MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT 48-2014 (YEAR 3)
2014 FINAL REPORT

Title: Estimation of deer damage to soybean production in Mississippi: a spatial and temporal context

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EXECUTIVE SUMMARY

Background and Objectives

Soybean is Mississippi's most important agricultural crop in terms of both land area planted and income. Damage to a soybean crop from wildlife, especially white-tailed deer, can be inevitable. However, white-tailed deer provide an economic impact of $1 billion to Mississippi alone; thus, localized eradication of white-tailed deer is not an ecologically or economically viable or responsible option. Alternative methods must be employed to reduce depredation to crops and to allow both of these critical resources to continue to thrive and coexist.

White-tailed deer damage soybeans every year due to the plant's high palatability, digestibility, and nutritional content. T he amount of damage (browsing and loss of yield) caused by deer within 5 soybean fields in eastern Mississippi was estimated and compared to the number of deer using each field during the 2012 and 2013 field seasons. The effectiveness of a chemical repellent was also evaluated.

Objectives were to 1) quantify variation in soybean height, plant count, and yield spatially within fields and temporally throughout the growing season, 2) relate white-tailed deer abundance to soybean damage and yield, 3) relate landscape characteristics surrounding soybean fields to spatial patterns of deer utilization of soybean plants, and 4) determine effectiveness of the chemical deer repellent Hinder® on soybean height, growth stage, and yield.

Three fields were selected to test the effectiveness of Hinder® during the 2013 season. Hinder® recommends the repellent should be applied every two weeks and additionally after precipitation events. Hinder® was applied manually to soybean using a carbon dioxide-pressurized, back-pack chemical sprayer with a fan nozzle. Hinder® was mixed with water before application and the recommended concentration rate of 6.4 ounces of Hinder® per 1 gallon of water was applied at the recommended rate of 10-20 gallons of solution per acre.

Four plots approximately 15m x 45m in size were established in each field along the field borders. Each plot was divided into three equal 15m x 15m sections and repellent was applied to each section at different intervals of time. The entire plot was sprayed with repellent immediately after soybean emergence. The second and third sections were then sprayed two weeks later and the third section was sprayed after an additional two weeks. Hinder® was re-applied after each rain event.

Report of Progress/Activity

Deer damage was heterogeneous in soybean fields but followed similar trends reported in previous research. In the study areas used in this test, deer reduced soybean height but not yield. The results from this study indicate that perception of deer damage exceeds actual damage, and other environmental conditions such as border type and field margins are responsible for much of the spatial variation in yield throughout fields.

Hinder® treatment resulted in taller plants with decreased deer damage. Multiple applications were required to achieve the most protection. However, soybean yield remained the same between Hinder® plots and unprotected areas of the field. Under normal conditions and deer populations, the cost of Hinder® application may exceed losses due to deer damage. However, in areas with extremely high deer populations, Hinder® applied during the first few weeks of soybean growth and particularly along field edges and forested borders could prevent excessive deer damage, particularly along areas of fields with forested borders.

Under normal conditions with typical deer populations, fields with one or more forested borders will receive more damage than fields with open border types. The majority of deer damage will also remain on the perimeter of each field. If a producer believes his losses to deer damage each year are intolerable, planting soybean in areas without adjacent deer habitat is advisable. Also, applying a repellant or temporary fence to protect soybean during the first few weeks of growth could prove beneficial in high deer density areas.

These results suggest that producers should reduce funds spent on repelling deer throughout the entire growing season and only protect plants during the early growth stages if protection is absolutely necessary.

The details of this study and its results are presented in a Master of Science thesis entitled "Estimation of deer damage to soybean production in Mississippi: a spatial and temporal context" by Gathel Caleb Hinton.

Table 1. County, size, border type, and deer counts from fields sampled to determine the impact of deer browsing on soybean height and yield during 2012 and 2013 in eastern Mississippi

Year	Field	County	Size (ha)	Border types[a]	Deer count (ha/deer)[b]
2012	Taylor 1	Noxubee	25.7	AF, MPH, PF	4.28
	Taylor 2	Noxubee	9.0	AF, ESP, MPH	1.02
	Taylor 3	Noxubee	8.7	MPH, PF	1.02
	Bigbee	Noxubee	13.4	AF, HF	2.68
	Hamilton	Monroe	7.3	AF, MPH	1.49
2013	Taylor 1	Noxubee	25.7	AF, MPH, PF	1.14
	Taylor 2	Noxubee	9.0	AF, ESP, MPH	0.59
	Taylor 3	Noxubee	8.7	MPH, PF	0.86
	Bigbee	Noxubee	13.4	AF, HF	3.83
	West Point	Clay	10.3	AF	10.3

a = Description of field border types followed by the classification used for statistical models (i.e., open or cover): AF = Agricultural field (open), PF = Pine forest (cover), MPH = Mixed pine-hardwood forest (cover), ESP = Early successional plants (open), HF = Hardwood forest (cover).

b = Mean of weekly counts of maximum number of deer observed in each field.

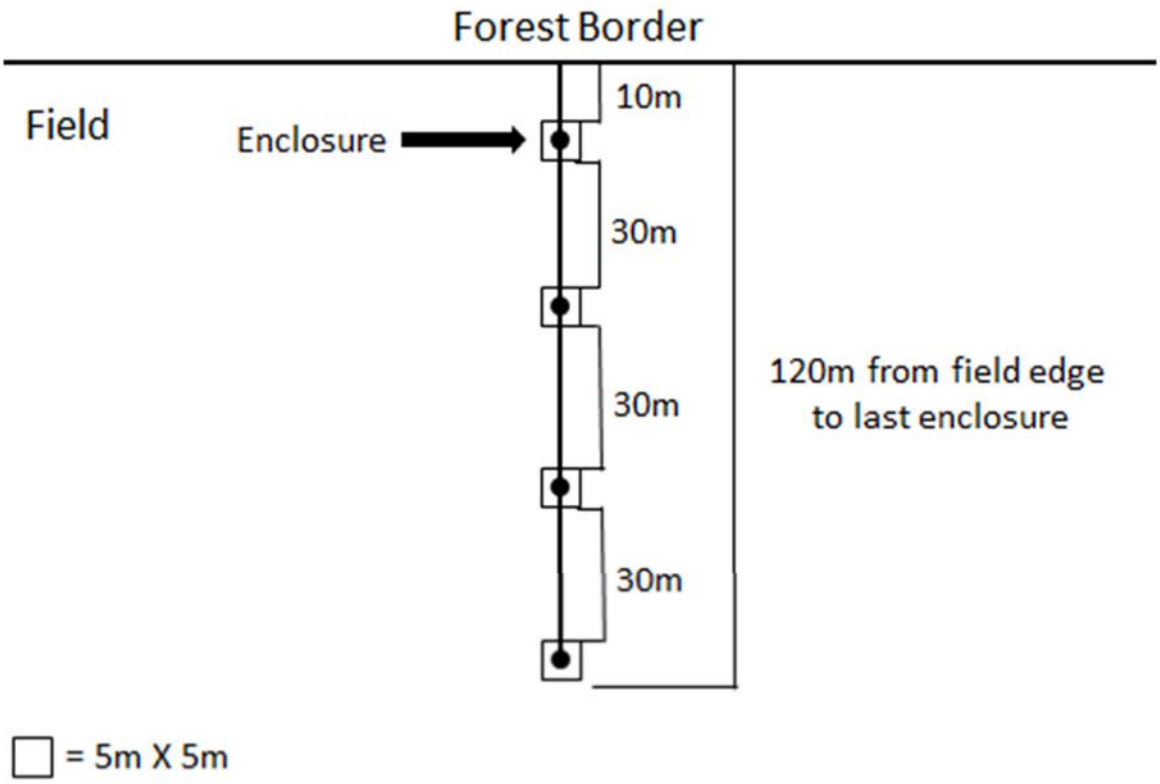


Figure 1 Diagram showing how each row of enclosures was placed entering the field from the border.

