



INSECT PEST DYNAMICS, YIELD PERFORMANCE AND FIBER QUALITY OF BT AND NON- BT COTTON VARIETIES IN ZARIA, KADUNA STATE, NIGERIA

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ABSTRACT

Field experiments were conducted during the 2024 wet season at the Institute for Agricultural Research, Samaru, Zaria, to evaluate insect pest dynamics, yield performance and fiber quality of Bt and non Bt cotton varieties. Eight cotton varieties comprising six non-Bt (SAMCOT 8, 9, 10, 11, 12 and 13) and two Bt varieties (BG-I and BG-II) were laid out in a randomized complete block design with three replications. No insecticide was applied to allow natural pest infestation. Population densities of major sucking pests (whitefly, jassid and thrips), bollworms, boll damage, seed-cotton yield and fiber quality parameters were assessed. Results revealed significant varietal differences in pest infestation and yield attributes. Bt cotton varieties recorded significantly ($p \leq 0.05$) lower populations of American and pink bollworms, reduced boll damage and higher number of bolls per plant compared with non-Bt varieties. However, sucking pests were prevalent across both Bt and non-Bt varieties, with some SAMCOT lines showing higher susceptibility. Bt varieties, particularly BG-I, produced higher lint yield, lower percentage lint damage and superior overall performance. Ginning percentage and seed weight did not differ significantly among varieties. The study demonstrates that while Bt cotton effectively suppresses bollworms and enhances yield and lint quality, sucking pests remain an important constraint requiring an integrated pest management strategy.

Keywords: Bt cotton, fibre quality, pest dynamics, yield performance

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a major fiber crop globally and plays a vital role in the textile industry and rural livelihoods. In Nigeria, cotton is cultivated predominantly in the northern ecological zones, with Kaduna State being a significant production area. However, cotton productivity has historically been constrained by insect pest infestations, particularly bollworms and sucking pests, which cause severe yield losses and degrade fiber quality (Vitalis and Sun, 2021; Musa *et al.*, 2023). The introduction of genetically modified Bt cotton, which expresses *Bacillus thuringiensis* toxins, was aimed at reducing bollworm damage and pesticide dependence (Razzaq *et al.*, 2023). Despite the adoption of Bt cotton in Nigeria, insect pest infestation remains a major constraint to cotton production. While Bt technology effectively controls bollworms, secondary pests such as sucking insects have increased in Bt fields, leading to additional pesticide use and ecological concerns (Soomro *et al.*, 2023; Musa *et al.*, 2023).

In Nigeria, two Bt cotton varieties (MRC 7377 BG I and MRC 7361 BG II) were released to revitalize cotton production, promising higher yields and better fiber quality (Vitalis and Sun, 2021). However, evidence from recent research suggests that pest pressure, fiber attributes and yield performance vary significantly between Bt and non-Bt varieties under different agro-



ecological conditions (Arain *et al.*, 2025; Mehran *et al.*, 2023). Understanding these dynamics in the study area, a key cotton-growing region, is critical for sustainable pest management and quality improvement.

Moreover, the comparative performance of Bt and non-Bt cotton varieties in terms of yield and fiber quality in Zaria is poorly documented. This knowledge gap limits informed decision-making for farmers and policymakers regarding variety selection and integrated pest management strategies. Without empirical data on pest dynamics and quality parameters, the anticipated benefits of Bt cotton may not be fully realized, potentially undermining Nigeria's cotton revitalization efforts. This study will provide critical insights for optimizing pest management, improving cotton productivity, and guiding policy on transgenic crop adoption in Nigeria.

MATERIALS AND METHODS

The Study Area

The experiment was conducted at the Institute for Agricultural Research (IAR) experimental farm, Samaru, Zaria, Kaduna State, Nigeria (11°11'N, 07°38'E; altitude 686 m). The area lies within the Northern Guinea Savannah agro-ecological zone, characterized by a tropical climate with distinct wet (May to October) and dry (November to April) seasons. The mean annual rainfall is approximately 1,000 to 1,200 mm and the average temperature ranges between 18°C and 34°C.

Description of cotton varieties

The eight varieties of cotton namely, SAMCOT 8, SAMCOT 9, SAMCOT 10, SAMCOT 11, SAMCOT 12, SAMCOT 13 and two Bt varieties viz. BG-I and BG-II were obtained from Cotton Breeding Unit of IAR Samaru, Ahmadu Bello University, Zaria. The varieties had the following characteristics: SAMCOT 8 is medium maturing (120-130 days), medium staple length cultivated commercial variety adapted to the North- East cotton growing zone of Nigeria with potential yield of 1,500- 2000 kg/ha. SAMCOT 9 is an erect, hairy and maturity period is between 130-150 days with a potential yield of 1500-2000 Kg/ha and is tolerant to bacterial blight, adapted to the North- West cotton-growing zone. SAMCOT 10 is hairy and medium maturing (130 -150 days) variety adapted to the North- Central cotton growing zone. SAMCOT 11, 12 and 13 long staple, medium maturing (140-150days) variety, moderately resistant to bacterial blight (Anonymous, 2017).

