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Full Length Research Article

The Effect of Weather Factors on the Population Density of *Oxycarenus* spp. (Hemiptera: Lygaidae) on Roselle and Kenaf

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ABSTRACT

Roselle, *Hibiscus sabdariffa* and Kenaf, *Hibiscus cannabinus* are two important fibre crops in most parts of Africa. Insect pests are one of the major constraints in the production of these crops. The cotton seed bug *Oxycarenus* spp. attacks Roselle and Kenaf during the seed formation stage and cause reduction in seed viability. This study examined the effect of weather factors namely, relative humidity, temperature, sunshine and soil evaporation on the population density of *Oxycarenus* spp. on Roselle and Kenaf during the planting seasons 2012 and 2013. The treatments consisted of two types of Roselle (Green-calyxed and Red-calyxed) and Kenaf. The experiment was laid out in the field using Randomized Complete Block Design and the treatments were replicated four times. The results showed that the population of *Oxycarenus* spp. was significantly ($p<0.05$) higher on green-calyxed *H. sabdariffa* and red-calyxed *H. sabdariffa* than on Kenaf in 2012 and 2013. The differences in the density of the bug per fruit on green-calyxed *H. sabdariffa* and red-calyxed *H. sabdariffa* were significant in the two planting seasons. Relative humidity in the morning and maximum temperature correlated positively and negatively, respectively with the density of *Oxycarenus* spp. during the two planting seasons. Sunshine hours per day correlated positively, while soil temperature and soil evaporation had a negative correlation with the bug density. This information on the seasonal variation in the bug density and its relationship with weather factors could be used in pest forecasting for these fibre crops which is an important tool in formulating a successful pest management programme.

Keywords: Malvaceae, Fibre crops, weather factors, *Oxycarenus* spp., pest management, planting seasons, pest density.

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) and Kenaf (*Hibiscus cannabinus* L.) belong to the family Malvaceae. In Nigeria, two botanical varieties (red-calyxed and green-calyxed) of *H. sabdariffa* are recognized. The calyx of the red variety is commonly used for the preparation of "Sobo" drink while the calyx of the green variety is used to cook soup, stew and sauces. The calyx of green roselle is very rich in vitamin C and riboflavin with some major mineral present (Babalola, 2000). Kenaf (*Hibiscus cannabinus* L.) is commonly cultivated for both food and fiber in West Africa. Fiber in both the retted and raw forms is used in the manufacturing of cordage and newsprint. The increases in global demand for paper and paperboard materials have increased the importance of Kenaf as a wood substitute (Adegbite *et al*., 2005). It is estimated that Kenaf is 3 to 5 times more productive per unit area of land than pulpwood trees and produces a pulp that is equal or superior to many woods (Theisen *et al*., 1978)

Insect pests infestation is one of the major factors militating against the cultivation of crops from the family Malvaceae. The cotton seed bug, *Oxycarenus* spp. (Hemiptera: Lygaeidae) is a pest of cotton and other members of the Malvaceae plant family, including kenaf, okra, and roselle. *Oxycarenus* spp. do not only feed on other plants in the order Malvales, especially in the family Malvaceae, but also in Tiliaceae and Sterculiaceae (Slater and Baranowski, 1994). This insect causes economic damage when it feeds on cotton seeds thus, reducing seed germination and oil quality. It is native to Africa, and has been reported to have been intercepted

on materials from Africa, Asia, Europe, the Middle East, Central America, South America and the Caribbean (Halbert and Dobbs, 2010).

Weather factors like temperature, relative humidity and rainfall play a vital role in multiplication and distribution of insect pests (Zafar *et al*., 2013). The numbers of generations and seasonal abundance of insects, especially phytophagous ones in a year are influenced by temperature, host selection and host suitability. Rainfall directly and indirectly influences seasonal abundance of pest by affecting the abundance and suitability of host plants (Zafar *et al*., 2013). To develop any pest management programme for a specific agro- ecosystem, complete knowledge on abundance and distribution of pest in relation to weather factors is a basic requirement (Patel and Shekh, 2006). For effective pest management strategy, it is necessary to know the proper ecological requirement of a pest species.

In Nigeria, *O*. *gossypinus* (Distant) and *O*. *hyalinipennis* (Costa) are the most abundant species, and they co-exist on their host plants, cotton, okra, roselle and kenaf. The biology of *O*. *gossypinus* on Okra in Nigeria has been studied (Ewete and Osisanya, 1988), however, little is known on the population of the bug on kenaf and roselle. This work was therefore conducted to provide information on the relationship between weather factors and the seasonal abundance of *Oxycarenus* spp. on roselle and kenaf.

