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Comparative Natural Resistance of Some Maize Varieties to *Sitophilus zeamais* (Motschulky)

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***Abstract* – Researchers have shown that seed resistance is a valuable tool in insect control. This study therefore, investigated the comparative natural resistance of six (6) maize varieties to *Sitophilus zeamais* under ambient laboratory conditions in Ado Ekiti, Nigeria. Treatment involved the measurement of 30g of clean, uninfested maize grains from the selected varieties, into covered Petri dishes. Each measure of maize grains in the covered Petri dishes was infested with 20 freshly emerged *S. zeamais* adults (10 males and 10 females) and left for 2weeks for the insects to mate and lay eggs; after which the old weevils were removed for new ones to emerge. Number of holed seeds and adult emergence from seeds was counted after 60days of infestation. Percentage weight loss from seeds was also determined to measure the level of each variety's resistance (tolerance) or susceptibility to *S. zeamais* infestation. Of the six (6) maize varieties tested, Regular popcorn shown the highest level of resistance to *S. zeamais*, with only 5 emerged adults and holed seeds respectively and 6.00% weight loss from seeds. This was followed by SWUN-Y with 9 mean numbers of emerged adults and holed seeds and 11.3% weight loss from seeds. TZPB-W has the least natural resistance to *S. zeamais* among the tested varieties, with an adult emergence of 31, 29 holed grains and 27% weight loss from infested seeds. All the tested varieties were significantly different (P<0.05) from the control and from each other in all parameters, except DMR-Y and TZSR-Y that bear the same Duncan statistical letters of 'c' compared to other treatments and the control. None of the tested varieties was able to completely prevent adult *S. zeamais* emergence from infested grains.**

***Keywords* – Infestation, Resistance, *Sitophilus zeamais*, Susceptibility.**

I. Introduction

Maize plant (*Zea mays*) Motschulsky is an important non-branching annual crop in the group of cereals (starchy grains). It is a crop of the grass family (Graminae) and sub-family Androponoidae. It is a caryopsis and one of the oldest and the mostly widely cultivated world cereals. The crop is mainly grown for its grain, which is utilized for human consumption and forms about 50-70% of the constituent of livestock feeds (Longe and Ofuya, 2009a). It is relatively inexpensive and provides many families with the much needed carbohydrate, as maize, is a very rich source highly digestible carbohydrate and which at the immature stage, also provides useful quantities of Vitamin C (Longe, 2010).

Maize originated from South and Central America and was introduced to West Africa by the Portuguese in the 10th century. It is one of the most important grains in Nigeria today, not only on the basis of the number of farmers that engages in its cultivation, but also by its economic value. It is a major important cereals being cultivated in the rainforest and derived savannah zones of Nigeria. Maize has been in the diet of Nigerians for centuries. It started as a subsistence crop and gradually became a more important staple food crop. It has now risen to a commercial crop on which many agro-based industries depend for raw materials (Longe, 2011).

Maize (*Zea mays* L) can be classified according to the structure of the grain. We have sweet corn, flint corn, popcorn, dent corn, soft or flour corn and pod corn. Also, there are different varieties like Western Yellow1096BP6., SWUN Yellow, Tsolo Yellow, DMR Yellow, TZSR White, N.S.5 White, TZPB White, TZSR Yellow, TZB (White), etc. According to IITA (2001) report, maize contains 80% carbohydrate, 10% protein, 3.5% fibre and 2% mineral. Iron and Vitamin B are also present, while the yellow varieties contain Vitamin A in addition.

Maize according to Longe and Ofuya (2010) has a variety of uses. Its grain is a rich source of starch, vitamins, proteins and minerals. The starch extracted from maize grain is used in making confectionaries and noodles. Corn syrup from maize contains high fructose and act as sweetener and retains moisture when added to certain foods. Edible oil is extracted from seeds, which is all-purpose culinary oil. Levulinc acid, a chemical derived from maize, is used as ingredient in antifreeze and is capable of replacing the toxic petroleum-based ingredients use. Plastic and fabrics are made from corn stocks. Ethanol obtained from maize can be used as a biomass fuel. Stigmas from female corn-flowers, known as corn silk, can be used as herbal supplements. Maize straw is a cheap source of energy and can be used in home-heating furnaces.