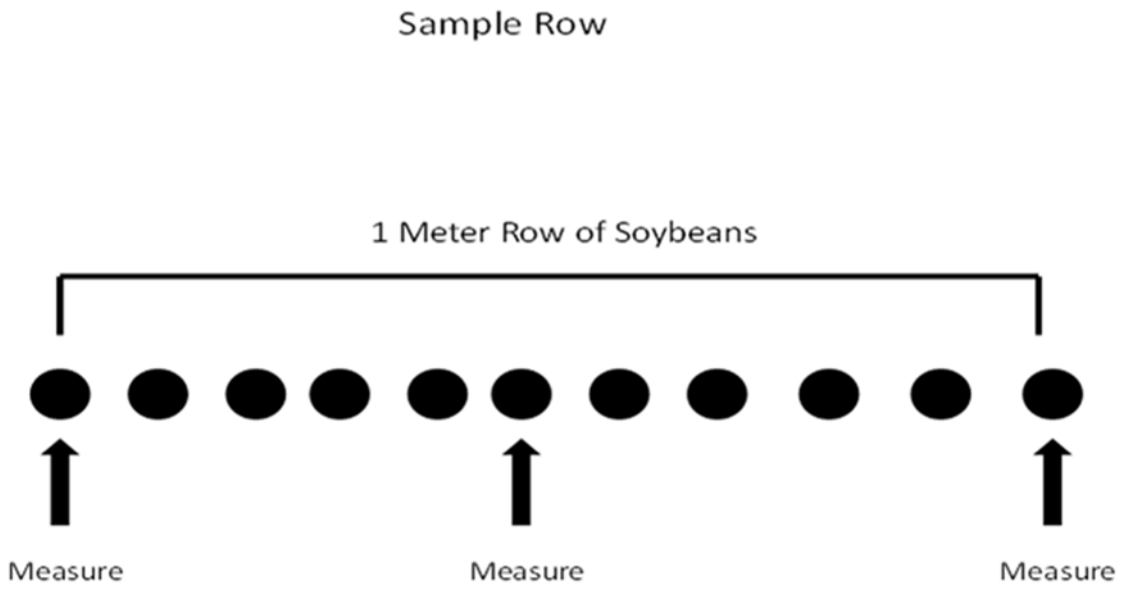


Figure 2. Diagram depicting process used to select soybean plants for sampling. Endpoint and midpoint plants were measured along a 1-meter sample plot.

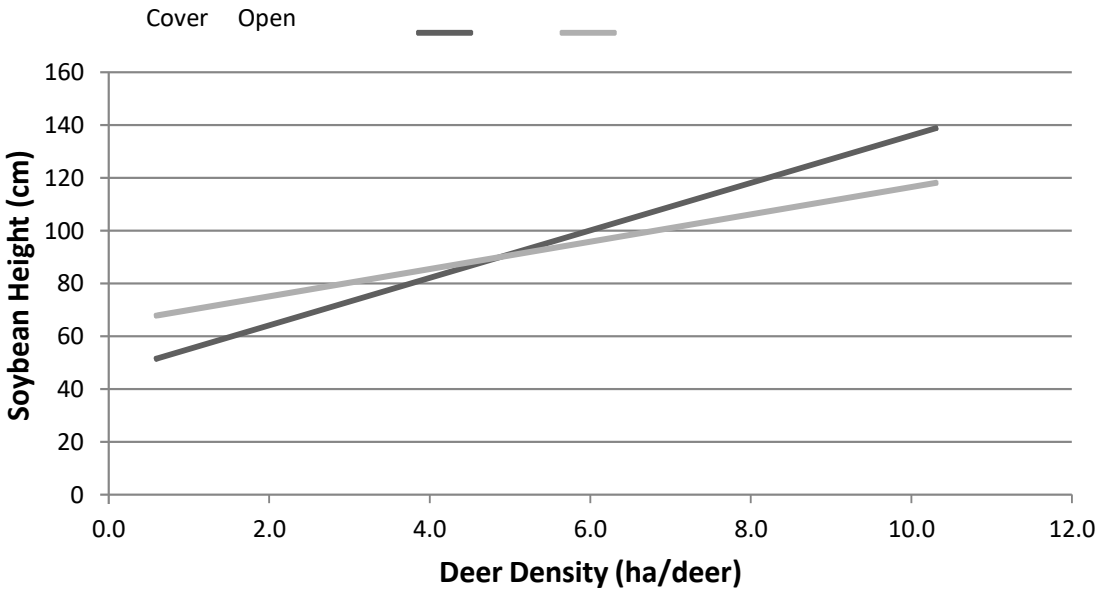


Figure 3. Interaction of border type and deer density on soybean height for 6 fields in eastern Mississippi during 2012 and 2013 using a mixed-model analysis of covariance with year and field ID as random effects and deer count as a covariate.

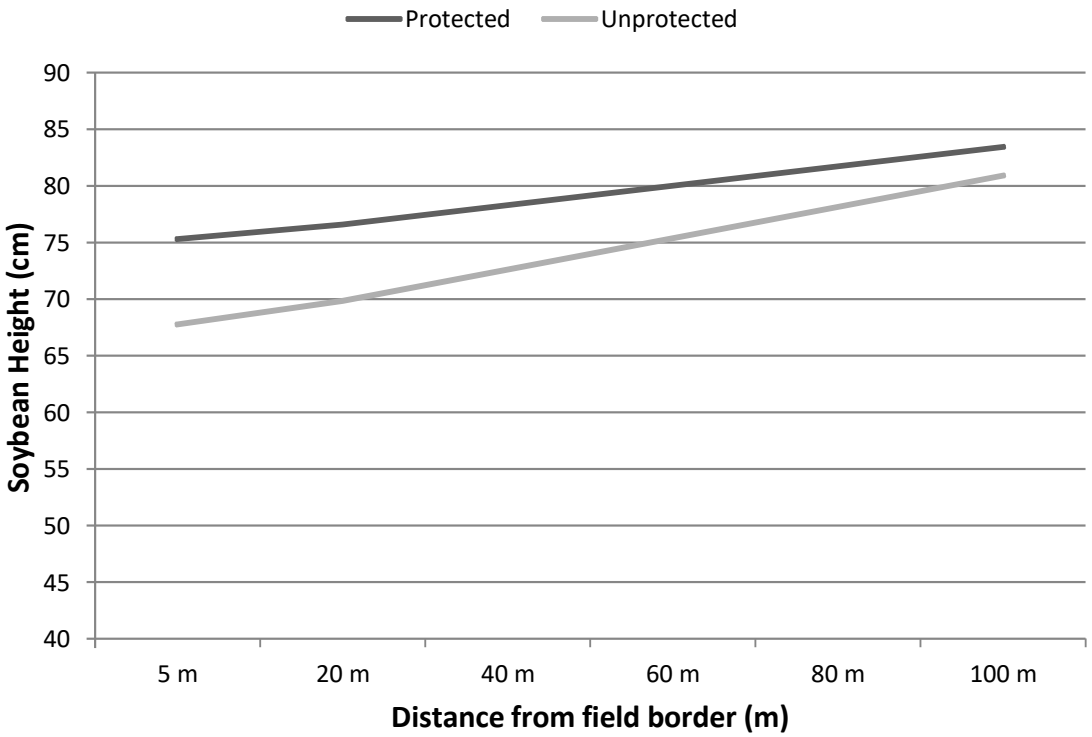


Figure 4. Interaction of deer protection and distance from field border on soybean height for 6 fields in eastern Mississippi during 2012 and 2013 using a mixed-model analysis of covariance with year and field ID as random effects and deer count as a covariate.

