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3004 Insect Population Dynamics in Maize Stored Using Four Storage Treatment Methods

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Abstract

Stored product insects cause significant losses in maize in sub-Saharan Africa (SSA). Several reduced-risk technologies are available for use as alternatives to conventional insecticides in SSA. In the present study, conducted February–December 2016, efficacy of Piper guineense, Bularafa diatomaceous earth (DE), PICS bags, ZeroFly bags and permethrin (Rambo™) to preserve maize quality in Nigerian markets was assessed. A sixth treatment was a negative control comprising maize in untreated polypropylene bags. Study locations were in four markets in Ibadan, Oyo and Ilorin towns. Each market had a storehouse (SH) which contained experimental 100-kg bags. In each SH, each treatment had six bags which were all sampled monthly to assess the efficacy of five technologies in preserving stored maize; in the PICS treatment, six bags were destructively sampled every four months. PICS bags were the most effective and had infestation levels of ≤ 0.54 live insects per kg of maize. Infestation levels in the control were ≤ 53.15 . Psocids were prevalent during the rainy season with highest levels of 14.71 in the ZeroFly® treatment in October. The fact that the highest infestation levels (53.15) were found in the control indicates the importance of insect pest management in SHs. Based on data obtained, order of effectiveness of the treatments was PICS > Zerofly > Permethrin > DE > Botanical > Negative control. Clearly, PICS bags, ZeroFly bags, DE and P. guineense, which are reduced-risk measures for insect control can be incorporated in integrated management of stored product insect pests in SHs.

Keywords:

Bularafa diatomaceous earth, PICS bag, Piper guineense, reduced risk technology, Zerofly bag

Introduction

Maize (*Zea mays* L.), one of the most important cereal crops in Nigeria, is persistently damaged by several insect pests (Ranum et al., (2014)); this causes post-harvest losses which remain a major challenge to small-scale farmers. In many African countries, postharvest losses of cereal crops due to insect pest infestation are estimated at 25% of the total crop harvested. In some Nigerian communities, 20–30% of total grain production is lost. In extreme circumstances losses of up to 80% have been reported (Fox, 2013). To reduce insect pest-related losses, synthetic insecticides are commonly used by farmers and grain merchants but this has negative effects on human health and the environment. The unintended consequences of synthetic insecticide use have prompted our search for low-cost, reduced-risk and sustainable alternatives.

In this study, the efficacies of four storage treatments to deter insect population growth were evaluated. These technologies were: untreated maize in PICS bags; untreated maize in ZeroFly® bags; Bularafa-derived diatomaceous earth (DE)-treated maize in polypropylene (PP) bags; and Piper guineense-treated maize in PP bags. These treatments were compared with two others; maize treated with Rambo® (a common synthetic pyrethroid insecticide used in Nigerian grains markets with permethrin as the active ingredient) in PP bags and untreated maize in PP bags — these two treatments comprised the positive and negative controls, respectively.

Materials and Methods

A yellow maize variety known as “SWAN 2” was used for this experiment and was purchased from a single local farm at Ijaye Farm Settlement, Ibadan, Nigeria. Aflasafe was applied to fields during maize production (Alejandro Ortega-Beltran, 2017). Maize was fumigated using Phostoxin® tablets to ensure that it was pest free before the experiment was set up. The experiment was conducted during the period February–November, 2016 in four storehouses (SHs) located in three grain markets in South-west Nigeria. The markets were, Arisekola market (AR) in Ibadan, Eleekara market (EL) in Oyo and Ago market (AGO) in Ilorin.

In the Bularafa-derived DE-treated maize, the DE was applied at a rate of 100 g per 100 kg of maize or 0.1% w/w or 1000 ppm (Nwaubani et al., 2014). In the P. guineense seed dust treatment, the application rate for the botanical was 1,500 g per 100 kg bag of maize or 1.5 % w/w or 15,000 ppm (Otitodun et al., 2015). Rambo was applied at a rate of 176 g per 100 kg of maize or 10 ppm (manufacturer's specification). Maize used for the experiment was clean, pest free, residual insecticide free and had a moisture content of approximately 9.7%. In each SH, six 100-kg bags were assigned to each treatment. In the case of the PICS treatment (hermetic storage), there were 18 bags in each SH to permit destructive sampling of 6 bags every 4 months. The experimental design was a randomized complete block design (RCBD) with a replication of four. Treatment ef-

facts were determined using analysis of variance (ANOVA) (PROC MIXED) performed with SAS version 9.4 (SAS Institute, Cary, NC) and differences in significance of means was determined by Tukey's HSD (honest significant difference) test at $P < 0.05$.

Results and Discussion

Two primary pests (*Rhizopertha dominica* and *Sitophilus zeamais*) and three secondary pests (*Oryzaephilus surinamensis*, *Liposcelis* spp. (Psocids or booklice) and *Cryptolestes ferrugineus*) were found infesting maize during the study. Data for only insect species that had an abundance of >2 insects per kg are reported. *Sitophilus zeamais* population in the Control was significantly higher than in the other treatments in October and November when there were 6.96 and 11.29 weevils per kg, respectively. In the other five treatments, the number of *S. zeamais* was numerically highest in the Botanical (*P. guineense*) treatment where there were 1.50 insects/kg in November but this density was not significantly different when compared with densities in other treatments (Table 1).

