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Assessment of damage and insect infestations on maize grains in three markets within Ilorin metropolis

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Abstract
This study evaluated the insect emergence and percentage weight loss on white and yellow maize sold in Ilorin markets (Ipata, Ago, and Mandate). Samples were collected from three different stores per market and brought to the Entomology laboratory of NSPRI for analysis. For each store, 100 g of each grain were placed separately in 360 ml kilner jars and left undisturbed for 14 and 21 days respectively. The result of the emergence of *Sitopilus zeamais* on white maize, reveals that there was no significant difference in the emergence of insects in the three markets throughout the months except for the month of January 2020, where insect emergence from the Mandate market (0%) was significantly lower compared to Ago (12.66%) and Ipata market (7.00%) respectively. Also, there was no significant difference in the percentage weight loss of white maize in the three markets throughout the months of study except in august 2019, where the Mandate differs from the Ago market. The result of insect emergence on yellow maize shows that there was no significance difference in the emergence of insects between the three markets throughout the months of the study. Similarly, the market comparison across the months reveals that there was no significant difference in the emergence of insects on yellow maize in all the markets across the period of study except the month of October, 2019, which differs from January 2020. As for weight loss, there was no significant difference in the percentage of weight loss in the three markets throughout the month of the study.

Keywords: Insect emergence, percentage weight loss, white maize, yellow maize and S*itophilus zeamais*

Introduction
Maize (*Zea mays* L.) is the major cereal crops produced worldwide [1]. Maize is both a staple and cash crop and it contributes to stabilizing household incomes and alleviating poverty [2]. Recently, world maize production has been about 10.14 billion MT [3]. In 2018, about 10.2 million tons of maize were produced from 4.8 million hectares, making Nigeria the highest producer in Africa [4]. The United States of America is the chief producer of maize, with over 30%; China, 21%; Brazil, 7.9% and Africa contributes about 7% of the overall world production of grain maize. Two–thirds of all maize produced in Africa is from Eastern and Southern Africa. [5]. But unfortunately, maize production in most parts of Nigeria is restricted to only the rainy months of the year [6]. This, however necessitates the need to store the maize grains throughout the dry season [6]. Different insect pests, attack maize during storage and among these pests, maize weevil *Sitophilus zeamais* is a serious cosmopolitan field-to-store pest of maize in tropical and subtropical regions [7], Post-harvest losses due to *S. zeamais* have been reported as an important constraint to grain storage in Africa [8], this pest damages the harvested maize by making holes and feeds the inner starch which causes weight loss and reduced the quality [9]. Several management techniques are available to control stored products and insect pests. Synthetic insecticides are commonly used to control pests in general and stored product pests in particular. Despite success in controlling insect pests using synthetic insecticides, their persistence in the environment, the toxic residues they leave in food and the development of resistance by insect pests require that more reduced-risk alternatives be sought [10]. Of all the pesticides released into the environment every year by human activity, persistent pesticides are among the most dangerous [11]. They are highly toxic, causing an array of adverse effects, notably death, diseases and birth defects among humans and animals [12] reported that the integrity of the food grains is greatly challenged due to insect pest attacks in store-houses; hence it becomes a paramount concern that insect pest infestation is checked to

ensure food security in the country.

This study seeks to screen insect emergence and percentage weight loss in white and yellow maize varieties sold in popular markets (Ipata, Ago, and Mandate) in Ilorin West local government area, Kwara state.

Materials and methods

Study area and sample source

This study was conducted in Ilorin Kwara State. The State is located in the coastal north-central between the Latitude: 8^0 $29^1.798^1$ North and longitude: 4^0 $32^1.528^1$ East. It has a total land area of 765km^2 with about the population of 777,667 making it the 7th largest city in Nigeria.

Source of the grain sampled

The sampled grains, white Maize and Yellow Maize variety were sourced for in three popular markets in Ilorin west local Government: (Ipata, Ago, and Mandate). In each of the markets, samples were randomly collected from three (3) different stores. The samples were brought to the Nigerian Stored Products Research Institute (Entomology Laboratory) where the presence of chemical was checked. It is believed that the presence of chemicals on grains would certainly prevent the activities of insect emergence. However, the absence of emergence would mean the presence of pesticide residue. The grains were sorted, rid of dirt and already damaged grains were removed leaving the wholesome grains.

Laboratory analysis of grain samples

For each stores, 100 g of the wholesome grain samples (white maize, yellow maize) collected from the three (3) different markets were placed separately in 360-ml kilner glass jars, after that it was covered with muslin cloth held down with a rubber band for aeration as well as to prevent the escape of any emerged insect. The maize samples were separately set up and left undisturbed for fourteen (14) days and twenty-one (21) days respectively, after that, the maize was sieved out on the fourteenth day to assess insect emergence and the maize was sieved out as well on the twenty-one (21) day.