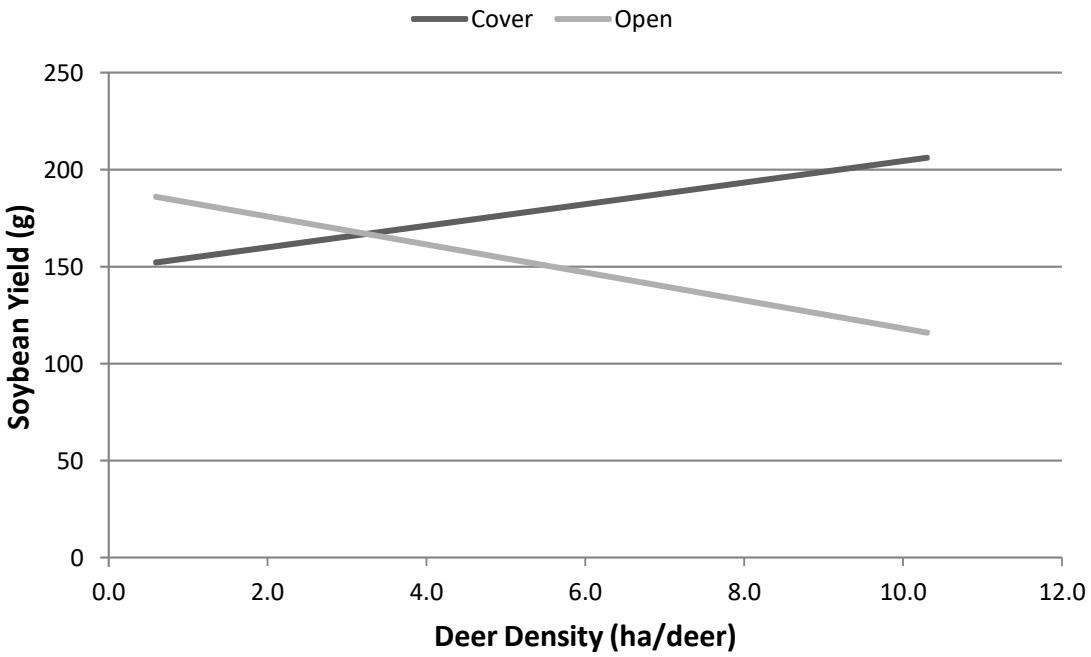


Figure 5. Interaction of border type and deer density on soybean yield for 6 fields in eastern Mississippi during 2012 and 2013 using a mixed-model analysis of covariance with year and field ID as random effects and deer count as a covariate.

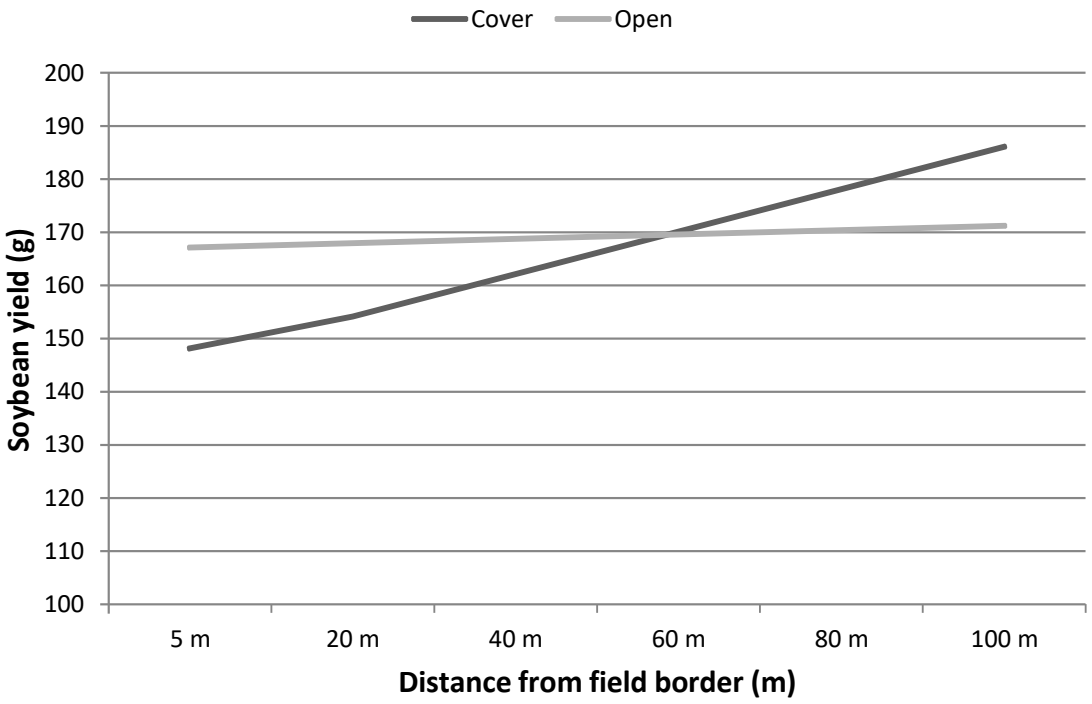


Figure 6. Interaction of border type and distance from field border on soybean yield for 6 fields in eastern Mississippi during 2012 and 2013 using a mixed-model analysis of covariance with border type and deer protection as fixed effects, year and field ID as random effects, and deer count and distance from field border as covariates.

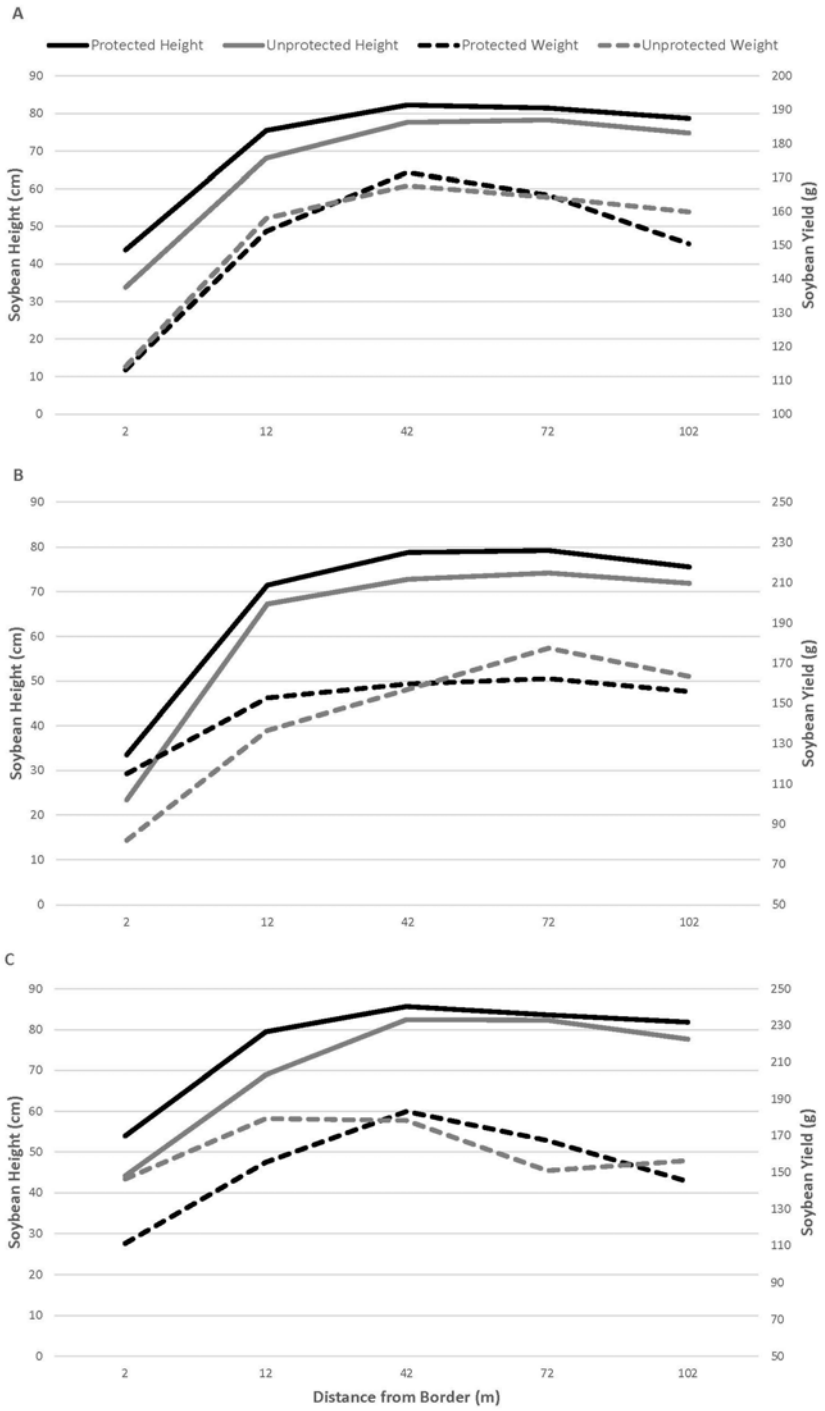


Figure 7. Variation in soybean height and yield related to deer protection and distance from field border (A), the cover border type (B), and the open border type (C) in eastern Mississippi in 2012 and 2013. Soybean height and yield estimates were derived from a mixed ANCOVA model using deer protection and border type as fixed effects, field and year as random effects, and deer density and distance from border as covariates.

