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Susceptibility of six local rice cultivars and efficacy of eco-friendly botanical to *sitophilus oryzae* (L) (coleoptera: *Curculionidae*)

Abstract

Six local rice cultivars, *Oryza sativa* (Linnaeus), were sampled from two vegetation zones; the Rain forest and Savanna wood land in Nigeria. The Towns where samples were taken include Abakaliki,, Ilesha, Igbemo, Minna, Zaria and Abuja. They were examined for their morphology and relative susceptibility to *Sitophilus oryzae,* a common pest of rice. Also a botanical, *Piper guineense*, was assessed for its efficacy in the control of *Sitophilus oryzae.* Twenty grams of each rice variety was infested with twenty weevils (*Sitophilus oryzae*) in three replicates. Susceptibility was assessed using Susceptibility Index. The length of the rice grain range from 6.24cm to 7.87cm, width ranges from 2.27cm to 2.43cm and the thickness range from 1.7cm to 1.92cm. The variety with the least Susceptibility Index was Abuja with mean SI 3.13 while the most susceptible variety with mean SI 4.13 while the most susceptible variety with mean SI 4,13 was Ilesha rice. In other samples Abakaliki rice had SI of 3.40, Igbemo rice had SI 3.47, Tapa rice from Minna had SI 4.00 and Zaria rice had SI 3.03. At the exposure of the adult *S. oryzae* to 2.5g concentration of *P. guineense*, total mortality was achieved within 3days in all the insects that emerged from different cultivars. This actually implies that total mortality will be achieved within 3days when exposed to insect at 2.5g of concentration with 20g of rice grain. Also, there is increase in percentage mortality trend at different time of exposure with increased Concentration.

Keywords: susceptibility, *Oryzae sativa, Sitophilus oryzae*, *Piper guineense,* adult mortality

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Introduction

Food security is important for a nation's security. The present security challenges faced by Nigeria as a country has been linked to high rate of food shortage as more than 54 million of citizens of the country go to bed with empty stomach.[1] Agriculture is the back bone of development of any country as opined by Adeyemo et al.,[2] In Nigeria local rice production as a popular cereal grain is encouraged instead of importation from foreign countries.[3] Rice (*Oryza sativa L.*), a major commodity in world trade, provides 20 % of the world's dietary energy supply. It is utilized mostly at the household level, where it is consumed as boiled or fried with stew as in Nigeria. Most rice is consumed as white polished grain despite the valuable food content of brown rice. The complete milling and polishing that converts brown rice into white rice destroys 67 % of the vitamin B3, 80 % of the vitamin B1, 90 % of the vitamin B6, half of the manganese, half of the phosphorus, 60 % of the iron, and all of the dietary fibre and essential fatty acids. Nigerian farmers are currently empowered to produce rice grains in abundance so as to reduce importation. The local cultivars of rice, *Oryzae sativa*, are popular as food and peculiar to each locality. Rice on the field and in storage as well as other stored grain products, are attacked by various arthropods causing quantitative and qualitative losses. Food insect contamination represents a crucial problem for food industries and for export commodities.[4] During storage and distribution, rice is often attacked by various storage insects. Among these are *Sitophilus oryzae* L. and *S. zeamais* Motsch, other storage insect pests of rice are *Rhizopertha dominica* and *Sitotroga cereallela*.[5] The most important and destructive of these insect pests is *S. oryzae which* can fly to the field and attack grain before it is harvested. Most of the damage to grains is done by the larvae, which devour almost the whole endosperm leaving only the hull and the weight of the food is reduced.[6] In addition to causing direct loss, they also reduce seed viability thus reducing the market and nutritional value of the food. Sautosh (1964) introduced a parameter that he called the Environmental Index to compare the success of development of insects in different environments.