Statistical analysis

The data were analyzed with Analysis of variance (ANOVA) using SPSS statistical package (Version 20)

Results and discussion

Table 1: Result of Emergence of *S. zeamais* on White Maize

	Aug. 2019	Sept. 2019	Oct. 2019	Nov.2019	Dec. 2019	January 2020	February 2020
Mandate	4.33±2.19$^{a(ab)}$	4.67±0.33$^{a(ab)}$	19.0±11.53$^{a(b)}$	7.67±4.09$^{a(ab)}$	3.33±1.45$^{a(ab)}$	0.00±0.00$^{a(a)}$	4.00±1.15$^{a(ab)}$
Ago	8.66±3.18 $^{a\ (a)}$	12.67±0.33$^{a(a)}$	2.00±0.00 $^{a\ (a)}$	3.00±1.15 $^{a\ (a)}$	5.67±2.02 $^{a\ (a)}$	12.66±3.52$^{b(a)}$	5.33±4.33 $^{a\ (a)}$
Ipata	4.00±4.00 $^{a\ (a)}$	4.67±0.33 $^{a\ (a)}$	6.67±3.18 $^{a\ (a)}$	3.67±1.33 $^{a\ (a)}$	7.00±1.00 $^{a\ (a)}$	7.00±2.08 $^{b\ (a)}$	7.67±7.17 $^{a\ (a)}$

Note: The superscript alphabets outside the brackets compares down the markets, while the superscript alphabets in the brackets compares the values across the period

Table 1: Result of Emergence of *S. zeamais* on White Maize

Table 1 shows the result of the emergence of *S. zeamais* on white maize, there was no significant difference in the emergence of insects in the three markets (Mandate, Ago and Ipata) throughout the months except for the month of January 2020 where the emergence of insect in white maize purchased from Mandate market (0%) was significantly lower from Ago (12.66%) and Ipata market (7.00%) respectively. However, Comparison of the market across the period of the study shows that the emergence of insects in white maize bought from Mandate was significantly different from the emergence in Ago and Ipata market.

Table 2: Result of Percentage Weight Loss White Maize

	Aug. 2019	Sept 2019	Oct.2019	Nov. 2019	Dec. 2019	Jan. 2020	Feb2020
Mandate	23.00±4.32$^{a(ab)}$	47.01±2.13$^{ab(b)}$	32.09±59.75$^{a(a)}$	10.94±5.55$^{a(a)}$	12.78±5.22$^{a(ab)}$	18.50±4.0$^{a(ab)}$	16.18±1.4$^{a(ab)}$
Ago	46.60±4.83 $^{b\ (de)}$	54.42±4.41 $^{b\ (e)}$	0.77±5.52 $^{a\ (ab)}$	33.59±4.41$^{a(cd)}$	28.50±9.3$^{a(bc)}$	18.00±2.0$^{a(bc)}$	16.45±0.8$^{a\ (b)}$
Ipata	29.78±9.24 $^{ab\ (a)}$	37.36±4.69 $^{a\ (a)}$	11.36±10.93 $^{a\ (a)}$	-1.16±1.49 $^{a\ (a)}$	14.25±2.99 $^{a\ (a)}$	26.94±1.63 $^{a\ (a)}$	13.93±1.55 $^{a\ (a)}$

Note: The superscript alphabets outside the brackets compares down the markets, while the superscript alphabets in the brackets compares the values across the period

Table 2: Result of Percentage Weight Loss for Month/ Market

As presented in table 2, there is no significant difference in the percentage loss in the three markets (Mandate, Ago and Ipata) throughout the months except in august 2019, where Mandate is different from Ago market. White maize purchased from Ago market had higher weight loss (46.60%) than Mandate (23%) and Ipata market (29.78%) and also in September 2019, Ago (54.42%) is different from Ipata market (37.36%). However, comparison across the period shows that there is significant difference in percentage weight loss of white maize in the three markets

Table 3: Result of Emergence of *S. zeamais* on Yellow Maize

	Aug. 2019	Sept. 2019	Oct. 2019	Nov.2019	Dec. 2019	January 2020	February 2020
Mandate	21.3±16.34 $^{a\ (ab)}$	27.0±11.68 $^{a\ (ab)}$	8.67±4.09 $^{a\ (a)}$	22.67±21.18 $^{a\ (a)}$	6.67±1.20 $^{a\ (a)}$	0.67±0.67 $^{a\ (a)}$	11.33±6.06 $^{a\ (a)}$
Ago	1.00±1.00 $^{a\ (ab)}$	15.67±10.49 $^{a\ (ab)}$	20.33±11.46 $^{a\ (b)}$	2.33±1.33 $^{a\ (ab)}$	3.00±1.00 $^{a\ (ab)}$	0.00±0.00 $^{a\ (a)}$	1.33±0.88 $^{a\ (ab)}$
Ipata	2.33±1.85 $^{a\ (a)}$	10.33±6.17 $^{a\ (a)}$	17.33±7.79 $^{a\ (a)}$	4.00±0.58 $^{a\ (a)}$	3.00±1.73 $^{a\ (a)}$	7.00±6.50 $^{a\ (a)}$	18.33±17.83 $^{a\ (a)}$

