HOST PLANT EFFECT ON MORPHOMETRY AND FECUNDITY OF THE VARIEGATED GRASSHOPPER (*Zonocerus variegatus* (L.) ORTHOPTERA: PYRGOMORPHIDAE)

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ABSTRACT

The effect of four host plants, Manihot esculenta, Cassia alata, Glyphaea brevis and Azadirachta indica on the survival, development and fecundity of the variegated grasshopper (Zonocerus variegatus) was investigated. One thousand eight hundred second instar nymphs were collected from abandoned farmlands, caged and fed with the leaves of different host plants mentioned above. Cassava leaves (M. esculenta) gave the best survival and fecundity rates followed though distantly by C. alata while G. brevis and A. indica gave very poor survival rates. The survival rate was generally poor at the early nymphal stages of the insects on all the host plants. With respect to fecundity, the insects reared on M. esculenta produced the greatest number of egg-pods and consequently eggs; whereas those reared on A. indica failed to produce any egg-pod.

Keywords: Host plant, Morphometry, Fecundity, Variegated grasshopper

INTRODUCTION

The variegated grasshopper, *Zonocerus variegatus* (L.) is a polyphagus insect which feeds on and defoliates a large numbers of farm crops. The importance of *Zonocerus* as a pest of food and cash crops has been recognized for many years. Inspite of its photophagus habits, it is generally not regarded as a very serious pest of farm crops because of their short-lived seasonal occurrence (Taylor, 1972). However, sporadic cases of severe damages have been reported from many parts of Southern Nigeria (Taylor, 1972).

Zonocerus is a large grasshopper, easily recognized by its disagreeable or unpleasant odour and multicoloured markings on its body (Youdeowei, 1974). They are more or less restricted to the tropics where the climate is relatively warm and where there is a wet or rainy season followed by dry season. One of the striking features of *Zonocerus* is the seasonality of their populations. As early as 1940, it was established that in Ibadan areas of Nigeria, there were two major populations – dry and wet season populations or generations (Golding, 1940). These terms are connected with the periods during which the nymphs appear in the field. The ovipositon of the dry season generation occurs from April to June. The second generation seems to be less abundant than the dry season populations (generations) and these generations are similar morphologically (Youdeowei, 1974). There are usually six nymphal stages but Jarath (1965) has recorded as many as eight nymphal stages in many instances. Each moulting (ecdysis) was preceded with two to three hour rest after which the insect continues its normal activities.

The effect of *Zonocerus* feeding is well known to farmers. In the field, they consume a variety of plant parts especially the leaves and stems. The damage caused by these insects are usually severe in some cases and the plants are defoliated leaving bare stems and branches. Cassava

(*Manihot* spp.) is the most important food crop attacked by *Z. variegatus*. The weeds commonly consumed include Siam weed (*Chromolaena odorata*) and wild marigold (*Aspilia* spp) (Youdeowei, 1974*). M. esculenta* leaves and bitter leaf (*Vernonia amygdalina*) (Shreb) were found to support growth and development of *Z. variegatus* (Bernays *et al.,* 1975; MacCaffery *et al.,* 1978; Tamu, 1990).

Although *Z. variegatus* utilize a wide range of plants, it is not yet clear which plant or combination of plant diet is most suitable for this insect. It has been observed that not all food plants eaten by *Z. variegatus* are adequate for their survival and development (Idowu and Sonde, 2003). In the field, the first nymphal instars tend to prefer Siam weed (*C. odorata*) and egg plant (*Solanum* spp) but later nymphs and adult prefer *Manihot* spp. Idowu and Sonde (2003) observed that *Z. variegatus* thrives very well on Siam weed from the 1st to the 4th nymphal instars. However, *C. odorata* and *Aspilia africana* do not support growth of the insect at later nymphal instars and adults (Bernays *et al.*, 1975).

Iheagwam (1979) stated that the influence of host plant on egg production and survival of adult *Zonocerus* was remarkable. The type of host plant influenced the fecundity of the insects either by affecting the number of eggs laid or indirectly by affecting their longevity.

This study was aimed at finding out the effect of four host plants on the survival rates, morphometry and fecundity of the variegated grasshopper (*Zonocerus variegatus*).

MATERIALS AND METHODS

Four cages, each measuring 36 cm x 36 cm x 48 cm were constructed with wood bought from timber shade. A fifth cage measuring 48 cm x 48 cm x 68 cm which served as a stock or supply bank was also constructed. The sides of the cages were made of wire gauze like-wise the top while the floor was constructed with a double layer of wood.

Second instar nymphs of *Zonocerus variegatus*. Used for this study, were collected from abandoned farm lands in Igbo-Eze South Local Government Area, Enugu State, Nigeria in December 2008 and 2009. 1,800 nymphs were collected in each of the study year. Collected insect nymphs were identified (Golding, 1940) as *Z. variegatus* by a curator in Museum of Natural History, Department of Zoology, University of Nigeria, Nsukka where voucher specimens were placed. These nymphs were put in the supply bank (fed on *Manihot* leaves) from where known numbers (100) of the nymphs were transferred to each of four the cages and continuously fed on the four selected host plants listed below (i) *Cassia alata* (L.) family Caesalpinaceae (ii) *Glyphaea brevis* (Spreng) family Tiliaceae (iii) *Azadirachta indica* (A. Juss) family Meliaceae and (iv) *Manihot esculenta* (Crantz), family Euphorbiaceae.