Subsequently, this index was used under the name Growth Index $\left(\frac{\log n}{Av}\right)$ to compare the development of larvae on a number of foods.[7,8] explained this principle as Susceptibility Index (SI) by combining two types of information, the percentage of individuals (n) completing a stage of life cycle and the average duration (Av) of this stage. Rice cultivars exhibit varying degrees of susceptible to damage by insects. One of the ways of reducing post harvest losses of grains is breeding for varietal resistance. The factors that confer resistance to the grains against infestation by a variety of storage insects are varied. Researchers have worked on the resistance or susceptibility of different cultivars of rice to attack by rice weevil (*S. oryzae.*).[9] Nevertheless there are still a lot of cultivars to be tested against *S. oryzae* infestation, especially the local cultivars. *Piper guineense* (African black pepper) is a West African spice plant with medicinal property and widely used traditionally in the treatment of various ailments.[10] The phytochemical studies of the plant revealed the presence of proteins, carbohydrates, alkaloids, steroids, glycosides, saponins, flavonoids, tannins and phenolic compounds (Echo *et al*., 2017). *Piper guineense* also contains vitamins, minerals and fat.[11] Various studies have been done on the plant to determine its pharmacological and Therapeutic properties such as antibacterial, antioxidant.[12] Though, pesticides were developed to control insect pest, they have created serious ecological problems[2,13] In order to replace these insecticides, entomologists of the world are rummaging for other means of controlling insects. Eco-friendly botanicals are very effective in the agricultural pest control without causing serious

harm to ecological chain or worsening environmental pollution. This research determines the morphological properties of different local rice cultivars, investigates the relative susceptibility of some local rice cultivars to the rice weevil, *Sitophilus oryzae* L. (Coleoptera: *Curculionidae*) and assesses the efficacy of *P. guineese* on mortality of adult rice weevil.

Materials and methods

Preparation of materials

Insect culture maintenance: The *Sitophilus oryzae* (L.) used for this study was obtained from stock culture in the Storage Research Laboratory of the Federal University of Technology Akure, Nigeria. New generation of the insect was reared on clean and uninfected polished rice (Aroso), in 1-litre Kilner jars covered with muslin cloths to ensure ventilation and prevention of weevil escape or entrance of other insects. This culture was maintained at ambient laboratory temperature of 28±2^{0}C and relative humidity range between 70-75%.

Sourcing of the local rice cultivars

Six cultivars of rice (*Oryza sativa*), were collected from different locations of two vegetation zones (Tropical rain forest and Savannah woodland), Nigeria. The Cultivars were Abakaliki rice, (Abakaliki, Ebonyi State), Ijesha rice (Ilesha, Osun State), Igbemo rice, (Igbemo, Ekiti State), Tapa rice, (Bida, Kogi State), Zaria rice, (Zaria, Kaduna State) and Abuja rice (Abuja, Federal Capital Territory), Nigeria. The rice samples were disinfested by freezing them for one week and the grains were considered to be totally disinfested. This is because all the life stages, particularly the eggs are very sensitive to cold.[14] After freezing, the rice grains were spread on normal white papers at room temperature and humidity in the Laboratory for 24 hours to bring them into normal condition to prevent moldiness.[15]

Preparation of plant powder

The dried *P. guineese* seeds were obtained from the market and the shafts were removed, milled into fine powder using commercial blender and sieve through 60 mesh size sieve. Powders were kept in Plastic bottles at room temperature and properly sealed to prevent quality loss.

Experimental procedure

I. Visual assessment of rice cultivars

This involve the use of hand lens, 100g of each variety of rice was viewed to study the morphological characteristics. Observations were made on Length, Width, Colour, Size and Shape of the grains. Data was collected during survey of sample grown on varied topography of land cultivated with rice.

