Final Report for Maryland Soybean Board 2021 Grant

Evaluating Soybean Variety Performance and Response to Deer Grazing

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Summary: Our study sought to better understand deer herbivory of forage soybeans. Our original proposal sought to understand 1) what varieties of soybeans can produce the best yields under heavy herbivory, 2) what varieties can best withstand deer grazing, 3) what varieties can attract deer away from conventional crops, and 4) estimate the costs and potential benefits of using particular varieties to attract deer away from conventional crops. Our research yielded important information on how to better design our studies in the future and uncovered insights that advance our knowledge of the timing and pattern deer damage on soybean crops that, if replicated in a second year, provide promising opportunities to develop strategies to reduce deer damage on soybean crops.

We developed a more detailed understanding of the patterns of deer grazing on soybeans and how these patterns are influenced by precipitation, and gained better insights into yields that can be expected from 3 different forage soybean varieties and how they compared to two conventional soybean varieties. In terms of deer grazing patterns, we documented that 74% of grazing activity occurred at night, with 44% of all grazing activity occurring in just five days of June and July (fig. 2). Statistical analysis of precipitation patterns found that grazing was significantly affected by rainfall events, with decreased grazing activity during rainfall events, increasing grazing activity one day following rainfall, and even greater grazing activity the second day after rain (see table 2 and fig. 3).

Anecdotally, we saw some evidence of deer preferring later maturing forage soybeans later in the season, which may provide relief to conventional soybeans during the full pod, beginning seed, and full seed stages (R4, R5, and R6) of development.[1,2] Co-PI James Lewis planted a buffer of forage soybeans around an irrigated cornfield, and anecdotally felt that the reduction in damage was well worth the investment and losses of yield from the buffer strip itself.

We have learned much in our first year studying this topic and made progress towards understanding what varieties produce the best yields under a moderate deer grazing situation, however, the highly variable nature of both deer grazing and deer populations limited our ability to answer the objectives as they were originally designed. Deer grazing intensity at the Wye Research & Education Center (Wye REC) was not as high as expected in 2021, possibly due to a die-off of deer from Epizootic Hemorrhagic Disease (EHD) in the fall of 2020 (field personnel found at least 5 deer carcasses on the center that fall). This led to only moderate levels of deer

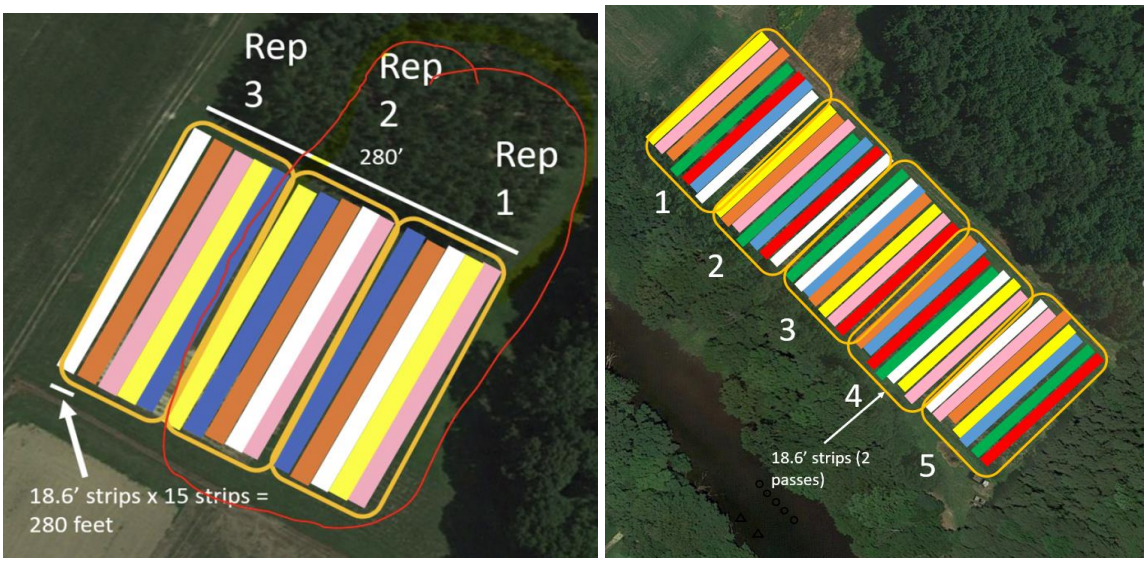
[1] Board, J.E., Wier, A.T. and Boethel, D.J. (1994), Soybean Yield Reductions Caused by Defoliation during Mid to Late Seed Filling. Agron. J., 86: 1074-1079. https://doi.org/10.2134/agronj1994.00021962008600060027x
[2] Fehr, W. R., B. K. Lawrence, and T. A. Thompson. "Critical stages of development for defoliation of soybean 1." Crop Science 21.2 (1981): 259-262.

