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Effects of varietal resistance in soybean, *Glycine max* (L.) Merril. on life history and damage potential of *Mirperus jaculus* in a rainforest ecosystem of Southwest Nigeria

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ABSTRACT: Studies were carried out at Ago-Iwoye, Southwest Nigeria to determine the effects of host plant resistance in four promising soybean varieties on selected developmental parameters and damage potential of *Mirperus jaculus* both in the field and laboratory. The study was conducted at ambient conditions and 12:12 hour light: dark photoperiod. Results confirmed antibiosis as the mechanism in resistant cultivars and it caused total cessation of nymphal development at the first instar on TGX 923-2E and a significant prolongation of the developmental period ($p<0.05$) from egg to adult on TGX 849-294D (22%) followed by TGX 536-02D (13%) compared to TGX 996-28E, the susceptible control. However, there was no significant reduction ($p>0.05$) in percentage survival of immature stages on the varieties that supported development to adult compared to the control. The sex ratio averaged 1:1 on the three varieties that supported development. In the field, TGX 923-2E plots did show any visible sign of infestation during early and late planting seasons, an indication of field resistance.

Key Words: *Mirperus jaculus*, Development, *Glycine max*, Susceptibility, Immunity.

Introduction

Soybean, *Glycine max* (L.) Merrill is one of the most important grain legumes widely grown in Nigeria. This crop is known to be very rich in the essential nutrients that are required for human survival. Specifically, it has a higher digestible protein and metabolizable energy content compared to cowpea. Also the lysine content is higher than most vegetable protein sources (Onochie, *1965).* Although soybean grains do not cook easily, it has been possible to prepare different kinds of household products from the dried grains such as 'soy-ogi', soymilk, 'moinmoin' and these have remained a favorite delight in most homes in southwest Nigeria. In addition, it is served as complement to many other local household menu and also as ready protein source for feeding livestock (Yuwa, 1963).

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The use of soybean products became particularly popular in Nigeria to supplement daily protein intake during the military era in Nigeria between 1985 and 1998 when household income dwindled and the national currency became devaluated and grossly inadequate to sustain the average families. Soybean has therefore become very important to national food security in Nigeria and probably in many other countries of Africa.

Production of this crop has however been constrained over the years by a number of insect pest problems that had caused substantial yield loss both in quality and quantity (Singh and Taylor, 1978). The hemipteran pod sucking bugs are a devastating complex comprising *Mirperus jaculus* Thumberg (alydidae) along with others such *Riptortus dentipes* F. (alydidae); *Clavigralla tomentosicolis* Stal. (coreidae); *Anoplocnemis curvipes* (coreidae);; *Nezara viriduia* (pentatomiidae) and *Aspavia armigera* F. (pentatomiidae). These bugs form the major post-flowering field pest of soybeans causing different kinds of damage particularly shriveling of the soybean pods. Of these pests; the two alydids, *M. jaculus* and *R. dentipes* F. are the least studied (Dumzo-Ajufo, 1984). However, these two species were visually observed in the late planting season of 1999 and 2000 at Ago-Iwoye, Nigeria to cause significant damage to the soybean crop. This study was initiated therefore initiated to determine the effects of varietal resistance in selected cowpea cultivars on the development, survival and damage potential of *Mirperus jaculus* as a major step to formulating an appropriate management strategy for this pest in the southwest Nigeria.

Materials and Methods

Insect culture and rearing cages

Four promising varieties of soybeans- TGX 849-294D, TGX *536*- 02D, TGX 923-2E and TGX996-28E (control) were obtained from the Grain Legume Improvement Programme at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. TGX996-28E was used as the control and was raised in 10kg-capacity plastic pots in continuous culture at two weeks interval. Two seedlings were seeded per pot and were arranged in a completely randomized manner in the Crop Garden of the Department of Crop Production, Olabisi Onabanjo University, Ago-Iwoye, Ogun state, Nigeria. Ago is located on 6.57^{o}N and 3.55^{o}E. The seedlings were watered twice daily during the dry spell and once every other day during the rainy days. Fresh pods of soybean were obtained from these for the insect culture and subsequent experiments.