II. Susceptibility test

Whole rice grains (100g) from each rice cultivars were accurately weighed with high precision Balance, Model: KDCN capacity 1100g, S/N: 100828072 and kept in plastic containers 250ml measuring. Twenty pairs of insect weevils, day old were introduced into each container from the stock culture. Three replications were taken for each rice cultivars. The opening end of the container was covered with a piece of 'muslin' cloth (for aeration) and tied with rubber bands. The released weevils were allowed to remain undisturbed in the containers with the gains for the first four weeks, and arranged in a completely randomized manner in insect breeding cages in the laboratory. The first census of the weevils, both living and dead, was made after 35 days since the insect release, and subsequently the counting was made every day. After each count, the dead weevils were discarded and the living ones were returned to the rearing medium. The recording of the number of weevils continued up to 56 days. The experiment was set up in a complete randomized design and each treatment was replicated three times. The data was be analyzed statistically. Susceptibility Index was calculated using formulae of Howe (1971). The Susceptibility Index combined two type of information, the percentage of individuals completing a stage of life cycle and the duration of this stage. Suitability of each variety was assessed on the basis of the number of adults that emerged (n) and the length of developmental period (Av) according to Howe.[8]

Formulae: susceptibility $Index = \frac{\text{Logn}}{\text{Av}}$

The susceptibility index (S.I) was calculated for each rice variety after 1st filial adult emergence. Then further calculations were made for 7days, 14days and 21days after adult emergence.

III. Contact toxicity test

In all tests 20 pairs of *S. oryzae* were introduced into each container (250ml) containing the local six cultivars of rice and the opening of the same was secured with top cover. Three replicates were used for the experiments. For dried powder application, 0.5g, 1g, 1.5g, 2g 2.5g of dried powder was placed in a plastic container (250ml). 20g grains each were added to it and shaken thoroughly for proper mixing with the powder. The percentage of Adult mortality was calculated for each Cultivar sample.

$$\%Mortality = \frac{numberofdeadinsect}{Totalnumberofinitialinsect} \times 100$$

IV. Data analysis

Data from the results were subjected to one-way ANOVA ($P > 0.05$) after checking for normality with, and means were separated by Tukey's Studentized Range Test at the 5% significance level using SPSS ver. 16 software.

Results

Visual assessment of rice cultivars

The morphological characteristics of the six local rice cultivars are presented in Table 1. Rice gotten from Abakaliki; dull in colour, slender, opaque, long grain and cultivated in lowland. Ilesha rice; having dirty white in colour, slender, opaque, short grain, cultivated in lowland. Tapa rice is white brown, robust, opaque, long grain, cultivated in upland. Igbemo rice is dull in colour, fairly robust, opaque, short grain and cultivated in upland. Zaria rice; dull white, robust opaque long grain and cultivated in upland. Abuja rice; is white, slender, its appears opaque, long grain and cultivated in upland. The significant value for length of the grain ranges from 6.24 to 7.8. Abakaliki rice grain has the least significant value of 6.24±0.12 while the Abuja rice has the higher significant difference7.87±0.09 compare to the other rice grain; this indicated that, it has the longest length among the rice cultivars. Between Ijesha and Tapa there is no significant difference but significant difference from Zaria. The significant value for width of the grain ranges from 2.27 to 2.43 there is no significant difference between them but Zaria has the highest numeric value (2.43±0.03) while Abuja rice grain has the least significant difference (2.27±0.04) from the other cultivars. This implies that Abuja rice has the least

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width. The significant value for Thickness of the rice grain ranges from 1.7 to 1.92. However, Abakaliki and Ijesha rice grain had the least significant value with no significant difference. Zaria rice grain had the highest significant difference (1.92±0.03) compared to the other variety of grain, which implies that Zaria rice grain has the highest value of thickness.

Table 1 Morphological characteristics of the Rice Cultivars used in the experiment

Rice variety	Colour	Shape	Appearance	Type	Cultivated Habitat	Length	Width	Thickness
Abakaliki	Dull	Farly robust	Opaque	long grain	Lowland	6.24±0.12a	2.31±0.03ab	1.70±0.02 a
Ijesha	Dirty white	Robust	Opaque	short grain	Lowland	6.37±0.13ab	2.32±0.04ab	1.70±0.02 a
Tapa	Dull brown	Robust	Opaque	long grain	Upland	6.57±0.14ab	2.29±0.04ab	1.88±0.33bc
Igbemo	dull	Fairly robust	Opaque	short grain	Upland	6.82±0.12bc	2.33±0.04ab	1.82±0.03 b
Zaria	dull white	Robust	Opaque	Long grain	Upland	7.21±0.09 c	2.43±0.03 b	1.92±0.03 c
Abuja	White	Slender	Opaque	long grain	Upland	7.87±0.09 d	2.27±0.04 a	1.83±0.02bc

Mean±SE represent three (3) replicates. Mean with the Same alphabet down the column are not significantly different (P>0.05) using Tukey's HSD (honest significant difference) at 0.05 level of significant.