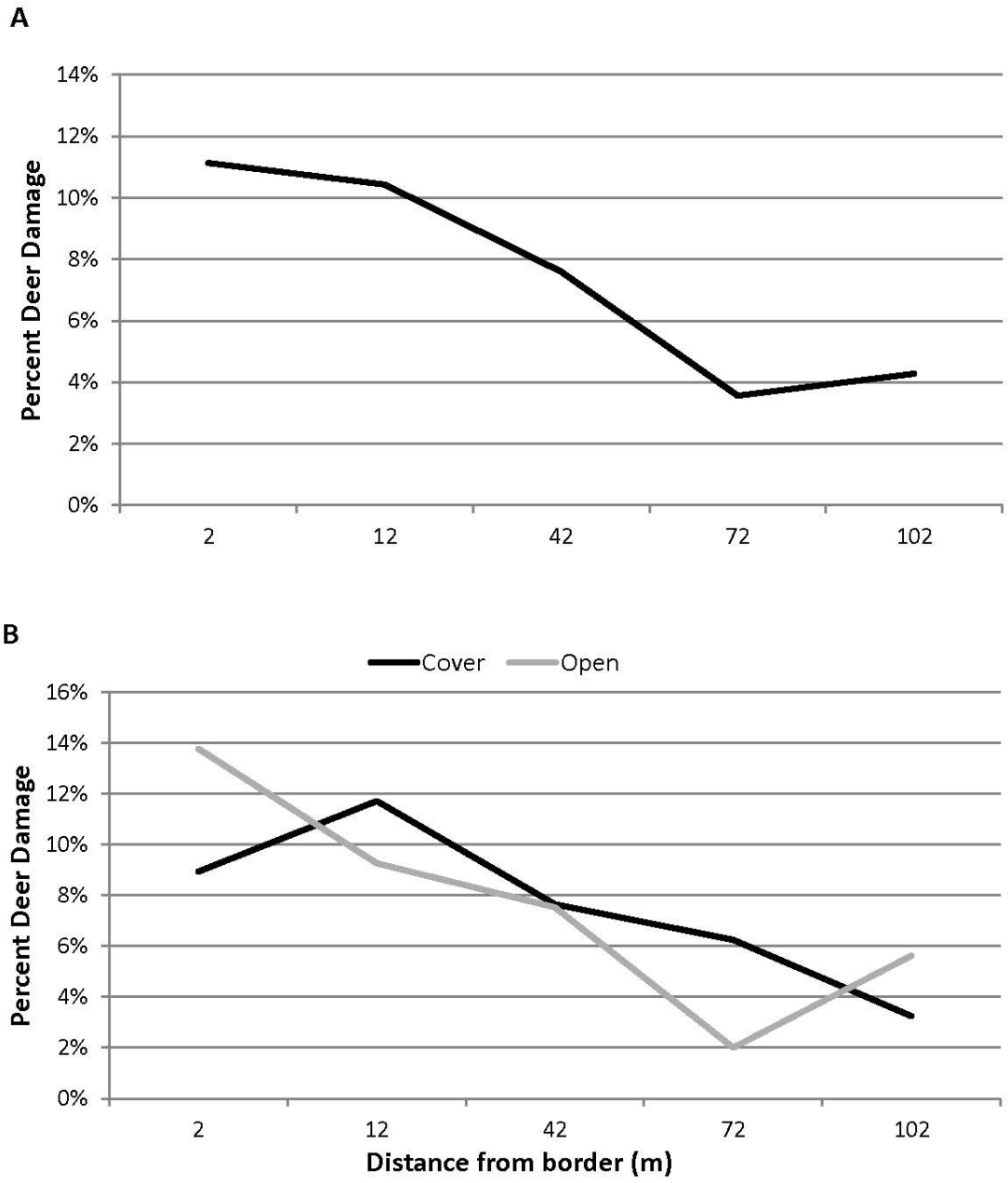
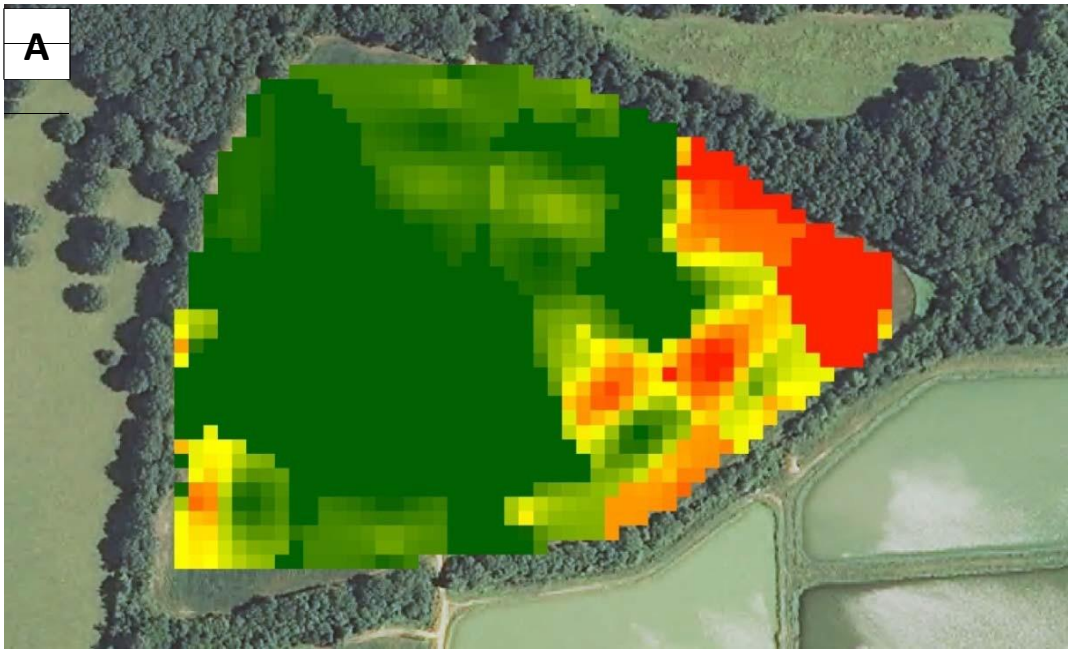
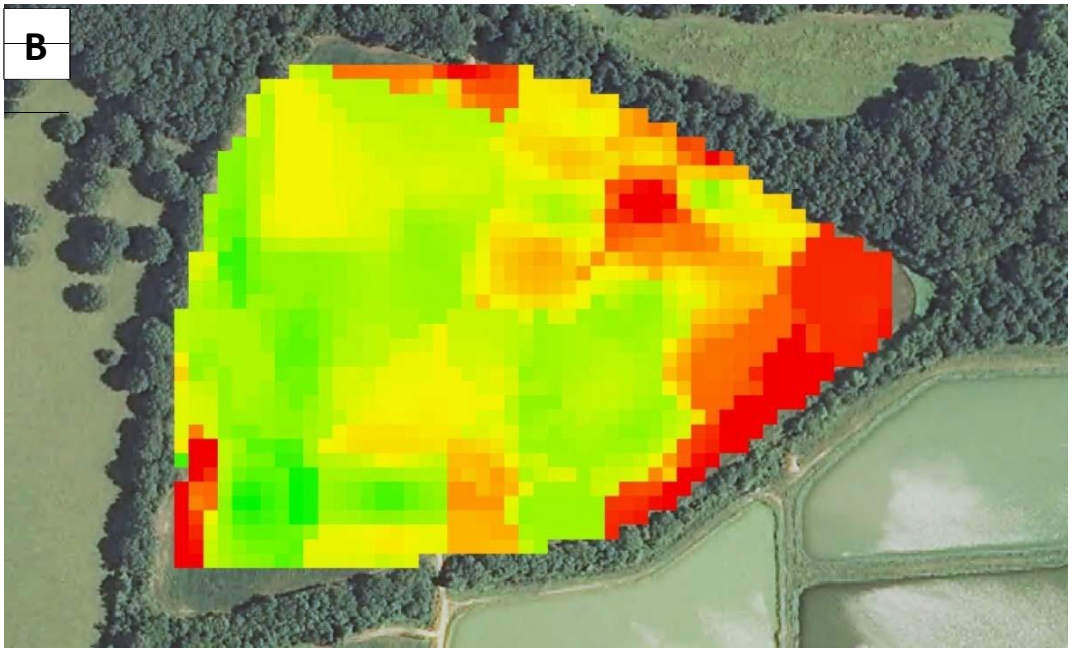


Figure 8. Variation in deer damage related to distance from field border (A) and the cover and open border types (B) in eastern Mississippi in 2012 and 2013. Deer damage estimates were derived from a GLIMMIX model using border type as a fixed effect, year and field ID as random effects, and distance from border and deer count as covariates.


