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ASSESSMENT OF ECONOMIC INJURY LEVELS OF COTTON SEED BUG, *Oxycarenus gossypinus* DIST. (HEMIPTERA: LYGAEIDAE) ON COTTON IN SAMARU ZARIA, NIGERIA

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ABSTRACT

Field trials were carried out during 2021 and 2022 cropping seasons at Samaru, Zaria to study the economic injury levels (EIL) of *Oxycarenus gossypinus* on cotton. Nymphal instar at levels 0 (control), 10, 20, 30, 40 and 50 per meter row of (SAMCOT- 9) cotton variety were released at boll forming stage into caged cotton. The treatments were arranged in a randomized complete block design (RCBD) replicated four times. Parameters assessed included, number of bolls produced; healthy and damaged, their weight and the rate of association between nymph density, weight of lint and lint staining rate. There was a decrease in yield of cotton with an increase in number of nymphs of O. *gossypinus* in the caged cotton. Weight of stained lint increased from 0.17 kg ha^{-1} to 4.69 kg ha^{-1} when cotton seed bug was infested with zero (where no nymph released) to 50 nymphs per caged plant, respectively. The cotton seed also decreased from 24.17 kg ha^{-1} to 15.38 kg ha^{-1}. The ratio of the value of yield saved to the cost of insecticide application at ten nymphs per meter row in 2021 was 0.69 and in 2022, was 0.78. The mean EIL value for *O. gossypinus* nymph was determined as 1.30 nymphs per meter row. Hence, appropriate control measures should be adopted to check regular increase in the cotton seed bug population to avoid cotton lint quality losses in the study area, this would ensure judicious and sound use of insecticides.

Keywords: Cotton; economic injury levels, *Oxycarenus gossypinus*, seed bug

INTRODUCTION

Cotton, *Gossypium hirsutum* L, belongs to the family Malvaceae (Paterson, 2009). It is a shrub, native to tropical and sub-tropical regions of the world. It is an important fiber crop, which is cultivated in more than 80 countries of the world (Kutama *et al*., 2015). Despite the strategic importance of cotton in national economic development, its productivity in most parts of the world is steadily declining (James, 2007; Anonymous, 2013). Primary among these production constraints is insect pest infestation, which often times necessitate control through intensive use of synthetic chemicals and the use of high yielding cultivars geared at managing insect pests that are a major problem in cotton production (Naranjo *et al*., 2008; Rafiq, 2014; Akhtar, 2016).

However, with the introduction of new varieties of cotton and changes in the sowing dates of cotton, the pest status of the crop has changed. Incidence of minor insect pests like the cotton seed bug and other sucking pests on cotton is becoming a great threat to cotton production in Nigeria. The cotton seed bug is flourishing, multiplying rapidly, and caused premature falling of flowers, squares and small bolls (Khan *et al*., 2014). *O*. *gossypinus* causes considerable reduction in weight of seeds, their viability, and their oil content (Schaefer and Panizzi, 2000). According to Srinivas and Patil (2004) the cotton seed bug caused 42.9 %, 40.8 %, 35.1 %, and 29.3 % losses in seed cotton weight, seed weight, oil content, and seed germination, respectively, when the population was 50 per plant. Very little research has been conducted on the assessment of lint quality losses caused by different densities of this bug on cotton (SAMCOT -9) in Nigeria and this could hinder the development of effective integrated pest management strategies against the pest in the country. Therefore, the presence research was carried out to assess the economic injury level and lint quality losses caused by different densities of cotton seed bug.

MATERIALS AND METHOD

Study Area

Field experiments were conducted during 2021 and 2022 cropping seasons at the Institute for Agricultural Research (IAR) Farm at Samaru, Zaria (11^{o} 11' N, 7^{o}38' E) in the northern Guinea Savanna of Nigeria. The fields were ploughed, harrowed, and ridged. Single super phosphate fertilizer was applied prior to planting at 31.5 kg P_2O_5 ha^{-1} for proper root development. SAMCOT 9 variety was used in both years. This variety of cotton is characterized by reddish stem, adapted to northern Nigeria cotton growing zone, medium maturing (130-150 days), with estimated yield of 1.5-2.0 tons per ha, medium staple, fine lint with good luster, and resistant to bacteria blight (IAR, 2015).

