Journal of Agriculture and Environment Vol. 18 No. 1, 2022: 37-45
ISSN: 1595-465X (Print) 2695-236X (Online)

RESPONSE OF COTTON VARIETIES TO FEEDING BY *Dysdercus volkeri* F. (HEMIPTERA: PYRRHOCORIDAE) IN ZARIA, KADUNA STATE

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ABSTRACT

Field trials were conducted in 2019 and 2020 cropping seasons at Samaru, Zaria and Kadawa to study the influence of cotton varieties on the populations of *Dysdercus volkeri* under unsprayed conditions. The experiments were laid out in Randomized Complete Block Design (RCBD) replicated four times. Number of *D. volkeri* nymph and adult populations, number of bolls produced, number of boll damaged, percent boll damaged and weight of cotton lint produced were assessed. The results showed that SAMCOT 11 and 12 had high significant ($P \leq 0.05$) number of nymph populations compared with SAMCOT 9 and 10 varieties in Samaru. While in Kadawa, SAMCOT 8 had lowest number of nymph populations compared with SAMCOT 9, 11 and 13 varieties. Adult populations were high ($P \leq 0.05$) from both locations on SAMCOT 8, 10 and 12 compared with SAMCOT 9, 11 and 13 varieties. Based on the number of boll damaged SAMCOT 8, 9 and 11 significantly ($P \leq 0.05$) had higher bolls damaged in both locations. Cotton lint damaged was high on SAMCOT 8, 10 and 12 varieties compared with SAMCOT 9, 11 and 13 varieties, however, in Kadawa SAMCOT 10 and 11 had the highest lint damaged compared with SAMCOT 12 and 13 varieties. SAMCOT 8, 9, 10 and 11 varieties recorded with high number of boll damaged, least weight of lint damaged and higher weight of lint per hectre and low population of *D. volkeri* across the two locations.

Keywords: *Dysdercus volkeri*; Population; SAMCOT; Yield

INTRODUCTION

Cotton, *Gossypium hirsutum* L., belongs to the family Malvaceae (Paterson, 2009). It is an important fiber crop, which is cultivated in more than 80 countries of the world. In Nigeria, cotton is the fifth most important export crop after cocoa, groundnut, oil palm, and rubber and one of the major sources of foreign exchange for the country (Kutama *et al*., 2015). The crop is adaptive to most ecological zones and is being cultivated in the Northern, Eastern and Southern part of the country. However, Northwest ecological zone which comprises of Kaduna, Kano, Katsina, Jigawa, Sokoto, Kebbi and Zamfara produce about 60 – 65 % of cotton in Nigeria (CBN, 2017). There are seven cotton varieties currently in commercial production in Nigeria, they are SAMCOT 8, 9, 10 (medium staples), 11, 12 and 13 (long staples) which are cultivated in the North- east, North-west, North- central, Southeast and South- west and Bt cotton, respectively (Gbadegesin *et al*., 2007). Katsina State is the largest producer of the commodity, producing between 90,000 and 100,000 metric tons of cotton over the last five years (FMARD, 2013).

However, among the major constraints hindering cotton cultivation are diseases and insect pests. Several insect species that belongs to the family Pyrrhocoridae are serious pests of cotton worldwide (Gutierrez *et al*., 2005; Sontakke *et al*., 2013; Jaleel *et al*., 2013) with cotton stainer causing significant losses of between 30-and 100 % in Nigeria if not controlled (Amatobi, 2007; Horna *et al*., 2009). Jaleel *et al*. (2013) are of the view that both adult and nymphal stages feed on seed inside the boll and produce the stains on the lint. It inserts the stylet into the bolls, reach to the seed; thus, the feeding damage causes reduction in size and finally the fruiting body may be aborted. Apparently, the most effective method of control is the use of broad-spectrum insecticides; however, misuse of pesticides is always associated with pest resistance to insecticides and may consequently lead to adverse economic and environmental problems (Yousuf *et al*., 2012). The use of cotton varieties that are resistant to attack by insect pests is one of the most promising alternative management strategies since it is economically and environmentally safe. A better understanding of pest populations is needed in order to integrate these and other pest control options into an overall integrated pest management (IPM) plan to maximize cotton production. Therefore, the study was undertaken to evaluate the influence of cotton varieties on the population of *D. volkeri* in the study area.

