

INFLUENCE OF WEATHER FACTORS ON THE POPULATIONS OF *DYSDERCUS VOLKERI* F. (Hemiptera: PYRRHOCORIDAE) ON COTTON VARIETIES IN ZARIA, KADUNA STATE

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ABSTRACT

Field trials were carried out in 2019 and 2020 cropping seasons at Samaru, Zaria to study the influence of some weather factors on the populations of *D. volkeri* using six cotton varieties. The experiment was laid out in Randomized Complete Block Design (RCBD) replicated four times. Insecticides were not applied as the study was done under natural infestation condition. The parameters assessed included nymph and adult populations of *D. volkeri*, minimum and maximum temperature, rainfall and relative humidity. The results showed peak incidence of *D. volkeri* nymph and adult populations (36.83 and 34.92) per three plants between September and October, 2019 when temperature and relative humidity were 38 °C, 70 % and 31 °C and 81 %, respectively. On the other hand, peak nymph and adult populations (18.88 and 20.75) per three plants between September, and first week of November, 2020 when temperature, relative humidity were 31 °C, 81 % and 35 °C and 23 %, respectively. In 2019, SAMCOT 8 (14.71) and SAMCOT 11 (12.65) varieties had significantly higher ($P \leq 0.05$) *D. volkeri* nymph and adult populations compared to other varieties, while in 2020 SAMCOT 12 (9.71) and SAMCOT 13 (9.63) recorded significantly higher ($P \leq 0.05$) *D. volkeri* nymph and adult populations. There was positive correlation between minimum temperature and number of nymph in 2019 cropping season. While in 2020, *D. volkeri* nymph populations positively correlated with relative humidity, minimum temperature, and evaporation. Similarly, minimum temperature, sunshine hours, soil evaporation, wind speed positively correlated with relative humidity.

Keywords: *Dysdercus volkeri*, Temperature, Relative humidity, Cotton

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 (Kutama et al., 2015). In Nigeria, cotton is the fifth most important export crop after cocoa, groundnut, oil palm, rubber and one of the major sources of foreign exchange for the country (Kutama et al., 2015).

In Nigeria, cotton is adaptive to most ecological zones and is being cultivated in the Northern, Eastern and Southern part of the country. However, Northwest ecological zone comprises of Kaduna, Kano, Katsina, Jigawa, Sokoto, Kebbi and Zamfara produced about 60 – 65 % of cotton in Nigeria (Central Bank of Nigeria CBN, 2011). There are

seven cotton varieties currently in commercial production in Nigeria and these are SAMCOT 8, 9, 10 (medium staples), 11, 12 and 13 (long staples) which are cultivated in the Northeast, North West, North - Central, Southeast and Southwest (Gbadegesin et al., 2007) and Bt cotton, respectively. Katsina State has become the largest producer of cotton in Nigeria, producing 90,000 – 100,000 metric tons of cotton over the last five years (FMARD, 2013).

Diseases and insect pests are among the major constraints hindering cotton cultivation in Nigeria. Several insect species that belongs to the order Pyrrhocoridae are serious pests of cotton worldwide (Gutierrez et al., 2005; Jaleel, et al., 2013; Sontakke, et al., 2013) with

cotton stainer causing significant losses of between 30-100 % in Nigeria if not controlled (Amatobi, 2007, Hornaet *al.*, 2009). Apparently, the most effective method of control is the use of broad - spectrum insecticides; however, misuse of pesticides always associated with pest resistance to insecticides and may consequently lead to adverse economic and environmental problems (Yousuf *et al.*, 2012). Weather factors, mainly temperature, relative humidity and rainfall, play a vital role in the survival of *D. volkeri* which can decrease and/or increase its population in cotton growing fields (Ali *et al.*, 2013). 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 determine the influence of weather factors on the incidence of *D. volkeri* population in cotton varieties in Zaria, Nigeria.

MATERIALS AND METHODS

Experimental Sites

Field trials were conducted in the 2019 and 2020 cropping seasons at Institute for Agricultural Research (IAR) Samaru (11° 11" N, 07° 38" E and 686 m in the Northern Guinea Savanna Ecological Zone, Zaria, Nigeria.