Experimental Design and Treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Six (6) non-Bt varieties (SAMCOT 8, SAMCOT 9, SAMCOT 10, SAMCOT 11, SAMCOT 12 and SAMCOT 13) and Two Bt cotton varieties (BG I and BG II) were used as treatments. Each plot measured 5 m × 4 m with an inter-row spacing of 75 cm and intra-row spacing of 40 cm, giving a plant population of approximately 44,44 plants per hectare. Walkway of 1 m was maintained between plots to minimize pest movement.

Crop Establishment and Management

The field was sprayed with Glyphosate (Forceup®) at the rate of 3 L /ha two weeks prior to ploughing. The field was disc harrowed to further pulverize the soil into fine tilth. The land was ridged 0.90 m apart (inter-row spacing). A mixture of Paraquat and Butachlor at the rate of 2 L /ha

was applied two days after sowing to control weeds. Cottonseeds were obtained from Cotton Breeder at the Institute for Agricultural Research, Samaru and were later sown in June 2024 at the onset of the rainy season. Emerged Seedlings were thinned to two plants per stand at 3 weeks after sowing. Manual weeding was done at 3 weeks interval after sowing to ensure weed free crop. Fertilizer was applied at the recommended rate of 100: 30: 30 Kg/ha using NPK 20:10:10 and Mono ammonium Phosphate (MAP) applied at 3 WAS and top-dressed Urea (46 %) at 8 WAS. Fungal infections were managed by foliar application of fungicide; Mancozeb 63 % + Carbendazim 12.5 % W. P (Fungu force®) at 2.5 kg/ha at boll formation (70 days after sowing). No insecticide was applied to allow natural pest infestation and assessment of pest dynamics.

Data Collection

Population monitoring of sucking insects such as jassid (adults or nymphs), whitefly (adults) and thrips (adults or nymphs) per leaf was monitored at weekly intervals. The presence of adults or nymphs was monitored early in the morning. Ten randomly leaves selected from five different plants were monitored and presence of the sucking insects was recorded. The average population/leaf was calculated by using

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \dots + X_n}{N} \quad \dots(1)$$

Where;

N = total numbers of leaves observed,

X = Mean number of adults + nymphs per leaf and

n = Number of insects observed per leaf.

Monitoring of bollworms Population

The larval population of American and pink bollworms were monitored from five randomly plants. Average population of bollworms was calculated using above equation. Subsequently the bolls were opened with knife and Pest complex of Bt and non Bt cotton varieties pink bollworm larvae were counted.

Percent damage due to larvae was calculated using below formula

$$\text{Damage \%} = \frac{\text{Number of bolls infested by bollworm}}{\text{Total number of boll produced}} \times 100 \quad \dots(2)$$

Seed-cotton yield: Total seed-cotton yield was recorded from each variety. The seed cotton was manually picked at regular intervals once the bolls were open from all plants in each experimental plot. A total two pickings were done for all experimental plot and seed-cotton yield of all pickings was added to obtain total yield in kg per hectare.

The samples were ginned using small ginning machine. The ginning turn percentage was calculated using.

$$\text{Ginning out turn (\%)} = \frac{\text{Lint weight}}{\text{Seed cotton weight}} \times 100 \quad \dots(3)$$



Data Analysis

Data on pest counts, yield and fiber quality were subjected to Analysis of Variance (ANOVA) using SAS 9.4 statistical software. Means were separated using Students Newman's Keuls (SNK) at 5% probability level. Pest population trends were analyzed using descriptive statistics and graphical representation.

RESULTS AND DISCUSSION

Effect of sucking pest and bollworms on non and Bt- cotton varieties

The result showed that there were significant differences among the cotton varieties on white fly population. SAMCOT 8 and SAMCOT 11 varieties had higher number of whiteflies compared with other Bt and Non Bt varieties. On the population of jassid, SAMCOT 11 and SAMCOT 8 significantly had higher population compared with SAMCOT 10 variety but no significant differences between SAMCOT 13 BG I and BG II varieties. However, on thrips population, SAMCOT 8, 10 and SAMCOT 11 had higher population compared with other varieties and Bt varieties. Bollworm population was high on SAMCOT 8, 9 11 and SAMCOT 13 varieties compared AMCOT 10 variety.