MATERIALS AND METHODS

Experimental Sites

Field trials were conducted in 2019 and 2020 cropping seasons at Institute for Agricultural Research (IAR) Samaru, Zaria (11^0 11’ N, 07^0 38’ E and 686 m above sea level in the Northern Guinea Savanna Zone and or at (location of the trials) Irrigation Research Station of IAR, Kadawa, Kano State (11^0 39’ N, 08^0 27’ E and 500 m above sea level in the Sudan Savanna of Nigeria.

Land Preparation

The field was sprayed with a herbicide, 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). Two days after sowing a mixture of Paraquat and Butachlor at the rate of 2 L /ha was applied to control weeds.

Description of Cotton Varieties

The six varieties of cotton namely, SAMCOT 8, 9, 10, 11, 12 and 13 were obtained from Cotton Research Unit, IAR, Ahmadu Bello University, Zaria and they had the following characteristics:

Table 1: Description of cotton varieties used

Variety	Days to Maturity	LOS	Yield kg/ha	Other attributes
SAMCOT 8	120-130	MSL	1,500- 2,000	tolerant to bacterial blight
SAMCOT 9	130-150	MSL	1,500-2,000	erect, hairy, tolerance to bacterial blight
SAMCOT 10	130-150	MSL	1,500	hairy and moderately resistant to bacterial blight
SAMCOT 11	140 -150	LSL	1,500	moderately resistant to bacterial blight
SAMCOT 12	160-165	LSL	1,500	moderately resistant to bacterial blight
SAMCOT 13	160-165	LSL	1,500	moderately resistant to bacterial blight

Source: Anonymous (2017). LOS = length of staple, MSL = medium staple length, LSL = long staple length

Treatments and Experimental Design

The treatments consisted of six cotton varieties (SAMCOT 8, 9, 10, 11, 12, and 13) planted to plots measuring 4.5 m x 4.5 m (Gross plot of 6 rows and 4.5m long) and 3.5m x 2.7m (Net plot of 4 rows and 3.5m long), they were replicated four times, giving a total of 24 plots. Plots within a replicate were separated by a 1.5 m alley while replicates were separated by a 2.0 m alley and arranged in a Randomized Complete Block Design (RCBD).

Weeding and Fertilizer Application

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. NPK 20:10:10 fertilizer was applied at the recommended rate of 100: 30: 30 Kg/ha at 4WAS and Monoammonium Phospate (MOP) applied at 3 WAS, and top-dressed Urea (46 %) at 8 WAS. The experimental plots were kept free from sucking and bollworm insects attack by spraying (Imidacloprid 20 % SL) and (Emamectin Benzoate 1.9 EC) 2L/ha once at square to flower formation (50 days) after sowing. Fungal infections were also 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).

Data Collection

The population of *D. volkeri* was monitored and recorded on three randomly selected plants from top, middle and bottom leaves at two weeks interval from boll formation (85-105 days) to maturity stages (130- 160 days).

Table 2: Scale for determination of visual staining of lint caused by *D. volkeri* populations

Scale	Percentage 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

Number of *D. volkeri* nymphs and adults, number of bolls produced, boll damaged, percentage boll damaged, weight of seed cotton, cotton lint stained, and percentage cotton lint stained were determined. Based on the percent lint stain assessment, visual staining score was done for each variety using a scale by (Khan *et al.* 2014) as modified (Table 2).

Data Analysis

Data were analyzed using Analysis of Variance (ANOVA) (SAS, 2003) and means were separated using Students Newman Keuls (SNK) (P≤0.05).

RESULTS

The cotton varieties were exposed to *D. volkeri* at different weeks after sowing in 2019 and 2020 cropping seasons at Samaru and the results obtained are presented hereunder.

Table 3: Influence of cotton varieties on mean populations of *D. volkeri* at different weeks after sowing in 2019 and 2020 cropping seasons at Samaru

	Mean population of *D. volkeri* at WAS						
Varieties	12	14	16	18	20	22	24
SAMCOT 8	5.75	18.75^{a}	38.50^{a}	62.25 ^{a}	5.75^{b}	1.00^{cd}	3.00
SAMCOT 9	6.00	6.00^{c}	23.00^{b}	10.25^{de}	10.25^{a}	4.75^{bc}	2.75
SAMCOT 10	8.75	22.50^{a}	33.75^{a}	41.25^{b}	5.50^{b}	6.00^{ab}	3.25
SAMCOT 11	11.00	3.00^{c}	18.50^{b}	23.75^{c}	0.50^{c}	0.00^{d}	1.75
SAMCOT 12	7.75	7.00^{c}	40.00^{a}	7.25^{e}	10.00^{a}	8.75^{a}	3.00
SAMCOT 13	10.75	12.25^{b}	18.50^{b}	15.25^{d}	10.25^{a}	1.25^{cd}	5.25
Mean	8.33	11.58	28.71	26.67	7.04	3.63	3.17
SE ±	1.626	1.308	2.158	1.817	0.787	1.042	0.792