Description of Cotton Varieties

The six cotton varieties, SAMCOT 8, SAMCOT 9, SAMCOT 10, SAMCOT 11, SAMCOT 12 and SAMCOT 13 obtained from Cotton Research Unit, IAR have the following characteristics: SAMCOT 8 is medium maturing (120-130 days), medium staple cultivated commercial variety adapted to the Northeast cotton growing zone of Nigeria; SAMCOT 9 is an erect, hairy and maturity period is between 130-150 days with a potential yield of 1500-2000 Kg/ha. It is tolerant to bacterial blight, adapted to the Northwest cotton growing zone. SAMCOT 10 is hairy and medium maturing (130 -

150 days) variety adapted to the North- Central cotton growing zone; SAMCOT 11 long staple, medium maturing (140 -150 days) variety, SAMCOT 12 and 13 maturity period are between 160-165 days with a potential yield of 1,500 kg/ha, tolerant to bacterial blight, adapted to the Southeast and Southsouth cotton growing zone of Nigeria, respectively (IAR, 2017).

Land Preparation and Experimental Layout

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. The six cotton varieties were sown on plots measured 5 m x 3 m in a Randomized Complete Block Design (RCBD), replicated four times.

NPK Fertilizer 20:10:10, MOP at 3 WAS and Urea (46 %) was applied as top dressing 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 during square to flower formation (50 days) after sowing. Fungal infection was also managed through foliar application of fungicide; Mancozeb 63 % + Carbendazim 12.5 % W. P (Fungu force®) at 2.5 Kg/ha during boll formation (70 days) after sowing.

Data Collection

The mean nymph and adult populations of *D. volkeri* was monitored and recorded from top, middle and bottom on three randomly selected cotton plants at weekly interval from boll forming to boll ripening stages. Numbers of nymph and adult populations of *D. volkeri* recorded were correlated with mean maximum, and minimum temperature (°C), relative humidity (%), rainfall (mm), and sunshine hours. Weather data was obtained from Meteorological Unit of IAR, ABU

Zaria. All data were statistically analyzed using Analysis of Variance and means were separated using SNK test at 5 % level of probability.

Results Weekly Mean Record of Nymph and Adult Populations of *D. volkeri* on Cotton based on some Weather Factors in 2019 and 2020 Cropping Seasons at Samaru

Table 1 shows the result on incidence of *D. volkeri* nymphs and adult populations in relation to temperature and relative humidity. The record on mean nymph and adult populations were 36.8 and 34.9 per three plants at the third week of October and September, 2019 when the temperature and relative humidity were 39°C, 70 % and 31 °C, 70 %, respectively. The peak record of mean nymph and adult populations 18.9 and 20.8 per three plants was in second week of October and first week of November, 2020 when the field temperature and relative humidity were 31°C, 81 % and 33°C, 69 %, respectively. The lowest record of mean nymph and adult populations was in the first and second week of September and November for both years when the temperature and relative humidity were 32°C, 73 % and 29°C and 15 %, respectively.

Populations of *D. volkeri* on Cotton Varieties with Corresponding Weather Factors during 2019 and 2020 Cropping Seasons

The result in Table 2 showed that there was significant difference ($P \leq 0.05$) among the cotton varieties in 2019 and 2020 cropping seasons, respectively. However, in 2019 SAMCOT 11 had higher ($P \leq 0.05$) mean of *D. volkeri* nymph populations compared to SAMCOT 8 when the temperature and relative humidity were 24.5 °C and 49 %, respectively, no significant difference was recorded on other varieties. Mean adults population was higher ($P \leq 0.05$) on SAMCOT 8 compared to SAMCOT 10 variety. SAMCOT 9, SAMCOT 12 and SAMCOT 13 statistically recorded similar number of adults; the lowest mean of adult populations was recorded on SAMCOT 11 under the same temperature, relative humidity and rainfall. Similarly, in 2020 SAMCOT 12 and

SAMCOT 13 had higher ($P \leq 0.05$) mean number of nymphs when the temperature and relative humidity were 24.6 °C and 43.6 %, respectively, compared to SAMCOT 9 but was statistically similar with SAMCOT 10. The lowest mean numbers of nymphs were recorded on SAMCOT 8 variety which was at par with SAMCOT 11 variety. However, in 2020 there was no significant difference among the cotton varieties on adult populations of *D. volkeri*.

