PEST STATUS OF THE GRAIN SUCKING BUG, S*TENOCORIS ELEGANS* BLOTE (HEMIPTERA: ALYDIDAE) ON RICE AND ITS SURVIVAL ON WILD HOSTS

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ABSTRACT

Determination of the pest status of an insect on a crop is an important step in decision making for effective pest management. Pest status of rice grain sucking bug (RGSB), Stenocoris elegans on rice, Oryza sativa was carried out by infesting rice panicles with 0 to 10 RGSB adults between 3 to 15 days after emergence, while development and survival of RGSB were investigated on rice, O. sativa and five other grass species. Treatments were arranged in a Completely Randomized Design with four replicates. Data were collected on the yield and damage of rice grains; and on nymphal developmental period, fecundity and longevity of S. elegans on each food hosts. Rice grain yield reduced significantly at population densities of 6 - 10 RGSB on rice panicles between 3 and 9 days after emergence. Grain damage increased significantly with increase in RGSB population but reduced with increase in the age of panicles. Nymphal developmental period of RGSB was significantly reduced on O. sativa than on S. anceps and E. crus-pavonis. Female RGSB laid significantly more eggs on O. sativa and E. crus-pavonis than on S. anceps. The grass species, P. maximum, P. auriculatum and S. aethiopicum did not support oviposition and development of RGSB. Adults RGSB significantly lived longer on rice than on grass species. This study showed that a population of 6 RGSB on rice panicles between 3 and 9 days after panicle emergence is critical for initiation of a control action against this rice pest; and also, the destruction of the grasses species: E. crus-pavonis and S. anceps near rice fields will reduce the multiplication of S. elegans and could therefore be incorporated into its IPM component

Key words: Stenocoris elegans, grain damage, alternate hosts, nymphal development, longevity

INTRODUCTION

Rice, *Oryza* species, belongs to the grass family Poaceae of the tribe Oryzae (Adesanya *et al.*, 2018). It is the most economically important food crop in many developing countries and has also become a major crop in many developed countries where its consumption has increased considerably (Ajala and Gana, 2015). Insect pests are one of the major constraints in rice production and could cause a crop loss ranging from 30 – 100% (Umeh *et al*, 1991). Many species of insects belonging to 8 insect orders have been reported to infest rice fields in Nigeria (Dale, 1994). The insect orders of economic importance in the Nigerian ecologies are: Coleoptera (beetles), Hemiptera (bugs) and Lepidoptera (moths), Diptera (midges) and Isoptera (termites) (Heinrichs and Barrion, 2004). African rice gall midge, *Orseolia oryzivora* (Diptera) is a pest at the vegetative stage of rice. The larvae cause severe crop damage from seedling to panicle initiation by producing tube-like ‘silver shoot’ or ‘onion leaf’ galls (swellings) that prevent panicle production (Nwilene *et al*., 2006; Ogah *et al*., 2009).

Stem borers are considered as the major problem in almost all the rice-growing area in African countries (Nwilene *et al*., 2013). They are primarily from two insect orders: Lepidoptera (Noctuidae, Crambidae and Pyralidae) and Diptera of Diopsidae family. These include *Maliarpha seperatella* Ragonot, of Pyralidae family, African pink borer, *Sesamia calamistis* Hampson of Noctunidae family, *Chilo partellus* Swinhoe of Crambidae family and *Diopsis thoracica* Macquart of Diopsidae family (Banwo, 2002; Leonard and Rwegasira, 2015). Larvae of stem borers cause significant yield loss during the vegetative and reproductive stages by boring into the rice stems and producing 'deadhearts' and 'whiteheads' which prevent panicle development (Ogah and Nwilene, 2017). Damages due to *Diopsis thoracica* delay booting of rice crop which resulted in the reduction of panicle numbers and ultimately yield losses (Ogah and Nwilene, 2017). Yield losses ranging from 60 to 100% have been reported to be caused by *D. thoracica* in heavily infested fields (Heinrichs and Barrion, 2004).

