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Original Article

Effect of intra-row spacing on boll infestation and yield loss of cotton (SAMCOT 9) caused by bollworm in Zaria, Nigeria

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ABSTRACT

Field studies were carried out at two locations in Samaru ($11^{0}11'$ N, 07^{0} $38'$ E and 686 m above sea level) and Maigana (11^{0} $10'$ N, $07^{0}37'$ E and 675 m above sea level) both in North Guinea Savannah ecological zone of Nigeria during the 2018 wet season to determine the effect of three intra-row spacing (40 cm, 45 cm, and 50 cm) on boll infestation, yield, and yield loss of cotton (SAMCOT 9) caused by bollworms. The experimental design was strip plot fitted into randomized complete block design. Data were recorded on boll infestation, yield, and yield loss from 16WAS before the commencement of the first picking. Reduction in boll infestation and yield loss as well as yield increase was observed on the 50 cm intra-row spacing than 45 cm and 40 cm. It is recommended that for plantation establishment of cotton (SAMCOT 9), farmers should adopt the use of 50 cm intra-row spacing for reduction in bollworm infestation as well as increase in yield.

Keywords: Bollworms, Cotton bolls, Crop production, Damage, Infestation, Intra-row spacing, North Guinea Savannah, Pest, Season, Yield loss, Yield

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INTRODUCTION

In cotton production, there are many factors that can reduce crop yield. One important cause is arthropod pests. Insects that cause loss to the fruit are more destructive than those that damage leaves, stems, and roots.[1] Total annual losses in the world are estimated at about U.S. $300 billion, and average yield loss ranges from 30% to 40%, and are generally much higher in many tropical and subtropical countries.[2] Cotton is subjected to yield and quality loss due to various lepidopterous pests. Among the different pests attacking cotton, bollworms account for 25–30% yield loss.[3] Infestation due to these insect pests also caused deterioration in lint quality and 10–40% losses in crop production.[4] In Nigeria, cotton is attacked by a number of insect pests throughout the developmental stages of the crop and caused a greater amount of damage to the crop.[5] The most important group of insects attacking cotton in Nigeria are the bollworms with species in five genera of importance which includes *Diparopsis watersi* Roths. (Red bollworm), *Helicoverpa armigera* Hubn. (American bollworm), *Pectinophora gossypiella* Saund. (Pink bollworm), *Earias* spp. Walk. (Spiny bollworms), and *Cryptophlebia leucotreta* Meyrick. (False codling moth) which are generally known as a pest of citrus but of some importance on cotton in Nigeria.[5,6] The range of pests damaging cotton crops is so extensive that farmers must use more than 1 control tactics to reduce their economic effect. Selection of particular tactics will be influenced by the agronomic and climatic factors affecting the insect infestation and the cost of their implementation. Each tactic has to be as compatible as possible with other control measures and integrated into a pest management program. Many farmers have relied almost entirely on chemical control, but problems of pesticide resistance and concern about environmental pollution have led to reappraisal of benefits of cultural and biological controls, and the need for integrated pest management.[7] Hence, suitable technology for the cotton farmers in various agroclimatic regions has to be adapted.[8] A number of control measures are integrated for the management

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of bollworm infestation on cotton in a way that is aimed at minimizing environmental contamination and maintaining durable suppression of pest problems. These tactics fall within the broad categories of preventative measures, cultural control, host plant resistance, chemical control, and biological control.[1]

MATERIALS AND METHODS

Study Area

The study was conducted during 2016 wet season at two different locations situated in Institute for Agricultural Research (I.A.R) farm Samaru (11^0 11' N, 07^0 38' E and 686 m above sea level) and Kaduna State Agricultural Development Agency (K.A.D.A) research farm in Maigana (11^0 10' N, 07^0 37' E and 675 m above sea level) both in North Guinea Savannah ecological zone of Nigeria. The study areas have a mean annual rainfall of 1016 mm and mean maximum and minimum temperatures of 32.2°C and 23.5°C, respectively.

Experimental Design and Layout

The fields for the experiment were ploughed, harrowed, and ridged at 0.90 m inter-row spacing. The treatments consisted of three intra-row spacing (40 cm, 45 cm, and 50 cm) replicated 4 times in a randomized complete block design with plot size of 4.5 m × 4.5 m (gross plot of 6 rows and 4.5 m long) and 3.5 m × 2.7 m (net plot of 4 rows and 3.5 m long). Plots within replication were separated by a 1.5 m alley while replications were separated by a 2.0 m alley.

