African Journal of Agricultural Research Vol. 7(42), pp. 5680-5684, 2 November, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR12.649
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Reduction of seed harvester ants, *Pogonomyrmex* spp. (Hymenoptera: Formicidae), damages by using some insecticides

Tufail Ahmad*, Adugna Haile, Hadish Gebremeskel and Shewit Mekonnen

Department of Plant Protection, Hamelmalo Agricultural College, State of Eritrea.

Accepted 18 June, 2012

Seed harvester ants are one of the dominant insect pest groups in Eritrea causing great economic loss in cereal crops from sowing up to harvesting. The effectiveness of malathion, carbaryl and neem seed extract on the reduction of seed harvester ant (*Pogonomyrmex* spp.) populations and damages was also evaluated by the amount of seed removal. Results of the study showed that high number of germination rate (14.6) and yield (1.7 kg/plot) was obtained from malathion-treated ant mounds while carbaryl showed fair control. But neem seed extract was not effective where low germination rate (3.24) and yield (0.7 kg/plot) was found. The seed removal rate for seed harvester ant colony was very high in pearl millet (89.4 to 100%) than in maize (59.2 to 51.3%).

Key words: Seed harvester ant, *Pogonomyrmex*, reduction, insecticides.

INTRODUCTION

The seed harvester ants, *Pogonomyrmex* spp. (Hymenoptera, Formicidae), are seed predators that harvest and eat seeds of different crops such as sorghum, pearl millet and maize as well as, wild grasses. Their abundance and varied ecological role make them influential in agricultural ecosystem around the world (Holldobler and Wilson, 1990). *Pogonomyrmex rugosus* occurs in arid and semi-arid plant communities throughout much of the southwestern United States (Carlson and Whitford, 1991) whereas *Pogonomyrmex californicus* was recorded to forage at high temperatures up to 53°C (Bernstein, 1974). Their diets are similar consisting of grass seeds which represent more than 93% of the seed and harvester ants nest in open desert and are easily found due to the conspicuous nest of the gravel disk and surrounding that is clear of vegetation, *Pogonmyrmex* spp. are abundant and conspicuous ant in low latitude arid areas of America (Cole, 1968). Seed removal rate by *Pogonomyrmex* seeds/colony) and by *Pogonomyrmex* *pronotalis* (50,000 seeds/colony) throughout the season is similar to the one reported for *Pogonomyrmex occidentalis* in North America and *P. occidentalis* was found to be able to remove up to 100% of the seed set of preferred crop species (Crist and MacMahon, 1992). The Florida harvester ant uses odor trials as well as, sun orientation to return to food sources and as such, placing baits on these trails may help control a colony (Ebeling, 1978). Insect growth regulator (IGR) materials are available that stop all egg production by the queen or selectively inhibit production of worker eggs, providing control within five to 10 weeks. Aerosol, dust and liquid fumigant mound treatments are effective insecticides that can be used for barrier treatment, but with lower levels of effectiveness. The seed harvester ants are a serious problem on the main cereal crops such as sorghum and pearl millet of sub-zone Hamelmalo (zoba Anseba, Eritrea). These ants collect seeds during the sowing period, cut the seedling at growing stage and during harvesting when collected in the field before threshing and make the land barn. Thus, this study was conducted in Hamelmalo sub zone to find out effectiveness of some insecticides; s malathion, carbaryl and neem seed extract *rastratus* (60,000 for the reduction of seed harvester ant

*Corresponding author. E-mail: tufailrm@gmail.com. Tel: +2917308649.

Table 1. Effect of different insecticides on seed harvester ants and germination test of sorghum crop.

Treatment	Mean of germination ± Standard error		
	7 DAG	14 DAG	21 DAG
Malathion	4.07±1.05[a]	5.28±1.21[a]	5.19±0.97[a]
Carbarayl	3.03±0.28[a]	3.40±0.26[b]	3.20±0.17[b]
Neem seed extract	1.24±0.32[b]	1.00±0.00[c]	1.00±0.14[c]
Control	1.24±0.32[b]	1.00±1.80[c]	1.00±0.22[c]
$LSD_{0.05}$	1.66	1.99	1.48

Means in the same row or in the same column and followed with the same letter are not significantly different according to $LSD._{0.05}$; DAG=Days after germination.

population, and to assess the amount of seeds removed in gram per colony.

