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AGRONOMY & SOILS

Influence of Defoliation and Loss of Apical Dominance on Cotton Growth, Development, and Yield

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ABSTRACT

Studies were conducted to evaluate the effects of simulated hail and wildlife damage on cotton (*Gossypium hirsutum* L.) in 2023 and 2024 at R.R. Foil Plant Science Research Center, Starkville, MS on a Leeper silty clay loam and the Pee Dee Research & Education Center, Florence, SC. Plots were arranged in a factorial arrangement of treatments with three levels. Treatments included damage type (node removal and foliage removal), intensity, and growth stage. Cotton growth and development, lint yield, and fiber quality were evaluated. All data were analyzed using PROC GLIMMIX in SAS v9.4. Data were subjected to analysis of variance and means were separated using Fisher's protected LSD at the 0.05 level of significance. Foliage removal ≥ 75% resulted in a decrease in lint yield when data were pooled. Node removal ≥ 50% at 8 and 12 nodes resulted in lower lint yield. For both node and foliage removal, cotton lint yield declined as the level of loss and growth stage increased. Data generated from this study will help assess the damage caused by extreme weather events and/or wildlife damage to cotton.

Cotton (*Gossypium hirsutum* L.) is a major row crop in the U.S. across the Mid-South region. In 2024, U.S. growers harvested approximately 3.49 million hectares of cotton. Mississippi, with a long-standing history of cotton production, ranked fourth nationally in cotton output. The state planted 210,436 hectares of cotton in 2024, a 30% increase from 2023, and successfully harvested 208,413 hectares (NASS, 2024). South Carolina planted 91,054 hectares of cotton in 2024, a 7% increase from 2023, and successfully harvested 89,435 hectares (NASS, 2024). Historically, fluctuations in production costs, commodity market prices, insect infestations, and weather patterns have affected cotton production (Anapalli et al., 2016).

Cotton is a high-input crop compared to those grown in rotation with cotton in Mississippi. Input costs associated with cotton production are substantial due to seed cost, pesticide applications, and fertilizer. Therefore, to optimize profit, growers must optimize yield (Wang, 2011). Cotton production is subject to unpredictable environmental factors such as drought, flooding, and severe weather. According to the National Oceanic and Atmospheric Administration, hail alone causes approximately $1 billion in damage to crops and property annually, with some years exceeding more than $2 billion in damage (Experienced Public Adjusters, 2021). Additionally, field crop losses from wildlife were estimated at $619 million in 2022 (NASS, 2022). As input costs continue to rise, weather and wildlife damage can significantly impact profitability before the crop is established or harvested. These events led to more than $17 billion of paid crop insurance in 2022 alone (Rain and Hail Insurance Society, 2023). Extreme weather events, along with repeated wildlife feeding, are unpredictable and yield impacts can be challenging to determine (Wang, 2011). Although crop insurance can help offset some of these losses, estimating actual damage remains a challenge.

Many naturally occurring environmental processes can reduce cotton yield by causing physical damage to vegetative and reproductive plant tissues. Yield losses depend largely on the crop's growth stage at the time of injury and the extent of damage (Wang, 2011). Smith and Varvil (1981) demonstrated that the plant's ability to recover decreases as the severity of the damage increases or when damage

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occurs at later development stages. Early-season hail or feeding damage can be managed by replanting with minimal yield penalty (Rain and Hail Insurance Society, 2023). However, replant decisions involve weighing seed cost and delayed planting against the projected yield loss from a reduced or compromised stand (Wang, 2011). Replanting is generally not considered once the plant has reached reproductive stages. Hailstorms during this time can destroy apical growing points, fruiting branches, or bolls, complicating yield loss estimation (Wang, 2011). The U.S. Department of Agriculture–Federal Crop Insurance Corporation and National Crop Insurance Service developed a step-by-step procedure in the early 2000s to estimate cotton yield loss due to hail damage, but the method protocol focuses on main stem node removal and does not account for foliage loss. Given advances in cotton varieties and management practices during the last two decades, investigation of the impacts of a range of foliage loss and terminal loss at multiple growth stages is warranted.