Correlations of *D. volkeri* Populations and Weather Factors

There was significant and positive correlation between minimum temperature (0.85*) and number of nymphs in 2019 cropping season as shown in Tables 3 and 4, respectively. Similarly, minimum temperature, sunshine hours, soil evaporation (0.86**), wind speed (0.69**) positively correlated with relative humidity. Sunshine hours (0.67**), rainfall (0.67**), soil evaporation (0.85**) and wind speed (0.69**) highly and significantly correlated with minimum temperature.

In 2020 there was highly significant and negative correlation between relative humidity (-0.70**), but positively correlated with minimum temperature (0.61**), soil evaporation (0.63*) and number of nymphs. However, maximum (-0.08) and minimum temperature (-0.10), and wind speed (-0.42) negatively correlated with number of adult *D. volkeri*. Furthermore, minimum temperature (0.97**), sunshine hours (-0.70**), rainfall (0.72**) and soil evaporation (0.94**) was highly correlated with relative humidity. Similarly, sunshine hours (0.76**), rainfall (0.75*) and soil evaporation (0.93**) significantly correlated with minimum temperature.

Discussion

In the present study the incidence of *D. volkeri* nymph and adult population was observed with varying temperature and relative humidity from 1st week of September to second week of

December 2019 and 2020, respectively. Peak incidence of *D. volkeri* nymph and adult populations was 36.8 per three plants in the third week of October when the field temperature and relative humidity were 38 °C and 70 %, respectively. The present study is in conformity with the report of Ali *et al.* (2013) who found that the peak incidence of bug populations on cotton in Pakistan was 19.23 % per three leaves in 1st week of September when the field temperature and relative humidity were 31 °C and 64 %, respectively. The lowest nymph population was recorded at the fourth and second week of November, of both years when the temperature and relative humidity were 29°C and 17 % respectively. This could be as a result of low temperature and relative humidity at this period. Ali *et al.* (2013) and Pal *et al.* (2020) reported that the incidence of sucking insect/mite pests was observed in whole study period except for red-spider mites which commenced development predominantly in the second fortnight of August to mid-November, 2013 with peak population count in second fortnight of September. This is consistent with the fact that, warm and dry conditions favour red spider-mites in cotton ecosystem (Wilson and Sadras, 2001; Russell, 2012).

The buildup and the fluctuation in the population of *D. volkeri* on cotton in both years and the locations are apparently influenced by the age of the crop and probably by the weather conditions. The low population of *D. volkeri* found in cotton during the month of September and the high population observed during the months of October and November showed that *D. volkeri* was more abundant on older cotton plants than on younger ones. The sudden drop in the population density after peaking could also be attributed to some rainfall patterns. The drop coincided with the period of low rainfall and high temperature which apparently may have exerted a depressing influence on the population of *D. volkeri*. Mohapatra (2008) reported that moderately high rainfall, temperature, sunshine and relative humidity that apparently

favour good crop growth also favour population increase of *D. volkeri* and that this is particularly true in the tropics, especially, West Africa where the peak season for the occurrence of *D. volkeri* is between September and October.

Weather parameters play an important role in the population fluctuation of sucking insects (Panickar and Patel, 2001). In the present study, there exist positive correlation between minimum temperature and number of nymphs. Similarly, minimum temperature, sunshine hours, soil evaporation, wind speed positively correlated with relative humidity. These findings are in partial agreement with the results of Patel and Patel (2015) who indicated that the population of thrips had significant positive correlation with maximum temperature and mean temperature. Pal *et al.* (2020) reported that the correlation coefficient of *Aphis gossypii* with weather parameters was positively correlated with temperature, relative humidity and rainfall in *Bt* and non-*Bt* cotton during 2013 and 2014. The results are also in partial agreement with Sammaiah *et al.* (2012) who mentioned that minimum temperature and rain fall showed moderate negative correlation with *D. cingulatus*. Jadhao *et al.* (2015) revealed non-significant correlation between nymphal population of *A. biguttulabiguttula* and weather factors on sunflower crop.

