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Assessment of some legumes and cereal grains susceptibility to maize weevil (*sitophilus zeamais)* infestation.

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Abstract:
A research study was carried out to assess the susceptibility of some cereal and leguminous crops to maize weevil (Sitophilus zeamais) infestation while in store. The produce include: Maize, Sorghum, Rice, Cowpea, Bambara nut and Groundnut. One hundred grams of each produce was placed in separate transparent plastic containers. Each container was released into; twenty pairs of three-day old S. zeamais adults for mating and oviposition. The covers of the plastic container were perforated to enhance proper ventilation. The insects were covered with nylon mesh and their perforated lids screwed in place to facilitate confinement of the weevils. Each treatment was repeated six times and laid out on the laboratory bench in a completely randomized design (CRD). The treatments were studied for four weeks for progeny emergence, the emerged progeny was removed from each container and counted. The daily count was continued until no more weevils emerged (at five weeks after treatment). Data on percentage weight loss were taken as compared with un-infested (control) using student t-test at 5 percent and 1 percent probability levels. Data obtained from the research laid out as factorial in CRD were subjected to analysis of variance using GenStat statistical software (Version 6) and significant means were compared using LSD and DNMRT at 5 percent level of probability. The result of adult emergency of S. zeamais on different host crops showed that with the exception of rice, the number of adult of S. zeamais that emerged from the cereals at 1 week of storage was significantly ($p<0.05$) higher than those that emerged from the legumes. Throughout the period of storage, the number of adults that emerge from maize was significantly ($p<0.05$) higher than any other host seeds. One week after storage, the number of adults that emerged from cowpea was significantly ($p<0.05$) higher than other legumes hosts and rice. At two weeks of storage, the cereal seed significantly ($p<0.05$) had higher adult emergence than the legumes seeds. There was no significant ($p<0.05$) difference in adult emergence among the legume crops. At 3 weeks and 4 of storage, emergence of adult S. zeamais showed similar trend. Significantly higher number of S. zeamais emerged from cereals than the legumes. However, the least adult emergence was obtained in Bambara nut and Groundnut. At the fifth week of storage, significantly ($p<0.05$) higher number of adults emerged from maize and sorghum compared with the other host plant produce. There was no significant ($p<0.05$) difference in adult emergence between rice grains and the leguminous seeds. The percentage weight loss in the infested seeds were significantly ($p<0.05$) higher than the control in both legumes and cereals. Within the 16 weeks of storage there was no significant difference ($p<0.05$) among the cereals but there was significant difference between cereals and legume

Key word: *Bambara nut; Cowpea; Cereal; Infestation; Legumes; Sitophilus zeamais; Sorghum*

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I. Introduction

According to (White, 1993) pest outbreak in grain reduces the quantity and quality thereby lowering its values. Insects not only feed on grains but also change the grain appearance. Hot spots in the crop can be developed by the insect heat and moisture as a result of their metabolic action. Several contaminated grains are not good for consumption by human. Infestation of grains by pest such as insects during preservation makes grains absolutely unfit for consumption due to contamination. In warehouses where large scale produce is preserved for considerably long period of time, high chance of loss is very possible, this loss can quantify in monetary terms. The average of quality for grains has been put in place in some of the developing nations to satisfy consumers whom the information for clean grains and its products are moving high.

Grain for local and international markets are examined to ensure prevention of quality and quantity losses that are possible during post-harvest operations. Keeping grains is susceptible to both inside and outside destruction by insects, but internal infestation is the most difficult to notice (Perderson, 1992). Several detection and control of internal insects from grains are important management principle for guarantying average shelf life.

The storage of farm produce has been a major challenge in food production due to the ravaging effects of insect pests (Buckland, 1981). Records of the storage and infestation of cereal has been as far back as 6000 BC (Levinson, 1994). There is therefore need to safeguard stored food from being infested by insects because, during long-term storage, they can destroy large quantities (Faruki et al, 2005). Few numbers of insects present in a bulk of produce are capable of severe damage and drastic reduction in market values of crops in developed nations. In most developed countries, if even a single line insect is found, grains can be graded low or completely rejected (Fields et.al 2009).

Damage to stored grains and pulses by insects ranged from about 10-40% and can be occasionally higher in countries with inadequate modern technologies (Shaaya et al 1997; Adda et al., 2002; Ukeh and Mordue, 2009). FOA, (2004) reported that *Sitophilus species* can, for a short period all over world damage over 96million metric tonnes of maize grains. Kossou and Bosque Perez (1998); Holst et.al (2000) and Meikle et al (2002) reported that maize weevil, *Sitophilus zeamais*Monstch in west Africa has caused above 30% weight loss in stored grain after limited duration of storage.