A


B

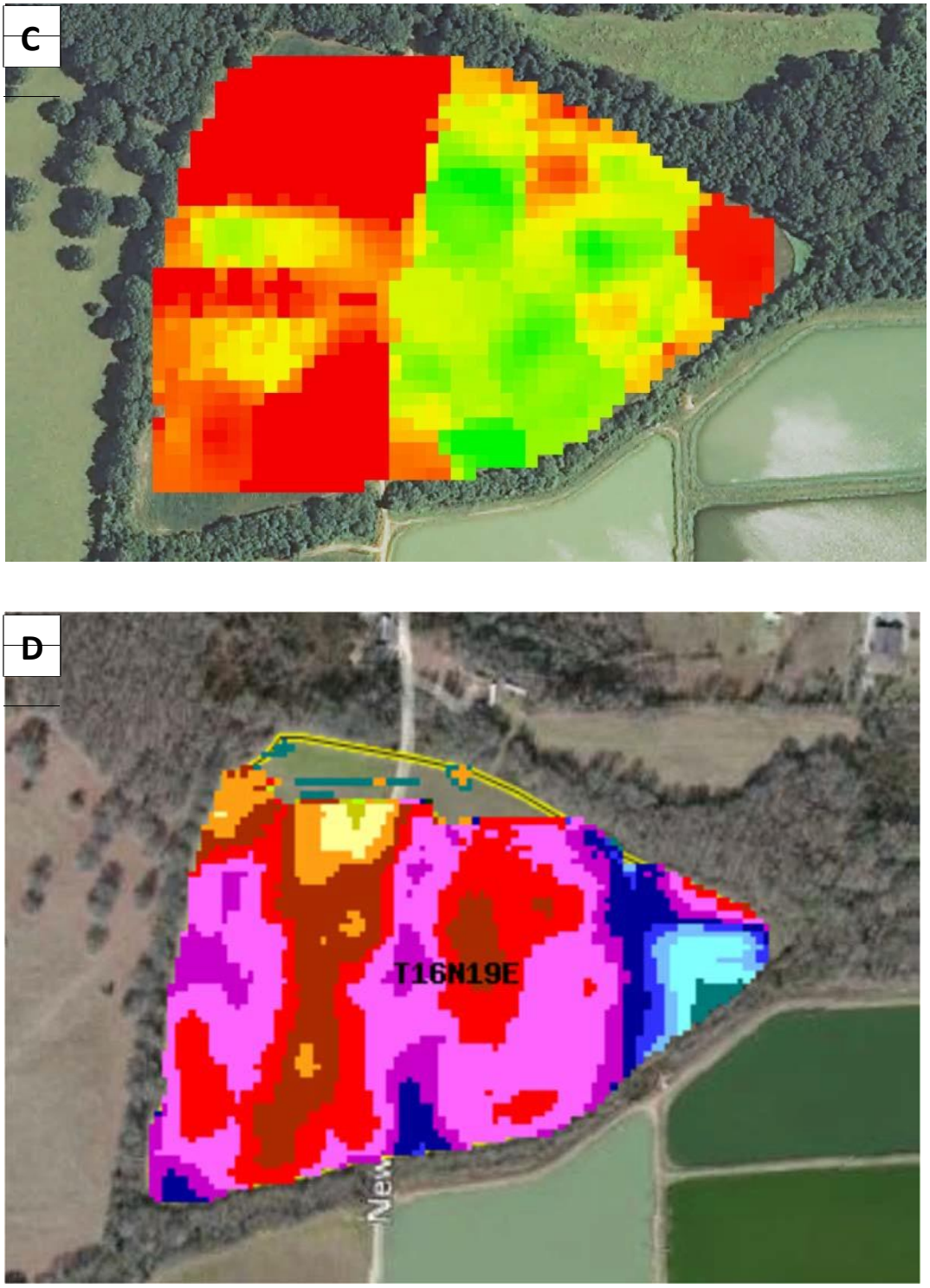
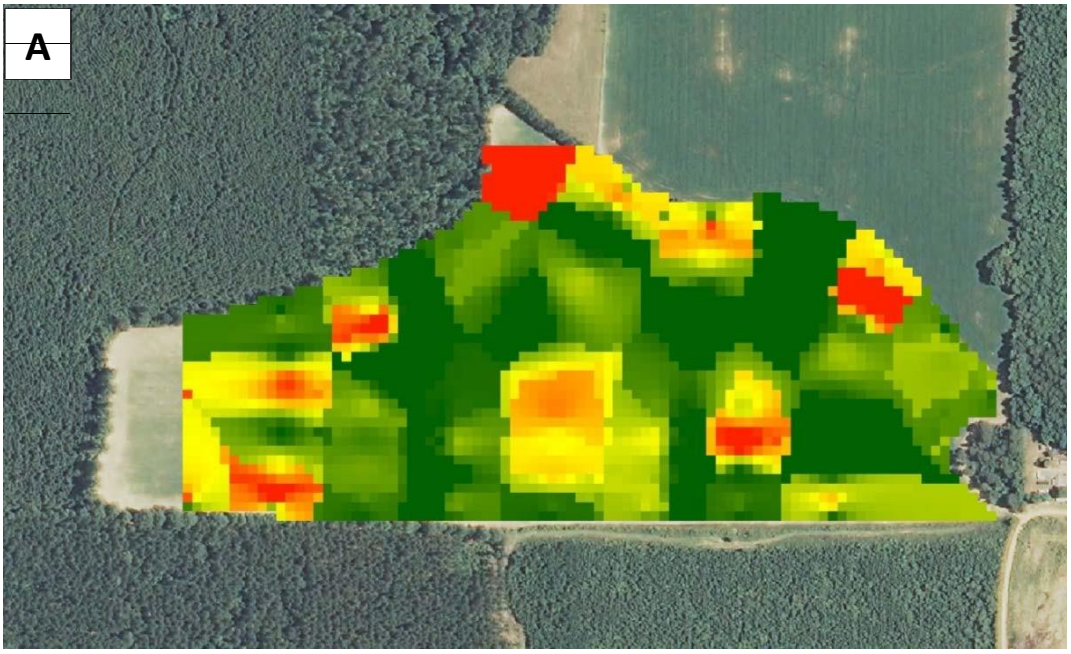
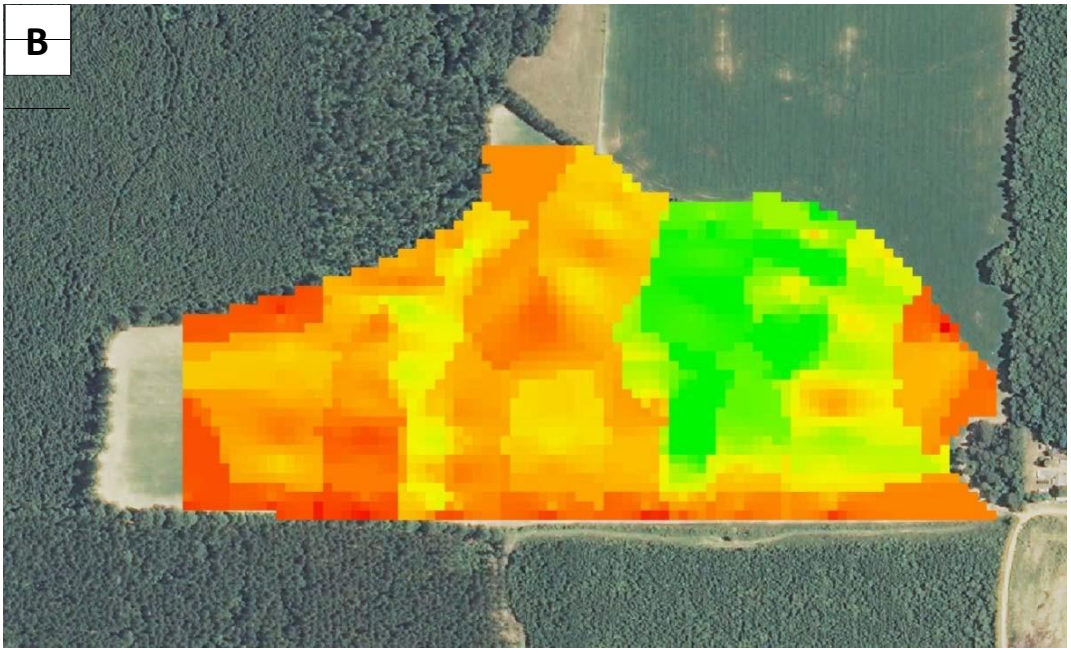


Figure 9. Spatial interpolation of soybean measurements depicting deer damage (A), soybean height (B), and soybean yield (C) as well as an NDVI satellite image (D) from the Bigbee study site in 2013.


