Maize Journal **2** (1&2): 57-59 (April & October 2013)

Maize grain losses due to *Sitophilus oryzae* L. and *Sitotroga cerealella* (Oliv.) infestation during storage

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ABSTRACT

A study was conducted with the objective of assessing the comparative grain damage and weight loss in maize due to infestation by varying population densities of *Sitophilus oryzae* (5, 10, 50 and 100 adults/ 500 g maize grain) and *Sitotroga cerealella* (50, 100, 150, 200 eggs/ 200 g maize grain) over a four month storage period. Significant differences were observed between initial and final insect densities of *Sitophilus oryzae* and *Sitotroga cerealella*. The maximum percent grain damage (53.30, 59.78) and weight loss (14.0, 4.9) was recorded at an initial population density of 100 adults and 200 eggs of *Sitophilus oryzae* and *Sitotroga cerealella*, respectively. The final insect population and weight loss due to *Sitophilus oryzae* exceeded that of *Sitotroga cerealella* whereas grain damage was high in *Sitotroga cerealella* infested maize at 120 days after storage. The Pearson correlation coefficient was positive and highly significant between infestation levels and progeny emerged (r = 0.82, r = 0.99), infestation levels and grain damage (r = 0.89, r = 0.95), infestation levels and grain weight loss (r = 0.93, r = 0.94) for *Sitophilus oryzae* and *Sitotroga cerealella*, respectively.

Maize is susceptible to storage pests which cause substantial quantitative, nutritional and qualitative losses depending on the pest species and duration of storage. Insect attack constitutes a major cause of losses of stored maize in the tropics and these losses have been reported from 10 to 30% during a storage period of 6 months (Tefera *et al*., 2011) much higher than losses caused by rodents and micro organisms. Rice weevil, *Sitophilus oryzae* (L.) and angoumois grain moth, *Sitotroga cerealella* (Oliv.) are principal pests of storage maize, capable of multiplying to large populations causing tremendous damage and weight loss to grain by hollowing them out. The larvae of these pests tunnel inside the kernels causing substantial damage and render the grain more susceptible to secondary insect pests (Weston and Rattlingourd, 2000). Though infestation commences in the field itself but most of the damage occurs during storage period. Feeding of the larvae inside the grains provides the best additional protection from direct contact with applied insecticides which is an important factor that contributes to serious loss of grains. The presence of insects also raises the grain temperature, due to their feeding activity, resulting in hot spots (Mills, 1989) which in turn stimulates seed deterioration and further fungal activity. The estimation of post harvest losses would provide knowledge about the extent of losses which ultimately helps in the development of management strategies. The present study aims to assess the magnitude of damage caused by *Sitophilus oryzae* and *Sitotroga cerealella* in stored maize at varying population levels over a four month storage period.

MATERIALS AND METHODS

Two experiments were separately carried out for *Sitophilus oryzae* and *Sitotroga cerealella* with four varying population levels of *Sitophilus oryzae* (5, 10, 50 and 100 adults/ 500 g grain) and *Sitotroga cerealella* (50, 100, 150, 200 eggs/ 200 g grain) over a four month storage period. Five hundred gram of maize grains were placed in a one-litre plastic jar and covered with muslin cloth. About 200 unsexed adults of *Sitophilus oryzae* were separately introduced into the plastic jar. After 10 days of oviposition, all adult insects of the insects were removed. Adult emergence was monitored daily and those emerged on the same day were transferred to plastic jars containing fresh grains and kept at the same experimental conditions until sufficient number of such insects were obtained. Different insect densities 5, 10, 50 and 100 adults of non sexed *Sitophilus oryzae* were released per each replicate in plastic jars containing five

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Table 1. Effect of *Sitophilus oryzae* and *Sitotroga cerealella* initial population density on grain damage and weight loss at 120 days after maize grain storage