Storage is one of the most critical post-harvest operations. If practiced improperly, it can result in contamination with molds and insects causing rapid detoriation of crop quality and reduced seed viability (Scott, 1999). Increased grain moisture content can accelerate this process; hence the whole dry pulses are less susceptible to attack by insects and molds than moist and broken pulses (Dowell et al., 1998). In addition, insects contaminate the stored seeds with frass (a mixture of excretions, molting and dead insects) thus encouraging the infestation with bacterial and fungal diseases through the transmission of their spores. Often, insect's contamination causes an unpleasant smell and taste of the product, while fungal contamination can affect the taste of the commodity and lead to the production of mycotoxins, such as aflatoxin from *Aspergillus flavus* of *A. parasiticus* that can have acute chronic effects on humans and livestock (Haines, 1991). Besides insects and fungi, stored products are also attacked by mites, birds and rodents, the later causing indirect weight loss by damaging packaging or storage facilities and by contaminating the commodity with feaces, urine and hairs. All these factors increase the seed damage and loss in viability which inevitably leads to considerable losses in the marketability of the food and to possible human health hazards (Haines, 1991).

In this research study, the percentage weight loss caused by maize weevil to some typical cereal and legume crops were evaluated as caused by susceptibility of these crops to maize weevil. This was necessitated by the huge losses in the marketability of the food crops and possible human health hazards as recorded by insect pest attacks. Also the need to investigate in order to identify the food crop that could serve as possible host to *Sitophilus zeamais* came up as it is a tool for monitoring (Wakefield et.al. 2005).

II. Material And Methods

Research location

The research was carried out at the Crop Science Insect Behaviour Room, University of Calabar, Calabar. Calabar is located in the Southeastern humid tropical rainforest zone of Nigeria (4.5^0– 5.2^0 N, 8.0^0 – 8.3^0 E), 39 m above sea level. It has a bimodal annual rainfall distribution ranging from 3000 to 3500 mm, a mean annual temperature range of 25.8 °C | 78.5 °F.

Determination of emergence

This research was carried out to evaluate the susceptibility of the following produce to infestation by *sitophilus zeamais.*

1. Maize (*Zeamais* (L) Mostch)
2. Sorghum (*sorghum bicolor* (L) Moench)
3. Rice (*Oryza sativa* (L)
4. Cowpea (*Vignaunguiculate* L (Walp)
5. Bambara nut (*Vigna subterranean* (L) Verde)
6. Groundnut (*Arachis hypogea*)

One hundred grams of each produce was placed in separate transparent plastic containers. Each container was released into; twenty pairs of three-day old *S. zeamais* adults for mating and oviposition following the method of Ukeh and Mordue (2011). The covers of the plastic container were perforated with holes to enhance proper ventilation. The insects were covered with nylon mesh and their perforated lids screwed in place to facilitate confinement of the weevils. Each treatment was repeated six times and laid out on the laboratory bench in a completely randomized design (CRD). The treatment was kept for four weeks for progeny emergence, the emerged progeny was removed from each container and counted. The daily count was continued until no more weevils emerged (at five weeks post treatment).

Determination of weight loss

One hundred grams of each maize seeds, sorghum, rice cowpea Bambara nut, and groundnut were placed in transparent plastic containers. Ten pairs of unsexed three-day old *S. zeamais* adult were introduced into each container.

The cover of the plastic containers was drilled with holes to facilitate air circulation and nylon mesh to avoid escape of the insect. The weevils were confined in cups covered with perforated nylon mesh.

The experiment was laid in completely Randomized Design (CDR) with the treatment repeated six times on the laboratory bench. Data on percentage weight loss were taken weekly after 28 days for F1 progeny till 16 weeks. On each occasion, the inset and the produce were separated from the powder emanating from each replication due to insect activities and weighed using a sensitive electronic balance (Matel).

Data analysis

Data on percentage weight loss of each produce caused by *S. zeamais* were compared with the control (un-infested) produce using student t-test at 5 percent and 1 percent probability levels. Data obtained from experiments laid out as factorial in CRD were subjected to analysis of variance using GenStat statistical software (Version 6) and significant means were compared using LSD and DNMRT at 5 percent level of probability.

III. Result

Determination of host preference

The result of adult emergency of *S. zeamais* on different host crops was presented in Table 1 below.