A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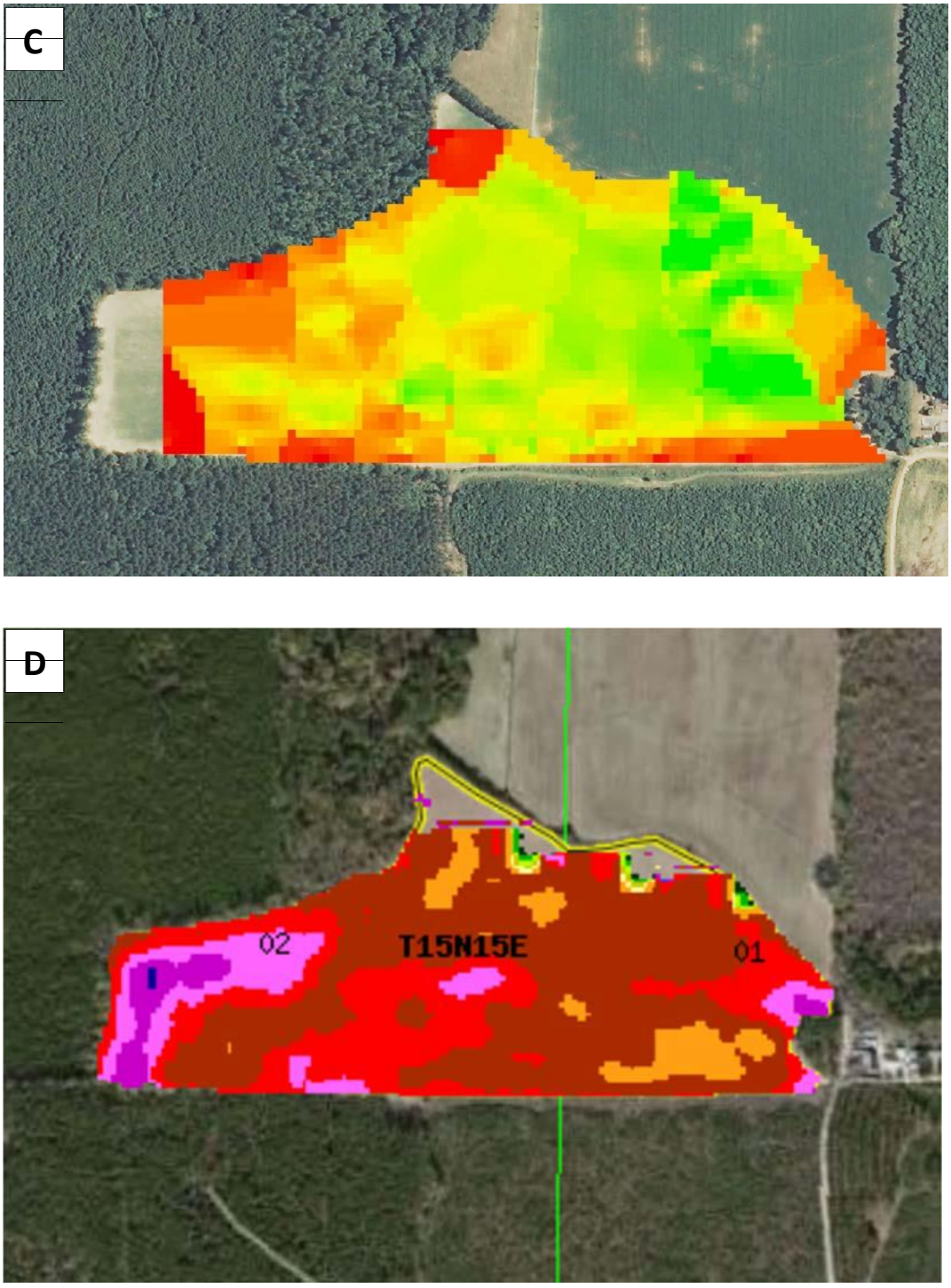
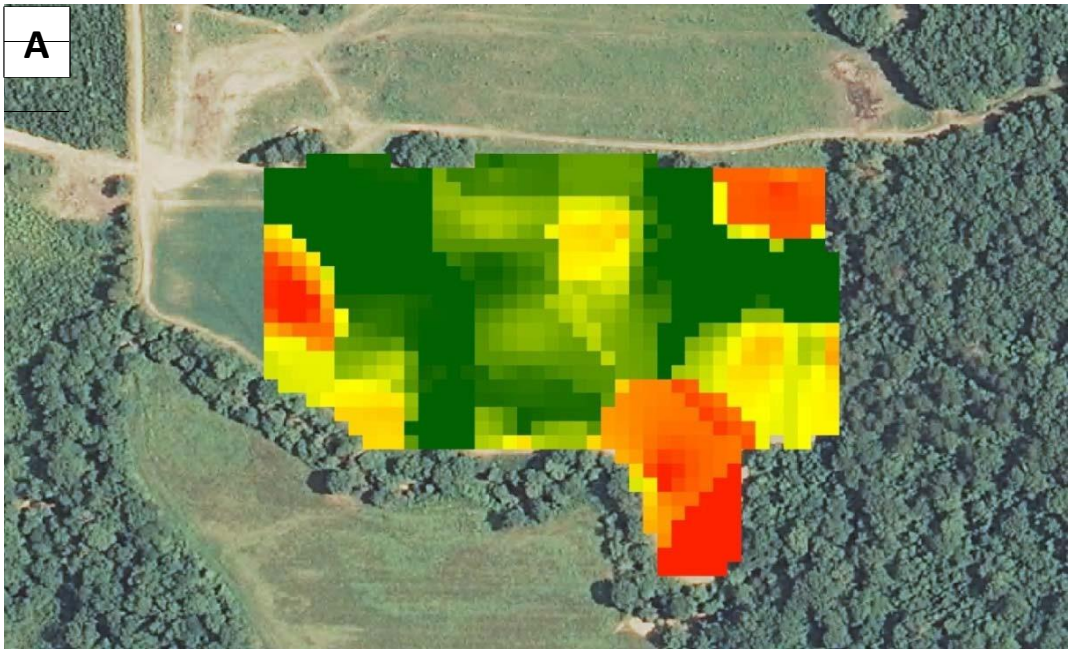