Wildlife feeding, particularly by deer, can also delay cotton maturity. In recent years, increased deer activity has been reported in cotton fields, with feeding on the terminal disrupting apical dominance and delaying maturity. This can lead to a variety of problems including reduced yield potential, heightened vulnerability to late-season pests, lower fiber quality, and delayed harvest (Collins and Edmisten, 2018). Data from North Carolina State University suggest that deer feeding at the two- to three-leaf stage can reduce seed cotton yield by 20 to 30%, whereas feeding at the four- to five-leaf stage can result in 18 to 36% loss. Feeding earlier in the season poses a high risk of seedling death due to damage below the cotyledons, whereas later feeding can result in yield loss with less risk to plant survival (Collins and Edmisten, 2018). Similar research performed by Plumblee et al. (2020) in Starkville and Brooksville, MS; Portageville, MO; and Jackson, TN found lint yield reductions ranging from 11 to 70% depending on timing and severity of damage. These trials also reported impacts on turnout, micronaire, fiber length, and strength, further emphasizing that the extent and timing of damage are critical to understanding the effects of both foliage and terminal removal on upland cotton.

Currently, few studies have addressed the combined effects of foliage and node removal in upland cotton. Data on cotton yield from hail and wildlife damage are limited, making it difficult for growers to make informed replant or management decisions. Therefore, the objective of this study was to evaluate cotton's response to foliage and node removal across different growth stages and levels of injury.

MATERIALS AND METHODS

Field experiments were conducted in 2023 and 2024 at two locations: the R.R. Foil Plant Science Research Center, Mississippi State University, Starkville, MS (33.474342° N, 88.776028° W), on a Leeper silty clay loam (fine, smectitic, nonacid, thermic Vertic, Epiaquepts) and the Pee Dee Research & Education Center, Clemson University, Florence, SC (34.28983° N, -79.73810° W), on a Russet sandy loam (fine, loamy, mixed, semiactive, mesic Aquic Hapludultes).

Planting and harvest dates for both years and locations are given in Table 1. Following harvest, each site was disked with a John Deere 2620 tandem disk (John Deere, Moline, IL) and bedded with a Bigham Ag hipper roller (Bigham Ag, Lubbock, TX) at 96-cm row spacing. Soil samples were taken and sent to the Mississippi State University Soil Testing Laboratory (Mississippi State, MS) and soil amendments were applied based on lab recommendations. Prior to planting, 10 cm of the beds were smoothed with an Agline Do All (Agline Farm Equipment, Carthage, MS). Cotton seeds were planted using three seed hill-drop plates with a John Deere 6430 and an Almaco four row planter (Almaco, Nevada, IA) equipped with John Deere max emerge row units. Delta Pine 2127 B3XF (Bayer Crop Science,

Table 1. Planting and harvest dates for 2023 and 2024 at R.R. Foil Plant Science Research Center, Starkville, MS and Pee Dee Research and Education Center, Florence, SC

Location	Planting Date	Harvest Date
Starkville, MS	3 May 2023	10 October 2023
	28 April 2024	3 October 2024
Florence, SC	11 May 2023	8 November 2023
	6 May 2024	8 October 2024

St. Louis, MO) was seeded at a depth of 2.5 cm and a seeding rate of 104,000 seeds ha^{-1}. Plots consisted of four 96-cm rows, each 12.2 m in length. Each treatment was replicated four times.

The experimental design was implemented as a randomized complete block design with a three-factor factorial arrangement of treatments. Factor A was type of damage with two levels: defoliation (foliage removal) and main stem removal (node removal). Factor B was damage intensity with three levels: 0, 50, and 75%. Factor C was growth stage at the time of damage application, with three levels corresponding to the 4-, 8-, and 12-node stage.

Simulated damage was applied to the two middle rows of each four-row plot. A new node was determined when a new leaf at the main stem terminal had unfolded or reached 2.5 cm in diameter (Kerby et al., 2010). Simulated damage consisted of counting nodes down the plant from the uppermost node and removing the entire terminal at that growing point (node removal) or removing all leaves at the desired node upward (foliage removal) (Table 2).