Conclusion

Population of cotton stainers was first found in the study areas between the first week of September to November when the cotton plants were at peak bloom (85 -95) days and full maturity stages (135 - 150) days, respectively. SAMCOT 10, 11 and 12 harbored more number of *D. volkeri* nymph and adult populations. There was positive correlation between minimum temperature and number of nymph populations. Similarly, minimum temperature, sunshine hours, soil evaporation, wind speed were highly and positively correlated with relative humidity



References

- Ali, B., Altaf, S. M., Murtaza, M. A. (2013). Influence of abiotic factors on the population of *Dysdercus koenigii* Fab. (Hemiptera: Pyrrhocoridae) in cotton field in Pakistan COMU Journal of Agriculture Faculty, 1 (1): 101–105
- Amatobi, C. I. (2007). *Arthropod pests of crops in Nigeria; General biology, natural enemies and control*. P. A. Ndahi printing. Zaria, Nigeria. 124 pp
- Central Bank of Nigeria (CBN). (2011). Gross-domestic product at 2010 constant basic price. Central Bank of Nigeria. *Annual report* Pp 14.
- Federal Ministry of Agriculture and Rural Development (FMARD) (2013). Draft Report of the National Committee on Cotton Production and Export Pp 147. www.fmard.gov.ng. Retrieved on 1st July, 2013.
- Gbadegesin, J., Onyibe, E., Uyovbisere, E. and Adeosun, J. O. (2007). *Cotton Production in Nigeria*. A Publication of the Cotton Sector Development Programme, Cotton Development Committee Pp 78.
- Gutierrez, A. Paul, Ponti, L., Ellis, C. K. and Thibaud, O. (2005). Analysis of climate effects on Agricultural systems - *The California Climate Change Center Report Series* Pp 152
- Horna, D., Kyotalimye, M. and Falck-Zepeda, J. (2009). Cotton Production in Uganda: would GM technologies the solution? A Paper presentation at the International Association of Agricultural Economists Conference, Beijing, China, August 16-22.
- Institute for Agricultural Research (IAR) (2017) Code and descriptors list of crop varieties released, IAR/ABU., Samaru- Zaria 73pp
- Jadhao, S. M., Shetgar, S. S., and Bhamare, V. K. (2015). Population dynamics of sucking insect-pests infesting sunflower and its relationship with weather parameters. *Annual Plant and Soil Research* 17:486-488.
- Jaleel, W., Saeed, S. and Naqqash, M. N., (2013). Biology and bionomic of *Dysdercus koenigii* F. (Hemiptera: Pyrrhocoridae) under laboratory conditions. *Pakistan Journal of Agricultural Science* 50: 373-378
- Kutama, A. S., Sharif, U., Dangora, L. L., Umma, M., Salusu, A. and Rabi, M. K. (2015). Yield of cotton and opinion of small- scale farmers on cotton production in Kano and Katsina States Nigeria. *Global Advance Research Journal of Agricultural Sciences*. Vol. 4(8) pp 234-438
- Mohapatra, L. N. (2008). Population dynamics of sucking pests in hirsutum cotton and influence of weather parameters on its incidence in Western Orissa. *Journal of Cotton Research and Development*, 22(2):192-194.
- Pal, S., Bhattacharya, S. and Sahani, S. K. (2020). Seasonal incidence and management of red cotton bug (*Dysdercus konini*) infesting Bt cotton under red lateritic zone of West Bengal. *Journal of Pharmacognosy and Phytochemistry*, 9(1): 1820-1825
- Panickar, B. K. and Patel, J. B. (2001). Population Dynamics of different species of thrips on chilli, cotton and pigeon pea, *Indian Journal of Entomology* 63: 170–175.
- Patel, H. C. and Patel, J. J. (2015). Population dynamics of thrips (*Thripstabaci* Lindeman) on onion in relation to different weather parameters. *Trends in Biosciences*. 8(2):531- 534.
- Paterson, A. H. (2009). *Genetics and Genomics of Cotton*. Springer. New York, USA.
- Russell, H., (2012). *Spider mite populations thrive in hot dry summers*. Michigan State University Extension Webpage(<http://expert.msue.msu.edu>) posted on: July 13, 2012.
- Sammaiah, C. Laxman, P. and Samatha, C. (2012). Study on infestation of cotton insect stainers on BT cotton and non-BT cotton in Warangal, Andhra Pradesh. *International Journal of Environmental Sciences*. 3(3):1155- 1160
- Sontakke, H., Baba, I., Jain, S., Saxena, A., Bhagel, A. K. and Jadhaw, B. (2013). Fecundity and fertility control of red cotton bug (*Dysdercus cingulatus*) by the extract of *Psoralea corylifolia*. *International Journal of Research in Pharmaceutical and Biomedical*