MATERIALS AND METHODS

Experimental Site (or field)

The research was conducted during the growing season in July to December, 2012 and repeated in July to December, 2013 at the experimental field of Savanna Forestry Research Station, Samaru, Zaria (Latitude 07º 05'N, Longitude 04º 50'E). The experimental site was situated in the Northern Guinea Savanna agro-ecology of Nigeria with frequent rain ranging between 165 and 250 mm.

Methodology

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three treatments made up of *Hibiscus cannabinus* and two varieties of *Hibiscus sabdariffa* (green calyxed and red calyxed) replicated four times. Each experimental plot was 4 m long and 3 m wide, with 6 rows of 50 cm apart and plant to plant distance of 30 cm, giving a plot area of 12.0 m^2. Each plot was separated with a distance of 1m. The experimental site was harrowed and ploughed using animal traction before marked out into plots. Two seeds were planted per hill (planting hole) and seedlings were thinned down to 1 stand per hill 2 weeks after germination. The plots were weeded three times at 15, 45 and 75 days after sowing.

Sampling for *Oxycarenus* spp. commenced 2 weeks after fruiting and continued weekly for 4 weeks. At each sampling time, ten fruits were randomly picked from each plot and put individually in a sampling bag. The fruits were carried to Entomology Research laboratory, Savanna Forestry Research Station, Samaru, Zaria where they were dissected to expose the bugs. The number of bugs per fruit consisting of the adults and the nymphs were counted and recorded.

Statistical analysis

The number of bugs per fruit was transformed using square root transformation $(x + 0.5)^{1/2}$ before being analyzed using the Analysis of Variance (ANOVA). Significant means were separated using Tukey's Honestly Significant tests at $p \leq 0.05$. Weather factors for the two planting seasons were collected from the Meteorological Station of the Institute of Agricultural Research, Ahmadu Bello University, Zaria. Linear correlation analysis was carried out to determine the relationship between the weather factors and the population of *Oxycarenus* spp.

RESULTS AND DISCUSSION

In 2012, the population of *Oxycarenus* spp. per fruit was significantly higher in green-calyxed *H. sabdariffa* (4.09±1.51) than in red-calyxed *H. sabdariffa* (3.63±1.73) and *H. cannabinus* (1.19±0.50). With an average of 7.00±1.76, the number of *Oxycarenus* spp. was significantly higher on red-calyxed *H. sabdariffa* than on the green-calyxed *H. sabdariffa* and *H. cannabinus*. In both planting seasons, the number of *Oxycarenus* spp. recorded on *H. cannabinus* was significantly lower than the number recorded on green-calyxed *H. sabdariffa* and red-calyxed *H. sabdariffa* (Table 1).

Table 1: Population of *Oxycarenus* spp per fruit (±S.E) on three *Hibiscus* species during 2012 and 2013 growing seasons in Samaru

Crops	2012	2013
Hibiscus cannabinus	1.19±0.50[c]	1.99±0.33[c]
Green-calyxed *Hibiscus sabdariffa*	4.09±1.51[a]	5.25±1.38[b]
Red-calyxed *Hibiscus sabdariffa*	3.63±1.73[b]	7.00±1.76[a]

Means with the same alphabet in the column are not significantly different from each other at $p \leq 0.05$

The fruit of *H. cannabinus* are small and hairy while the fruits of the two varieties of *H. sabdariffa* are large and smooth. The possession of hairs on the fruits of *H. cannabinus* may prevent the attraction of the bugs contrary to the fruits of *H. sabdariffa* which are smooth. Secondly, the big fruit size with corresponding high number of seeds may also influence the density of *Oxycarenus* per fruit. The presence of large number of seeds in *H. sabdariffa* may enhance abundance of food for the multiplication of the bugs than in *H. cannabinus* (Adu-Mensah and Kumar, 1977).

As presented in Figure 1, the number of bugs per fruit in 2012 increased in the three plants from 2 weeks after fruiting, peaked at 4 weeks after fruiting and declined thereafter. In 2013, the number bugs per fruit in each of the Hibiscus species increased from the second week after fruiting up to fifth week after fruiting (Figure 2). In the two planting seasons, density of *Oxycarenus* increased sharply from the third week after fruiting. These periods coincided with the seed maturity stage which favoured the development and multiplication of the nymphs and adults of *Oxycarenus* spp. During these periods, the fruits dehisce and the bugs have free access to the seeds.