Adult *M jaculus* were collected from the cowpea plots on the Teaching and Research farm, Olabisi Onabanjo University, Ago-Iwoye. A stock culture was raised and maintained in plastic oviposition/emergence cages (14 x 9 x 6cm with top lid) in the laboratory at ambient temperature 26 ± 1.8^{0}C. A glass vial that was filled with water and plugged with absorbent cotton wool was inserted into a side of each cage to provide water for the insect. Newly emerged adults were separated, sexed and placed in pairs per plastic cages. Each pair was supplied with fresh soybean pods (R-7 stage) daily for feeding and oviposition. The eggs were incubated under laboratory conditions until eclosion and emergence of the first instar nymphs. Day-old first instar nymphs used for all the experiments were generated this way. The climatic characteristics of the study site are presented in table 1.

Varietal effects of soybean resistance on life history parameters of M. jaculus

Teneral adults were removed from the culture and placed in pairs per plastic cage. A fresh pod was taken from each of the four soybean varieties and placed separately in each cage containing a pair of adult to constitute each treatment. The treatments were arranged in a completely randomized design in 15 replicates. Eggs laid in each treatment were removed daily and incubated in separate petri dishes. Each set of eggs from the same parent was observed till eclosion and record of egg viability and period to emergence of first instar were taken for each treatment. Thereafter, 100 day-old nymphs that hatched from each treatment were collected and reared on its host soybean variety. The nymphal development within each stadium was monitored daily by records of the exuviae that indicated number of moults. Fresh water and pods were supplied daily and the cages were kept clean by removing secretions and faeces from them. Number of nymphs dying per treatment was recorded and thereafter expressed as percentage mortality per

instar per treatment. Sex ratio was determined by a count of total number of adults of each sex per treatment.

Screen house assessment of damage by M. Jaculus on soybean yield

The four soybean varieties- TGX 849-294D, TGX 536- 02D, TGX 923-2E and TGX996-28E (control) were raised in 10kg capacity plastic pots at 2 seedlings/pot in a screen-cage (1 80xl20x90cm) at the Crop Garden of the Department of Crop Production, Olabisi Onabanjo University, Ago-Iwoye, Nigeria. The seedlings were watered twice daily during the dry spell and once every other day during the rainy days. The design was a split plot arranged in a randomized complete block in 20 replicates. The main plot consisted of three insect populations (20, 40, 60 and 80 day old adults) while the subplots consisted of the four soybean varieties. Adult *M. jaculus* used we collected from the laboratory culture and introduced carefully into each replicate at 6weeks after seeding when to soybean pods attained the reproductive R-7 stage. Data on grain yield per plant we taken after harvesting at 110 DAS. The harvested grains were dried to constant weight and sorted to determine percentage damage. Thereafter, to yield per plant determined and converted to kg/ha All data were subjected to arc sine transformation before analysis of variance and where significant, means were separated using the Least Significant Difference (LSD) at *P=0.05* (Gomez and Gomez, 1984).

Assessment of field infestation of soybean varieties by M. Jaculus

This field experiment was conducted at the Teaching and Research farm, Olabisi Onabanjo University Ago-Iwoye, Nigeria and laid out in a randomized complete block in five replicate. Bach of the four soybean varieties listed above was planted in two rows in each bock (4x2.5-m) at one seed per hill. Spacing was 60x15-cm between and within rows. A O.5m perimeter border row was used to separate the blocks. All agronomic practices such as land preparation and other farm maintenance operations were as described for soybean by Heinrichs et at, (1985). No fertilizer was appliect. The varietal effects of the soybean treatment on percentage reduction of bug population were determined by a count of the number encountered per stand at 65 days after seeding (DAS) and thereafter weekly until harvesting. Counting was done between 8.00h and 11.00h local time once weekly on thirty middle-stands leaving out the bonier rows. The population data we subjected to one-way analysis of variance and means separation by LSD (0.05).