Sciences, 4 (2): 633-635.

Wilson, L. J. and Sadras, V. O., (2001). *Host plant resistance in cotton to spider mites. Acarology. Proceeding's 10th International Congress*

Yousuf, J. M. Attaullah, M., Anjum, I. and Khawaja, S.

(2012). Toxicity assessment of chlorpyrifos, λ -cyhalothrin and neem extract against *Dysdercus koenigii* with reference to survivorship, fecundity and some biochemical parameters. *IOSR Journal of Pharmacy* Vol. 2(5); pp44-52.

Table 1: Weekly Mean Record of Nymph and Adults of *D. volkeri* Populations on Cotton Based on Some Weather Factors in 2019 and 2020 Cropping Seasons at Samaru Zaria

Month	Week	2019 Cropping season					2020 Cropping season				
		Mean Nymph Population $\pm$ SE	Mean Adult Population $\pm$ SE	Mean Temp. ($^{\circ}$ C)		Mean R/H (%)	Mean Nymph Population $\pm$ SE	Mean Adult Population $\pm$ SE	Mean Temperature ($^{\circ}$ C)		Mean R/H (%)
				Max	Min				Max	Min	
September	W1	2.417 $\pm$ 1.051	1.792 $\pm$ 0.778	32	20	80	1.958 $\pm$ 0.749	3.958 $\pm$ 0.998	32	20	73
	W2	5.458 $\pm$ 0.743	8.333 $\pm$ 1.626	32	19	76	6.208 $\pm$ 0.651	5.000 $\pm$ 1.385	32	19	75
	W3	13.88 $\pm$ 1.526	34.92 $\pm$ 6.317	31	19	81	13.708 $\pm$ 0.938	9.167 $\pm$ 0.815	31	19	77
October	W4	10.917 $\pm$ 1.418	11.583 $\pm$ 1.308	33	18	71	11.583 $\pm$ 1.308	12.666 $\pm$ 1.603	33	19	63
	W1	4.147 $\pm$ 2.217	10.625 $\pm$ 3.175	34	20	73	10.625 $\pm$ 3.175	4.167 $\pm$ 2.217	33	20	66
	W2	9.458 $\pm$ 0.870	28.708 $\pm$ 2.158	33	20	71	18.875 $\pm$ 1.639	9.458 $\pm$ 0.870	33	20	69
	W3	36.833 $\pm$ 3.388	16.125 $\pm$ 1.731	39	19	70	16.125 $\pm$ 1.731	4.417 $\pm$ 1.006	79	19	60
November	W4	8.125 $\pm$ 1.203	26.667 $\pm$ 1.817	35	15	50	4.417 $\pm$ 0.822	1.917 $\pm$ 0.695	35	15	42
	W1	20.750 $\pm$ 1.319	5.583 $\pm$ 2.481	35	12	27	2.958 $\pm$ 1.694	20.750 $\pm$ 1.319	35	12	23
	W2	13.583 $\pm$ 3.677	7.042 $\pm$ 0.787	35	12	17	5.333 $\pm$ 0.778	11.875 $\pm$ 0.920	35	12	18
	W3	4.958 $\pm$ 1.136	4.250 $\pm$ 0.896	34	13	16	5.500 $\pm$ 0.660	5.625 $\pm$ 4.105	34	13	17
December	W4	2.000 $\pm$ 0.791	3.625 $\pm$ 1.042	32	12	16	7.083 $\pm$ 0.697	2.792 $\pm$ 1.009	33	11	13
	W1	4.208 $\pm$ 1.491	2.583 $\pm$ 0.707	29	13	17	3.333 $\pm$ 0.615	6.125 $\pm$ 0.728	32	12	14
	W2	4.500 $\pm$ 0.794	3.167 $\pm$ 0.792	32	12	17	1.292 $\pm$ 0.739	0.667 $\pm$ 0.405	29	13	15