MATERIALS AND METHODS

Location of the experiment

The study was conducted in August to November 2011, at Hamelmalo Agricultural College (1286 msl; latitude 15.53 and longitude 38.66°; annual rain fall 450 mm) and its surrounding village located in Anseba region, about 12 km north east of Keren (Ministry of Agriculture, 1997). The soil type in the studied area was sandy loam and the major crops grown in the area were sorghum, pearl millet and groundnut.

Chemical treatments and experimental design

Three chemical treatments were prepared, (1) 10 ml of malathion 57% EC was mixed with 100 g sorghum; (2) carbaryl solution was prepared by mixing 10 g of carbaryl 85% WP with half teaspoon of sugar and then mixed with 100 g of sorghum seed and misted with 5 ml of water; (3) neem seed extraction was prepared by using 10 g/plot of peeled seed material crushed using a pestle and mortar and then soaked with 20 ml water followed by storing in clean bottle for overnight; one tea spoon of soap was added to the soaked material and squeezed through muslin cloth and mixed with 100 g of sorghum seed. Randomized complete block design (RCBD) was used in performing the experiment with four treatments and three replicates. The individual plots were 7.07 m^2 and total experimental area was 84.84 m^2.

Seed removal rate

The assessment of seed removal rates by harvester ant colonies was done by adding 400, 600, 800 and 1000 g of sorghum, pearl millet and maize at selected ant colonies in the evening hours and the remaining seeds was collected in the early morning and reweighted by using electronic balance and difference in weight was recorded as an indication for seed removal rates.

Data collection

The data collection was done to identify the effectiveness of the chemicals based on the number of seed germinated and the total yield obtained from the plots of ant mound treated with different chemicals. Germinated seed was counted by using square meter stick. The other cultural and agronomic practices were done during the cropping season. After the harvesting the yield/plot was calculated by standard method.

Statistical analysis

The obtained data was analyzed statistically by the application of software GENESTAT and Sigma plot version 10 for correlation, analysis of variance (ANOVA). Sufficiently, ANOVA and Least Significant Difference (LSD) can be used in comparing means to get the significant differences and as such, revising the statistical analysis is required.

RESULTS AND DISCUSSION

Effects of treatments on seed germination rate

Seed harvester ant population was very high in the selected ant mounds inside the sorghum fields. After seven days sowing of sorghum seed, germination was counted and recorded that there was significant difference (P<0.05) among the different treatments (Table 1). The highest germination rate was recorded for malathion-treated seeds (4.07), whereas it was lowest for those treated with neem seed extract (1.24) and control (1.24), respectively. In the first counting, there was no significant difference (P<0.05) among (malathion and carbaryl) and (neem seed extract, control). But the germination in control and neem seed extract plots was significantly (P<0.05) different in germination from plots treated with malathion and carbaryl. The second counting of seed germination was observed after 14 days of sowing. The result revealed that germination in every treatments was significantly (P<0.05) different to each other (Table 1). The highest mean of germination was obtained for seeds treated with malathion with 5.3, followed by carbaryl, neem seed extract, and control, with 3.4, 1.0 and 1.14, respectively. Germination rate was recorded after 21 days. There was significant difference among the treatments at (P<0.05). The highest was recorded for malathion (5.28) followed by carbaryl (3.21) and the lowest was to neem seed extract (1.00) and control (1.00). There was a significant difference between

Table 2. Means for sorghum seed germination rates.

Treatment	Mean ± Standard error
Malathion	14.63±0.52[a]
Carbaryl	9.64±0.12[b]
Neem seed extract	3.24±0.11[c]
Control	3.38±0.08[c]
$LSD_{0.05}$	4.81

Means followed by same letter are not significantly different according to $L.S.D._{.0.05}$

Table 3. Effect of treatments on yield of sorghum.

Treatment	Yield (kg/plot) ± Standard error
Malathion	1.73±0.25[a]
Carbaryl	1.19±0.11[b]
Neem seed extract	0.70±0.06[c]
Control	0.70±0.45[c]
Grand mean	1.08
$LSD_{0.05}$	0.348

Means followed with the same letter are not significantly different according to $L.S.D._{0.05}$

malathion and carbaryl while neem seed extract was with no significant difference from control.

Overall mean of the treatments show significant (P<0.05) difference in each other. The highest was found in malathion (14.633) and carbaryl (9.643) while the neem seed extract showed no significant difference with control at P<0.05. Harvester ants, *Pogonomyrmex* spp., are specialist seed predators that are reported to disperse seeds in several ways. Seeds that foragers collect (at distances ranging from <1 m to >20 m) and return to the nest may eventually germinate and grow if the colony dies or emigrates and significant differences between treatments may be attributed to foraging behavior seed harvester ants (MacMohan et al., 2000).