Susceptibility of Cultivars of Rice

The mean number of adult insects (*Sitophilus oryzae*) that emerged from the different percentage of each cultivars varied significantly (P>0.05). This was show in Table 2, as the record was taken 7days, 14days and 21days. The adult emergence for 7days between the cultivars, it was observed that Abuja rice has the lower significant value and Ilesha has the highest significant value, which of highest significantly difference from others while Zaria, Abakaliki and Igbemo have no significant difference. This implies that Abuja rice is the least susceptible with significant difference of 6.33 while Ilesha rice is the most susceptible with significant difference of 48.67 within the period of 7days after 35days of emergence. Likewise, The adult emergence for 14days between the cultivars, it was observed that Abuja rice has the least significant value and Ilesha has the highest significant value, which of highest significantly difference from others while Zaria and Abakaliki have no significant difference. This implies that Abuja rice is the least susceptible with significant difference of 34.33 while Ijesha rice is the most susceptible with significant difference of 75.67 within the period of 21days. Howbeit, on the 21days of counting the number of adult emergence, it was observed that Abuja rice still has the least significant value of 58.67 and Tapa rice grain has the highest significant value of 89.67 The susceptibility index was observed and recorded 7days, 14days and 21days for the six cultivars. On the day seven it was observed that Abuja rice is of the lower significant difference while Ilesha rice grain is significantly the highest. Likewise on the 14days, but on the 21day of observation, Tapa rice grain is significantly higher than Ilesha rice.

Table 2 Adult Emergence for 7days, 14days and 21days

Rice variety	7days	14days	21days
Abuja	6.33±0.82a	34.33±0.67a	58.67±0.88a
Zaria	15.00±2.00b	41.33±2.03b	65.00±2.08b
Abakaliki	14.00±0.57b	46.00±1.15bc	65.67±0.58b
Igbemo	18.00±0.57b	48.00±1.15c	61.00±0.58ab
Tapa	25.33±0.67c	68.00±1.00d	89.67±1.45c
Ijesha	48.67±0.33d	75.67±1.86c	87.67±1.45c

Mean±SE represent three (3) replicates. Mean with the same alphabet down the column are not significantly differently different (P>0.05) using Tukey's HSD) (Honest Significant Differences) at 0.05 level of significant.

Using the scale for susceptibility index which is shown at the appendix 2, Ilesha rice with index susceptibility SI 4.19 and 4.44 was moderately resistance on the 7days and 21days while Tapa rice with index of susceptibility S I 4.3 was the most moderately resistant on the 21 day. Abuja, Abakaliki, Zaria and Igbemo rice grain show that they are resistance in term of susceptibility index ranking however Abuja rice grain is the least resistance with susceptibility index SI 2.06 at 7days, Zaria with susceptibility index SI 3.50 and 3.73 at 14 and 21 days respectively. Conclusively; Ilesha and Tapa is most moderately resistance within the 21 days. On the seven day, in terms of adult emergence, Abuja rice has the lowest Susceptibility and all through the 21days of counting. Also, in the index Susceptibility is resistance. On the seven day, in terms index Susceptibility, is resistance and significantly difference from Igbemo rice. On the seven day, in terms of index Susceptibility is resistance and less significantly difference from Tapa and Ilesha rice On the seven day, in terms e index Susceptibility is resistance and significantly difference from Igbemo rice. On the seven day, in terms of the index Susceptibility Tapa rice is moderately resistance but less significantly difference from Ilesha rice. On the seven day, in terms of adult emergence, Ilesha rice has the highest Susceptibility and also, the index Susceptibility is moderately resistance.