damage, which produced counterintuitive results, such as decreased plant biomass in plots protected from grazing, and non-significant effects of deer grazing on soybean yields.

Research Methods:

We used a randomized complete block design to test three glyphosate-tolerant soybean varieties and two conventional varieties in two separate fields (we planted additional varieties in the second field as space allowed) (Fig. 1). Each of these fields border forested areas and have historically experienced problems with deer damage on crops. We placed 5-10' diameter hog-wire deer exclosures on each plot and use trail cameras on ten strip plots (replicate 1 and 2) to quantify deer grazing activity by varieties. We clipped 2-3 plants from both inside and outside each exclosure to better understand how biomass of plants varied based on deer herbivory.

Fig.1: Randomized complete block design of forage and conventional soybean varieties planted in field C8/C9 (left) and field E5 (right) at the Wye Research & Education Center. Red circle on field C8/C9 denotes the plots monitored with 10 motion activated trail cameras.



Our study tested the following five soybean varieties:

Forage soybeans:

- La Crosse Seed, var. GT1 Brier Ridge; Group 4.7
- Biologic, var. R13-2423RR, Group 6
- Eagle Seed, var. Big Fellow, Group 7

Conventional soybeans:

- Pioneer Group 3.1, var. 86160724
- Pioneer Group 5.3, var. 5PQYD12

Each trail camera was set to take a single photo when motion was detected, and would continue to take a photo every 5 seconds that motion was detected. Undergraduate student employees from the University of Maryland used automated computer vision tools to classify photos

(Wildlife Insights) and manually reviewed photos of deer and classified them by whether they were grazing or passing through the field. We used the number of photos of deer grazing as an indicator of level of grazing activity.

We used a generalized linear model coupled with a time lag variable to assess correlations between deer grazing activity and rainfall events.

We provided demonstration seeds of forage varieties at a collaborating farmer's fields in Caroline County, MD, and near Harrington, DE, to evaluate performance of these varieties in different soil types and with different deer populations.

Results and Discussion:

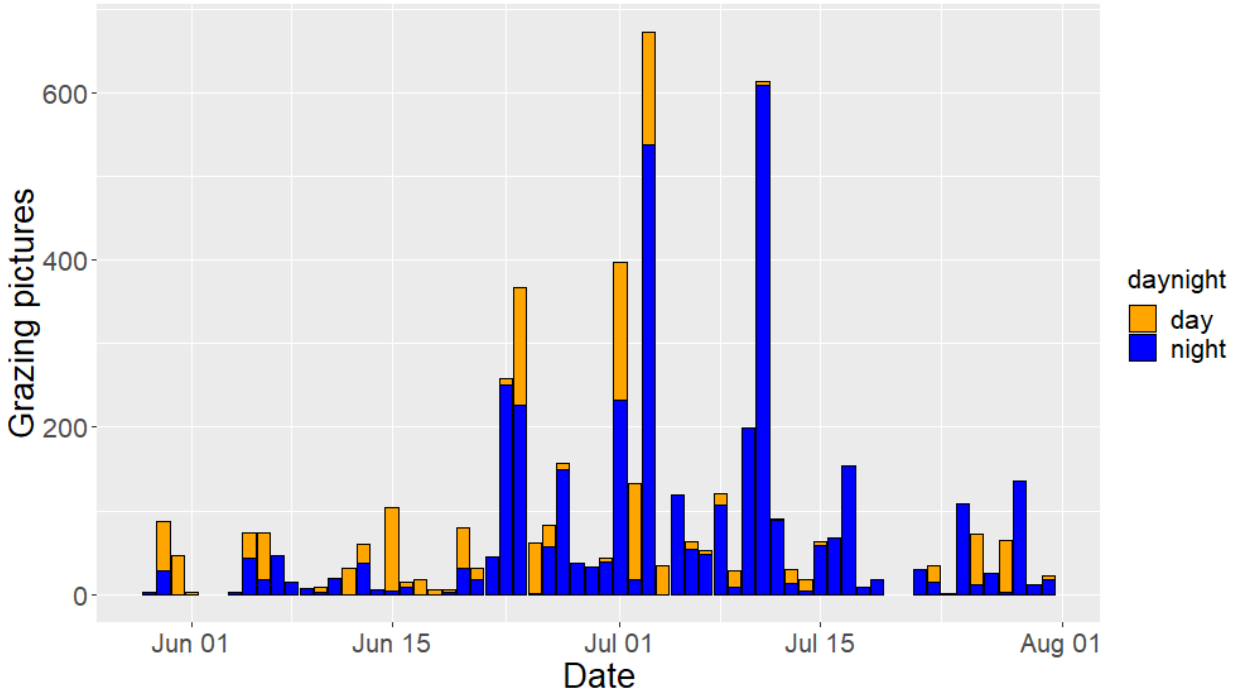
Yield Results: Yield results found that the group 4.7 forage soybeans (GT1 Brier Ridge) and the conventional group 5.3 soybeans (Pioneer), provided the highest yields (see table below), with the lowest yield from the group 7 forage soybeans by Eagle Seed. Although the Big Fellow forage soybeans yielded the lowest amounts, they did appear to attract deer most in August, which may have helped alleviate deer grazing pressure during the R4-6 stages of development on conventional soybeans. We plan to more closely monitor this dynamic in the coming year.

Table 1: Average yields for different varieties of forage and conventional soybeans in 2021 at Wye Research & Education Center.

Variety	Yield (bu/acre)
Pioneer, Group 5.3, Conventional	54.1
GT1 Brier Ridge, Group 4.7, Forage	53.5
Pioneer Group 3.1, Conventional	52.2
Biologic, Group 6, Forage	49.0
Big Fellow, Group 7, Forage	36.4

Camera Trap Results: We found that during the 60-day growing period approximately 45% of deer grazing activity in the field across all soybean varieties occurred in just 5 days: June 23 and 23, July 1 and 3, and 11. We also found that 74% of all deer grazing activity occurred at between sunset and sunrise (fig. 2).

Fig. 2: Number of pictures of deer grazing by day or night across all soybean varieties in summer 2021.