Standard agronomic practices for pest management, nitrogen, and harvest aid applications were followed in accordance with Mississippi State University Extension recommendations (Bond et al., 2024; Crow et al., 2024; Raper et al., 2024). This experiment was in a rainfed environment. Split applications of 32% urea ammonium nitrate were applied: 23 kg ha^{-1} at emergence and 32 kg ha^{-1} at pinhead square. Nitrogen was applied using a liquid applicator equipped with a piston pump driven by a hydraulic drive controller. Plant growth regulators were applied as needed. Thidiazuron and ethephon were applied when untreated control plots reached approximately 60% open bolls.

In Starkville, MS, canopy light interception was measured 7 and 14 d after treatment (DAT) using a LI-191 Quantum Sensor (Li-Cor, Lincoln, NE). The quantum sensor was placed on the ground diagonally under the damaged plots and one reading was taken from each plot between 10:00 am and 2:00 pm when full sun was present. A light interception equation (Purcell et al., 2002) was modified to calculate canopy cover:

$$\mathrm{C} = \left[1 - \left(\frac{\mathrm{PAR\ below}}{\mathrm{PAR\ above}}\right)\right] \times 100$$

where C represents canopy cover (%), photosynthetically active radiation (PAR) (μmol s^{-1} m^{-2}) was measured below the canopy (PAR below), and above the canopy (PAR above) (Shepherd et al., 2018). Plant canopy height was measured at the end of the season from five randomly selected plants per plot

Table 2. Treatments combinations consisting of three growth stages, two damage types, and three levels of damage

Treatment	Growth Stage	Type of Damage	Level of Loss (%)
1	4 Node	Node Removal	0
2	4 Node	Node Removal	50
3	4 Node	Node Removal	75
4	4 Node	Foliage Removal	0
5	4 Node	Foliage Removal	50
6	4 Node	Foliage Removal	75
7	8 Node	Node Removal	0
8	8 Node	Node Removal	50
9	8 Node	Node Removal	75
10	8 Node	Foliage Removal	0
11	8 Node	Foliage Removal	50
12	8 Node	Foliage Removal	75
13	12 Node	Node Removal	0
14	12 Node	Node Removal	50
15	12 Node	Node Removal	75
16	12 Node	Foliage Removal	0
17	12 Node	Foliage Removal	50
18	12 Node	Foliage Removal	75

by measuring from the soil surface to the terminal. Lint percentage, lint yield, and fiber characteristics were pooled across both years and locations. Seed cotton yield data were collected from the two center rows of each plot using a John Deere 9960 spindle picker modified for small-plot research. Lint percentage was determined from a subsample of 25 hand-harvested bolls per plot and ginned using a 10-saw Continental laboratory gin (Continental Eagle Corp., Prattville, AL). After ginning, lint percentage was calculated by dividing the lint weight by the total weight of seed plus lint. High Volume Instrumentation was conducted by the U.S. Department of Agriculture, Agricultural Marketing Service Classing Office in Memphis, TN, for analysis of fiber micronaire, length, uniformity, and strength.

Statistical Analysis. All data were analyzed using the PROC GLIMMIX procedure in SAS v.9.4 (SAS® Institute Inc., Cary, NC). Type of damage, damage intensity, growth stage, and their interactions were considered fixed effects. Random effects included year, location nested within year, and replication nested within location. Means were separated using Fisher's protected LSD at 0.05 level of significance. Growth parameters, including light interception and canopy height were analyzed using data collected from Starkville, MS in 2023 and 2024. Lint percentage, yield, and fiber characteristics were analyzed across both locations and years as pooled datasets. Regression was used to evaluate the relationship between light interception and lint yield using SigmaPlot v.14 (Systat Software, Inc., San Jose, CA)

RESULTS AND DISCUSSION

Light interception A (LIA) was affected by level of loss ($p < 0.0001$) (Table 3). Mean LIA ranged from 64.6 to 77.9% (Table 4). There was no difference in mean LIA between the untreated and 50% level of loss (Table 4). As the level of loss increased to more than 50%, LIA readings decreased (Table 4).