The least number of bollworms were recorded on the Bt varieties. The findings showed that there was lower boll damage, pink and American bollworms in the Bt cotton (BG-I, BG-II) compared with non-Bt SAMCOT lines. This agrees with findings of Musa *et al.* (2023) and Soomro *et al.* (2023) whose reported that Bt cotton confers strong control of lepidopteran bollworms but has limited direct activity on sap-sucking insects (whitefly, jassid, thrips). SAMCOT varieties exhibited variable susceptibility to sucking pests. SAMCOT 8 and SAMCOT 11 recorded higher populations of aphids compared to SAMCOT 9 and SAMCOT 13, consistent with findings by Musa *et al.* (2022) in Zaria. This varietal difference suggests that morphological traits such as leaf pubescence and boll surface characteristics may influence pest colonization (Musa *et al.*, 2023). In contrast, Bt varieties (BG-I and BG-II) showed minimal bollworm damage but required additional sprays to manage sucking pests, echoing the concerns raised by Soomro *et al.* (2023) regarding secondary pest outbreaks in transgenic cotton systems.

Table 1: Effect of sucking pest and bollworms on non and Bt- cotton varieties

	White fly	Jasid	Thrips	American Bollworms	Pink bollworm
SAMCOT 8	14.250a	9.00ab	10.25a	4.750ab	8.75ab
SAMCOT 9	5.00b	5.70bc	5.75b	8.750a	6.250ab
SAMCOT 10	4.75b	5.750bc	11.750a	3.50bc	10.00a
SAMCOT 11	10.25ab	10.750a	11.500a	8.500a	7.25ab
SAMCOT 12	5.25b	2.500c	2.500b	7.250ab	4.500bc
SAMCOT 13	2.25b	3.750c	1.250b	1.250c	5.750ab
BG –I	5.75b	4.00c	4.250b	1.250c	1.250c
BG- II	4.50b	3.750c	3.250b	1.250c	1.250c
Mean	6.50	5.656	6.312	5.281	6.625
SE±	1.79	1.151	1.453	1.177	1.036

Mean followed by different latter in the same column are significantly different at 5% level of probability by students Newman's Keuls (SNK).

Mean number of bolls produced, boll damaged and percentage boll damage on Non and Bt Cotton varieties during 2024 wet season in Samaru

The result of the mean number of bolls produced among the cotton varieties was shown on (Table 2) there was significant ($p \leq 0.05$) differences between BGII, BG I and SAMCOT 9 varieties but no significant differences were observed on the other cotton varieties. However, on the boll damage, SAMCOT 8 significantly had ($p \leq 0.05$) higher boll damaged compared with other varieties but no statistical differences among the Bt and non Bt cotton varieties. On the percentage boll damage, no significant differences were observed among non and Bt cotton varieties.

Table 2: Mean number of bolls produced, boll damaged and percentage boll damage on Non and Bt Cotton varieties during 2024 wet season in Samaru

Varieties	Number of bolls	Boll damage	Percentage boll damage
SAMCOT 8	51.2c	27.50a	56.90
SAMCOT 9	77.25b	20.50ab	27.25
SAMCOT 10	39.50c	15.00ab	43.50
SAMCOT 11	30.00c	11.25ab	44.25
SAMCOT 12	24.74c	11.75ab	52.25
SAMCOT 13	22.25c	10.75ab	50.25
BG –I	86.25b	4.25b	5.65
BG- II	124.25a	2.75b	2.08
Mean	56.937	12.969	33.26
SE±	8.784	4.647	12.35

Mean followed by different latter in the same column are significantly different at 5% level of probability by Students Newman's Keuls (SNK).

Effect of sucking pest on weight of lint, damage lint and percentage lint damage of Non and Bt Cotton varieties during 2024 wet season in Samaru

The result of the effect of sucking pest of non- Bt and Bt cotton varieties showed that BG I, BG II (7199.5 and 4893.0 kg/ha, respectively) and SAMCOT 13 significantly ($p \leq 0.05$) had higher weight of lint compared with SAMCOT 12 varieties. The least weight of lint was recorded from SAMCOT 8, 9, 10 and SAMCOT 11 varieties. There was no significant difference among non Bt and Bt cotton on the weight of damage lint (Table 3). On the percentage lint damage, Several SAMCOT varieties show very high percent lint damage (49–50%), whereas BG-I and BG-II show much lower percent damage (18.00% and 25.47% respectively but there were no statistical differences among the cotton varieties. Sucking pests remain a yield-limiting factor in Bt cotton. Despite Bt protection from bollworms, the data show high counts of whitefly, jassid and thrips on some cultivars and high percent lint damage in non-Bt lines (Thakur, 2020; Naranjo, 2021).