The relationship between the weather factors and the density of the bug showed that relative humidity in the morning correlated negatively with the number of bugs in both planting seasons (Table 2). Maximum and minimum temperatures correlated positively with the bug population in the two planting seasons except in 2013 where minimum temperature correlated negatively with the bug density. This is an indication that humid weather does not favour the population build of *Oxycarenus* spp. on Kenaf and Roselle in the study area. Similar studies on *Oxycarenus* spp. reported relative humidity and temperature correlated negatively and positively, respectively with bug population (Patil *et al*., 1992; Chaudhari *et al.,* 1999; Qayyoum *et al*., 2014). Insects are able to function faster and more efficiently at higher temperatures as warm climate positively influence their feeding, development and dispersal (Drake, 1994).

The number of sunshine hours per day also correlated positively with the bug density in 2012 and 2013. Soil temperature and evaporation had a negative correlation with the bug density during planting seasons. This explains that bug infestation could be high at low rate of soil evaporation. However, this may not be the case as *Oxycarenus* spp. are not soil-living (subterranean) pests. The variation in the density of cotton bug on Kenaf and Roselle between the

two planting seasons and also the variation in the influence of some weather factors are indications that weather factors are critical in forecasting the population of this bug. Weather factors have been described to have direct impact on insect population dynamics by modulating the developmental rates, survival, fecundity, voltinism and dispersal (Karuppaiah and Sujayanad, 2012). This study thus demonstrates a seasonal population fluctuation of *Oxycarenus* spp. on Roselle and Kenaf in relation to weather factors.

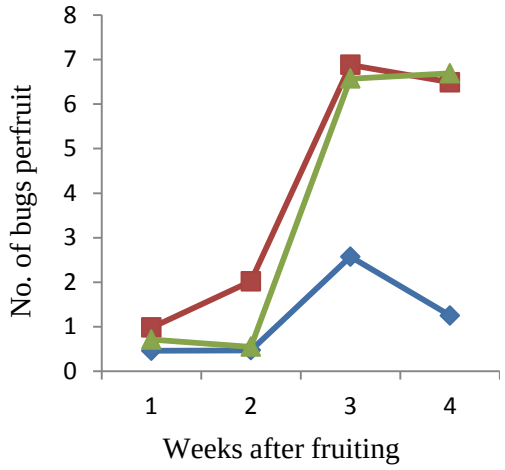

Figure 1: Population of *Oxycarenus* spp. on three *Hibiscus* species in Samaru during the 2012 growing season

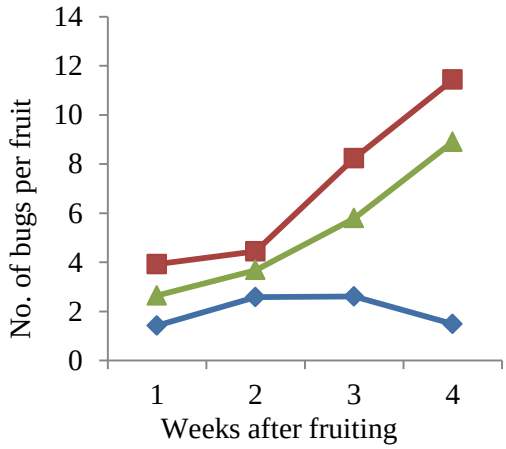

Figure 2: Population of *Oxycarenus* spp. on three *Hibiscus* species in Samaru during the 2013 growing season

Table 2: Linear correlation coefficients of the relationship between weather factors and the number of *Oxycarenus* spp. on three *Hibiscus* species in Samaru, during 2012 and 2013 cropping seasons

Weather factors	Linear correlation coefficient (r) 2012	Linear correlation coefficient (r) 2013
Relative humidity (%) at 10.00 a.m.	-0.74	-0.85
Relative humidity (%) at 4.00p.m.	0.61	-0.75
Maximum Temperature (°C)	0.089	0.14
Minimum Temperature (°C)	0.089	-0.48
Soil temperature (°C) at 10.00a.m.	-0.29	-0.75
Soil temperature (°C) at 4.00p.m.	-0.23	-0.34
Sunshine (hours/per day)	0.43	0.82
Open pan evaporation (mm)	-0.91	-0.20

CONCLUSION

Population dynamics of a pest is a key factor in planning effective management strategies. From this study, population of Oxycarenus spp. increased with the age of Roselle and Kenaf fruits. More damage to seeds is therefore expected to be inflicted on the seeds if they are left to over mature in the field. Timely harvest of the fruits is necessary to prevent further increase

in the population Oxycarenus species on Kenaf and Roselle.

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