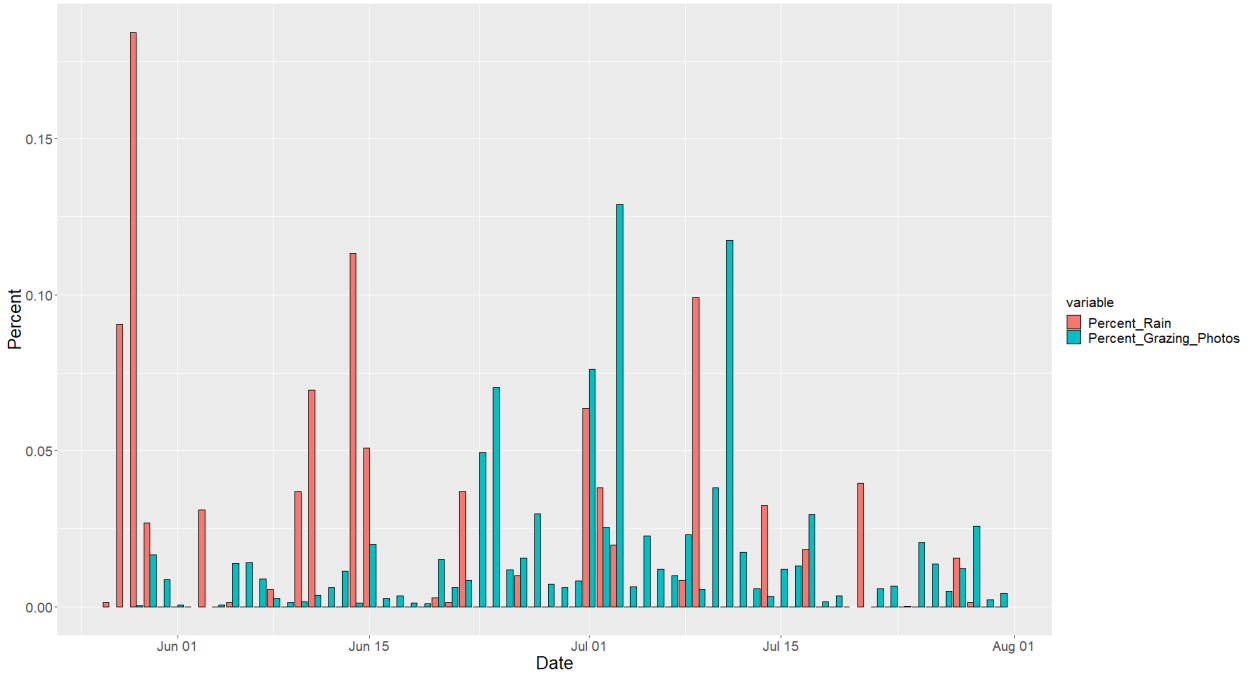


Initial review of precipitation data suggested that these spikes in deer grazing were associated with a 1-2 day time delays after rainfall events. A generalized linear model showed a statistically significant increase of deer grazing on soybeans one day after rain, and an even stronger effect two days after rainfall events (Table 2 and Fig. 3). The model also showed a statistically significant decreased in deer grazing activity during rainfall events. We are continuing to analyze this data for other weather-related predictors for deer activity such as wind and barometric pressure to better plan timing for deer deterrent activities.

Table 2: Results from generalized linear model assessing significance of deer grazing activity following precipitation. Lag0 is during the same day as rainfall, Lag 1 is one day following rain, etc. A negative estimate (red) shows decreased deer grazing activity while positive esitimates show statistically positive grazing activity following rainfall events.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	2.75591	0.03014	91.425	< 2e-16	***
Lag0	-2.56833	0.39784	-6.456	1.08E-10	***
Lag1	2.90027	0.09054	32.033	< 2e-16	***
Lag2	3.20245	0.07978	40.139	< 2e-16	***
Lag3	-0.21909	0.1876	-1.168	0.243	

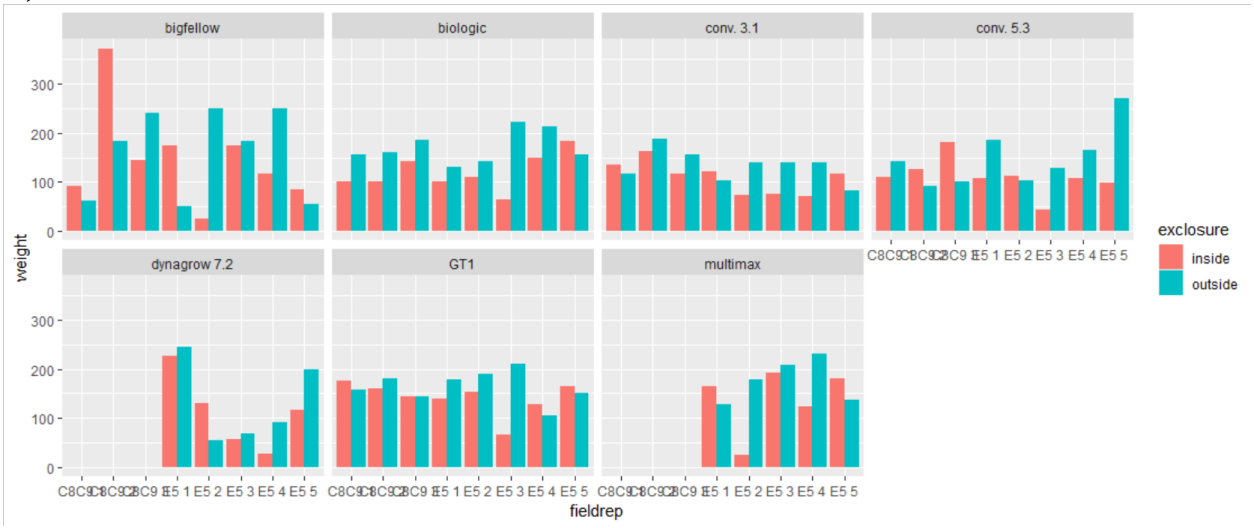
Fig. 3: Percent of deer grazing photos (blue) and percent of rainfall (red) in June and July 2021 at Wye Research & Education Center.