Treatment	*Sitophilus oryzae*		*Sitotroga cerealella*	
	Grain damage (%)	Weight loss (%)	Grain damage (%)	Weight loss (%)
50	19.33^{B} ±5.61	2.42 ^{B}±0.98	22.50^{C} ± 1.98	2.22^{C} ± 0.27
100	25.33 ^{B}±3.67	3.84^{AB} ±0.54	40.25^{B} ± 2.26	3.88^{B}± 1.45
150	45.67 ^{A}±5.55	8.23^{AB} ±2.24	53.75^{A} ± 2.50	4.09^{AB} ± 0.68
200	53.33^{A} ±4.25	14.03^{A} ±4.74	59.75^{A} ± 2.23	4.91^{A}± 0.24

Each value is the mean of four replicates (mean ± SD). Figures in parentheses are angular transformed values. Means followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test.

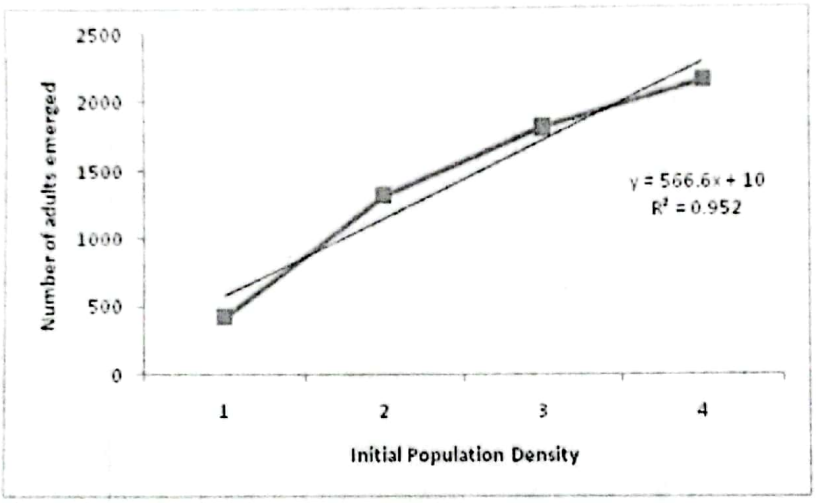

Figure:1 Effect of *S.oryzae* initial population density on adult emergence at 120 days after maize grain storage

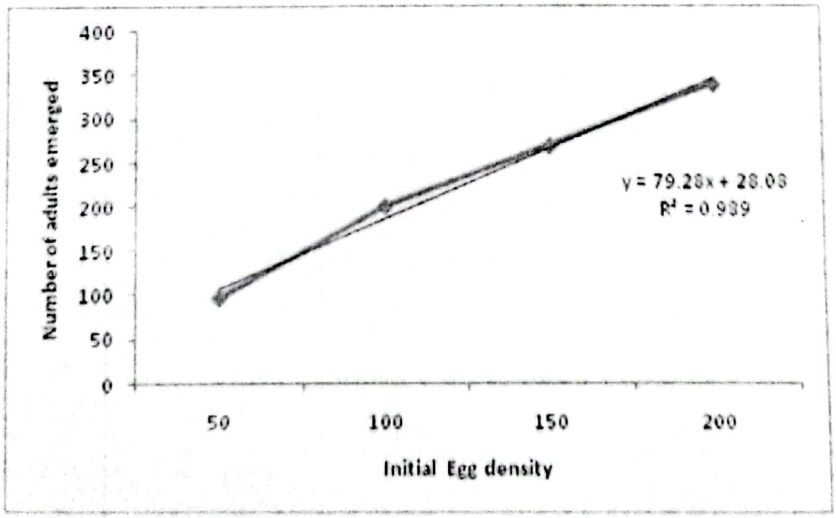

Figure:2 Effect of *S.cerealella* initial egg density on adult emergence at 120 days after maize grain storage rgence at 120 days after maize grain storage

