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ABSTRACT: Damage from white-tailed deer (*Odocoileus virginianus*) has become a common complaint of soybean (*Glycine max*) producers in many areas of the Southeast. Both short- and long-term, single-field and community-wide solutions to this problem are needed. This paper describes a multi-agency, multi-state effort, involving agronomists, wildlife biologists, producers, and other landowners, to assess soybean losses from deer and to evaluate potential solutions. One phase of this work, which is supported by soybean producer checkoff funds, involves evaluating agronomic practices for reducing crop losses. These include drilled (rather than wide-row) plantings and use of insect-resistant or dense-pubescent cultivars (varieties) which may deter browsing, especially where deer pressure is light to moderate. Evaluations of these practices, in comparison with conventional ones, are being conducted in producer's fields in SC, NC, and VA. The other phase of this work is a cooperative project involving Clemson University, the SC Wildlife and Marine Resources Department, soybean producers and' other landowners in a 7500-acre tract in Hampton and Jasper Cos., SC. The deer population in this tract will be monitored and reduced over a 3-year period, and the resulting effects on soybean crop losses and herd quality will be assessed.

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Damage to soybean by white-tailed deer has been reported in the southeastern USA for a number of years (Flyger and Thoerig 1962, DeCalesta and Schwendeman 1978, Moore and Folk 1978, Garrison and Lewis 1987), and crop depredation problems have increased nationwide as deer populations have increased (Conover and Decker 1991). Suggested methods to alleviate deer damage, including fencing, repellents, lights, and noisemakers, are costly and often unreliable (Flyger and Thoerig 1962, Moore and Folk 1978, Hygnstrom and Craven 1988). Both short-term solutions that producers can use to reduce deer damage on a single-field or farm basis, as well as reduction of the deer population through herd management techniques, are needed for the coexistence of two resources (deer and soybeans) in areas of the Southeast experiencing extreme deer pressure. This paper outlines an approach to investigate both agronomic practices (single-field solutions) and population reduction (a community-wide approach) for reducing deer damage to soybeans.

Investigations of agronomic practices for reducing deer damage are being conducted in several southeastern states. The United Soybean Board (through the American Soybean Association) and state boards in South Carolina, North Carolina, and Virginia have allocated producer check-off funds to support our efforts. One objective of this work is to evaluate various soybean cultivars (varieties) and breeding lines for deer preference. Preliminary data indicates that certain insect-resistant cultivars may be less preferred by deer than are conventional (insect-susceptible) cultivars.

For example, in 1991, deer damage measurements were taken four times during the first 40 days after soybean planting in a producer's field in Colleton Co., SC. Measurements were taken for four soybean cultivars: Lamar and Crockett, both of which show resistance to foliar-feeding insects (Hartwig et al., 1990, Bowers, 1990, Rowan et al. 1991), and the insect-susceptible (conventional) cultivars Leflore and Perrin. Previous studies at other locations had indicated that 16% or fewer plants were damaged in fields with histories of deer depredation (DeCalesta and Schwendeman 1978, Garrison and Lewis 1987). At our location, however, much larger percentages (37 to 94%) of plants were damaged by deer during the observation period (Table 1). The insect-resistant cultivars Lamar and Crockett sustained less deer damage than the susceptible cultivars leflore and Perrin at the first two observation dates. However, the percentage of damaged Lamar plants increased substantially after 11 July, with 75% of plants damaged by the end of that month. The percentage of damaged plants was lower for Crockett than for the two susceptible cultivars throughout the observation period. Yield estimates were also higher for Crockett (1882 kg/ha; 28 bu/ac) than for Perrin (605 kg/ha; 9 bu/ac) or Leflore (1008 kg/ha; 15 bu/ac). Lamar and Leflore yields were estimated to be identical.

Table 1. Deer damage to four soybean cultivars at four observation dates in 1991. The plants were growing in a small field in a heavily wooded location in Colleton Co., SC.

Cultivar	3 July	7 July	22 July	29 July
	---------------------------------- % of plants damaged (SE)			----------------------------------
Leflore	71 (9)	82 (7)	86 (5)	87 (5)
Lamar	53 (13)	53 (13)	74 (7)	75 (6)
Perrin	65 (14)	79 (7)	87 (3)	94 (3)
Crockett	37 (15)	41 (17)	53 (15)	56 (12)

In 1992; various soybean genotypes (cultivars and lines) were grown inside and outside an electric fence at three locations in Virginia. Yield reductions due to deer (yield decrease outside fence as a percentage of yield inside fence) were low at two locations, but at West Point, VA, yield was reduced 43% when averaged over genotypes (Table 2). The genotypes evaluated included the insect-resistant cultivar Lamar (27% yield reduction) and the insect-resistant line N80-50385 which showed no yield reduction. In addition, two isolines differing only in pubescence sustained different levels of deer damage; yield was reduced 47% for the glabrous isoline D88-5328, as compared with 23% for the pubescent isoline D88-5272. Yield reduction was less for later-maturing insect-resistant lines (20% reduction) than for early-maturing ones (67%).