The plant bugs from the sub family, Heteroptera attack rice at post flowering stage and are considered important in rice production. Some of these bugs reported are *Leptocorisa* spp. Latreille, *Nezara viridula* Linnaeus, *Riptortus dentipes* Stal, *Mirperus jaculus* Thunberg, *Aspavia armigera* Fabricius and *Stenocoris* spp. Blote (IITA 1986; Ewete and Olagbaju 1990; Umeh *et al*, 1991; Alam 1992; Heinrichs and Barrion 2004). Grain sucking bug**,** *S. elegans* infests rice its major host, at a period in its phenology when the panicles are at the milky stage. The bugs suck the sap and leave the glumes empty or half filled. Its feeding punctures on rice grains create entrance for other pathogenic organisms for secondary infection leading to pecked grains. It has been reported that the hill infestation, panicle infestation, grain infestation and partial grain infestation of *L. acuta* on rice were 5.42 to 13.75%, 27.27 to 54.55%, 4.70 to 7.58% and 1.82 to 2.58% respectively (Akter *et al*., 2020). Assessment of the damage by the Pentatomid, *A. armigera* on rice has also been conducted in Nigeria (Ewete and Olagbaju 1990).

The grain sucking bug, *Stenocoris elegans,* completes its nymphal developmental period in 18 days on rice (Alamu and Ewete 2014). This period covers sixty per cent of the 30-day grain ripening period of rice. The feeding activity of the bug is restricted to the ripening period of rice hence; only one generation can be completed within the rice growing season. Therefore, other food sources are required to sustain its population from one crop season to another. The pest status and alternative food sources for S. elegans are important to provide useful information on the development of management strategies of the bug. The objectives of this study were to evaluate the pest status of *S. elegans* on rice and assess the potentials of some grasses as alternative hosts.

MATERIALS AND METHODS

Plant establishment and infestation with bugs

Seeds of upland rice variety, IDSA 10, obtained from West African Rice Development Association (WARDA), now African Rice, IITA, Ibadan, Nigeria were planted in plastic pots filled with top soil and arranged on the roof top garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria. After germination, the seedlings were thinned down to one stand per pot after three weeks. Fertilizer, N.P.K. 15-15-15 was applied at the rate of 5g per plastic pot. Weeding and watering of plants were done regularly. Infestation of the rice plants with the test insects was done by caging on the panicles 0, 2, 4, 6, 8 and 10 bugs (1 male: 1 female) at 3, 6, 9, 12 and 15 days after panicle emergence. The study was conducted as a 6 x 5 factorial experiment and treatments were laid out in a Completely Randomized Design (CRD) with four replications. The shape of the rearing cage is cylindrical and dimension of each cage measured 8 cm diameter by 6.5 cm high with sleeve muslin cloths covering the two open ends. Two rectangular openings were made with one on each side of the cage and covered with a nylon mesh (30mesh/cm) for proper aeration. A stake was used to support each cage containing the appropriate number of insects. The insects were allowed to feed from the time of introduction until the panicles turned brown at about 30 days after emergence. The cages were examined daily in order to replace any dead bug with the right number and sex.

Effect of different population of *S. elegans* at varying infestation periods on yield, damage and viability of rice grain

When the grains were completely brown, they were harvested, sun-dried, threshed and the clean grains were weighed. The weights were recorded as grain yield. Estimation of percentage yield loss due to *S. elegans* infestation was determined according to the formula of Walker (1987)

$$P = \frac{R_m - Y_i}{R_m} * 100$$

P = grain loss or % yield loss; R_m = Control yield; Y_i = Yield of the i^{th} treatment

Grain damage and viability were determined using the floatation and germination tests, respectively. One hundred seeds were randomly selected from the grains in the seed lot and placed in beaker (500 ml) containing 400 ml distilled water. Each beaker with the content was stirred with a glass rod and allowed to settle. Floated grains (damaged) were removed and counted as well as those that sank (undamaged) after which the percentage of damaged grains was calculated as follows:

$$\frac{\text{No.of damage grains}}{\text{Total number of grains}} * 100$$

For germination test, one hundred grains were randomly selected and were arranged in Petri-dishes containing 9cm Whatman filter paper constantly moistened with sterile distilled water. Germination record was taken on the 7th day.

Sampling of grass weeds for *S. elegans*

Grass weeds growing near West African Rice Development Association (WARDA) experimental rice plots at International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and rice fields at Apete - Ibadan, Ido Local Government Area of Oyo State, Nigeria were observed for occurrence of *S. elegans*. Samples of grasses on which *S. elegans* was found were collected for identification at the Department of

Botany and Microbiology, University of Ibadan, Ibadan, Nigeria. After the proper identification of the grasses, further investigations were made on them for the development and survival of *S. elegans*.