Contact toxicity test

The total number of dead adult insects were noted and recorded in each plant powder exposed to the insect in a covered container containing 20g of rice grain of the six cultivars. Mortality of *S. oryzae* was reported at 24, 48, 72, 96 and 120 hours. The highest mortality trend in all concentrations was achieved at exposure times ranging from 24 to 76h after the beginning of the experiment. There were significant differences between tested concentrations after 24 and 96h. Weevil mortality was observed for some days and the percentage mortality recorded was calculated.

Mortality observed on abuja rice

At the exposure of the insect (*Sitophilus oryzae*) to difference concentration ranges 0.5g to 2.0g at the same period (24hours) it was observed that there is no significant different between the concentration ranges from 1.0g to 2.0g but 0.5g is significantly ranges from them this indicated that 0.5g concentration has the least mortality. After 48hours of exposure, concentration of 2.5g has the

highest significant difference from other concentration, which implies that higher mortality was recorded for 2.5g and total mortality was recorded after 72hours with concentration of 2.0g and 2.5g.Also, the effect of the plant powder with concentration 2.5g has the significant percentage mortality rate after 48hours. This implies that the highest percentage mortality rate was first recorded after 48hours (two days) with concentration of 2.5g. At 120hours there is no significant difference in all the concentration. In summary, for the insect pest mortality on Abuja rice, there is percentage increase in mortality at different time of exposure with increase in concentration, but the first highest mortality was recorded after 48hours with 2.5g concentration.

Mortality observed on abaka like rice

At the exposure of the insect (*Sitophilus oryzae*) to difference concentration ranges 0.5g to 1.5g at the same period (24 hours) there is no significant difference between their mortality rate and concentration of 2.0g and 2.5g there is no significant difference but significant difference from the concentration ranges between 0.5g to 1.5g.This implies that at the same period of time there is increase in mortality rate in 2.0g and 2.5g. After 48hours of exposure, 0.5g and 1.0g of concentration is least significant difference from 1.5g, 2.0g and 2.5g. This indicated that percentage mortality rate was least recorded compare to concentration of 1.5g, 2.0g and 2.5g at the same period of time. After 72hours of exposure 2.0g and 2.5g has the highest significant difference from 0.5g, 1.0g and 1.5g concentration. After 120hours of exposure, there is no significant difference in their percentage mortality rate at difference concentration. Percentage mortality was achieved in increase in trend at different time of exposure different concentration but highest percentage mortality was observed after 48hours at the concentration of 2.0g and 2.5g. Also, the first total percentage mortality was recorded after 72hours (3days) of 2.0g and 2.5g concentration.

Mortality observed on igbemo rice

At the exposure of the insect (*Sitophilus oryzae*) to difference concentration ranges 0.5g to 1.5g at the same period (24 hours) there is no significant difference between their mortality rate and concentration of 2.0g and 2.5g there is no significant difference but significant difference from the concentration ranges between 0.5g to 1.5g.

Mortality observed on zaria rice

At the exposure of the insect to plant powder of different concentration ranges from 0.5g to 2.5g at the same period which is 24hours .only 2.5g is significant difference from them. The efficacy of the plant was dose-dependent ater48hour as the 2.0g and 2.5g is most significant difference from other concentration but 2.5g is of highest in numerical value. Also, insect expose to different dose ranges from 0.5g to 2.5g at the same time (120hours) there is no significant different.

Mortality observed on tapa rice

After 24hours, no mortality rate was recorded when expose to 0.5g, At the expose to different correlation ranges from 0.5g to 2.5g at the same time, there is no significant difference between 0.5g to 1.5g but significant difference from mortality rate recorded at 2.5g concentration which is of highest significantly difference from other concentration. This implies that the 2.5g has the highest mortality rate at that same period. There is highest mortality trend in all concentration achieved at different time of exposure.