Differences were observed for LIA at different growth stages ($p = 0.0181$) (Table 3). Means for LIA ranged from 67.2 to 75.8% (Table 4). Readings from damage initiated at 4- and 8-node growth stages did not differ with respect to mean LIA. Similarly, reading from damage initiated at 8- and 12-node growth stage did not differ with respect to mean LIA, regardless of the type of damage and level of loss (Table 4). When damage occurred at the 4-node growth stage, the mean LIA was greater than when damage occurred at the 12-node growth stage (Table 4).

Light interception B (LIB) was affected by main effect level of loss ($p = 0.0121$) (Table 3). Means ranged from 79.6 to 87.1% (Table 4). Similar to LIA affected by level of loss, there was no difference in mean LIB between the untreated and 50% level of loss (Table 4). As the loss level exceeded 50%, LIB readings decreased (Table 4).

Mean canopy heights at the end of the season were affected by the main effect level of loss ($p = 0.0002$) (Table 3). Means ranged from 80.2 to 90.6 cm (Table 5). The greatest mean canopy height was observed from the plants in the untreated check (Table 5). There was no difference in mean canopy height when comparing 50 and 75% levels of loss.

Table 3. nalysis of variance probability values for growth parameters affected by type of damage, level of loss, and growth stage at R.R. Foil Plant Science Research Center, Starkville, MS in 2023 and 2024

	LIA[z]	LIB[y]	CHES[x]
		p-values	
Type of Damage	**0.1573**	**0.4694**	**0.7260**
Level of Loss	**< 0.0001**	**0.0121**	**0.0002**
Growth Stage	**0.0181**	**0.4782**	**0.3987**
Type of Damage * Level of Loss	**0.1770**	**0.9348**	**0.7835**
Type of Damage * Growth Stage	**0.3959**	**0.2532**	**0.8971**
Level of Loss * Growth Stage	**0.4794**	**0.9239**	**0.9194**
Type of Damage * Level of Loss * Growth Stage	**0.7816**	**0.7962**	**0.8076**

[z]Light interception reading A 7 d after damage simulation

[y]Light interception reading B 14 d after damage simulation

[x]Canopy height end of season

Table 4. Light intercept reading A means as affected by level of loss and growth stage at R.R. Foil Plant Science Research Center, Starkville, MS in 2023 and 2024

Level of Loss (%)	LIA[z]	LIB[y]	Growth Stage	LIA[x]
0	77.9 a[w]	86.1 a	4 node	75.8 a
50	73.2 a	87.1 a	8 node	72.7 ab
75	64.6 b	79.6 b	12 node	67.2 b
LSD (0.05)	8.4	7.5		8.3

[z]Light interception reading A 7 d after damage simulation by level of loss

[y]Light interception reading B 14 d after damage simulation by level of loss

[x]Light interception reading A 7 d after damage simulation by growth stage

[w]Means followed by the same letter are not different $p < 0.05$

Table 5. Mean canopy heights (cm) as affected by level of loss at R.R. Foil Plant Science Research Center, Starkville, MS in 2023 and 2024

Level of Loss (%)	CHES[z] (cm)
0	90.6 a[y]
50	80.6 b
75	80.2 b
LSD (0.05)	7.6

[z]Canopy height end of season (cm)

[y]Means followed by the same letter are not different $p < 0.05$

However, when comparing canopy heights from plants that had 50 and 75% loss to the untreated check, there was an 11.1% decrease in the mean canopy height of plants at the end of the season (Table 5). These data agree with research conducted by Plumblee et al. (2020), which showed differences in plant height where damage occurred at first bloom (roughly 12 node). Plant heights were reduced by 14 and 20% when six and eight nodes were removed, respectively, compared to the untreated. As the damage level increased, the height was reduced.

Lint percentage was affected by the level of loss ($p = 0.0003$) (Table 6). Levels of loss, 0 and 50%, did not differ with respect to lint percentage. Greatest lint percentages were observed at 0 and 50% levels of loss (Table 7). When level of loss increased to 75%, the mean percentage of lint percentage decreased (Table 7).