Means within the same column followed by the different letter(s) are significantly different at (P≤0.05) of Student Newman Keuls (SNK) Test. WAS = Weeks After Sowing

There was no significant difference recorded among the cotton varieties on population of *D. volkeri* adults at 12 WAS as shown in (Table 3). However, at 14 WAS, SAMCOT 8 and 10 recorded significantly higher *D. volkeri* adults' population which were at par compared to SAMCOT 12 and 13. The lowest number of adults was observed on SAMCOT 11 (3.00) though not significantly different from SAMCOT 11 and SAMCOT 12 varieties. At 16 WAS, among the six cotton varieties, SAMCOT 8 (38.50), SAMCOT 10 (33.75) and SAMCOT 12 (40.00) recorded similar and significantly (P≤0.05) higher number of *D. volkeri* adults than SAMCOT 9, 11 and 13. At 18 WAS, SAMCOT 8 had significantly higher (62.25) number of adults *D. volkeri* compared with other varieties. However, SAMCOT 11 had higher number of adults *D. volkeri* than SAMCOT 9, but the lowest number of adults (7.25) was recorded on SAMCOT 12, except that it was not significantly different from SAMCOT 9. At 20 WAS there was significant difference (P≤0.05) between the cotton varieties. Higher number of adult populations (10.25) of *D. volkeri* was recorded on SAMCOT 9, 12 and 13. SAMCOT 8 and SAMCOT 10 were not significantly different from each other. Similarly, significant differences were recorded on the cotton varieties on number of adult *D. volkeri* populations at 22 WAS. SAMCOT 12 and SAMCOT 10 varieties had significantly higher number of adult *D. volkeri* populations compared to SAMCOT 9 variety. The lowest number of adults was recorded on SAMCOT 8 except that it was significantly at par with SAMCOT 11 and SAMCOT 13 varieties. No significant differences were recorded on the populations of *D. volkeri* among the cotton varieties at 24 WAS.

The result in Table 4 showed that there was significant difference ($P \leq 0.05$) among the cotton varieties on percent lint stained. The percentage lint stained was statistically higher on SAMCOT 9 compared with other varieties except SAMCOT 8 and SAMCOT 10 varieties which were not significantly different from SAMCOT 12. The lowest mean percentage lint stained (61.10 %) was recorded from SAMCOT 11 variety and this was significantly different from other varieties. The varieties SAMCOT 8, 9 and 10 were categorized as dark yellow stained and SAMCOT 11, 12 and 13 were rated as slightly dark yellow. None of the varieties was pure white or slightly white due to *D. volkeri* attack.

Table 4: Response of *D. volkeri* infestation on boll production and seed cotton yield in 2019 and 2020 cropping season at Samaru

Varieties	MNBP	MWL (kg/ha)	MPLS	Stain colour
SAMCOT 8	74.50^{a}	411.11^{b}	$82.42a^{b}$	Dark yellow
SAMCOT 9	69.75^{a}	231.25^{c}	88.16^{a}	Dark yellow
SAMCOT 10	69.75^{a}	479.17^{a}	83.74^{ab}	Dark yellow
SAMCOT 11	34.75^{d}	243.06^{c}	61.10^{d}	Slightly dark yellow
SAMCOT 12	45.25^{c}	396.53^{b}	78.41^{b}	Slightly dark yellow
SAMCOT 13	55.50^{b}	362.15^{b}	69.87^{c}	Slightly dark yellow
Mean	3.11	353.88	77.28	
SE ±	57.833	18.442	1.815	

Means within the same column followed by the different letter(s) are significantly different at ($P \leq 0.05$) of Student Newman Keuls (SNK) Test.