Figure 10. Spatial interpolation of soybean measurements depicting deer damage (A), soybean height (B), and soybean yield (C) as well as an NDVI satellite image (D) from the T1 study site in 2013.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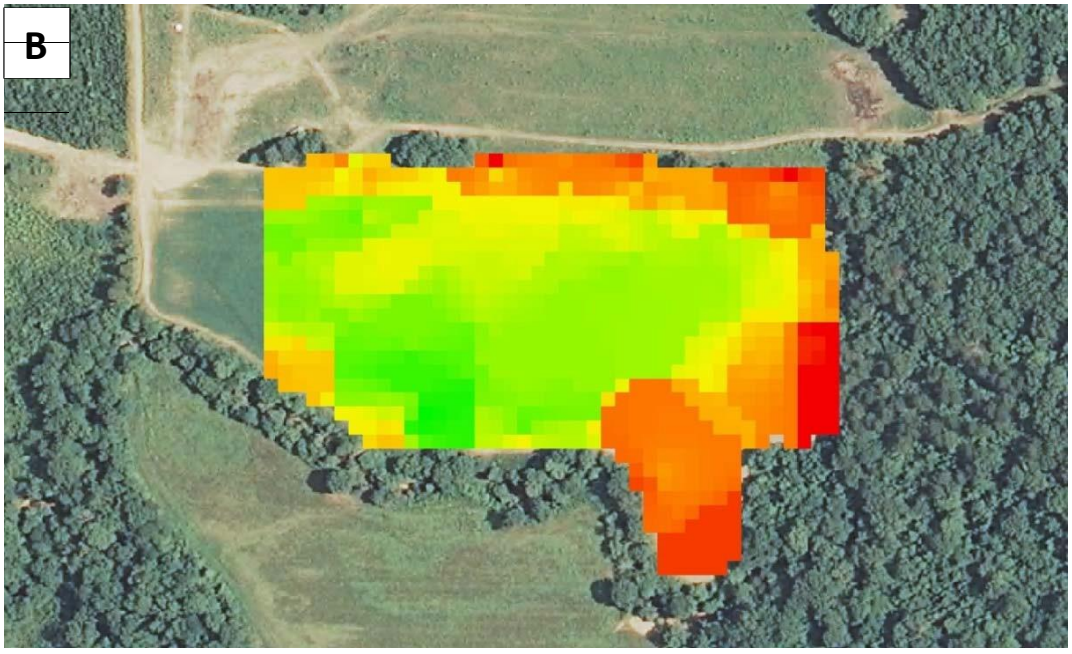
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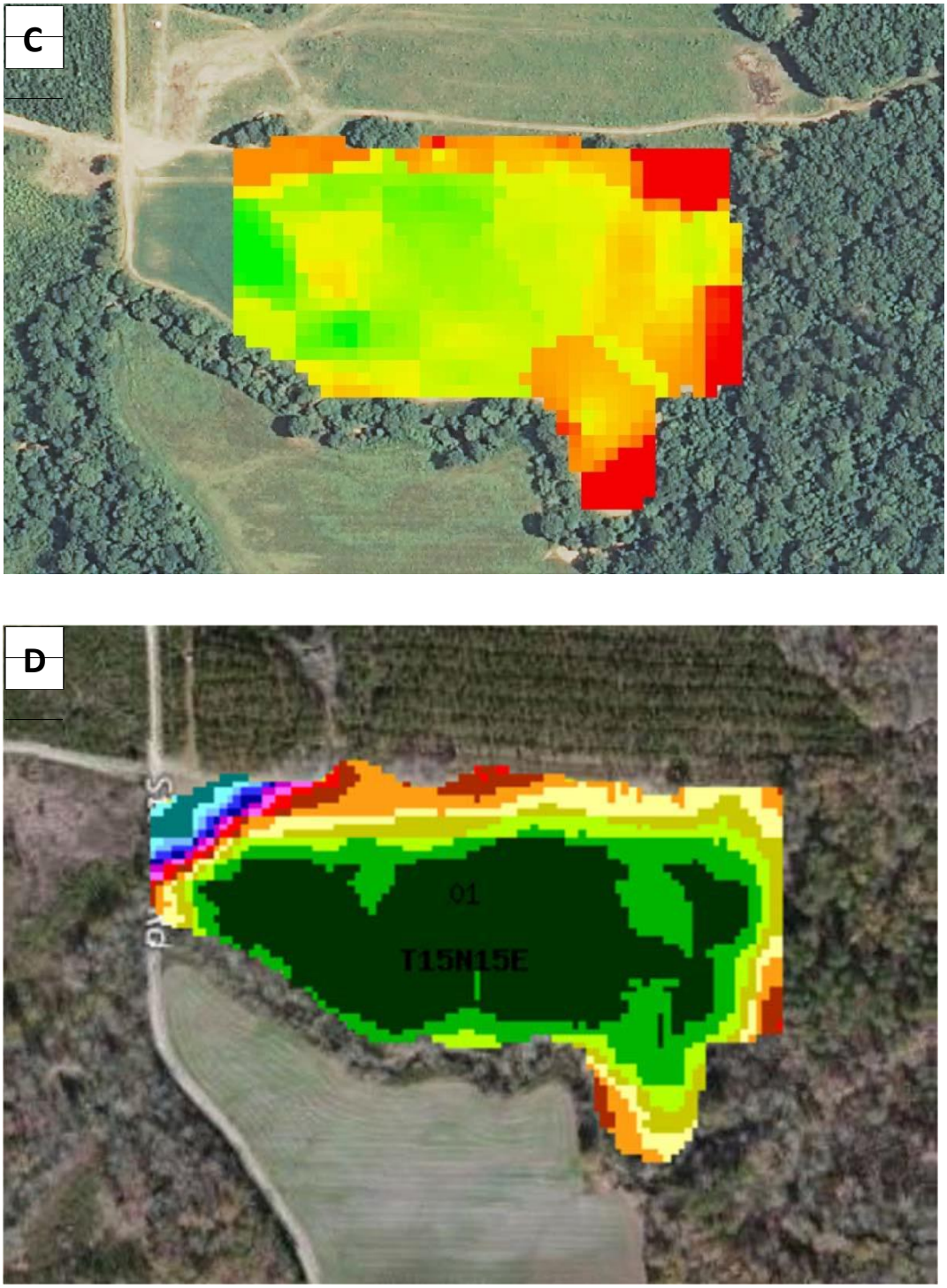
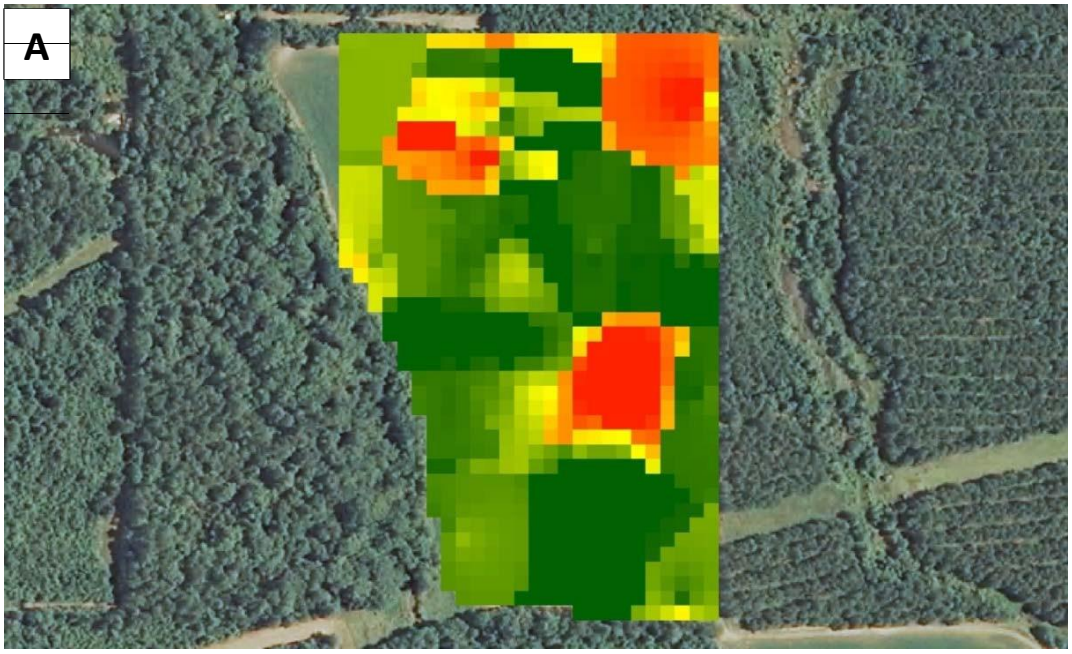
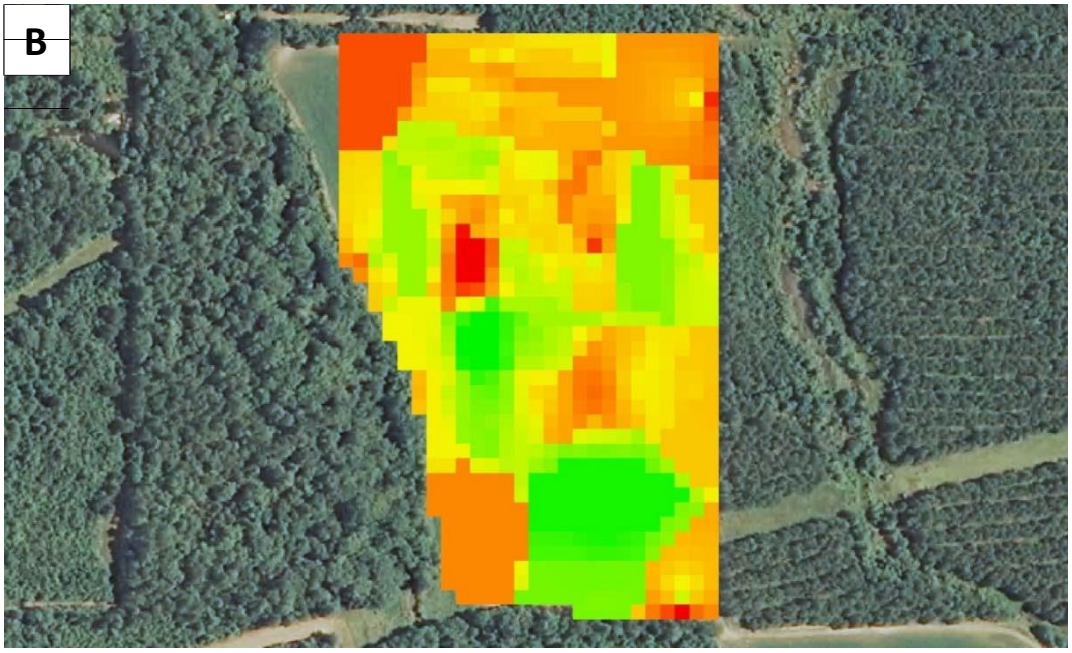