Lint percentage was affected by the main effect growth stage ($p = 0.0243$) (Table 6). Regardless of the type of damage and level of loss, damage to 4- and 12-node cotton did not differ with respect to lint percentage. Similarly, damage to 8- and 12-node cotton did not differ with respect to lint percentage (Table 7). When damage occurred to 8-node cotton, there was a decrease in lint percentage (Table 7). These results agree with the results of Plumblee et al. (2020), who found that as damage increased at the 8-node growth stage, lint percentage was reduced.

The interaction between type of damage and level of loss affected lint yield ($p = 0.0478$) (Table 6). Lint yields ranged from 952 to 1549 kg ha^{-1} (Table 8). Regardless of growth stage, yield following no foliage removal, no node removal, or 50% foliage removal did not differ and resulted in the highest

Table 6. Analysis of variance probability values for lint percentage, lint yield, and fiber quality characteristics pooled across both years and both locations

	Turnout	Yield	Micronaire	Length	Uniformity	Strength
	p-values					
Type of Damage	0.9497	0.0004	0.7301	0.8215	0.3294	0.1874
Level of Loss	0.0003	<0.0001	0.7009	0.0587	0.3397	<0.0001
Growth Stage	0.0243	<0.0001	0.3113	0.1140	0.2033	0.2425
Type of Damage * Level of Loss	0.4651	0.0478	0.6650	0.6055	0.4075	0.2513
Type of Damage * Growth Stage	0.0690	0.9825	0.1284	0.8627	0.2942	0.5634
Level of Loss * Growth Stage	0.0535	0.0114	0.8553	0.4472	0.3881	0.3893
Type of Damage * Level of Loss * Growth Stage	0.6560	0.8922	0.5453	0.8962	0.1850	0.5855

Table 7. Lint percentage means as affected by level of loss and growth stage pooled across both years and both locations

Level of Loss (%)	TO (%)
0	45.1 a[z]
50	44.7 a
75	44.3 b
LSD (0.05)	.38
Growth Stage	
4 node	44.9 a
8 node	44.4 b
12 node	44.7 ab
LSD (0.05)	.38

[z]Means followed by the same letter are not different $p < 0.05$

mean lint yield (Table 8). Seventy-five percent foliage removal and node removal greater than or equal to 50% resulted in lower lint yields compared to no damage, respectively. Foliage removal 75% and node removal 50% decreased lint yield by 20 and 23% compared to the untreated check (Table 8). Node removal 75% resulted in a 38% decrease in lint yield and represented the greatest decrease in any included treatment (Table 8). Data from this study were consistent with previous research, which found that large reductions in leaf area (foliage removal) are required before cotton lint yield was affected (Wilson et al., 2003). Research by McGinty et al. (2019) conducted similar treatments when examining node removal. Their data showed that when four nodes were removed from the plant at the 8-node growth stage, significant yield loss (21.6%) was generated. Smith and Varvil (1981) observed yield losses of 16 to 31% following node clippings at 10, 12, and 14 nodes.

The interaction between level of loss and growth stage also affected lint yield ($p = 0.0114$) (Table 6). Lint yields ranged from 917 to 1544 kg ha^{-1} (Table 9). No removal had the greatest lint yields (Table 9). The 0, 50, and 75% levels of loss at the 4-node growth stage did not differ in realized lint yield. Additionally, the 0 and 50% levels of loss at the 8-node growth stage did not differ in realized lint yield. As removal at the 8-node stage increased to 75%, lint yield decreased by 32%. The greatest mean lint yield reduction of 41% occurred following 75% removal at the 12-node stage (Table 9). Previous research conducted by Yang et al. (2016) produced similar results. Removal of the terminal bud at the 12-node stage reduced cotton lint yield. Yang et al. (2016) stated that node 8 and 12 stages correspond to pinhead square and first bloom, respectively, which indicates that cotton lint yield was sensitive to main stem node removal at the initiation and development of reproductive structures (Yang et al., 2016).