MNBP = Mean number of bolls produced, MWL = Mean weight of lint (kg/ha), MPLS = Mean percentage lint stained

The result of the effect of cotton varieties on the population of *D. volkeri* showed that at 12 WAS, SAMCOT 8 significantly ($P \leq 0.05$) had higher mean populations of *D. volkeri* when compared to SAMCOT 9 but no significant differences were recorded among other varieties. On the other hand, at 14 WAS, there were significant differences ($P \leq 0.05$) between SAMCOT 13 and SAMCOT 11 varieties on the populations of *D. volkeri*. Similarly, among the cotton varieties, significant difference was recorded between SAMCOT 10 and SAMCOT 8 varieties on populations of *D. volkeri*. The lowest mean population (1.75) of *D. volkeri* was recorded on SAMCOT 9. At 16 WAS, SAMCOT 9, SAMCOT 13 and SAMCOT 8 varieties supported significantly similar *D. volkeri* mean populations when compared with SAMCOT 12 variety which was statistically at par with SAMCOT 10 variety (Table 5). With respect to 18 WAS, there were significant differences ($P \leq 0.05$) between the cotton varieties. SAMCOT 10, SAMCOT 11 and SAMCOT 13 varieties had significantly higher mean populations of *D. volkeri* compared with SAMCOT 9 (2.50) variety, the lowest mean population of *D. volkeri* was recorded on SAMCOT 8 but was not significantly different from and SAMCOT 12 variety. There was no significant difference among the cotton varieties in the population of *D. volkeri* at 20 WAS. However, at 22 WAS, SAMCOT 11 variety significantly ($P \leq 0.05$) recorded higher mean (14.25) populations of *D. volkeri* compared with SAMCOT 12 (6.25) variety, no statistical difference was recorded among other varieties. Similarly, at 24 WAS SAMCOT 9, SAMCOT 10, SAMCOT 11 and SAMCOT 13 varieties statistically had similar mean populations of *D. volkeri* when compared with SAMCOT 8 and SAMCOT 12 varieties.

Table 5: Response of cotton varieties on Mean populations of *D. volkeri* at different weeks after sowing in 2019 and 2020 cropping seasons at Kadawa

Varieties	Mean Populations of *D. volkeri* at WAS						
	12	14	16	18	20	22	24
SAMCOT 8	12.75[a]	3.75[d]	8.25[abc]	0.00[c]	2.00	5.00[bc]	0.00[b]
SAMCOT 9	9.00[b]	1.75[f]	13.75[a]	2.50[b]	0.50	0.00[c]	2.75[ab]
SAMCOT 10	4.25[c]	8.50[c]	5.00[cd]	5.75[a]	4.75	2.75[bc]	5.50[a]
SAMCOT 11	4.75[c]	9.50[b]	0.50[d]	7.00[a]	1.75	14.25[a]	2.75[ab]
SAMCOT 12	4.25[c]	3.25[e]	7.00[bc]	0.25[c]	2.00	6.25[b]	0.00[b]
SAMCOT 13	2.33[c]	17.67[a]	11.67[ab]	6.67[a]	0.67	0.00[c]	4.67[a]
Mean	6.39	6.97	7.52	3.57	2.00	4.91	2.52
SE ±	0.897	0.000	1.519	0.395	1.083	1.189	0.837

Means within the same column followed by the different letter(s) are significantly different at (P≤0.05) of Student Newman Keuls (SNK) Test. WAS = Weeks after Sowing

The results on number of bolls showed that SAMCOT 9 had statistically higher (P≤0.05) mean (51.50) number of bolls compared with SAMCOT 10 variety (Table 6). However, the lowest mean number of bolls was recorded on SAMCOT 13 but was statistically at par with SAMCOT 8 and 11. SAMCOT 10 had significantly higher weight of lint compared with SAMCOT 11, SAMCOT 13 varieties. The lowest weight of seed cotton seed (845.14 kg) was obtained from SAMCOT 8 but was statistically at par with SAMCOT 9 and SAMCOT 12. On percentage lint stained there were significant differences (P≤0.05) among cotton varieties on percent lint stained. SAMCOT 8 (86.99 %), SAMCOT 10 (79.06 %) and SAMCOT 11 (83.32 %) had significantly higher (P≤0.05) mean percent lint stained than SAMCOT 12 (33.90 %) variety. However, there was no statistical difference among the SAMCOT 9 and SAMCOT 13 varieties. On the stain colour, SAMCOT 8 and 11 were categorized as dark yellow stained, SAMCOT 12 and 13 were light yellow stained and SAMCOT 9 and 10 were white and slightly dark yellow stained, respectively. None of the varieties was pure white or slightly yellow due to *D. volkeri* attack.