Mortality observed on ilesha rice

Concentration ranges from 0.5g to 1.5g recorded no mortality rate at exposure to the insect this could be duty to their strong immune system compare to other insect emerged from other variety of rice at the same period (24hours).In summary, at the exposure of the insect to 2.5g concentration, evoked total mortality within 3days in all the insects emerged from different cultivars. This actually implies that total mortality will be achieved within 3days when exposed to insect at 2.5g of concentration with 20g of rice grain. Also, there is increase in percentage mortality trend at different time of exposure with increase with increase in concentration.

Percentage weight loss

The percentage weight loss of the rice cultivars were measure before and after the experiment. Generally, they are significantly difference from each other due to the feeding activity of *Sitophilus oryzae.* Also, difference in the length, width and thickness of the rice grain could also add to the weight loss difference in the variety. Abakaliki rice is significantly difference from Ilesha, Tapa, Igbemo, Zaria and Abuja rice between Ilesha and Igbemo rice, there is no significant difference, However Abuja rice has the least significant value, this implies that minimum weight with 0.20% is achieve. In Abakaliki rice grain maximum percentage weight of 4.20% was achieved.

Discussion

Cultivars, age, hardness, size, moisture content, etc. influenced the oviposition, reproduction, development and infestation of the rice weevils (Bamisile *et al*., 2014). The susceptibility of rice cultivars to the infestation of *S. oryzae* depends not only on a single factor; but, it depends on the combination of many factors like grain hardness, nutritive value, and natural resistance. In addition, the factors comprising grain size and moisture content in the rice grains might be the reasons of severe infestation by the rice weevil population.[16] Susceptibility, which is an indication of the potential rate of increase of a pest population, was evaluated for the rice weevil *S. oryzae* in this study on the basis of adult weevil emergence, from the parameters considered in this study, The adult emergence for 7 and 14days between the cultivars, it was observed that Abuja rice has the least significant value physical factors of resistance such grain hardness, seed texture and thickness could have been responsible for its low susceptibility. Grain hardness is found to be negatively correlated with susceptibility to *Sitophilus* species.[17-18] Although not measured in this study, the hardness of this variety might have reduced the ability of adult weevil to make hole on the grains for oviposition and likewise reduce the ability of the larvae to feed properly on the endosperm, because it has highest number emergence of insects (Table 2) (Figure 1) (Figure 2) & (Table 3). For Ilesha rice grain of this variety, the high adult emergence observed could be as a result of the availability of nutritional requirement that support the population growth of *S. oryzae.* Population growth of *S. oryzae* is known to be influenced by the medium in which the insect is reared.[14] Other factors of resistance could be essential nutrients which may have low or no growth inhibitors that could favour the rapid development of the weevils. In terms of index of susceptibility, Abuja, Abakaliki, Zaria and Igbemo with index of susceptibility SI 3.93, 4.03, 3.73 and 3.86 respectively were resistant but among these cultivars Zaria rice was the least resistance while Tapa and Ilesha were moderately resistance with SI 4.30 and 4.22. The indices of susceptibility (SI) observed in this work

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is much lower than those of Ashamo. SI ranged from 2.06 to 4.30 while that of Ashamo.[9] ranged from 5.5 to 10.8.[9] And it was observed that some parameters in this study is differ from his work which include; the number of insects introduced and the gramme of the rice grain measured, 20 pairs of insect weevils to 100g of rice grain, While in his work he introduced ten insect weevils to 12g of rice grain. The period for oviposition in this study was 7days compare to his work which was 14days. Also, the counting of adult emergence was 21days and while his work was 28days.The difference in parameters could have cause low susceptibility index. Gbaye and Olanrewaju, 2016. Lower moisture contents might have affected the initial availability of moisture for the development of the weevil and the subsequent adult emergences which will in turn reduce the SI. Lower moisture content will increase grain hardness; therefore dehulled rice should be kept at lower moisture level during storage. It is even better to store un-dehulled rice for long-term storage because the intactness of the hull is one of the major factors that confer resistance on rice grains against rice weevil attack.[20] Medicinal plants have played important and integral role in the replacement of precarious, un ecofriendly and expensive synthetic chemical insecticides. Among other control measures, plants and their derivatives have appeared more promising because of their accessibility, ease of application and its familiarity among poor resource and illiterate farmers. Use of plant as crop protectant is as old as production of crop itself even before popularity of synthetic chemical insecticides. Though, many of the discovered effective plant powders and oils are yet to be comparable to many of the synthetic chemical insecticides in term of their potency. Therefore, the search for other plants that could comparably contend with chemical insecticides become of interest. More so, the tropical zones of the world are well endowed with many medicinal plants that could be insecticidal.[21-23] The ability of dose of plant powder used in this study to cause adult mortality of *Sitophilus oryzae* can be attributed to the insecticidal prowess of *P. guineense* used in this study. In addition, the mortality rate of the insect in the study can be said to be dose dependent, as mortality increased with increase in concentration.