Fiber strength was affected by level of loss ($p < 0.0001$) (Table 6). Means for strength ranged from 29.0 to 30.1 g/tex (Table 10). Mean strength at 75% loss was greater than strength observed following 50% and 0% levels of loss (Table 10). Results show that cotton strength increased as level of loss increased. Previous research by Plumblee et al. (2020) reported similar findings where they found a 3% increase in fiber strength when eight nodes were removed from the plant at both pinhead square and first bloom.

Light Interception Regression Analysis. Crop growth and development play a pivotal role during the cropping season, controlling the rate of leaf addition, the total number of leaves produced, and the whole plant leaf area. Plant height and leaf area are

Table 8. Lint yield (kg ha^{-1}) means as affected by the interaction between type of damage * level of loss pooled across both years and both locations

Type of Damage	Level of Loss (%)	Lint Yield (kg ha^{-1})
Node Removal	0	1528 a[z]
Node Removal	50	1184 b
Node Removal	75	952 c
Foliage Removal	0	1549 a
Foliage Removal	50	1347 ab
Foliage Removal	75	1237 b
LSD (0.05)		149

[z]Means followed by the same letter are not different $p < 0.05$

Table 9. Lint yield (kg ha^{-1}) means as affected by the interaction between level of loss * growth stage pooled across both years and both locations

Level of Loss (%)	Growth Stage	Lint Yield (kg ha^{-1})
0	4 node	1544 a^{z}
0	8 node	1537 a
0	12 node	1534 a
50	4 node	1448 a
50	8 node	1294 ab
50	12 node	1041 bc
75	4 node	1326 ab
75	8 node	1054 bc
75	12 node	917 c
LSD (0.05)		182

^{z}Means followed by the same letter are not different $p < 0.05$

Table 10. Fiber strength as affected by level of loss pooled across both years and both locations

Level of Loss (%)	Strength (g/tex)
0	29.09 b^{z}
50	29.58 b
75	30.12 a
LSD (0.05)	.59

^{z}Means followed by the same letter are not different $p < 0.05$

significant factors determining solar light interception by row crops (Chapepa et al., 2020). This study measured light interception to evaluate crop compensation for canopy damage, (node or leaf removal) at 7 and 14 d after damage, and to investigate the impact of these types of damage on cotton lint yield.

Results indicated a linear correlation between solar light interaction resulting from physical damage, such as node or leaf removal, and end-of-season cotton lint yield (Fig. 1). In this regression model, the dependent variable is predicted lint yield (kg ha^{-1}, Y), which reflects the amount of lint produced by the crop and serves as a key indicator of agricultural productivity. The independent variable is light interception (X), expressed as a percentage, which represents the amount of sunlight captured by the crop canopy and is closely linked to photosynthetic activity. Greater regression estimates of solar light interception measured 7 d after damage with cotton lint yield (Fig. 1) with an R^2 value of 0.65 ($p < 0.01$), meaning that 65% of the variation in lint yield can be attributed to variations in light interception than the light interception measured at 14 d after the damage (R^2 of 0.25 [$p < 0.01$]) (Fig. 1). The spread of the light interaction measured at 7 d was greater than the values measured at 14 d of damage with cotton lint yield. Cotton lint yield increased with an increase in the percentage of light interception at times 28 and 31 kg ha^{-1} for a unit increase in a light interception at 7 and 14 d of measurement, respectively (Chapepa et al., 2020).

The stronger correlation for LIA ($R^2 = 0.65$) suggests that the 1-week period following initial crop damage could serve as a more reliable indicator of end-of-the-season cotton lint yield, particularly when adjusting for insurance purposes. However, further research is needed to validate this hypothesis and refine the timing for more accurate yield predictions. These findings align with those of Li et al. (2022), who reported a positive linear correlation between