Table 6: Response of *D. volkeri* infestation on boll production and seed cotton yield in 2019 and 2020 cropping season at Kadawa

Varieties	MNBP	MWL (kg/ha)	MPLS	Stain colour
SAMCOT 8	47.00[ab]	345.14[c]	86.99[a]	Dark yellow
SAMCOT 9	50.75[a]	443.75[c]	18.67[c]	White
SAMCOT 10	48.50[ab]	1006.25[a]	79.06[a]	Slightly dark yellow
SAMCOT 11	33.25[b]	777.43[b]	83.32[a]	Dark yellow
SAMCOT 12	34.25[b]	394.10[c]	33.90[b]	Light yellow
SAMCOT 13	43.00[ab]	718.06[b]	27.89[bc]	Light yellow
Mean	42.78	609.60	56.15	
SE ±	3.639	56.233	3.79	

Means within the same column followed by the different letter(s) are significantly different at (P≤0.05) of Student Newman Keuls (SNK) Test.

MNBP = Mean number of bolls produced, MWL = Mean weight of lint (kg/ha), MPLS = Mean percentage lint stained

DISCUSSION

Some cotton varieties were less preferred for feeding, oviposition and damage than others. SAMCOT 10, 11 and 12 in the present study attracted the highest populations of *D. volkeri* populations. This could be attributed to insect pest preference or non- preference for some cotton genotypes which may possess characters that affect the behavior and selection pressure of the insect during search for food, shelter, and oviposition. Stadler (1977) reported that biochemical factors affect the behavior and metabolic process of pest, while morphological factors mostly influence the mechanism of locomotion, feeding, oviposition, ingestion and digestion of pest. Heritable characteristics of some crops, race, species, clone or individual may reduce the probability of successful utilization of that plant as a host by an insect species, race, and biotype (Painter (1951) and Onyishi *et al.* (2013). SAMCOT 8, 11, and 13 had the least number of *D. volkeri* damaged on boll among cotton varieties having cream to purplish colour that could be less attractive to *Dysdercus* populations.

D. volkeri needs denser canopy formation as hiding places against predators (Shah *et al*., 2016). However, SAMCOT 8 and 9 varieties adopted in North- East and North-- West, respectively mature early and probably have passed stages of attack before the peak infestation of *D. volkeri* populations early- September through November in the study areas. Findings had shown that SAMCOT 12 had significantly higher number of *Dysdercus*/boll damage compared to other varieties in 2019 at both locations. This could be attributed to their susceptibility to the insect pest infestations. Higher cotton lint stained ranged from white, light yellow, slightly yellow and dark yellow stained was observed across the two locations Kadawa and Samaru, due to the fact that some of the varieties were suitable for the growth and development of *Dysdercus* populations, as a result of their nutritional or antibiotic factors. This agrees with who reported that *D. volkeri* as a major economic pest of sunflower, through its feeding which removes sap from seed causing damage to the plant and yield reduction (Mani (2013)

SAMCOT 8, 9 and 10 lint were stained dark yellow, white, slightly dark yellow and slightly yellow stained across the two locations in 2019 cropping season compared to other varieties except SAMCOT 13 variety which showed light yellow stained lint. The findings of the present study were at variance with Henry (1983), who reported that lint of cotton is stained pinkish from crushed insects. The variation may be attributed to the fact that the colour of lint was observed after crushing the insects. The coloration observed in the present study may be from the reaction of saliva, secreted by the insect during feeding on immature cotton lint concurring with the report of Schaefer and Panizzi (2000). The fact that SAMCOT 9 variety adapted to North- West Nigeria did not give the highest cotton lint weight, could be as a result of genetic differences among the varieties. Low cotton lint yield output obtained in 2019 could be attributed to their susceptibility to insect pest infestation. The higher cotton lint weight recorded in SAMCOT 8, and SAMCOT 10 in Samaru in 2019 compared with other cotton varieties may be due to the genetic difference of the varieties.

CONCLUSION

Cotton lint stained was highest on SAMCOT 8, 9 and 10 in Samaru, while, in Kadawa SAMCOT 8 and SAMCOT 11 had the highest lint stained. Boll damaged was highest on SAMCOT 8, SAMCOT 9 SAMCOT 10 and SAMCOT 11 and they had the lowest mean weight of lint stained, higher weight of lint per hectare and low population of *D. volkeri* across the two locations. SAMCOT 9 cotton variety harbored low populations of *D. volkeri*, resulting in low boll damaged and stained lint (11.25, 18.67), respectively. SAMCOT 9 harbored low populations of *D. volkeri*, low number of bolls damage and lint stain, therefore can be utilized by the famers in the study areas and in breeding programme for the management of *D. volkeri* as a component of IPM package for cotton stainer control.

Acknowledgements

The authors are grateful to Mr. Elias Otokpa and Mohammad Saleh of Fibre Entomology Laboratory, Institute for Agricultural Research (IAR), ABU Zaria for technical and field assistance.

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