Experimental Design, Field Layout and Data Collection

The experiments were laid out in randomized complete block design (RCBD) with four replications. Three seeds were sown per hole at the spacing of 90 cm by 40 cm, later thinned to two per stand. Two plants were covered with screen mesh cages of size 0.50 m x 0.50 m x 0.50 m as adapted from Musa *et al*. (2021) for each treatment before square initiation to avoid natural infestation by other sucking insects.

Table 1: Scale for determination of visual staining of lint caused by *D. volkeri* population

Scale	Lint staining (%)	Colour of lint
1	0	Pure white
2	1-20	White
3	21-40	Light yellow
4	41-60	Slightly yellow
5	61-80	Slightly dark yellow
6	81-100	Dark yellow

Source: Khan *et al.* (2014) as modified

During artificial infestation, *O. gossypinus* were placed directly on the bolls between 6.00 and 7.00 am. A camel hairbrush was used to transfer the different nymph densities (0, 10, 20, 30, 40 and 50) newly emerged adult of *O. gossypinus* per two plants. At maturity, total number produced, and damaged bolls were recorded, weight of total lint from all the covered plants in each cage was determined, the color of the lint picked from each boll of each respective treatment was visually observed and graded as per scales for determination of visual staining of lint (Table 1).

Data Analysis

The relationship between the nymph density and lint yield was determined by regression analysis. Yield data were extrapolated to kg ha^{-1} and yield losses due to different *O. gossypinus* rates were derived by deducting the yield of respective treatment from the yield of untreated control (where no *O. gossypinus* were released). The monetary values of yield losses were determined according to the prevailing market price of cotton lint at Samaru just after harvest. Lamda cyhalothrin at one litre was considered for calculating the cost of insecticidal application. Three spray applications of Lamda cyhalothrin at one liter per hectare according to Musa *et al.* (2021) were done for calculating the cost of insecticidal applications. Benefit cost ratio (BCR) was worked out as the ratio of the value of yield saved to the cost of insecticidal application. The economic injury level for cotton seed bug nymph was calculated by linear regression equation as follows:

$$Y = a + bX$$

Where, Y = yield per cage, a = a constant (the y intercept), b = yield loss per *O. gossypinus*, X = number of nymphs per cage. EIL = gain threshold, yield reduction per *O. gossypinus*. Gain threshold = management cost ₦ha^{-1}Market value of lint ₦kg^{-1}.

RESULTS

Effect of *O. gossypinus* infestation on boll produced, damaged bolls, total weight of lint produced and weight of damaged yield loss and stain lint of cotton in 2021 and 2022 cropping Seasons. Table 2 showed that there were significant differences ($P<0.05$) on mean number of bolls produced among the cotton plants infested with 10, 20, 30, 40 and 50 nymph densities and untreated control. However, 10 (53.50) and 20 (49.00) nymph densities statistically recorded a similar number of bolls which were at par with 50 nymphs per metre row length. A lower number (42.50) of bolls was produced from 30 nymphs per row but was also statistically similar to 20 and 50. There was a significant difference ($P<0.05$) among nymph densities on number of bolls damaged. Forty nymphs had the highest mean (31.00) of boll damaged and were significantly different from 20 nymphs (18.75). Similarly, among the nymph caged, significant differences were observed between 30, 50 and 10 densities. The lowest mean number (3.25) of bolls damaged was recorded with zero nymphs (untreated) per cage.

Plants with no caged nymph had significantly higher weight of lint (24.17 kg) compared with those caged with 10, 20 and 50 nymph densities. The lowest mean weight of lint was obtained on the cotton plants caged with 30 nymph (11.77 kg) density. Cotton plants caged with 50 number of nymphs had significantly ($P<0.05$) higher weight of stained (4.69

kg) which were at par with 40 nymph (3.02 kg) densities. There were significant differences ($P<0.05$) between cotton caged with 20 and 30 nymph densities on weight of stained lint. Similarly, 10 number of nymphs had significantly higher weight (0.97 kg) of stained lint which was at par with zero (0.17 kg) number of nymphs.