Each of the four cages was allocated to one of the four host plants. At weekly intervals, the dead insects in any of the four cages were replaced from the stock supply. In all cases the number of dead insects as well as replacements was recorded. Where all the insects at a particular instars stage did not survive on a host plant, replacement was made with the older nymphs e.g. if all 2nd instar nymphs in a cage did not survive, replacement was made with 3rd instars. The host plants on which insects were fed were also collected from Igbo-Eze South Local Government Area Enugu State, Nigeria.

The insects in the supply bank were fed on cassava (*Manihot*) leaves. Leaves of the test host plants collected were introduced into each of the cages containing the nymphal instars understudy. The leaves were changed on alternate days and water was always sprinkled on the leaves at some intervals to keep them constantly moist. Oviposition trays of moist

sand were also provided in each of the four cages to facilitate egg-laying.

The following measurements on adult insects from each cage were taken and recorded.

(a) Length of the insect (male and female)
(b) Length of elytron
(c) Length of femur
(d) Weight of insect

All measurements were carried out in the Department of Applied Biology Laboratory, Enugu State University of Science and Technology, Enugu, Nigeria.

The number of egg-pods laid by the female insects, and the number of egg-pods per female from each of the 4 cages were counted and recorded. The length of the insect, length of femur, length of elytron and weight of the insects from each of the 4 cages were compared. Again, the number of egg-pod/egg masses deposited and the number of eggs per egg – mass from each of the cages were recorded.

RESULTS

The survival of *Z. variegatus* was generally low at the early stages on the four different host plants (Table 1). Out of the 100 nymphs fed with each of the host plants at the 2nd instar stage, all died with the exception of only 15 which survived on *M. esculenta* leaves. At the third instar stage, the result was slightly different with small percentage of survivors (24%) on *Manihot* leaves and negligible survival rate on the rest. At the later stages, (4^{th} instar to adult stage), the rate of survival was high on *M. esculenta* followed by *C. alata* (Table 1). The rate of survival at early and later stages including adult on *G. brevis* and *A. indica* leaves was amazingly low with no survivor at 2^{nd} instar stage.

Different host plants influenced the development of elytron, femur and the whole length and weight of the insect (*Z. variegatus*) in both sexes. Insects reared on *M. esculenta* and *C. alata* had greater elytron length than those raised on *G. brevis* and *A. indica* (Table 2). However, there was no significant different ($P = 0.05$) in elytron length between the male and female insects reared on *Manihot* and *Cassia* leaves but the females reared on *Glyphae* and *Azadirachta* leaves had slightly greater elytron length than the males. On the other hand, the insects reared on *G. brevis* had greater femur length than those reared on other plant hosts while those reared on *A. indica* had the least femur length.

With regards to body length, the insects reared on *M. esculenta* showed higher body length than those reared on other plant hosts while the least body length was recorded on those reared on *A. indica*. Generally, the body length of the female *Zonocerus* reared on all the host plants were higher than those of males (Table 2). Regarding body weights, insects reared on *Manihot* had greater body weight than those reared on other host plants while the least body weight for the insects were recorded among those reared on neem plant (*A. indica*) leaves. With the exception of the insects reared on *Cassia*, all the females reared on others plant hosts had greater body weight than the males (Table 2).

On fecundity rate, the mean number of egg-pods of female *Zonocerus* fed on *Manihot* was highest whereas no egg-pod was obtained among the females fed with *A. indica* and only one egg-pod per five females and four egg-pods per 22 females were observed on female *Zonocerus* fed on *G. brevis* and *C. alata* respectively. Female *Zonocerus* reared on *Manihot* and Cassia produced more number of eggs per pod than those reared on *Glyphae* (Table 3). The number of pods per female grasshopper reared on each of the host plants except *A. indica* (neem plant) leaves was one (1). The mean number of eggs per female *Zonocerus* reared on *Manihot* was highest (22) while very low mean numbers of egg per female pod were produced on those reared on *Cassia* and *Glyphae* (Table 3).