Effect of food on nymphal development of *S. elegans*

Ten first nymphal instars of *S. elegans* were placed on seeds of rice variety IDSA 10 and seeds of five grass species namely, *Echinochloa crus-pavonis* (Kunth) Schult., *Setaria anceps* Stapf, *Paspalum auriculatum* J. Presl, *Panicum maximum* Jacq. and *Sorghum aethiopicum* (Hack.) Stapf as food sources in well aerated plastic boxes having internal dimension of 15.4 x 10.6 x 6.5 cm. Water was supplied from a glass vial plugged with cotton wool. Each of the food sources was replicated five times and arranged in a Completely Randomized Design (CRD). The plastic boxes were examined thrice daily (8: 00 a. m., 2: 00 p. m. and 8: 00 p. m.) for nymphal development through moulting. The day of each moult was recorded until adults emerged. The period of nymphal development on each food source, fecundity and longevity of adults were recorded.

Effects of food sources on oviposition and survival of *S. elegans*

Two pairs of teneral adults were placed on different food sources (rice and five grass species) in cylindrical plastic cages 8 cm diameter x 20.5 cm high. The experiment was arranged in a Completely Randomized Design (CRD) with each food source replicated five times. The cages were examined daily for oviposition. Another experiment was set for mortality study with five pairs of teneral adults on each of the different food sources. Each treatment was replicated five times and arranged in a CRD. Insect mortality on each food source was counted daily.

DATA ANALYSIS

The data obtained were subjected to analysis of variance and treatment means were separated using Tukey's Honestly Significant Difference (HSD) at 0.05 probability level.

RESULTS

Effect of *S. elegans* numbers at varying infestation periods on yield, damage and viability of rice grain

There were significant reductions in the grain yield of rice at 10 bugs per rice panicle at 3, 6, and 9 days after panicle emergence (Table 1). These yield reductions represented yield losses of 45.2%, 48.3% and 41.9%, respectively. All population levels of the bug had no significant effect on the grain yield at 12 and 15 days after panicle emergence.

Table 1: Mean grain yield (g/plant) (±SE) of rice at varying numbers of *S. elegans* caged on rice plants at different days after panicle emergence (percentage yield reductions in parentheses)

No. of bugs/cage	**Grain yield at different days of infestation after panicle emergence**				
	3	6	9	12	15
0	4.0 ± 0.9a	5.8 ± 0.9a	6.2± 0.7a	5.3 ± 0.9a	4.9 ± 1.8a
2	3.4 ± 1.0a (15)	4.8 ± 2.1ab (17.2)	5.6 ± 0.6ab (9.7)	5.2 ± 1.4a (1.9)	4.8 ± 0.2a (2.0)
4	3.3 ± 1.5a (17.5)	3.8 ± 0.9ab (34.5)	5.1 ± 0.4ab (17.7)	5.1 ± 1.1a (3.8)	4.2 ± 1.0a (14.3)
6	3.1 ± 1.7a (22.5)	3.5 ± 1.1b (39.7)	4.6 ± 1.8ab (25.8)	4.7 ± 1.3a (11.3)	3.9 ± 2.1a (20.4)
8	2.6 ± 0.9a (35)	3.1 ± 1.1b (46.6)	4.1 ± 2.1b (33.9)	4.2 ± 2.0a (20.8)	3.8 ± 2.0a (22.4)
10	2.3 ± 1.0b (42.5)	3.0 1.1b (48.3)	3.6 ± 1.1b (41.9)	4.1 ± 2.6a (22.6)	3.3 ± 1.1a (32.7)

Means followed by the same letter in the column are not significantly different (Tukey's HSD, $p<0.05$)

Table 2 showed that population densities of 2 - 10 bugs per rice panicle caused significant grain damage at all infestation periods. However, the severity of damage inflicted on grains decreased with increase in the age of panicles. Similarly, the percentage germination of rice grain reduced significantly with increase in the population of bugs at early stages of panicle infestation. In addition, there was a progressive increase in the germination of rice grain with increase in the age of panicles (Table 3).