With the exception of rice, the number of adult of *S. zeamais* that emerged from the cereals at 1 week of storage was significantly ($p<0.05$) higher than those that emerged from the legumes. Throughout the period of storage, the number of adults that emerge from maize was significantly ($p<0.05$) higher than any other host seeds. One week after storage, the number of adults that emerged from cowpea was significantly ($p<0.05$) higher than other legumes hosts and rice. At two weeks of storage, the cereal seed significantly ($p<0.05$) had higher adult emergence than the legumes seeds. There was no significant ($p<0.05$) difference in adult emergence among the legume crops. At 3 weeks and 4 of storage, emergence of adult *S. zeamais* showed similar trend. Significantly higher number of *S. zeamais* emerged from cereals than the legumes. However, the least adult emergence was obtained in Bambara nut and Groundnut. At the fifth week of storage, significantly ($p<0.05$) higher number of adults emerged from maize and sorghum compared with the other host plants. There was no significant ($p<0.05$) difference in adult emergence between rice grains and the leguminous seeds.

TABLE 1

Effect of some stored grains progeny development of *S. zeamais* after five week of infestation.

Types of Grains (100g)	Mean number of progeny emergence (Weeks)				
	1	2	3	4	5
Rice	7.75 d	4.75 c	5.25 c	4.25 c	0.25 c
Sorghum	23.00 b	17.50 b	12.50 b	10.80 b	8.00 b
Maize	92.50 a	69.00 a	77.80 a	30.50 a	14.50 a
Bambara nut	7.25d	0.75d	0.25e	0.50e	0.00c
Groundnut	6.75 d	1.25 d	0.25 e	0.25 e	0.00 c
Cowpea	15.20 c	1.00 d	3.80 d	2.50 d	0.00 c

*Mean followed by the same letter within a column are not significantly different according to DNMRT at 5% probability level

Determination of percentage weight loss

Table 2 below revealed that the percentage weight loss in the infested seed was significantly ($p<0.05$) higher than the control. In Table 2 also, the percentage weight loss in the infested Bambara nut was significantly different ($p<0.05$) from the control. The same results were also observed for Cowpea, groundnut, rice, sorghum and maize. Within the 16 weeks of storage there was no significant difference ($p<0.05$) among the cereals but there was significant difference between cereals and legumes.

TABLE 2

Effect of *S. zeamais* on percentage weight loss of stored grains

	Sorghum	Cowpea	Bambara nut	Groundnut	Rice	Maize
Control	5.48b	2.72b	1.95b	3.81b	5.05b	12.25b
Treated	17.57a	9.58a	9.46a	8.96a	22.15a	33.44a
SED (±)	3.12	1.29	1.39	1.71	2.36	4.28
t_{cal}	3.88	5.33	5.40	3.01	3.43	4.95
T tab [0.05]	2.78					
Ttab[0.01]	4					

IV. Discussion

In line with the results above, it is evident that the longer the seeds are exposed to insect pests, the higher the weight loss due to feeding activities. Insects can also find secondary host if primary host seeds are not available. The research confirmed the result of Egbon and Ayertey (2009) that *Sitophilus species* will most preferably switch host to cowpea instead of maize because it develops faster on cowpea, just as it does on sorghum than maize.

Also, the result reveals that weight loss caused by *S. zeamais* is higher in cereals seeds than in leguminous seeds. It is agreed that the oil content of legumes seeds could have resisted the insect infestation (Ukeh and Mordue, (2009), Campbell, (2004). It was observed that the treated seeds had greater percentage weight loss compared to the untreated grains. There was significant difference between the cereal grains and the legume grains but the cereals suffered the highest significant weight loss than the legumes. The studies confirmed the observations of Hodges et al. (1998), who has earlier reported that *S. zeamais* and *oryzae*are attracted to sources of sitophilure when flying or walking. Several authors (Egbon 2009; Adelani 2008, Cox, 2007), have reported *S. zeamais* as primary cosmopolitan cereals pest. Odoriferous nature of some certain plant like legumes is the reason for preference *S. zeamais*.

V. Conclusion and recommendations

The risks of crop produce infestation within the processing cycle between the field to the consumer remains worrisome due to certain aspects of packaging, negligence in warehouses and stores as well as average shelf-life of products. Maize, rice and sorghum produce are susceptible to weight loss caused by *S. zeamais* at any point within the marketing channel. Generally, stores as well as retail shops are usually colonized by insects migrating from other produce. It is therefore recommended that:

1. Regular monitoring with the help of pheromone trap should be done to regulate pest infestation outbreak.
2. Separation of stored produce should be done at the warehouse to regulate cross infestation
3. The control of *S. zeamais* should not be restricted to maize given its ability to infest other produce.

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