Table 1. Effects of four treatments on mean numbers of live *Sitophilus zeamais* per kg of maize

Months	Mean number of live <i>Sitophilus zeamais</i> ± SE				
	Botanical	Control	DE	Permethrin	ZeroFly
August	0.00±0.00 ^a	0.04±0.04 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a
September	0.04±0.04 ^a	0.96±0.75 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a
October	0.13±0.13 ^a	6.96±2.14 ^b	0.04±0.04 ^a	0.00±0.00 ^a	0.00±0.00 ^a
November	1.50±1.25 ^a	11.29±3.20 ^b	0.08±0.58 ^a	0.33±0.29 ^a	0.08±0.06 ^a

Psocid infestation was significantly high during the rainy months of July, September, October and November. In July, the numbers of live psocids per kg were significantly higher in the Control (10.33) and ZeroFly (14.71) treatments than in the other treatments. Psocid numbers were significantly higher in DE than in other treatments in September (10.79) October (13.71) and November (13.42).

Table 2. Effects of four treatments on mean numbers of live psocid per kg of maize.

Months	Mean number of live psocids ± SE				
	Botanical	Control	DE	Permethrin	ZeroFly
May	0.00±0.00 ^a	1.38±0.67 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a
June	0.00±0.00 ^a	0.00±0.00 ^a	0.00±0.00 ^a	0.54±0.31 ^a	0.00±0.00 ^a
July	6.96±2.98 ^{ab}	10.33±2.62 ^{ab}	4.71±1.74 ^a	1.88±0.71 ^a	14.71±12.43 ^b
August	3.13±1.13 ^a	1.42±0.67 ^a	6.04±1.57 ^a	1.33±0.51 ^a	5.08±2.88 ^a
September	2.92±1.05 ^a	1.50±0.47 ^a	10.79±2.43 ^{ab}	4.00±0.45 ^a	3.58±1.02 ^a
October	2.33±0.87 ^a	3.42±0.92 ^a	13.71±2.27 ^b	6.25±1.88 ^a	2.25±0.71 ^a
November	0.77±1.10 ^a	0.00±0.00 ^a	13.42±1.67 ^b	7.00±1.14 ^a	0.67±0.00 ^a

All treatments had very low to moderately high numbers of live insects (0–1.71 per kg) until the onset of the rains in June when insect density in the Control increased to > 2.0 . In July, significantly higher numbers were found in the Control (16.13) and ZeroFly (15.00) compared with other treatments. In September, there were significantly higher numbers in the Control (10.88) and DE (13.42) treatments compared to other treatments. In October, the Control (17.63), and DE (14.17) had significantly higher numbers than Botanical (10.75), Permethrin (6.50) and ZeroFly (2.63). Number of insects in the control (26.54) in November was significantly higher than in all the other treatments. There were significantly lower numbers of live insects in PICS (0.54) and ZeroFly (2.62) in October compared to other treatments. The highest number of insects was found in the Control (17.63) but this was not significantly higher than in DE (14.17) (Table 4).

Conclusion and Recommendations

The negative control had the highest insect infestation levels and this highlights the importance of using effective back up interventions to manage insect infestations in stored grain after fumigation. The botanical treatment (*P. guineense*) did not offer satisfactory control of stored-product insects; future research should investigate applying this botanical at a higher dosage. DE seemed to be effective only during the first 4 months of storage. Ways of formulating the crude DE used in such a way that it offers long term protection needs to be investigated. Permethrin and ZeroFly bags were quite effective against stored-product insect pests. However, because ZeroFly bags reduce infestation without direct application of insecticide to the maize, it is a much more preferred treatment. Use of grain protectant such as Rambo® can result in undesirable levels of insecticide residues in stored grain.

In most cases where moderate to high densities of live insects were found, psocids disproportionately contributed to numbers of insects involved, zerofly bags inclusive (Tables 2). Psocids (booklice) are however more troublesome due to their presence than actual damage they cause on grains. Maize infested by Psocids in this study remained aesthetically neat without damage. High number of Psocids in the Zerofly bags could be suggesting a growing tendency of resistance against the Deltamethrin in Zerofly bag. PICS bags were the most effective treatment against stored-product insect infestation. Our data show that ZeroFly and PICS bags can be used as effective tools in IPM system of stored-maize.

References

- Ahmedani, M. S., Shagufta, N., Aslam, M. and Hussnain, S.A. (2010). Psocid: A New Risk for Global Food Security and Safety. *Applied Entomology and Zoology*, 45 (1): 89–100.
- Alejandro, O. (2017). Management of Aflatoxins: Pre-Harvest, Post-Harvest and Integrated Management. IITA/CGIAR research to nourish Africa. www.iita.org
- Fox, T. (2013). *Global Food: Waste Not, Want Not*; Institution of Mechanical Engineers: Westminster, London, UK.
- Nwaubani, S.I., Opit, G.P., Otitodun, G.O. and Adesida, M.A. (2014). Efficacy of Two Nigeria-Derived Diatomaceous Earths Against *Sitophilus oryzae* (Coleoptera: Curculionidae) and *Rhyzopertha dominica* (Coleoptera: Bostrichidae) on Wheat. *Journal of Stored Products Research* 59: 9-16.
- Otitodun, G.O., Opit, G.P., Nwaubani, S.I., Okonkwo, E.U. and Gautam, S.G. (2015). Efficacy of Nigeria-Derived Diatomaceous Earth, Botanicals and Riverbed Sand against *Sitophilus oryzae* and *Rhyzopertha dominica* on Wheat. *African Crop Science Journal* 23 (3): 279– 293.
- Ranum, P, Peña-Rosas, J.P. and Garcia-Casal, M.N.. (2014). Global Maize Production, Utilization, and Consumption. *Annals of the New York Academy of Sciences*, 1312: 105–112