Table 2: Mean percentage damage (±SE) of rice grains at varying numbers of *S. elegans* caged on rice plants at different days after panicle emergence

No. of bugs/cage	Grain damage at different days **of infestation after panicle emergence**				
	3	6	9	12	15
0	11.2 ± 2.3a	3.9 ± 0.6a	3.9 ± 0.8a	6.0 ± 0.1a	5.4 ± 0.6a
2	21.3 ± 4.1b	16.1 ± 1.4b	12.7 ± 1.2b	20.3 ± 1.5b	6.6 ± 1.1a
4	30.1 ± 16.4c	33.0 ± 4.1c	18.1 ± 1.9b	20.8 ± 1.7b	6.9 ± 0.4a
6	32.8 ± 12.7c	44.3 ± 8.9d	32.0 ± 1.6c	21.1 ± 1.9b	17.1 ± 2.9b
8	37.5 ± 10.3c	54.2 ± 11.3e	42.5 ± 2.0d	23.7 ± 1.5b	23.1 ± 2.0b
10	60.0 ± 14.9d	60.1 ± 10.8e	43.5 ± 2.0d	28.9 ± 0.9b	38.4 ± 2.9c

Means followed by the same letter in the column are not significantly different (Tukey's HSD, $p<0.05$)

Table 3: Mean percentage germination (±SE) of rice grains at varying numbers of *S. elegans* caged on rice plants at different days after panicle emergence

No. of bugs/cage	Germination of rice grains at different days of infestation after panicle emergence				
	3	6	9	12	15
0	91.5 ± 1.5a	95.8 ± 2.2a	96.3 ± 2.5a	96.5 ± 1.7a	93.0 ± 2.2a
2	90.0 ± 1.6a	92.0 ± 3.5a	91.5 ± 3.9ab	88.5 ± 4.2ab	95.5 ± 3.2a
4	83.3 ± 1.8b	83.3 ± 6.4a	90.5 ± 3.6ab	84.8 ± 2.5ab	92.5 ± 2.7a
6	79.5 ± 3.9b	68.3 ± 1.8b	83.5 ± 4.9bc	84.5 ± 4.7ab	89.0 ± 5.9a
8	76.5 ± 1.4b	57.0 ± 1.4b	77.0 ± 2.7bc	83.5 ± 2.2ab	96.0± 2.1a
10	48.5 ± 1.8c	43.8 ± 1.1c	74.5 ± 5.2c	79.5 ± 2.9b	91.3 ± 4.3a

Means followed by the same letter in the column are not significantly different (Tukey's HSD, $p<0.05$)

Effects of food on nymphal development, oviposition and survival of *S. elegans*

The effect of food sources on the development of *S. elegans* showed that nymphs were reared successfully to adult stage on three out of six food sources tested (Table 4). The mean period of nymphal development when reared on *O. sativa*, 18 days was significantly lower than when reared on seeds of two grass species, *S. anceps* (20.6 days) and *E. crus-pavonis* (21.1 days) which were not significantly different from each other. Nymphs of *S. elegans* could not develop into second instar stage on *S. aethiopicum, P. auriculatum* and *P. maximum.*

Table 4: Mean duration of nymphal development (days) of *S. elegans* reared on different food sources

Food source	Nymphal instars					
	I	**II**	**III**	**IV**	**V**	**Mean total developmental period of nymphal instars** ±S.E
O. sativa	3.0	3.0	3.0	3.0	6.0	18.0 ± 0.60a
S. anceps	3.0	3.0	3.5	3.8	7.3	20.6 ± 0.81b
E. crus-pavonis	3.0	3.0	3.3	3.5	8.3	21.1 ± 1.02b
P.auriculatum	3.0	*	*	*	*	*
S. aethiopicum	3.0	*	*	*	*	*
P. maximum	3.0	*	*	*	*	*

Means followed by the same letter in the column are not significantly different (Tukey's HSD, $p<0.05$)
*No development of *S. elegans*

Table 5 showed the mean fecundity and longevity of mated adults of *S. elegans* on different food sources. The highest mean numbers of eggs were laid when fed on *O. sativa* (270.5 eggs) and *E. crus-pavonis* (222.2 eggs). The bug laid significantly fewer numbers of eggs when fed on *S. anceps* (97.0 eggs) compared to *O. sativa* and *E. crus-pavonis*. The least number of eggs were laid when fed on *P. maximum* (mean = 0.8) while *S. elegans* did not lay egg on