hundred grams of maize grains (11% moisture content) and kept for 120 days. Eggs of *Sitotroga cerealella* were obtained by placing about 100 freshly-emerged adult moths in a one litre plastic jar containing 100 grams of maize grains and folded wax paper. The insects were allowed to mate and lay eggs for seven days. After seven days, the adults were separated and the eggs laid in the crevices of the folded paper were collected after 24 h. Two hundred grams of maize grains were taken in plastic jars and different egg densities 50, 100, 150 and 200 eggs of *Sitotroga cerealella* were added per each replicate. The treatments were arranged in completely randomised design with four replications in laboratory. After 4 months, the plastic jars were opened, the content separated into grains and number of insects emerged, number of kernels damaged, weight of damaged and undamaged kernels were recorded. The number of insects emerged were square root transformed while percent grain damage and weight loss were angular transformed in order to stabilize the variance. The transformed data were analyzed using one-way analysis of variance by SAS VERSION 9.3. Significant differences between means were separated using DMRT ($P < 0.05$).

RESULTS AND DISCUSSION

Significant differences were observed between initial insect density and final insect density for *Sitophilus oryzae* ($F= 8.19$, $P < 0.001$) and for *Sitotroga cerealella* ($F =7.25$, $P < 0.001$) after 120 days of maize storage (Figures 1 and 2). There was an increasing trend in the final insect density with a corresponding increase in an initial insect density and storage time. Significant differences were observed between initial insect densities in percent grain damage for both *Sitophilus oryzae* ($F= 3.85$, $P < 0.001$) and *Sitotroga cerealella* ($F= 9.34$, $P < 0.001$) at 120 days after storage. The minimum (19.33) and maximum (53.33) percent grain damage was recorded at 50 and 100 insect density of *Sitophilus oryzae* (Table 1) and in case of *Sitotroga cerealella*, the minimum (22.50) and maximum (59.75) percent grain damage was observed at 50 and 200 egg densities (Table 1) after 120 days of storage, respectively. There were significant differences among initial insect densities in affecting grain weight losses for both *Sitophilus oryzae* ($F= 4.79$, $P< 0.001$) and *Sitotroga cerealella* (Table 1) ($F= 18.94$, $P< 0.001$) respectively at 120 days after storage. Waktole and Ayana (2012) reported that percent grain damage and weight losses by *Sitophilus zeamais* increased with storage period of six months. The percent weight loss due to feeding by *Sitophilus oryzae* and *Sitotroga cerealella* ranged from 2.42 to 14.03 and 2.22 to 4.91, respectively with varying population levels. The maximum percent grain weight loss was caused by *S.oryzae* which might be due to extensive tunnelling to the grain. The present results are in agreement with Derera *et al.* (2001) who reported grain losses ranging from 20 - 90% caused by *Sitophilus zeamais* in stored untreated maize grains. However, maximum percent grain damage was inflicted in *Sitotroga cerealella* infested maize (59.75) compared to *Sitophilus oryzae* (53.33). Togola *et al.* (2010) reported that infestation by *Sitotroga cerealella* in many rice-producing zones caused 3-18 % grain damage , depending on the area and length of storage. This is comparable to present results with slight percentage modification in grain damage which may be due to size of grain sample, method and duration of study. The damage by *Sitotroga cerealella* also ranged from 3% to 18 % over 4 months storage period in infested samples of rice (Abou *et al.*, 2010). The Pearson correlation coefficient was positive and highly significant between infestation levels and progeny emerged ($r = 0.82$, $r = 0.99$), infestation levels and grain damage ($r = 0.89$ $r = 0.95$), infestation levels and grain weight loss ($r = 0.93$, $r = 0.94$) for *Sitophilus oryzae* and *Sitotroga cerealella*, respectively. The present findings are in agreement with Uttam *et al.*(2002) who reported significant positive correlation with the insect population of *S. cerealella* and percent of damaged grains (+0.95) and percent grain weight loss (+0.85) when infested with different rice varieties.

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