Figure 11. Spatial interpolation of soybean measurements depicting deer damage (A), soybean height (B), and soybean yield (C) as well as an NDVI satellite image (D) from the T2 study site in 2013.


A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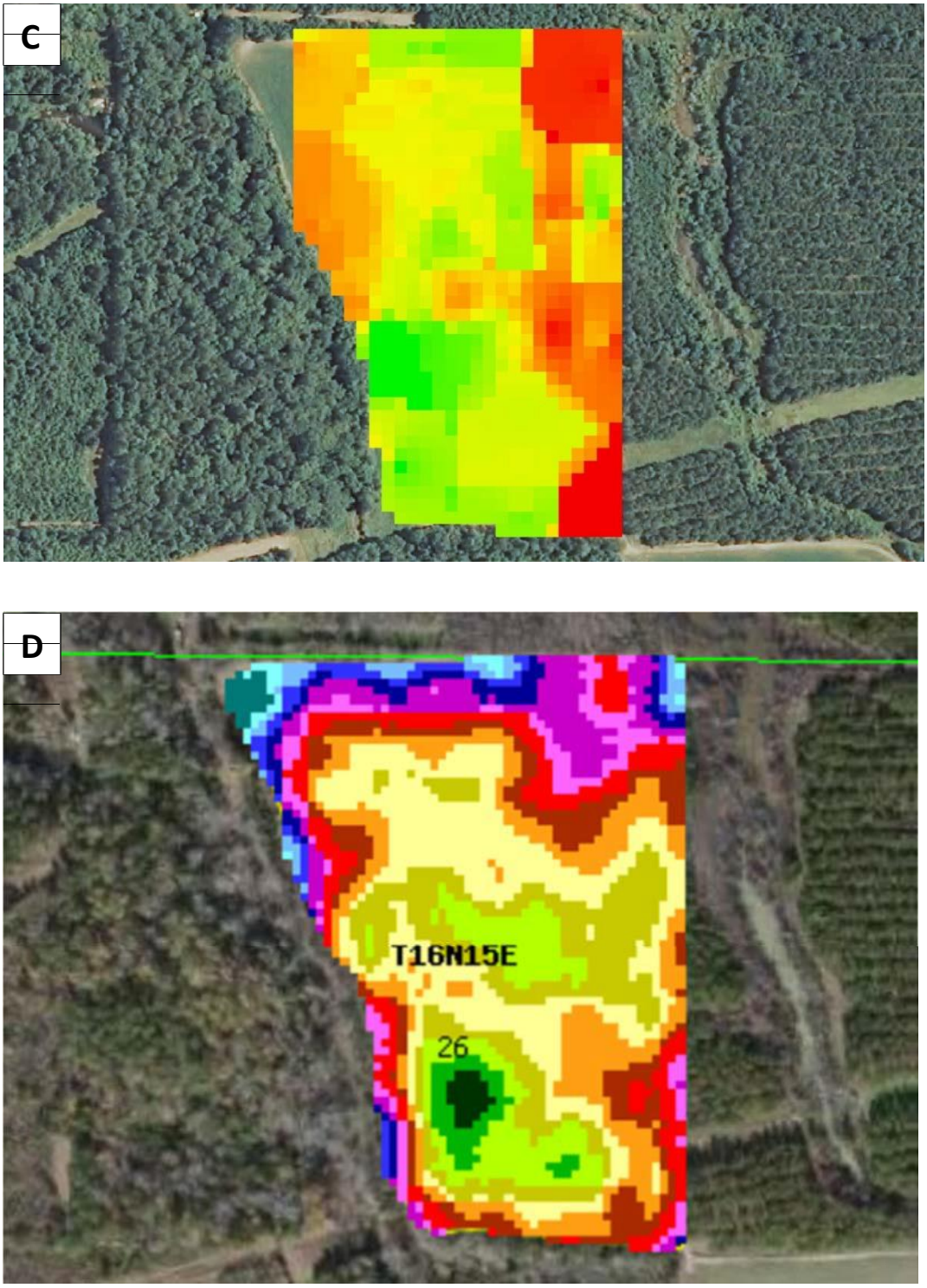

Figure 12. Spatial interpolation of soybean measurements depicting deer damage (A), soybean height (B), and soybean yield (C) as well as an NDVI satellite image (D) from the T3 study site in 2013.

Table 2. County, size, and border type from fields treated with Hinder and sampled to determine the impact of deer browsing on soybean height and yield during 2013 in eastern Mississippi.

Year	Field	County	Size (ha)	Border types[a]
2013	Taylor 1	Noxubee	25.7	AF, MPH, PF
	Taylor 2	Noxubee	9.0	AF, ESP, MPH
	Taylor 3	Noxubee	8.7	MPH, PF

[a] = Description of field border types followed by the classification used for statistical models (i.e., open or cover): AF = Agricultural field (open), PF = Pine forest (cover), MPH = Mixed pine-hardwood forest (cover), ESP = Early successional plants (open), HF = Hardwood forest (cover).
[b] = Mean of weekly counts of maximum number of deer observed in each field.

Figure 13 Diagram showing the placement of Hinder® plots in a soybean field.

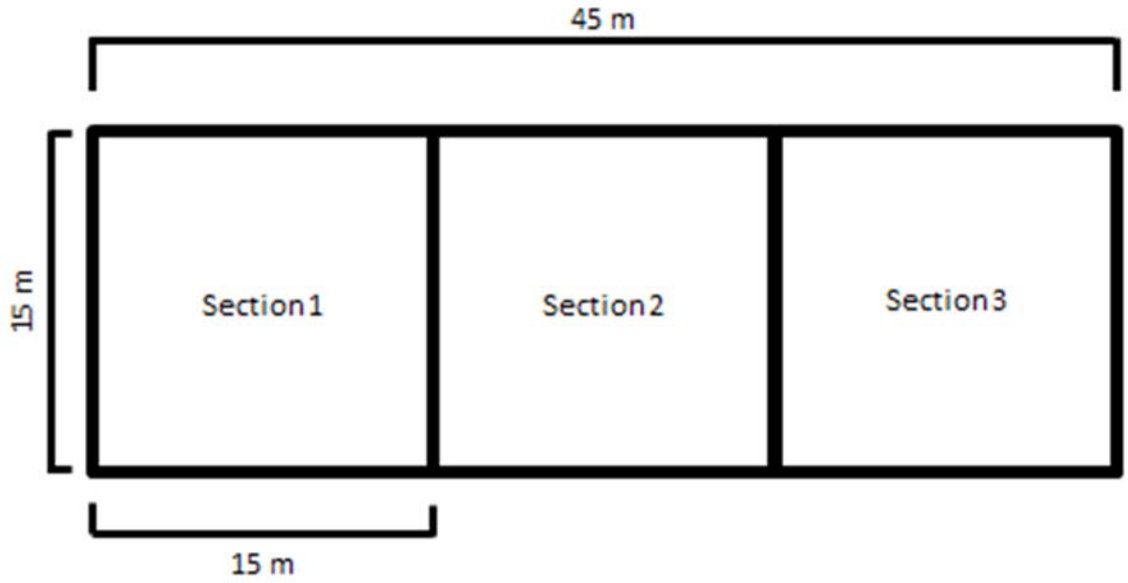

Figure 14. Diagram showing the size and division of Hinder® plot.