Fresh maize can be boiled, roasted or cooked with beans and eaten. Maize grains can also be grounded and prepared into paste for making palp; or fried in oil into 'corn-cake' ('Pekere' in Yoruba). Very dry maize can be powdered into 'flour' which can be prepared into various foods, such as Semovita, Bread and various snacks; while dry grains of a particular variety (The Regular Popcorn), can be roasted into a popular refreshment known as 'popcorn' or 'guguru' in Yoruba Language (Longe 2010). Industrially, maize can be used for the production of cereal baby foods, corn-oil, glucose, gum, starch and alcohol. The grains constitute the major ingredient in the production of livestock feed(mash), particularly, for poultry and pigs as it gives the highest conversion of dry matter to meat, milk and eggs. The green leaves of maize plant can also be fed as fodder to livestock or in the form of hay/silage. The sale of maize grains or its products/ by-products, constitutes a major trade in our local markets and the grain board; forming an important source of income and livelihood of our people.

In view of the above benefits, national and international bodies have developed interest in promoting maize production for households' food security and poverty alleviation. Some of these efforts have been channelled through biological and agronomic research into the development of high-yielding varieties along with best cultural practices. In Southwest Nigeria, at least 30% of the cropland has been put to maize production under various cropping systems. Maize is grown by most households annually, either as a vegetable at the house or on the farm. Maize production has shifted from being a predominantly food crop to a major income earner for farmers in many countries in Africa. Excess maize grains after production season may be stored for use in subsequent times and for various reasons (Lale, 2001).

During storage, maize grains could be infested by a catalogue of stored product pests. One of the most devastating is the larvae of the weevil (*Sitophilus zeamais*) Motschulsky (Coleoptera: Curculionidae) (Longe and Ofuya, 2009b). The maize weevil is capable of developing on all cereal grains and cereal products (Bekele, 2002). Attack by this pest begins in the field and continues in storage, causing substantial damage to stored grains as the pest population rapidly increases (Longe and Ofuya, 2010). The weevils (*S. zeamais*) bore into maize kernels in the field or in storage and lay eggs. The young insects grow to maturity inside the kernels, eating them from the inside out. This causes loss in the maize's nutritive value and weight. A contaminated supply of seed will most likely contaminate other stores. This sort of damage is especially severe on subsistence farmers, who may depend on one year store of grain to provide germinating seeds for the next. While boring through the seed, the insects create powder and kernel fragments that encourage infestation by other secondary storage pests (Longe, 2011).

Damage done to stored maize by maize weevil (*Sitophilus zeamais*) Motschulsky in the tropics is enormous Pre-harvest losses attributed to maize weevil were about 8-10% and this continues during storage. World annual losses due to post-harvest losses as a result of pest infestation had been put between 25-40% (Hill, 1990). Infestations not only cause significant losses due to consumption of grains; they also result in elevated temperature and moisture conditions that lead to accelerated growth of moulds including mycotoxins (Tripathi et al., 2002). It is imperative therefore, that a greater attention should be paid to the crops during storage in order to make them available for use throughout the year.

Any reduction in loss due to the discovery or development of resistant maize varieties would go a long way to increase the availability of food grains and ensure a successful millennium development goal on food security in Nigeria and beyond. This study will also improve the knowledge of consumers on the type of variety that can be stored for future purposes and that of farmers on the type of variety that can be stored as grain for the next season. This also gives them an idea on the type of variety that is resistant to *Sitophilus zeamais* attack, thus, saving them time and money. This paper therefore reports an investigation into the comparative natural resistance of six maize varieties to *Sitophilus zeamais*.

II. Materials and Methods

Experimental Site

The experiment will be conducted at the Crop, Soil and Environmental Sciences Laboratory of the Faculty of Agriculture, Ekiti State University, Ado- Ekiti.

