clay content (B) and lower vapor pressure deficit (VPD) (Site, $F_{3,14}$ =12.7, ***p*<0.001**) (C).

Seed coat treatment reduced early insect stippling damage

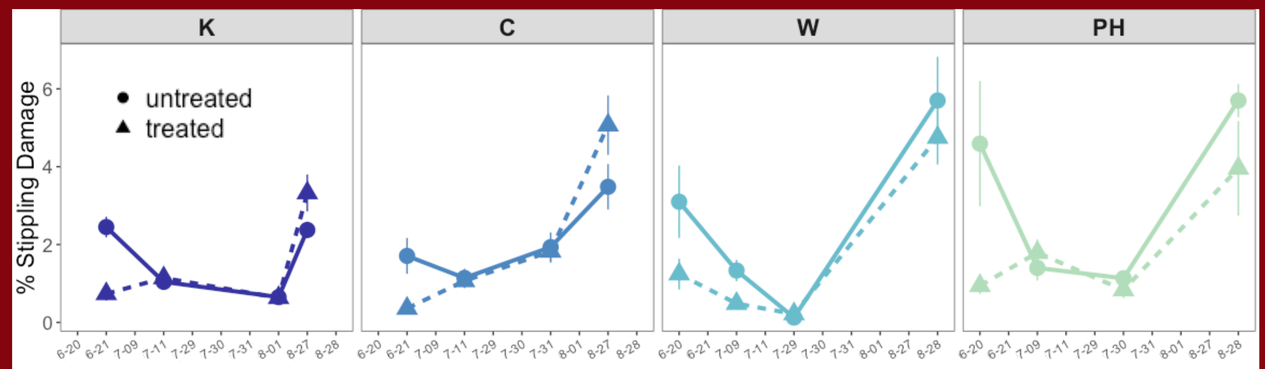

Figure 2. Stippling damage observed across farms and sampling dates. Sampling was repeated on the same plants roughly every 3 weeks, with sampling #1: June 20-21, #2: July 9-11, #3: July 29-Aug 1, and #4: Aug 27-28

The effect of seed coat on stippling damage changed over the season (Date:seed coat interaction, $F_{9,133}$=5.5, ***p*<0.001**), so we ran a separate model for each date. Coated seeds had significantly lower stippling damage on only the first sampling date (Seed coat, $F_{1,22}$=17.4, ***p*<0.001**)

But did not change late season trait expression or fitness

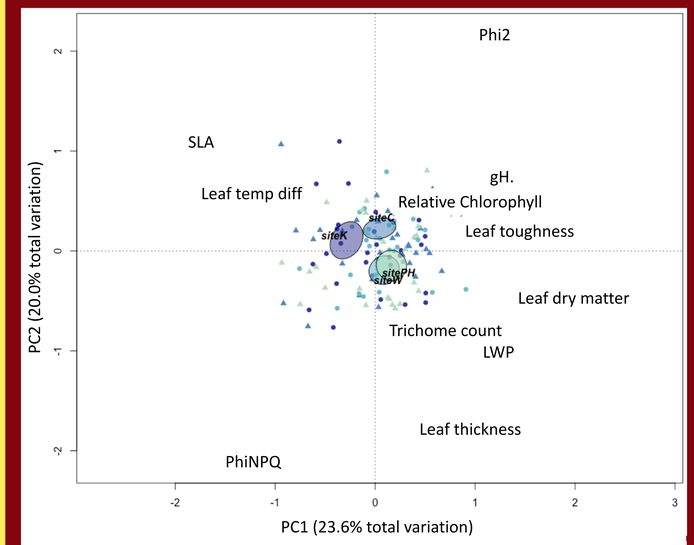

Figure 3. Principal components analysis of plant traits (black text) collected from individual soybean plants (points) in July, with different colors specifying different farms and shapes denoting seed coat treatment (legend with Figure 1) .

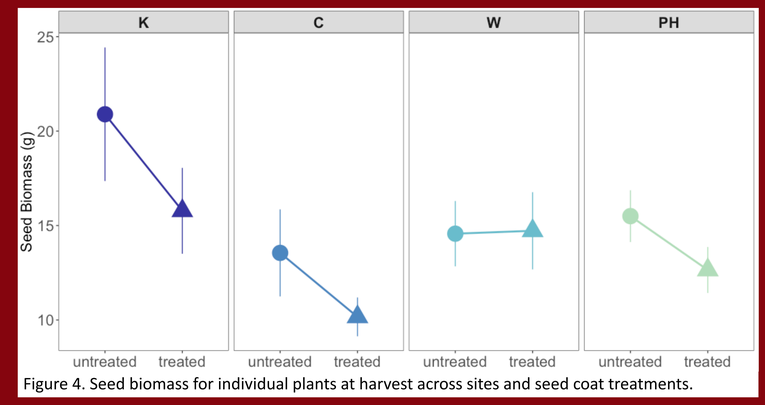

Figure 4. Seed biomass for individual plants at harvest across sites and seed coat treatments.

Mid-summer plant traits were used to construct a multivariate space (Figure 3). Principal components analysis (PCA) created two axes which represented about 44% of plant trait variation. A post-hoc *envfit()* test[3] showed significant differences in plant traits among sites (r^2=0.21, ***p*=0.001**) but not between seed coat treatments (r^2=0.006, *p*=0.5).

Seed biomass at harvest (Figure 4) was not significantly different across sites ($F_{3,19}$=2.5, *p*=0.09) or due to seed coat treatment ($F_{1,20}$=1.9, *p*=0.19).

TIMELINE

June
Planting
Damage:
-% leaf area impacted by sap sucking insects (stippling)

July
Damage
Traits:
-Photosynq MultispeQ v2.0
-Destructive sampling on subset of leaves

August
Damage

September
Damage
Harvest:
-Seed biomass

DISCUSSION

We observed early season decreases in insect damage on plants treated with seed coats, but this decrease had no late season effect on fitness. There are several potential explanations for this:

1) Soybean plants may be generally tolerant of early season damage
2) Seed coats could be influencing rhizobial communities in the soil, which could be negating their positive early season impacts
3) The effectiveness of seed coats could vary inter-annually with weather patterns and pathogen/pest pressure in a location[2]

Next steps include another year of field observations at each site and experimentally manipulating rhizobial community and drought.

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