Table 1: Survival rate of *Zonocerus variegatus* on different host plants at different instar stages and adult stage

Host Plant	2nd Instar nymph			3rd Instar nymph			Adult insect		
	a	b	c	a	b	c	a	b	c
M. esculenta	100	15	15	115	28	24	78	64	82
C. alata	100	0	0	100	7	7	65	22	34
G. brevis	100	0	0	100	3	3	51	5	10
A. indica	100	0	0	100	1	1	50	3	6
				4th Instar nymph			5th Instar nymph		
M. esculenta	-	-	-	78	78	100	78	62	79
C. alata	-	--	-	57	27	47	77	15	19
G. brevis	-	-	-	53	5	9	55	1	2
A. indica	-	--	-	51	0	0	50	0	0

Key: *a = Number of nymphs stocked, b = number of survivors, c = percentage survival*

Table 2: Morphometrics of both sexes of *Zonocerus variegatus* reared on four different host plants*

Host Plant	Elytron (mm)		Femur (mm)	
	M	F	M	F
M. esculenta	21 ± 0.05 (29)	21.1 ± 0.6 (30)	15.8 ± 0.2 (29)	15.4±0.2 (30)
C. alata	19.8 ± 0.6 (9)	19.3 ± 0.5 (13)	15.7 ± 0.4 (9)	15.2±0.2 (13)
G. brevis	14.5 ± 0.5 (2)	15.0 ± 1.0 (3)	17.0 ± 1.4 (2)	19.3±1.4 (3)
A. indica	13.0 ± 0.0 (1)	14.0 ± 0.0 (2)	12.0 ± 0.0 (1)	14.0±0.1 (2)
	Whole Insect (mm)		Weight (g)	
M. esculenta	30.7±0.6 (20)	32.6±0.5 (30)	1.0±0.05 (29)	1.3 ± 0.3 (30)
C. alata	28.3±1.2 (29)	29.6±0.8 (13)	7.7±0.03 (9)	0.9. ± 0.5 (13)
G. brevis	27.5±0.5 (2)	30.3±1.8 (3)	0.05±0.1 (2)	0.7 ± 0.1 (3)
A. indica	23.0±0.0 (1)	25.0±0.02 (2)	0.4±0.0 (1)	0.5 ± 0.07 (2)

**Length of elytron, femur and whole insect as well as insect weights are given as X ± se while no. of insects are given in brackets, (m = male and f = female).*

Table 3: Fecundity rate of *Zonocerus variegatus* on different host plants

Host Plant	Number of females	Number of egg pods	Number of eggs/pod
M. esculenta	30	20	34±1.3
C. alata	22	4	26±2.2
G. brevis	5	1	12±0.00
A. indica	3	Nil	Nil
		Number of pods/female insect	Number of eggs/female insect
M. esculenta	-	1	22
C. alata	-	1	5
G. brevis	-	1	2
A. indica	-	Nil	Nil

DISCUSSION

The results of this study showed that the type of plant host had significant effect on the survival, development and fecundity of *Z. variegatus*. Earlier, Idowu and Sonde (2003) showed that the average body length, wing length, fermur and legs including body weight of adult *Zonocerus* was greatly influenced by different plant hosts – and mixed plant host diet. Again, Iheagwam (1979), noted that the influence of host plants on egg production and survival of the adult was remarkable. Idowu and Sonde (2003) noted that the average number of eggs laid by the adult insect fed on cassava and mixed host plant leaves were significantly higher than the average number of eggs laid by the insects fed on paw-paw (*Carica papaya*) and *Acalypha* leaves.

It is possible that when *Zonocerus* are fed on suitable host plants, they may live longer and the female may therefore oviposit more than once in its life-time. These effects may be attributed probably to nutritional differences among host plants or to differences in the digestibility of the host plants or even both by *Z. variegatus*. The inability of the insect to feed and survive on *A. indica* leaves could be attributed to the antinutritional properties or bitter taste of their leaves. Pradham and Jotwani (1968), had earlier reported that the neem posses extra ordinary gustatory repellant properties against the desert and migratory locusts. Sowunmi and Akinnusi (1983) reported that 1% and 2% neem kernel admixture treatments provided effective preservation against maize and cowpea seeds for eight months against *Sitophilus zeamais* and *Callosobruchus maculatus* where low pest damage were encountered.

There have been conflicting reports on the host plant food preference by the first nymphal instars of *Z. variegatus*. Field observations have shown that the first nymphal instars tend to go more for plants that give them more protective shelter rather than food (Rodrigues and Moreira, 2002; Sarafrazi *et al.,* 2004) as against earlier reports of Youdeowei (1974) Bernay *et al.* (1975) and Toye (1974). This study has however provided further support for previous reports that later nymphal instars and adult *Zonocerus* survived more on *Manihot* species than any other host plant.

The effect of host plant on morphometrics of both sexes of *Zonocerus* was also significant. The body length and weights of *Zonocerus* fed on cassava leaves (*Manihot* sp) were more than those fed on other host plants and the same is applicable to the development of wing and femur. It is therefore clear that the overall development of various body parts depends mainly on the type of host plant which the *Zonocerus* feed on.

The effect of the host plant on *Zonocerus* was more outstanding on fecundity than in other aspects. Among the four host plants studied, *Manihot* (*Cassava*) gave the best fecundity results followed by *C. alata* while the fecundity rate recorded on *G. brevis* was poor and those fed on *A. indica* (neem plant) leaves failed to produce eggs. This findings was strongly in support of the earlier report by Iheagwam (1979), which showed that host plant influenced the fecundity of *Zonocerus* either directly by affecting the number of eggs laid or indirectly by affecting their longevity.

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