Maize Varieties

Maize varieties to be used for experiment include; TZSR-Y, SWUN-Y, TZPB-W, TZSR-W, DMR-Y and Pop Corn. The maize grain will then be put in the freezer for about two weeks to remove any possible infestation.

Table 1: Shows the physical properties of the maize varieties used for the experiment.

Variety	Coat colour	Grain size	Coat texture
TZSR-Y	Yellow	Medium	Smooth
SWUN-Y	Yellow	Medium	Smooth
TZSR-W	White	Medium	Smooth
TZPB-W	White	Large	Smooth
DMR-Y	Yellow	Medium	Smooth
Popcorn	Yellow	Small	Smooth

Insect Culture

The initial stock of *Sitopilus zeamais* to be used for the experiment was obtained from the store of Agricultural Development Programme, Ado-Ekiti. These weevils were then taken to the laboratory for confirmation. The weevils were cultured on clean uninfected SWUN-Y cultivar grains in a container with net covering to prevent the escape of the weevils and also to give room for respiration.

Description of Experimental Set-up

Thirty grams of maize grain from each variety were placed in the Petri dishes with three replicates and one control respectively. The samples in each Petri dish apart from the controls were infested with 20 adult *Sitophilus zeamais* (10 males and 10 females). After 2 weeks the insects were sieved out and the maize samples kept for 60days. After 60days newly and freshly emerged weevil adults were counted and the following data were collected:

- The number of adult weevils that emerged.
- Number of damaged(holed) seeds
- Final weight
- Percentage weight loss

Data Analysis

Data was analysed using Analysis of Variance (ANOVA) table and significant means separated, using Duncan's Multiple Range Test (DRMT).

III. Results

Table 2 indicates that all the maize varieties infested with *Sitophilus zeamais* were significantly different (P<0.05) from the control with 0.00 recordings from the data collected after the experiment from recordings on all the parameters tested, from viz: number of damaged or holed seeds, adult emergence and weight loss from seeds. Significant differences (P<0.05) also exist among the six (6) maize varieties tested and in all the parameters considered, except between DMR-Y and TZSR-Y varieties. Lowest adult emergence and number of damaged (holed) seeds (5 respectively) were obtained from the popcorn variety ditto to the lowest percentage weight loss of 6 from infested seeds after the experiment. This is followed by the SWUN-Y variety with 11.3 percentage weight loss, holed seeds and adult *S. zeamais* emergence respectively. TZPB-Y maize variety recorded the highest percentage weight loss of 27.0 and the highest *S. zeamais* adult emergence and holed seeds after experiment. Observations further indicate a positive correlation between the parameters tested as the variety with the highest percentage weight loss of 27.0 (TZPB-W), also recorded the highest number of holed seeds and *S. zeamais* adult emergence from seeds and vice versa. This trend was observed in all the treatments.

Table 2: Comparative effect of maize weevil (*Sitophilus zeamais*) on different varieties of stored maize grains

MV	ISW	FSW	PWL	MNDS	MAES
TZSR-Y	30a	25.1c	16.3c	14c	15c
SWUN-Y	30a	26.6b	11.3b	9b	9b
TZSR-W	30a	23.9d	20.3d	21d	21d
TZPB-W	30a	21.7e	27.0e	29e	31e
DMR-Y	30a	25.3c	15.7c	14c	14c
Popcorn	30a	28.2a	6.0a	5a	5a
Control	0.00b	0.00f	0.00f	0.00f	0.00f

Means in each column having the same letters are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT).

KEY:
MV- Maize varieties
ISW- Initial seed weight
FSW- Final seed weight
PWL- Percentage weight loss
MNDS- Mean number of damaged (holed) seeds
MAES- Mean adult emergence from seeds

Table 3 shows the rating of the tested maize varieties with respect to their levels of natural resistance or susceptibility to *S. zeamais* attack as indicated by the parametric indices used in the experiment. The varieties were rated as highly resistant, resistant, moderately resistant, susceptible (non- resistant) and highly susceptible. Only popcorn was rated as highly resistance while the SWUN-Y variety was rated as resistant. DMR-Y and TZSR-Y were rated as moderately resistant while TZSR-W was rated as susceptible. Only TZPB-W was rated to be highly susceptible among the tested varieties.