S. aethiopicum and *P. auriculatum*. With an average longevity of 43 days, mated adults of *S. elegans* significantly lived longer on *O. sativa* than on other host plants. The shortest longevity of 10.8 days recorded on *S. aethiopicum* was not significantly different from 11.2 days recorded on *P. maximum* (Table 5)

Table 5: Mean fecundity and longevity of mated adults of *S. elegans* on different food sources

Food source	**Fecundity** ± S.E	**Longevity (day)** ± S.E
Oryza sativa	270.5±58.56a	43.0 ±10.60a
Echinochloa crus-pavonis	222.2 ± 61.51a	33.8 ± 7.02b
Setaria anceps	97.0 ± 17.67b	17.8 ± 2.96d
Paspalum auriculatum	0.0 ± 0.00c	17.8 ± 2.96d
Sorghum aethiopicum	0.0 ± 0.00	10.8 ± 1.83e
Panicum maximum	0.8 ± 0.8c	11.2 ± 2.48e

Means followed by the same letter in the column are not significantly different (Tukey's HSD, $p<0.05$)

DISCUSSION

Investigations on the pest status of *S. elegans* showed that the severity of yield loss and seed damage varied with the bug density and the stage of panicle development. In this study, 10 adults of *S. elegans* caused a significant yield loss which ranged from 41.9 to 48.3 per-cent between 3 and 9 days of panicle development. Rice grains suffered greater damage at high densities of *S. elegans* on rice panicles during the early stages of panicle development. However, the extent of damage reduced drastically as the panicles became matured. The greater damage inflicted by the bug on rice panicle during early stages of development is reflected in the low percentage germination of grains observed at early stages of panicle development. This finding supports the reports that hemipterans bugs caused severe losses to rice during the flowering and milky stage than during the soft dough stage (Pantojoa *et al*., 2000; Dilipkumar *et al*., 2006). Ewete and Olagbaju (1990) had earlier recorded a significant damage of rice due to *Mirperus jaculus* at a population of four bugs per panicle. Similarly, other heteropterans, *Oxycarenus gossypinus*, (Ewete 1978), *Clavigralla tomentosicollis* (Jackai *et al*., 1989) and *Aspavia armigera* (Ewete and Niba 1994; Jooda *et al*., 2014) have been reported to cause significant damage to crops at high densities during early stages of seed development. Therefore, a population density of at least four bugs per rice panicle within the first nine days of panicle development is necessary to initiate a control action against *S. elegans*

S. elegans completed its life cycle on *O. sativa*, *E. crus-pavonis* and *S. anceps* but nymphs of *S. elegans* could not develop to the second instar stage on *S. aethiopicum*, *P. auriculatum* and *P. maximum*. There is a possibility that first nymphal instars of *S. elegans* do not feed. This has been reported by Panizzi (1997) for the first nymphal instar of pentatomids who are also hemipterans bugs. This could have been the reason why the first nymphal instars of *S. elegans* survived on *S. aethiopicum*, *P. auriculatum* and *P. maximum*. Subsequently, after the first nymphal instar stage, other nymphal stages could not survive on these three grass weeds. Similarly, female fecundity was low and life span of adult *S. elegans* was shortened on *S. aethiopicum*, *P. Auriculatum* and *P. Maximum*. This finding may suggest that the food quantity and quality of *S. aethiopicum*, *P. auriculatum* and *P. maximum* are not enough to support the development and survival of *S. elegans*. In addition, these three grass weeds may possess chemical substances that are antagonistic to the biology of the rice bug. The completion of nymphal development, significant high fecundity and longer life span of *S. elegans* on *O. sativa*, *E. crus-pavonis* and *S. anceps* clearly supported the survival and establishment of the bug population on these host plants. Consequently, in the absence of rice in the field, *E. crus-pavonis* and *S. anceps* can act as alternative hosts to *S. elegans*. Rothschild (1970) had earlier reported the occurrence of the Alydid bug, *Leptocorisa oratorius* on the weeds, *Echinochloa crusgalli*, *Paspalum scrobiculatum* and *Pennisetum* sp. though with only *E. crusgalli* supporting the breeding population of *L. oratorius*. Also, Heinrichs and Muniappan (2017) reported that the major grass serving as an alternate host to rice insects is *Echinochloa* spp.

Conclusively, the destruction of *E. crus-pavonis* and *S. anceps* around rice fields could reduce the population build up of *S. elegans* and could be incorporated into the Integrated Pest Management (IPM) component of this rice pest.

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