Results and Discussion

The nymphs of *Mirperus jaculus* developed to the adult stage on tender pods of all the tested soybean varieties although this occurred at different duration with varied effects on the morphology and physiology of the insect (Table 1). The complete development of this bug to adult on the test soybean confirms the host plant status to the bug. Total developmental period of *M. jaculus* from the first instar nymph to the adult ranged from 27days to 29 and 31 days depending on the soybean varieties. These developmental periods were however longer than those obtained for *Riptortus dentipes*, another alydid reared on cowpea (Ama, 1975; Akingbohungbe, 1977), and soybean (Ewete and Joda, 1996). The comparatively rapid nymphal development of *M. jaculus* recorded in this study on TGX 849-294D also indicated higher susceptibility of this variety than others. Conversely, the variety TGX 996-28E that recorded the longest developmental period indicated less suitability as host to the bug and hence resistance is inferred. These observations agreed with Corpuz (1969) that the biology of stinkbugs could vary greatly with the host plant varieties and climatic conditions. These also agreed with the varied effects of the host plant varieties on the biology of the pod-sucking bugs of cowpea by Materu and Kettle (1972) and Egwuatu and Taylor, (1979)

Mirperus jaculus is oviparous and it laid its eggs under laboratory conditions in chains of 4 - 16 eggs either on the pods, on sides of the cage or the cover as well as on the water source. The first instar nymphs aggregated around the empty eggshells immediately after eclosion and appeared not to feed. The period of development varied with each soybean variety as well as with each stadium (Table 1). The minimum developmental period of the first instar averaged 3.0 days when fed on the soybean variety TGX 536—02D. The fifth instar had the longest developmental period and this ranged between 7.6 ± 0.16 days on TGX 536m - 02D, and 8.l ± 0.31 days on TGX 996 - 28E, while it was 8.4 ± 0.22 days on TGX 849 -

294D. TGX 923 - 2E did not support its development (Table 1). The mean nymphal developmental period was significantly shorter on TGX ~49 — 294D soyabean variety. Similarly the survival rate of the developmental stages varied significantly ($p<0.05$) with each stadium (Table 2).

Table 1: Mean development period of *Mirperus jaculus* reared on the soybean varieties.

Soybean varieties	Mean nymphal development period (days ± S.E.)					
	I	II	III	IV	V	TDP*
TGX 536-02D	3.0 ± 0.15b	6.7 ± 0.45c	6.8 ± 9.63c	5.6 ± 0.16b	7.6 ± 0.16b	29.7 ± 0.80b
TGX 996-28E	4.2 ± 0.13b	6.7 ± 0.63c	5.7 ± 0.15bc	6.4 ± 0.22b	8.1 ± 0.31b	31.1 ± 0.64b
TGX 849-29D	4.0 ± 0.0b	4.7 ± 0.21b	4.4 ± 0.27b	6.2 ± 0.13b	8.4 ± 0.22b	27.7 ± 0.80b
TGX 923-2E	0a	0a	0a	0a	0a	0a

Means followed by the same letter in the same column are not significantly different ($p<0.05$) Tukey HSD test.
*Total Development Period, n = 15.

Table 2: Mean percentage nymphal survival of *Mirperus jaculus* reared on four varieties of soybean.

Soybean varieties	% Nymphal instars surviving					Total Emerged Adults
	I	II	III	IV	V	
TGX 536-02D	100a	63.0b	60b	60b	56.7b	41.6c
TGX 996-28E	100a	86.7a	85a	80a	78.3a	71.7a
TGX 849-29D	100a	65.0b	65b	65b	60.0b	53.3b
TGX 923-2E	100a	0c	0c	0c	0c	0d

Means followed by the same letter in the same column are not significantly different ($p<0.05$) Tukey HSD test. (n=60)