TABLE 3: Performance Rating of Tested Maize Varieties

Variety	Level of Resistance to *S. zeamais*
TZSR-Y	Moderately resistant
SWUN-Y	Resistant
TZSR-W	Susceptible
TZPB-W	Highly susceptible
DMR-Y	Moderately resistant
POPCORN	Resistant

IV. Discussions

The use resistant or tolerant crop varieties is a preventive measure and in the event of an average intensity of infestation is sufficient to keep the pest population below the control threshold (Cochrane, 1994). Obadofin (2014) opined that an important component of crop protection and improvement in the world over is the development of pest resistant crop varieties.

The use of resistant varieties against storage insect pests, when successful, has a number of comparative advantages over other control measures, particularly the use of chemical insecticides.

Morah and Mbata (1992) reported that storing of resistant maize varieties have been advocated as a way of controlling the maize weevil *Sitophilus zeamais* infestation and that C-10 variety of maize was highly resistant to *S. zeamais*. Similarly, Falomo, 1999, observed that there was 100% mortality of *S. zeamais* adults within 4weeks, when exposed to TZM1205 and TZLC0M4C3 maize varieties and that there were zero F1 adult emergences from TZM1205 and TZL COMP4C3 varieties. High post-infestation adult mortality of *S. zeamais* (50% or more) was also recorded in IC25 (9450) SR, TZBR, ELDANA 3C4, SIN 93 TZVT, SR-W, TZBR, SES and 3C4-Y.

In this study, the Regular popcorn maize variety was found to be resistant to *S. zeamais* infestation among the six (6) maize varieties tested; as the lowest record of freshly emerged *S. zeamais* adults (5 only) damaged or holed seeds (5) and percentage weight loss from infested seeds (6.00%), after experiment. This was followed by the SWUN-Y variety with 11.3% seed weight loss; while the number of holed seeds and emerged adults stands at 9.00 respectively. The Regular popcorn was classified as highly resistant, while SWUN-Y was grouped as resistant.

Of the six (6) tested varieties, TZPB-W exhibited the least resistance ability to *S. zeamais* infestation with 29 holed numbers of seeds, 31 emerged adults and 27% weight loss from seeds. Next to it in ranking is the TZSR-W variety, with 21 mean numbers of holed grains and adult emergence respectively and 20.3% weight loss from seeds. Both TZSR-W and TZPB-W were categorized as susceptible and highly susceptible to *S. zeamais* adults and 14 holed seeds respectively were categorized as moderately resistant to the weevil attack.

The study further shown that the maize variety with the highest amount of emerged adults (TZPB-W) also recorded the highest amount of holed seeds and vice versa. In other words, increasing population of emerged adults causes more extensive damage to infested grains and vice versa. This agrees with the findings of Singh et al (1998) which says that the number of emerging adults determines the extent of seeds damage and that seeds that permit more rapid and higher levels of adult emergence, will be more extensively damaged.

The very low number of emerged *S. zeamais* adults in some of the tested maize varieties, particularly the Regular popcorn, might suggest the presence in them of some active ingredients in the seeds, which may be toxic to the developmental stages of the weevil particularly the feeding larvae, leading to their death and consequent non-emergence of adult weevils from them. Arnason et al, 1997 have reported the presence of some biochemical compounds, particularly Ferulic acid in the kernels of maize varieties. These bio-chemicals probably confer antibiosis on the tested varieties and which may explain in part the significantly lower number of emerged adults from the infested maize varieties.

V. Conclusion and Recommendations

Result from the study shows that maize varieties can resist insect infestation to some extent even without the application of chemical insecticides. Of the six maize varieties studied, Regular popcorn was observed to exhibit the highest level of natural resistance to *S. zeamais*. It is therefore suitable for recommendation to farmers. TZPB-W on the other hand was the most susceptible to adult *Sitophilus zeamais* attack followed by TZSR-Y, hence would not be suitable for longer storage except insecticides are applied. Breeding of TZPB-W with popcorn can also help in improving its natural resistance to *S. zeamais*.

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