W1= Week 1, W2= Week 2, W3= Week 3, W4= Week 4

Table 2: Mean Population of *D. volkeri* on Cotton Varieties with Corresponding Weather Factors in 2019 and 2020 Cropping Seasons at Samaru

2019 and 2020 Cropping Seasons at Samara								
Variety	Mean Nymph Pop.	Mean Adult Pop.	Optimum Temp (°C)	R/H (%)	Mean Nymph Pop.	Mean Adult Pop.	Optimum Temp (°C)	R/H (%)
2019				2020				
SAMCOT 8	10.68b	14.71a	24.5	49	5.88d	6.23	24.64	43.57
SAMCOT 9	7.98c	11.82bc	24.5	49	7.93b	6.07	24.64	43.57
SAMCOT 10	7.67c	12.43b	24.5	49	7.16bc	6.96	24.64	43.57
SAMCOT 11	12.65a	9.61d	24.5	49	6.27cd	8.00	24.64	43.57
SAMCOT 12	8.75c	11.07bcd	24.5	49	9.71a	7.73	24.64	43.57
SAMCOT 13	7.50c	10.29cd	24.5	49	9.63a	7.54	24.64	43.57
SE±	4.951	0.472			0.333	0.556		

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

Table 3: Correlation of *D. volkeri* Populations to Weather Factors in 2019 Cropping Season

Weather factor	1	2	3	4	5	6	7	8	9
Nymph	1.00								
Adult	0.29	1.00							
R/humidity	0.19	0.54	1.00						
Max. Temp	0.85**	0.13	0.20	1.00					
Min. Temp	0.13	0.49	0.97**	0.22	1.00				
Sunshine hrs	0.23	0.14	-0.65*	0.10	-0.67**	1.00			
Rainfall (mm)	-0.24	0.06	0.67	-0.21	0.67**	-0.81**	1.00		
Evaporation	0.25	0.56	0.86**	0.19	0.85**	-0.39	0.64	1.00	
Wind speed	-0.41	-0.54*	-0.67**	-0.39	-0.69**	0.28	-0.58*	-0.88**	1.00

*Significant at 5 level of probability, ** Significant at 1 level of probability

Table 4: Correlation of *D. volkeri* Populations and Weather Factors in 2020 Cropping Season

Weather factor	1	2	3	4	5	6	7	8	9
Nymph	1.00								
Adult	0.37	1.00							
R/humidity	-0.70**	0.72**	1.00						
Max. Temp	0.43	-0.08	0.19	1.00					
Min. Temp	0.61**	-0.10	0.97**	0.20	1.00				
Sunshine hrs	-0.48	0.37	-0.70**	-0.02	-0.76**	1.00			
Rainfall (mm)	0.45	0.01	0.72**	-0.23	0.75*	-0.67**	1.00		
Evaporation	0.63*	0.04	0.94**	0.25	0.92**	-0.55*	0.71**	1.00	
Wind speed	-0.50	-0.42	-0.28	-0.41	-0.27	-0.18	-0.16	-0.52*	1.00

*Significant at 5 level of probability, ** Significant at 1 level of probability