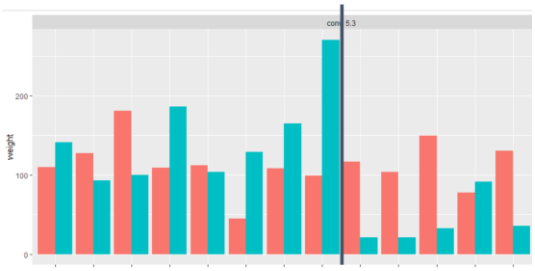
We collected biomass data and found that moderate grazing that occurred at the Wye Research & Education center oftentimes served to increase the biomass of soybean plants (fig. 4a). However, very high densities of deer severely reduced biomass of soybean plantings at a cooperating farmers' property near Harrington, DE (fig. 4b). Yield estimates from within and outside exclosures were highly variable, but and confounded by rabbit grazing and limited size of exclosures that we do not feel confident in making assessments about yield effects by moderate deer grazing experienced at the Wye in the summer of 2021.

Fig. 3: Biomass measurements from inside (blue) and outside (red) deer grazing exclosures. Table 3a) denotes biomass of different varieties at the Wye Research & Educaiton center, which experienced only moderate deer grazing pressure in 2021, while 3b) compares biomass of the Pioneer group 5.7 variety between the Wye REC (left of black line) and a cooperating farmer's field near Harrington, DE (right of black line), which had notably greater deer grazing pressure.

A)



B)



<u>Improvements for future work:</u> Our experience over the year yielded important insights to guide future research, in particular, widening our treatments to reduce error associated with classification of images of deer grazing, placing deer exclosures a greater distance from cameras, widening exclosures to a full 10' diameter, using chicken-wire exclosures instead of hog-wire to keep rabbits from grazing in exclosures, conducting monthly forage analysis of soybean leaves, and developing a clipping experiment to artificially reproduce herbivory in a controlled manner designed to mimic deer grazing. Grazing activity between soybean varieties varied considerably and may have been confounded by the placement of deer grazing exclosures, so we will remedy this problem in the coming year. Yield measurements from exclosures to full 10' diameter exclosures will also provide more confidence in the difference in yields under grazing and non-grazing situations. We believe a second year of data needs to be gathered to assess deer preferences with greater confidence. In 2022 we are also testing the effectiveness of planting into green cover crops as a way to reduce early seeding mortality from deer grazing.

Outreach and Education: We participated in a field day for the Wildlife Subcommittee of the Maryland Farm Bureau on 7/20/21 and presented a poster at the Maryland Commodity Classic on 7/22/21. We also participated in the Maryland Soybean Board Field Day on August 11, 2021. We have given presentations to the Maryland Farm Bureau annual convention (~50 attendees), a webinar for Lower Shore farmers (~20 attendees, hosted by Meaghan Perdue), at the Talbott County Corn Club (~50 attendees), to the Caroline County Winter Agronomy meeting (to 110 attendees via recording), and to the University of Maryland Extension monthly administrative meeting (~200 attendees). We have written articles for the Maryland Farm Bureau magazine (coming out in summer 2022), and for the Crop Damage Quarterly newsletter mailed out by Delaware Department of Natural Resources. We have engaged with undergraduate research assistants to help with the research, who have learned about the issue of wildlife damage on crops and one of them presented her research findings in the classroom setting at the University of Maryland as part of a class research project.