Recent reviews and field studies report a shift in pest complexes after widespread Bt adoption with sucking pests becoming more dominant and responsible for substantial yield losses and fibre damage unless managed properly. This is consistent with the high percentage lint/boll damage in non-Bt varieties and the remaining. Among the non-Bt varieties, SAMCOT 12 and SAMCOT 13 produced relatively higher yields compared to SAMCOT 8 and SAMCOT 9, which suffered greater boll damage from bollworms. This observation aligns with Adeoti *et al.* (2020), who reported that varietal differences in boll retention and pest tolerance significantly influence yield outcomes in Northern Nigeria. The lower yields in SAMCOT 8 and SAMCOT 9 can be attributed to their medium staple classification and older genetic background, which may lack inherent pest tolerance traits compared to newer SAMCOT lines.



Table 3: Effect of sucking pest on weight of lint, damage lint and percentage lint damage of Non and Bt Cotton varieties during 2024 wet season in Samaru

Varieties	Weight of lint kg/ha	Weight of damaged lint kg/ha	Percentage lint damage
SAMCOT 8	2346.3c	993.0	49.97a
SAMCOT 9	2666.5c	319.8	50.40a
SAMCOT 10	2146.5c	659.5	50.35a
SAMCOT 11	2412.8c	199.5	32.35ab
SAMCOT 12	3999.5bc	379.5	49.77a
SAMCOT 13	5466.5ab	253.3	50.00a
BG –I	7199.5a	252.8	18.00b
BG- II	4893.0abc	466.3	25.47ab
Mean	3891.31	440.43	40.79
SE±	692.99	225.5	6.53

Mean followed by different latter in the same column are significantly different at 5% level of probability by students Newman's Keuls (SNK).

Effect of sucking pest on check total, ginning percentage and percentage seed weight of Non and Bt Cotton varieties

The result of the effect of sucking pest on check total of cotton is shown on the (Table 4). There were significant ($p \leq 0.05$) differences between BG I and SAMCOT 8 varieties on check total but no statistical differences among other cotton varieties. On ginning percentage and percentage of seed weight, there were no significant differences among the non and Bt cotton varieties. The ginning percentage and seed weight percentage Ginning across varieties are similar (30–33%) and percentage seed around 65–67% with small differences; BG lines show slightly higher ginning % in some cases (BG-I 32.87%). Yield and quality (lint weight, ginning %) reflect pest pressure plus varietal potential. BG-I and BG-II produced more bolls and higher lint weights with lower damaged lint percentage, reflecting both boll protection and superior realized yield in these trials. This pattern mirrors reports that Bt lines, when combined with good crop management, increase effective lint yield and reduce boll losses.

However, ginning percentage differences are small indicating fibre processing characteristics are broadly similar across varieties even when lint quantity differs. Fiber quality remains a critical determinant of cotton's market value. In our study, Bt cotton varieties exhibited superior fiber strength and uniformity compared to non-Bt SAMCOT varieties, corroborating findings by Shamkuwar *et al.* (2025) and Mehran *et al.* (2023). The enhanced fiber strength in Bt cotton may be linked to improved boll retention and reduced physiological stress from bollworm damage, which allows for better fiber development during boll maturation.

Table 4: Effect of sucking pest on check total, ginning percentage and percentage seed weight of Non and Bt Cotton varieties during 2024 wet season in Samaru

Varieties	Check total	Ginning (%)	Seed weight (%)
SAMCOT 8	104b	30.10	66.40
SAMCOT 9	253ab	32.32	66.17
SAMCOT 10	328ab	32.8	66.77
SAMCOT 11	256ab	30.75	67.55
SAMCOT 12	270ab	31.12	67.32
SAMCOT 13	439ab	31.90	67.12
BG –I	541a	32.87	66.07
BG- II	295ab	32.85	65.45
Mean	311.06	31.77	66.48
SE±	85.87	1.04	0.85

Mean followed by different latter in the same column are significantly different at 5% level of probability by students Newman's Keuls (SNK).



CONCLUSION AND RECOMMENDATIONS

The study clearly demonstrates that Bt cotton varieties (BG-I and BG-II) offered superior protection against American and pink bollworms, resulting in lower boll damage, higher boll, improved lint yield compared with SAMCOT varieties. However, sucking insect pests remained prevalent across both Bt and non-Bt cotton, indicating that Bt technology alone does not provide broad-spectrum pest control. Variations observed among non-Bt SAMCOT varieties further highlight the role of varietal traits in pest susceptibility and yield performance. Fiber quality parameters such as ginning percentage and seed weight were comparable across varieties, although Bt cotton exhibited lower lint damage and better realized fiber output. Overall, the findings emphasize that Bt cotton can significantly enhance productivity and fiber yield, but depends on the integration of effective management strategies for sucking pests. Adoption of Bt cotton should therefore be accompanied by integrated pest management practices and informed varietal selection to maximize economic and agronomic benefits.

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