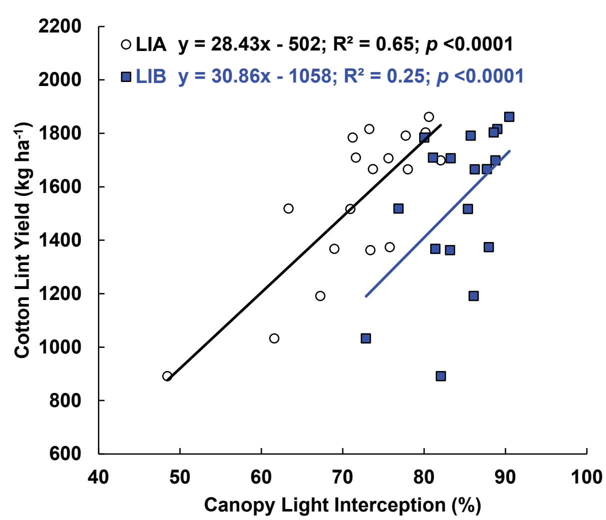

Figure 1. Regression analysis of canopy light interception and cotton lint yield

leaf area index and cotton yield. Their study also emphasized the importance of leaf area in influencing overall cotton productivity, reinforcing the idea that greater light interception leads to higher yields.

CONCLUSIONS

This study examined how cotton responds to node and foliage removal at different levels and during three critical growth stages: 4, 8, and 12 node. The results revealed that cotton damage significantly affected key growth parameters, including canopy light interception and canopy height. As the level of damage occurred later in the season, there was a corresponding decrease in these parameters. A strong positive correlation between light interception and lint yield was observed, with cotton yield increasing by 28 and 31 kg ha^{-1} for every unit increase in light interception at 7 and 14 d, respectively. This highlights the critical role of leaf area and canopy biomass in determining cotton productivity. The 1-week period following initial crop damage (LIA) was identified as a potentially reliable predictor for end-of-season yield, as indicated by the stronger correlation ($R^2 = 0.65$), although further research is needed to verify these findings. Lint percentage was also affected by increased levels of damage, with the lowest lint percentage observed following damage at the 8-node stage. Interestingly, no reductions in lint yield were observed from node or foliage removal at the 4-node growth stage, suggesting that cotton plants at this stage were able to compensate for damage. In contrast, greater damage at later growth stages, particularly at the 8- and 12-node stages, reduced lint yield. Node removal levels of 50 and 75%, as well as foliage removal of 75% or greater, led to decreases in lint yield. Fiber strength increased when paired with higher levels of loss. Overall, node removal played the greatest role in reducing lint yield, whereas foliage removal of at least 75% was required before a yield penalty was observed. The 4-node growth stage showed little delay, with plants compensating for the simulated damage. Greater losses occurred at later growth stages, particularly at the 12-node stage, which had the greatest effects on growth and development, lint percentage, and lint yield. The severity and timing of damage are crucial factors in determining the plant's ability to compensate.

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REFERENCES

Anapalli, S., W. Pettigrew, K. Reddy, L. Ma, D. Fisher, and R. Sui. 2016. Climate optimized planting window for cotton in the lower Mississippi delta region. Agron. 6(4):46. https://doi.org/10.3390/agronomy6040046

Bond, J., T. Bararpour, H. Bowman, D. Dodds, T. Irby, E. Larson, B. Pieralisi, D. Reynolds, and B. Zurweller. 2024. 2024 Weed management suggestions for Mississippi row crops. Mississippi State University Extension Service, Publ. 3171, Mississippi State University, Starkville, MS.

Chapepa, B., N. Mudada, and R. Mapuranga. 2020. The impact of plant density and spatial arrangement on light interception on cotton crop and seed cotton yield: an overview. J. Cotton Res. 3:18. https://doi.org/10.1186/s42397-020-00059-z

Collins, G., and K. Edmisten. 2018. Evaluating damage from deer feeding on North Carolina cotton [online]. North Carolina State University Extension, Publ. AG-848. Available at https://content.ces.ncsu.edu/evaluating-damage-from-deer-feeding-on-north-carolina-cotton (verified 28 June 2026).

Crow, W., D. Cook, F. Musser, and T. Towles. 2024. 2024 Insect control guide for agronomic crops. Mississippi State University Extension Service, Publ. 2471, Mississippi State University, Starkville, MS.

Experienced Public Adjusters. 2021. Hail size explained: what size hail will cause hail damage to your home or your business [online]. Experienced Public Adjusters, Orlando, FL. Available at https://experiencedpublicadjusters.com/hrf_faq/hail-size-explained-what-size-hail-will-cause-hail-damage-to-your-home-or-your-business/ (verified 28 June 2026).