Table 3 Mortality Rate of Sitophilus oryzae At Different Concentration of piper

Rice Cultivars	Time	Concentration				
		0.5g	1.0g	1.5g	2.0g	2.5g
Control (Imported Rice)		0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a
Abuja(RA)	24H	13.33±1.67a	33.33±3.33 b	36.67±3.33 b	36.67±3.33 b	40.00±00 b
	48H	36.67±1.67 a	53.33±3.33 b	60.00±5.00 b	63.33±3.33b	83.33±3.33 c
	72H	73.33±3.33 a	73.33±3.33 a	76.67±6.67 a	100.00±0.00 a	100.00±0.00 b
	96H	86.67±3.33 a	90.00±2.89ab	96.67±3.33ab	100.00±0.00 b	100.00±0.00 b
	120H	96.67±3.33 a	96.67±3.33 a	100.00±0.00 a	100.00±0.00 a	100.00±0.00 a
Abakaliki(RAb)	24H	1.67±0.83 a	6.67±0.33 a	6.67±0.33 a	23.33±3.33 b	26.67±1.67 b
	48H	5.00±2.89 a	13.33±3.33 a	36.67±3.33 b	70.00±5.77 c	80.00±5.77 c
	72H	21.67±1.67a	36.67±1.67 b	60.00±2.89c	100.00±0.00 d	100.00±0.00 d
	96H	45.00±2.89 a	73.33±1.67 b	90.00±2.89 c	100.00±0.00 d	100.00±0.00 d
	120H	91.67±6.01 a	93.33 ±6.67 a	93.33±3.33 a	100.00±0.00 a	100.00±0.00 a
Igbemo(RIg)	24H	3.33±1.67 a	10.00±2.89ab	20.00±2.89bc	33.33±3.33 c	56.67±3.33 d
	48H	23.33±1.67 a	23.33±3.33 a	36.67±3.33 a	80.00±0.00 b	90.00±5.77 b
	72H	50.00±2.89 a	53.33±3.33 a	66.67±6.67 a	96.67±3.33 b	100.00±0.00 b
	96H	73.33±3.33 a	80.00±0.00bc	90.00±5.77 a	96.67±3.33 c	100.00±0.00 c
	120H	91.67±4.41 a	91.67±4.41 a	100.00±0.00 a	100.00±0.00 a	100.00±0.00 a
Zaria(RZ)	24H	6.67±1.67 a	10.00±0.00 a	13.33±3.33 a	13.33±3.33 a	43.33±3.33b
	48H	6.67±1.67 b	36.67±1.67 b	36.67±4.41 a	73.33±3.33 c	83.33±6.67 c
	72H	36.67±3.33a	73.33±8.82 a	73.33±8.82 a	93.33±3.33 a	100.00±0.00 a
	96H	70.00±0.00 a	90.00±5.77 a	90.00±5.77 a	96.67±3.33 a	100.00±0.00 a
	120H	90.00±0.00 a	93.00±6.67 a	96.00±3.33 a	100.00±0.00 a	100.00±0.00 a
Tapa(RT)	24H	0.00±0.00 a	3.33 ±1.67 a	10.00±2.89 a	26.67±3.33 b	36.67±1.67b
	48H	16.67±3.33 a	20.00±5.77 a	30.00±0.00 a	76.67±1.67 b	93.33±3.33 c
	72H	40.00±5.77 a	46.00±3.33 a	46.67±3.33 a	93.33±3.33 b	100.00±0.00 b
	96H	53.33±3.33 a	73.33±3.33 b	80.00±5.77bc	96.67±3.33 cd	100.00±0.00 d
	120H	76.67±3.33 a	96.67±3.33 b	96.67±3.33 b	100.00±0.00 b	100.00±0.00 b
Ijesha(RI)	24H	0.00±0.00 a	0.00±0.00 a	0.00±0.00 a	13.33±1.67 b	16.67±1.67 b
	48H	6.67± 1.67 a	13.33±1.67 a	16.6±3.33 a	73.33±3.33 b	90.00±5.77 c
	72H	26.67±1.67 a	30.00±2.89 a	46.67±3.33 b	90.67±1.67 c	100.00±00 c
	96H	50.00±2.89 a	50.00±5.27 a	73.00±8.81 b	100.00±0.00c	100.00±00 c
	120H	66.67±3.33 a	76.00±3.33ab	86.67±3.33 b	100.00±0.00 c	100.00±00 c