Seed Material and Sowing

The cotton variety used for the study was SAMCOT-9 an erect, hairy, and medium staple cultivated commercial variety adapted to the North-West cotton growing zone of Nigeria under rain-fed conditions. Maturity period is between 130 and 150 days with a potential yield of 1500–2000 $Kgha^{-1}$. It was obtained from the Cotton Research Programme of the Institute for Agricultural Research (IAR), and the seeds were treated with Dress Force 42WS (Imidacloprid 20% + Metalaxyl-M 20% + Tebuconazole 2%) 8 g/kg before sowing. Seeds were sown at 4 seeds per hole at a depth of 3 cm, 90 cm inter-row spacing, and 40 cm, 45 cm, and 50 cm intra-row spacing into the prepared ridges. Emerged seedlings were thinned to two plants per stand at 3WAS. A mixture of Paraquat and Butachlor as pre-emergence at the rate of 1 L/ha was applied. Supplementary hoe weeding was done throughout, especially at the critical growing periods of weeds interference. Fertilizer was applied at the recommended rate of 60:13:25 kg/ha using NPK 15:15:15 at 3WAS and urea was used for top dressing at 8WAS.

Data Collection and Analysis

Five plants were randomly selected from each net plot and observations were recorded on these plants on percent boll infestation, yield, and percentage yield loss. Data on percentage boll infestation and percentage yield loss were transformed using arcsine transformation. All transformed data were subjected to analysis of variance (ANOVA) using SAS software package (version 9.0). Mean differences among treatments were separated using Student's-Newman's-Keuls test (SNK) at $P = 0.05$.

RESULTS AND DISCUSSION

Effect of Intra-row Spacing on Fruiting Bodies Infestation by Bollworms at Samaru and Maigana in 2016 Wet Season

The effects of the three intra-row spacings on the percentage of fruiting bodies infested by bollworms were found to be similar ($P > 0.05$) in the two locations and their combined data, although lower boll infestation was recorded on the 50 cm intra-row spacing. This could be as a result of narrow intra-row spacing which could allow continuous feeding activities of the bollworms resulting in the observed higher percentage of the fruiting bodies infested as well as a little reduction observed from the wider intra-row spacing that could hinder their activities. This agrees with the finding of Butter *et al*.[9] who evaluated the effect of intra-row spacing on the incidence of bollworms on cotton and observed that closer spacing of 75 cm × 15 cm recorded higher incidence of cotton bollworms on locule basis than the wider spacing of 75 cm × 30 cm. Similarly, the impact of plant spacings on the population dynamic of sucking pests of cotton has shown that lower intra-row spacing (12.5 cm) resulted in higher populations of both jassids (*Amrasca devastans*) and thrips (*Thrips tabaci*) than wider intra-row spacing (32 cm) that resulted in lower populations of the two insects.[10] It has also been reported that high crop density will interfere with applied insecticide from reaching the target plant parts leading to improper coverage.[8] However, it has been reported that adoption of intra-row spacing for the control of bollworms will render the crop more accessible to insecticides or biopesticides, thus targeting the larvae more readily.[1]

Effect of Intra-row Spacing on the Yield of Seed Cotton at Samaru and Maigana in 2016 Wet Season

The three intra-row spacings present similar ($P \geq 0.05$) effect on the yield of seed cotton and this was similar for the two locations and their results combined. Although, highest yield of seed cotton was obtained from the 50 cm intra-row spacing, this was similar ($P \geq 0.05$) with the 40 cm and 45 cm intra-row spacings. This observation could be attributed to the optimization of the microclimate in the immediate environment by the crop and the restricted movement of the bollworms to cause substantial damage in the wider intra-row spacing compared to the narrow intra-row spacing which will manifest in yield reduction.[9] It has also been reported that plant population density (inter-rows and inter-holes spacing, and the number of plants per hill) is very important agronomically for each crop, because it enables optimum utilization of climatic and soil resources by the plant, and when considering crop protection should be adjusted in a way suitable for plant growth, that will create less favorable microclimatic conditions for pests and diseases.[11] Similarly, cotton planted on solid row and wider spacing had higher yield than those planted on skip row with narrow spacing.[12] The result of the experiment on okra pod yield has also shown that the highest number of okra pods per plant was obtained from plots planted at the widest spacing of 60 cm × 70 cm while the lowest pods per plant were obtained from 60 cm × 20 cm planted plots.[13] Evaluation of the effects of inter- and intra-row spacing on the yield of okra also revealed that wider intra-row spacing significantly increases yield and yield components of okra compared to lower yield obtained from the narrow intra-row spacing.[14] It has also been reported that the use of different inter-intra row spacing significantly influenced yield losses of tomato cultivars and that incidence of disease and insect attack were higher in plot with narrow inter- and intra-row spacing which gave the highest fruit yield but significant highest percentage of marketable fruit yield was recorded in plots with wider inter- and intra-row spacing.[15]