Cotton plants caged with 30 and 40 numbers of nymphs had significantly higher percent yield reduction compared to 10, 20 and 50 number of nymphs which was at par with zero nymph density. On the stain colour, zero infestation *O. gossypinus* were rated as pure white lint while 10, 20 and 30 nymph densities were categorized as light yellow stained. Infestation of 30 and 40 nymph densities were rated as slightly yellow stained. None of the cotton lint was white, slightly dark yellow or dark yellow due to *O. gossypinus* infestation. A strong positive correlation was found ($r^2 = 0.69$) between nymph density and damage lint (Fig. 1).

Table 2: Combined average effect of *O. gossypinus* infestation on boll produced, damaged bolls, weight of lint yield loss and stain colour of cotton in Samaru

Density of Nymph	Total No of bolls produced	No of bolls damaged	Total weight of lint (kg/ha)	Weight of stain lint (kg/ha)	Yield loss (%)	Stain colour
0	58.50a	3.25e	24.17a	0.17f	0.00c	Pure white
10	53.50abc	9.00d	16.22b	0.97e	32.19b	Light yellow
20	49.00bcd	18.75b	15.52b	2.47c	35.15b	Light yellow
30	42.50d	12.50c	11.77c	1.90d	50.92a	Slightly yellow
40	55.75ab	31.00a	10.69c	3.02b	55.16a	Slightly yellow
50	45.25cd	14.25c	15.38b	4.69a	35.68b	Light yellow
Mean	50.75	14.79	15.63	2.21	34.85	
SE ±	2.287	0.956	0.825	0.092	2.858	

Means within the same column followed by the different letter(s) are significantly different at ($P\leq0.05$) of Student Newman Keuls (SNK) Test.

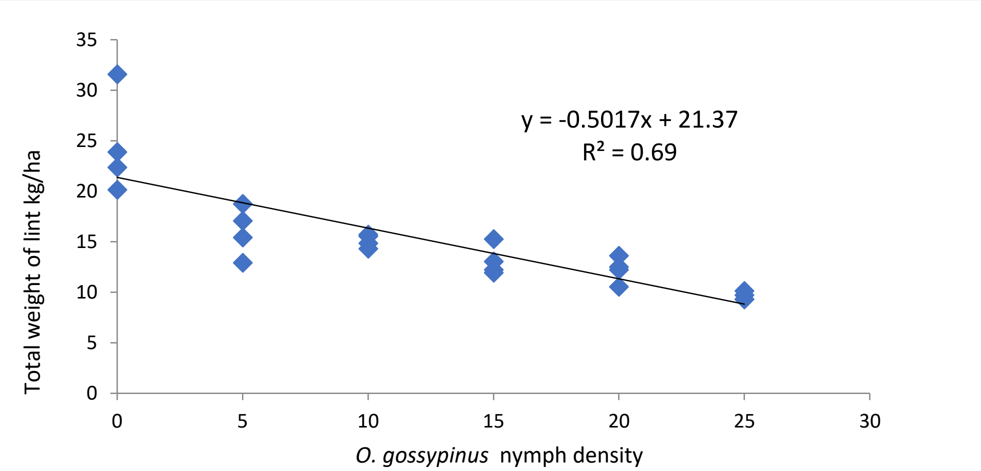

Fig 1: Combined relationship between *O. gossypinus* nymphs and weight of cotton seed lint in 2021 and 2022 cropping seasons

Table 3: Economic analysis of *O. gossypinus* management of cotton plant at Samaru during 2021and 2022 cropping seasons

Density of Nymph/cage	2021			2022						2021	2022
	Yield loss Kg/ha	Value of yield loss ₦/ha	Value of yield loss saved ₦/ha	Yield loss Kg/ha	Value of yield loss ₦/ha	Value of yield loss Saved ₦/ha	Cost of insecticide (₦)	Cost of labor (₦)	Total cost (₦)	BCR	BCR
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	32.19b	12,877	10,301	35.11b	14,748	11,790	7, 500.00	7, 500.00	15, 000.00	0.69	0.78
20	35.15b	14,058	11,246	36.64b	15,388	12,310	7, 500.00	7, 500.00	15, 000.00	0.74	0.82
30	50.92a	20,367	16,293	44.89ab	18,856	15,090	7, 500.00	7, 500.00	15, 000.00	1.08	1.01
40	55.16a	22,064	17,651	48.77ab	20,483	16,390	7, 500.00	7, 500.00	15, 000.00	1.17	1.09
50	35.68b	14,271	11,417	59.56a	25,015	20,010	7, 500.00	7, 500.00	15, 000.00	0.76	1.33