Mean percentage survival was lowest at the second instar stage on all varieties whereas survival rates were higher in the third, fourth and fifth instar stages although the differences were not significant ($p>0.05$) (Table 2). Thus relatively few adults (25% -75%) emerged from the nymphs reared and the male to female sex ratio was 1:1 (Table 3). Specifically, only one-quarter of the nymphs reared on the soybean variety - TGX 536 - 02D emerged as adults. This implies that this variety does not favour the rapid population build-up of the bug and most probably by an adverse effect on its development as reflected on the high mortality recorded However, about 50% of the total number of nymphs reared on TGX 996 -28E emerged as adults while about 66.7% of the total nymphs reared on TGX 849 - 294D. None of the nymphs survived to adult on the soybean variety TGX 923 – 2E beyond the first day of the first. This implies therefore that all the four varieties used in this experiment exhibited some form of resistance to *M. jaculus*. Painter (1951) described tree mechanisms of resistance in plants to insects. Antibiosis is greatly implicated in this study especially as the adverse effects of feeding were shown in elongation of developmental periods and high mortality. When compared in order of resistance, soybean variety TGY 923 - 2E > TGX 536 - 02D > TGX 996 - 28E > TGX 849 - 29D. Variety - TGX 849 - 294D was the most susceptible while TGX 923 2E was the most resistant in the screen house.

Table 3: Sex ratio of Mirperus jaculus reared from egg batches tested for viability.

Soybean varieties	Total Emerged Adults	Male	Female	Sex Ratio
TGX 536-02D	25	13	12	1.1:1
TGX 996-28E	43	18	23	1:1.3
TGX 849-29D	32	14	18	1:1.3
TGX 923-2E	0	0	0	0

Average sex ratio = 1:1

Damage caused by this pest to soybeans ranged from 14% - 56% compared to the control. The severity of damage was significantly higher ($p < 0.05$) with increase in the infesting population (Table 3). This therefore establishes the pest status of *M. jaculus*. Even at lower population treatments level, there were different levels of damage but variety TGX 923 - 2E appeared to be comparatively more resistant. Field of infestation of soybeans by *M. jaculus* was not established early but was delayed until harvesting time in the early season crop planted between March and June although. However, adult insects were established relatively early in the late season crop at about 4 weeks after planting in mid July (Table 4). It was observed that infestation of this pest is often masked by the presence of other bugs such as *Riptortus dentipes*; C*lavigralla tomentosicolis; Anoplocnemis* curvipes; *Nezara viridula* and *Asparvia armigera* usually because the damage symptoms are very similar. This has made in-depth studies of this pest to suffer neglect. The relatively early occurrence of this bug in the late crop might be a carryover effect of the population buildup of the first crop and probable presence of alternate hosts in the surrounding environment. Oftentimes, the number of insect attracted per plant can serve as a pointer to the susceptibility of a host plant to an insect (Smith 1989). In this study, *M. jaculus* was not conspicuous in the first season crop but was important among the bug complex of the second season crop on the field. Akingbohungbe (1977) reported similar observation that *Riptortus dentipes* and *Mirperus jaculus* were present in legume field e.g. cowpea during the late season. Raheja and Apeji (1980) also reported that grain legumes were susceptible to *M. jaculus* between September and October in the late season crop in the northern Nigeria. Raheja and Apeji (1980) also reported a comparatively low population of the bugs in Northern Nigeria when compared to the findings of this study at Ago Iwoye and elsewhere in the Southwest Nigeria (Libby, 1968). Such low record of *M. jaculus* by Raheja and Apeji (1980) that has translated to apparent resistance of the most commonly used varieties of soybean to *M. jaculus* might be due to ecological resistance. It would therefore be wrong to assume that a masked damage by *M. jaculus* should not present a major problem to soybean varieties probably because resistance to other common pod-sucking bugs effectively put population build up of this species beyond the economic threshold level in check.

Table 4: Severity of seed damage to four varieties of soybean at different population density of *Mirperus jaculus* in the screen house.