Effect of Intra-row Spacing on Percentage Yield Loss of Seed Cotton at Samaru and Maigana in 2016 Wet Season

The result of the two locations combined indicated no significant difference in percentage yield loss of seed cotton among the three intra-row spacings. However, at Samaru, 50 cm intra-row spacing recorded lower percentage yield loss similar ($P \geq 0.05$) to the 45 cm but significantly ($P \leq 0.05$) lower than the 40 cm spacing [Tables 1-3]. However, both 45 cm and 40 cm intra-row spacings had similar ($P \geq 0.05$) yield loss. The percentage yield loss obtained in Maigana from the three intra-row spacings was found to be similar ($P \geq 0.05$). This observed difference in percentage yield loss of seed cotton in the wider intra-row spacings could be attributed to restricted movement of bollworms from causing continuous damage to the bolls in contrast to the narrow intra-row spacing, which could aid the voracious ability of the bollworms. The observation from this study supported by the finding, which indicated an inverse relationship between okra leaf damage area and increased plant spacing, in other words, increased plant spacing will probably lead to reduced leaf damaged area.[16] Osipitan *et al*.[13] reported that okra planted at a closer spacing of 60 cm × 30 cm and 60 cm × 40 cm recorded significantly higher populations of flea beetle and more leaf damage than the wider spacing of 60 cm × 60 cm and 60 cm × 70 cm, which recorded lower population, and less damage from flea beetles.[13] It has also been shown that disease and insect attack were higher at narrower inter- and intra-row spacing, and that the highest (56.7%) percentage of marketable tomato fruit yields was obtained from 40 cm intra-row spacing and the lowest (55.0%) percentage of unmarketable tomato fruit yields obtained from 20 cm intra-row spacing.[15] Closed spaced vegetable crops have also been reported to suffer more from disease and insect pest attack due to closing up of canopy, which diminish the amount of chemical spray reaching the lower part of plant, and also create conducive environment for disease and insect pest development.[17] This agrees with the findings from this study where at closer intra-row spacing, the cotton canopy is much closed thus preventing better penetration of the applied sprayed botanical.

Table 1: Effect of intra-row spacing on percentage infestation of fruiting bodies in Samaru and Maigana

Mean percentage infestation of bollworms in fruiting bodies 17WAS (%)			
Treatments	**Samaru**	**Maigana**	**Combined**
Intra-row spacing (cm)			
40	50.6	43.4	47.0
45	50.2	43.2	46.7
50	49.2	42.6	45.9
SE±	1.340	0.907	0.796
Significance	NS	NS	NS

NS: Not significant at P=0.05 using SNK

Table 2: Effect of intra-row spacing on yield of seed cotton 21WAS in Samaru and Maigana

Mean yield of seed cotton in Kgha-1			
Treatments	**Samaru**	**Maigana**	**Combined**
Intra-row spacing (cm)			
40	1478.8	580.4	1029.6
45	1563.0	584.1	1073.6
50	1702.6	610.1	1156.4
SE±	101.82	32.58	66.90
Significance	NS	NS	NS

NS: Not significant at P=0.05 using SNK

Table 3: Effect of intra-row spacing on percent yield loss of seed cotton 21WAS in Samaru and Maigana

Mean percentage yield loss of seed cotton ha-1 (%)			
Treatments	**Samaru**	**Maigana**	**Combined**
Intra-row spacing (cm)			
40	38.7a	33.2	36.0
45	37.5ab	32.6	35.1
50	34.4b	31.4	32.9
SE±	1.710	0.870	1.274
Significance	*	NS	NS

Means followed by same letter (s) within the same column are not different statistically at P=0.05 using SNK. NS: Not significant, *: Significant at $P \leq 0.05$

CONCLUSION

The demonstrated by the use of 50 cm intra-row spacing in this study suggests its practicability and effectiveness as a potential cultural method for managing bollworms infestation on cotton which can be integrated with other methods in an IPM program in an eco-friendly manner.

Recommendation

Based on the above results, it is recommended that for plantation establishment of cotton using SAMCOT-9, the farmer should adopt the use of 50 cm intra-row spacing for reduction in bollworm infestation as well as increase in yield.

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