The price of cotton in Zaria during 2021 and 2022 were ₦400.00 /kg and ₦420.00 /kg respectively, cost of Lamda cyhalothrin per liter was ₦2,500.00 /lit. 3 lit were used. Labour ₦ 7,500.00

To calculate the EIL, it was necessary to know not only the rate of yield reduction in question but also the cost of controlling the insect and market price of the crop. In the year under review, one liter of Lamda cyhalothrin was selling at ₦ 2,500.00. The field was sprayed three times at rate of 1 liter / spray. For spraying 1 liter three times (₦2, 500.00 × 3 = N7, 500.00). Application cost of five laborers for the three applications = ₦500.00 × 5 × 3 = ₦7, 500.00. Therefore, cost of insecticides and application cost = N7, 500.00 + ₦7, 750.00 = ₦ 15, 000.00.

The market price of cotton in January 2021 and 2022 were ₦ 400 per kg and ₦420.00 per kg, respectively. Therefore, the average market price of cotton per kg = ₦410.00. The ratio of the value of yield saved to the cost of insecticide application at ten nymphs per meter row was 0.69 and 0.78 during 2021 and 2022, respectively (Table 3). The mean regression equation for 2021 and 2022 derived is as follows:

$$Y = 0.502 X + 21.37$$

Where, X = *O. gossypinus* density per meter row, Y = BCR.

DISCUSSION

Increasing cultivation of cotton on a large scale and reduction in insecticide application on bollworms in cotton agro ecology, cotton seed bug, which was considered as minor pest causing damage to reproductive parts of the cotton plant at different developmental stages is crucial. The study revealed that the bug damage bolls, seed cotton lint and these affect lint color. The total weight of cotton lint per plant in the cages ranged from10.69 kg/ha to 24.17 kg/ha. The present study was in agreement with Khan *et al.* (2014) who reported that the dusky cotton bug has the potential for causing serious damage to cotton in terms of cotton seed weight and cotton lint. The percentage lint damage increased with increasing nymph density, this may be as a result of cannibalism when the population of nymph was high up to a point. This corroborated the reports of Musa *et al.* (2021) who observed proportionate increase in damage of cotton lint with increase in the adult population levels of *D. volker*. Sewify and Semeadaj (1993) reported 6.8%, 32%, and 6% reduction in cotton yield, seed weight, and oil content, respectively. In the present study, the minimum yield reduction per nymph was 32.19 % per plant at the lowest pest density. These findings are in conformity with Schaefer and Panizzi (2000) which reported a considerable reduction in weight of seeds due to attacks by the dusky cotton bug. The cotton seed bug has the potential to cause serious damage to cotton seed weight and cotton lint. Hill (1983) also reported it as a major pest in Southeast Asia, India, and Africa on both cotton and okra.

The mean values of EIL in the 2021 and 2022 cropping seasons were found to be 1.33 using Lamda cyhalothrin insecticides. This might be associated with the lower damage potential and higher management costs in both years. Thus, EIL value increased with increase in the cost of protection. According to the lint staining scale used, the color of lint changed from pure-white to light yellow when bolls were exposed to 10 and 20 pairs of bugs, whereas the color changed to slightly yellow when bolls were exposed to 30 and 40 pairs of cotton seed bugs. These results were not in agreement with those of Henry (1983), who reported that lint of cotton was stained pinkish from crushed insects. The variation in result may be attributed to the fact that the observed color of lint after crushing the insects, while the color of lint in the present study was observed after feeding by the nymph cotton seed bugs. The yellow coloration may be due to the reaction of toxic saliva, secreted during feeding, with immature cotton lint as reported by Schaefer and Panizzi (2000).

CONCLUSION

From the economic injury level values obtained in this study the infestation of *O. gossypinus* at low population level can cause significant yield loss. Hence, appropriate control measures should be adopted to check regular increase in the cotton seed bug population to avoid cotton lint quality losses due to stains in the study area, this would ensure judicious and sound use of insecticides.

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