We are continuing to evaluate a number of insect-resistant soybean cultivars and lines at field locations in the three states. In Virginia, screening efforts include soybean genotypes with various pubescence types (sparse, normal, and dense pubescence), genotypes with both insect-resistance and dense-pubescence, and blends of insect-resistant and -susceptible cultivars. Field studies on the influence of drilling (as opposed to conventional wide row spacings) on deer damage are also being conducted as part of this project. This work has been prompted by producer reports that deer seem to prefer the wider spaced rows, perhaps because the threat of danger is easier to recognize than in close rows. We also think that closely-spaced plantings can recover better from moderate browsing than can conventional plantings. This is because of the ability of the soybean plant to compensate (through branching) for additional space such as that left by an adjacent plant which was damaged.

In a related effort, a study is underway at Clemson University's Simpson Research and Education Center near Pendleton, SC, to evaluate soybean growth and yield under various clipping treatments designed to simulate moderate to extreme deer damage. The clipping treatments consist of removal of one-fourth to one-third of the main-stem of all plants in a 4-row plot. The treatments are performed at 4 times during the season (3 times during vegetative growth plus one treatment after pod formation), with 16 treatments representing all combinations of clipping and treatment date. Evaluation of plan! development and plot yield under these treatments All provide information which is needed by agronomists and wildlife biologists who must assess the potential of a crop to recover from damage, especially when it has been repeatedly browsed.

Table 2. Yield reduction from deer feeding for IQ soybean genotypes at West Point, VA, in 1992.

Genotype	Outside Electric Fence	Inside Electric Fence	Yield Reduction
	------------------------kg/ha	-------------------------	
Essex	921	2970	69
Camp	1284	2446	48
Hutcheson	1700	3158	46
Centennial	1626	2063	21
Lamar	1915	2641	27
D88-5328	833	1566	47
D88-5272	2157	2789	23
MBB80-147-1	1962	2399	18
MBB83-365	363	1989	82
N80-50385	1747	1660	(5)
LSD (0.05) = 376			

Reduction of the deer herd is another potential solution to the crop damage problem. This is a long-term, large-scale solution requiring cooperation on the part of farmers, other landowners, sportsmen, and wildlife agencies (Moore and Folk 1978). We have initiated a project, supported by the South Carolina Wildlife and Marine Resources Department, to assess the relationship of deer density to soybean crop damage and to monitor the effects of herd reduction on crop damage and deer herd condition. This work is being conducted in a study area of about 7500 acres (3400 hectares) in Hampton and Jasper Counties, SC. Spotlight surveys of the area indicate a deer population of 1 deer per 5 to 6 acres (1 deer per 2.3 to 2.7 ha). We will work with landowners and hunting clubs in the area to begin reducing the herd see this season (1993) and will continue the herd reduction effort through the 1995 hunting season. Crop damage, herd condition, and other factors will be monitored during this period.

Eight soybean fields within the study area, and eight similar fields outside the area, have been selected for measurements of deer damage to the crop. Deer exclosures have been installed in the fields to provide undamaged soybean samples so that the yield potential of each field (without deer) can be assessed. A map will be constructed for each field showing the extent and degree of deer damage, and plant samples will be taken from areas of high, medium, and low damage. These samples, along with the samples from the exclosures, will be evaluated in the lab for further information about the timing and extent of deer damage to the soybean plants. Crop damage will be determined each year of the project and will be related to deer herd numbers (inside as well as outside the area of herd reduction).

In addition, indices of deer herd condition (weight, age, sex, antler characteristics, lactation rates, etc.) will be recorded for deer harvested in the study area, and the influence of herd reduction on these indices will be evaluated. Extrinsic factors such as availability and quality of native plant food (determined by sampling along vegetation line transects and mast collection in acorn traps), weather variables, and changing patterns of land use will also he monitored and related to crop damage patterns. This project should provide much needed information about optimal deer herd numbers to wildlife managers, crop producers, and the professionals who advise them.

In summary, the goal of this work is to obtain information that will allow for better management of two consisting resources: deer and soybeans. We are examining agronomic solutions, such as use of insect-resistant or dense-pubescent soybean cultivars and drilling, which may reduce deer damage on a single-field basis. We are also investigating the effect of reducing deer population on crop damage and deer herd quality; this is by necessity a community-wide approach. Information from this work should be helpful to crop producers, wildlife managers, and others who are interested in enhancing soybean production potential and deer herd quality in areas with high deer populations.

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