Note: The superscript alphabets outside the brackets compares down the markets, while the superscript alphabets in the brackets compares the values across the period

Result of Emergence of *S. zeamais* on Yellow Maize

Table 3 shows that, there was no significance difference in the emergence of insects between the three markets (Mandate, Ago and Ipata) throughout the months of the study. Similarly,

the comparison of the market across the months reveals that there was no significant difference in emergence of insect on yellow maize in all the markets across the study period except the month of October, 2019 which differs from January 2020. There was no significant difference in emergence of insect in January 2020 where emergence of insect in the yellow maize was very low compared to other two markets, yellow maize purchased in September 2019 and October 2020 had highest emergence than the other months of study this implies that the maize has no chemical and is safe for consumption

Table 4: Result of Percentage Weight Loss Yellow Maize

	Aug. 2019	Sept 2019	Oct.2019	Nov. 2019	Dec. 2019	Jan. 2020	Feb2020
Mandate	35.63±3.53 a (bc)	45.72±6.95 a (c)	4.08±20.25 a (a)	7.43±2.96 a (a)	13.22±4.09 a (ab)	15.84±0.85 a (ab)	24.09±1.04 a (abc)
Ago	34.06±6.12 a (bc)	40.97±9.32 a (c)	6.69±3.75 a (a)	19.95±7.62 a (ab)	24.20±5.80 a (abc)	16.86±2.84 a (ab)	18.61±4.59 a (ab)
Ipata	24.21±10.99 a (a)	19.56±8.83 a (a)	6.76±6.77 a (a)	23.89±8.63 a (a)	15.28±1.92 a (a)	28.06±6.22 a (a)	15.86±2.47 a (a)

Note: The superscript alphabets outside the brackets compares down the markets, while the superscript alphabets in the brackets compares the values across the period

Table 4: Result Of Percentage Weight Loss Yellow Maize

As presented in table 4 above, there was no significant difference in the percentage weight loss in the three markets (Mandate, Ago and Ipata) throughout the month of the study. However, percentage weight loss in Mandate market, the months of October and November 2019 differs from august and September 2019. In Ago market, the month October differs from august and September 2019 while November differs from September 2019 respectively. In Ipata market there was no significant difference.

Discussion

Maize purchased from Mandate market had highest emergence of *S zeamais* and this might be due to the fact that the temperature favored the growth and development of the insect. The favorable temperature shows the potential of stored products pest to cause serious losses to stored maize. Moisture contents also play important roles in storage of grain at safe moisture level of 13% and above. However, at favorable temperature and moisture of 13% and above grains can be infested by some insects and some mould. Absence of insects in the grain purchased in the record in Mandate market in January 2020, might be due to a trace of residual effect of the chemical used for preserving the grain against insect damage, this is in agreement with Mohiuddin, [13] .The reason for high insect emergence in some markets could be that some of the bags are exposed making it vulnerable to cross infestation from the environment Chimoya *et al*., [14]. Improper maintenance of the storage structure and environment can give rodents access to bag to create holes on the bags and increase access of stored product pests thereby facilitating cross infestation Akowuah [15] noted that higher insect infestation and fungal were recorded in wooden storage facilities in markets, possibly due to improper construction of structures which have inadequate ventilation. Highest emergence of *S. zeamais* on yellow maize from Mandate market in the month of August and September 2019, could be responsible high damage of maize in August and September causing high weight loss of the grain. Mandate market also stored bags of grains on the floor without the use of pallets this practice indicates poor handling and storage system and that could contribute to greater insect activity. Pantenius [16] estimated 0.2%-11.8% weight loss due to insect infestation in maize after some months of storage, insect infestation was found as the major reason of storage losses in grains.

Conclusion and recommendation

Some of the stored grains were observed to be seriously infested after one month of storage leading to serious weight loss of the grain. It is therefore necessary to improve control measures against stored products pests of storage by practicing hygiene of the storage facilities, integrated pest management so as to promote food security in Nigeria. It is therefore recommended that further research should be conducted on pesticide residue and aflatoxin levels on grains obtained from the markets.

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