Malathion and carbaryl show effective control of the seed harvester ants than other treatments, causing a high reduction of the population of the ants. As a result of this, the germination rate was high. Neem seed extract and control were less effective in controlling the harvester; thus, the population of the ants increased. The cutting and damaging were recorded in neem seed extract-treated seeds and control plot. The treatments correlated in overall was significant (P<0.05), with each other (Table 2).

According to Hill (1975), harvester ants, *Messorbar baruscan*, cause a grazing loss to the magnitude of 10 to 20% in some areas. In addition to clearing vegetation around their nests, harvester ants also forage for grass seeds and seeds from other plants over a wide area, covering as much as 30% of the total area of rangelands (Stoddart et al., 1975).

Effect of treatments on yield of sorghum

Yield performance was also studied for sorghum crop by applying different treatments. The analyzed data showed that average yield (kg/plot) differed significantly among all treatments (Table 3). The highest yield was obtained by applying malathion (1.731 kg/plot) and the lowest was in the control (0.701 kg/plot).

Seed removal rate for various crops by seed harvester ants

Seed harvester ants are known for removing various crops and grasses seed for their consumption and storing them in their storage rooms (Figure 1). Therefore, to assess the amount of seed removed by the ants, percentage of removed seeds per ants colony was calculated. In this study, sorghum, pearl millet and maize seed was taken for assessing seed removal efficiency for seed harvester ants *Pogonomyrmex* spp. As shown in Table 4, at 600 g seed of different crops, the highest removal was scored in pearl millet (99.5%), followed by sorghum (97.9%) and lowest removal seed per colony was by maize (57.1%). The removal rate in 800 g was also high in pearl millet (99.0%) and lowest in maize (53.3%). When 1000 g was applied on the different ant colonies, the highest seed removal rate per colony of ant was recorded in pearl millet (89.4%), sorghum (87.9%) and the lowest removal rate was in maize (51.3%). Therefore, in all cases, the removal rate of pearl millet was very high with 100.0 and 89.4% out of 400 and 1000 g, followed by sorghum and the maize was lowest 59.2 and 51.3% out of 400 and 1000 g, respectively. Mull and MackMohan (1997) suggested that differences in removal rates are due in part to a higher probability of discovery for patches located near trials. In both experiments, there was significant variation in seed removal patterns among individual ant colonies.

Hauges and Westroby (1990) also found that the time of the year also had a strong influence on seed removal rate (21% of total variation) with the highest rates occurring in summer and the lowest in winter. Also, differences in the removal rates between the two seed species used was the third most important source of variation (4%), and there was also significant variation in the removal rate between the same months in different years. In the present study, it was found that the seed harvester ants were most excellent in removing sorghum and pearl millet because of their smaller size in comparison with maize. A similar observation was also made by Gabriela and Javier (2011) who found out that ants preferred grass seeds, but *P. inermis* did not have a lower preference for non grass seeds. Also, in analyzing the relationship between preferences for seeds by the six species of ants and the size and morphology of seeds, Gabriela and Javier (2011) found out the ants had a higher preference for seeds of intermediate size; they

Table 4. Seed removal rate for various crops (percentage) by seed harvester ants.

Quantity (g)	Sorghum ± S. E.	Pearl millet ± S. E.	Maize± S. E.
400	100.00±0.00[a]	100.00±0.00[a]	59.18±1.21[a]
600	97.91±1.25[b]	99.58±0.11[ab]	57.05±1.11[a]
800	93.66±1.76[c]	99.03±0.35[b]	53.27±1.23[b]
1000	87.86±1.99[d]	89.44±0.87[c]	51.30±1.65[b]
$LSD_{0.05}$	2.07	0.77	2.29

Means in the same column followed with the same letter are not significantly different according to $L.S.D._{.0.05.}$

a) Seeds found in ant storage room

b) Malathion treated plot

c) Area barren by seed harvester ant

d) Seed harvester ant cutting seedling

e) Harvesting of seeds

f) Larvae and pupa found in digging

Figure 1. Infestation and population of seed harvester ants in and around Hamelmalo area and management.

found no relationship between preference for seed and seed morphology. Pearl millet which is smaller than maize and sorghum, hence the highest seed removal rate was found in pearl millet in present study.

ACKNOWLEDGEMENT

The authors are very grateful to the Dean, Hamelmalo Agricultural College, Keren Eritrea for providing all

necessary facilities for nicely finishing Senior Research Project.

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