Mean ±SE represent three (3) replicates. Mean with the same alphabet down the column are not significantly differently different (P>0.05) using Tukey's HS) (Honest Significant Differences) at 0.05 level of significant.

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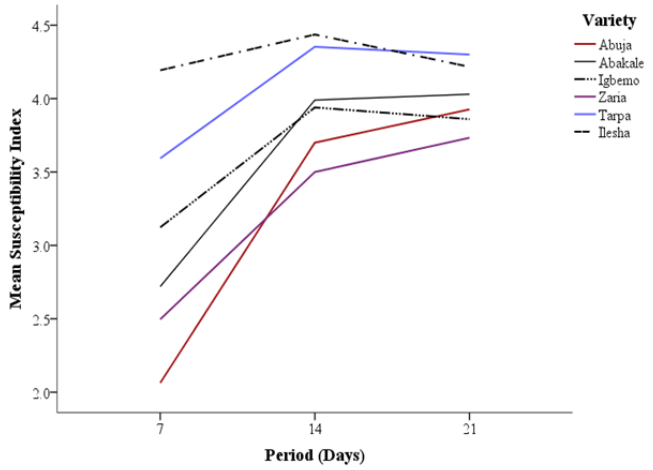

Figure 1 The Susceptibility Index of the six rice cultivars.

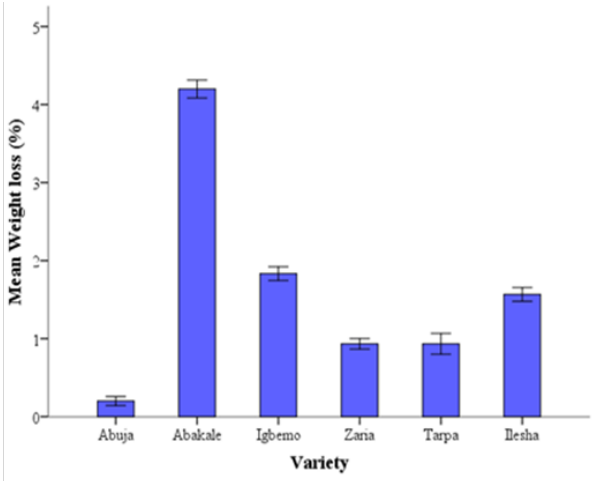

Figure 2 The mean percentage weight loss (after 35days).

Conclusion

From this study it was observed that susceptibility in terms of adult emergence take place on 7 and 14 days among the rice cultivar. The highest susceptibility was recorded in Ilesha rice while the least was recorded on the Zaria rice. *Piper guineense* has insecticidal properties which can cause mortality of *Sitophilus orysae*, thus it could be used in grain protections and farmers who stores rice for marketing purpose and consumption could use it to protect the rice.

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None.

Conflicts of interest

The authors declared there is no conflicts of interest.

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