Population of infesting day old adults	**Soybean varieties**	**Undamaged seeds (g) /infested hill**	**% damage seeds/ infested hill**
No insects (control)	TGX 849 – 29D	118.50a	0a
	TGX 536 – 02D	115.75ab	0a
	TGX 996 – 28E	115.25ab	0a
	TGX 923 – 2E	112.75b	0a
10 adults	TGX 849 – 29D	89.50b	25.24b
	TGX 536 – 02D	85.50b	27.318a
	TGX 996 – 28E	92.25b	20.00c
	TGX 923 – 2E	103.00a	12.078d
20 adults	TGX 849 – 29D	70.75b	40.06b
	TGX 536 – 02D	63.00c	45.54a
	TGX 996 – 28E	74.00b	35.33c
	TGX 923 – 2E	93.00a	17.94d
40 adults	TGX 849 – 29D	487.00c	48.54b
	TGX 536 – 02D	59.50b	58.12 a
	TGX 996 – 28E	61.50b	48.34b
	TGX 923 – 2E	89.00a	21.04c

Means in the same column followed by the same letter at each population level are significantly different (p=0.05; Tukey HSD)

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References

AINA, J. O (1975). The life history of *Riptortus dentipes* (F) (Alydidae: Hemisptera). A pest of growing cowpea pods. *J. Nat. Hist. 9:* 589 — 596.

AKINGBOHUNGBE. A.E. (1977). Notes on the identity and biology of the *Riptortus* species (Heteroptera: Alydidae) associated with cowpea in Nigeria *J Nat Hist.* 11: 477 — 483.

AKOB. C.A (1990). The development and Pest Status of *Aspavia armigera F.* (lzlemiptera: Pentatomidae) on Sovabean. M. Sc. Dissertation. Univ ersitv of Ibadan. ‘lipp.

CORPUZ. LR.. (1969). The biolo~v and natural enemies of *Nezara viriduia 11 Phiii~pp. Entorno/.* 1: 227—239. DUMZO — AJIJFO. Caroline (1984). The bionomics of the stink b0ug of so abean. Ph. D. Thesis University of Ibadan. 240 p.

EGWUATU. R. I. and T.A. TAYLOR (1977). Studies on the biology of *A. tomentosicollis* Stat in the field and insectarv: *Bull* of Ent. Res. 67: 49 — 57.

EWETE. F.K. and A. 0. JODA (1996. The development of *Riptortus dentipes F.* (Hemiptera: Alydidae) and damage caused on soybean. *African Crop Science Journal* 4 (3): *345 — 50.*

LIBBY, J. L. (1968) Insect Pests of Nigerian Crops *Rep Bull* no. 269 University of Winconsin. U.S.A

MATERU. M E. A. and D. J. KETTLE (1972) Laboratory observations on the bionomics of *Acanthomia spp.* (Hemiptera: Coceida). Trop Pestic *Resi.* Ins. Miscellaneous *Rep.* of the Tropical Pest Research Institute. Arusha. Tansania no. 804. l3p.

MORRISON F R. (1956) Pages 1138 — 1139 In: F. B. Morrison feeds and feeding 2nd ed Morrison Pub. Co. Bhaca. New York.

ONOCHIE. B. E. (l965) The potential value of soyabean as a protein supplement in Nigeria diet. Proc. 3rd Ann. *Conf. Agric. Soc.* of Nigeria 4: 43-45.

PAINTER, R. H. (1951) *Insect Resistance in Crop Plant.* Macmillan New York 240pp.

RAHEJA. A. K. and S. A. APEJI (1980). Insect Pest Management Cowpea O*cc. Publ. Ent. Soc.* Nigeria 25 (1980). 59 – 69.

SINGH, S. R. and T. A. TAYLOR (1978). Pests of grain legumes and their control in Nigeria. *In:* Pests of grain legumes ecology and control edited by Singh. S. R. Van Emden. H. F. and Taylor. T. A. Acad. Press London.

SMITH. C. N-I. (1989). Plant Resistance to Insects: John Willey Publication 1989. 286pp.

YUWA, J A. (1963). Introduction of soyabean into Abuja: *Samaru Agric.* Newsletter 5 (63 —64): 100 — 101.