Kerby, T., M. Bourland, and K. Hake. 2010. Physiological rationales in plant monitoring and mapping. pp. 304–317 *In* J.M. Stewart, D.M. Oosterhuis, J.J. Heitholt, and J.R. Mauney (eds.), Physiology of Cotton. Springer, New York, NY. https://doi.org/10.1007/978-90-481-3195-2_27

Li, H., Z. Liu, Y. Chen, X. Zhang, and D. Chen. 2022. A positive correlation between seed cotton yield and high-efficiency leaf area index in directly seeded short-season cotton after wheat. Field Crops Res. 285:108594. https://doi.org/10.1016/j.fcr.2022.108594

McGinty, J., G. Morgan, and D. Mott. 2019. Cotton response to simulated hail damage and stand loss in central Texas. J. Cotton Sci. 23(1):1–6. https://doi.org/10.56454/OXUC6037

National Agricultural Statistics Service [NASS]. 2022. Mississippi Statistics [online]. United States Department of Agriculture, Washington, D.C. Available at www.nass.usda.gov/Statistics_by_State/Mississippi/ (verified 28 June 2026).

National Agricultural Statistics Service [NASS]. 2024. Mississippi Statistics [online]. United States Department of Agriculture, Washington, D.C. Available at www.nass.usda.gov/Statistics_by_State/Mississippi/ (verified 28 June 2026).

Plumblee, M., D. Dodds, J. Krutz, T. Raper, A. Jones, A. Catchot, T. Irby, and J. Jenkins. 2020. Effect of physical damage to early- and late-maturing cotton cultivars. Agron. J. 112:1140–1147. https://doi.org/10.1002/agj2.20104

Purcell, L.C., R.A. Ball, J.D. Reaper, and E.D. Vories. 2002. Radiation use efficiency and biomass production in soybean at different plant population densities. Crop Sci. 42:172–177. https://doi.org/10.2135/cropsci2002.1720

Rain and Hail Insurance Society [RHIS]. 2023. 2023 Crop insurance update. Letter from Rain and Hail Insurance Society, 1. Available at https://biz.rainhail.com/pdf_files/mktg/mktg_0123.pdf (accessed 08 Jan 2025).

Raper, T., B. Pieralisi, T. Sandlin, B. Wilson, S. Kerns, and Z. Treadway. 2024. 2024 Mid-South cotton defoliation guide [online]. University of Tennessee, Publ. W376. Available at https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/cotton/2024_MidSouth_DefoliationGuide.pdf (verified 28 June 2026).

Shepherd, M.J., L.E. Lindsey, and A.J. Lindsey. 2018. Soybean canopy cover measured with Canopeo compared with light interception. Agric. Environ. Letters. 3(1):180031. https://doi.org/10.2134/ael2018.06.0031

Smith, C.W., and J.J. Varvil Jr. 1981. Recoverability of cotton following simulated hail damage. Agron. J. 73(4):597–600. https://doi.org/10.2134/agronj1981.00021962007300040007x

Wang, G. 2011. Assessing cotton yield loss to hail damage in southern Arizona [online]. Arizona Cooperative Extension, Univ. Arizona, publ. AZ1549. Available at https://arizonaag.com/wp-content/uploads/2013/06/assessing-cotton-yield-loss-to-hail-damage-in-southern-arizona-2011.pdf (verified 28 June 2026).

Wilson, L.J, V.O. Sadras, S.C. Heimoana, and D. Gibb. 2003. How to succeed by doing nothing: cotton compensation after simulated early season pest damage. Crop Sci. 43(6):2125–2134. https://doi.org/10.2135/cropsci2003.2125

Yang, S, R. Kaggwa, P. Andrade-Sanchez, M. Zarnstroff, and G. Wang. 2016. Lint yield compensatory response to main stem node removal in Upland cotton (Gossypium hirsutum L.) J. Agron. Crop Sci. 202(3):243–253. https://doi.org/10.1111/jac.12142