academicJournals

Vol. 6(3), pp. 25-29, March, 2015
DOI: 10.5897/JSPPR2014.0179
ISSI 2141-6567
Article Number:709372E51302

http://www.academicjournals.org/JSPPR

Journal of Stored Products and Postharvest Research

Full Length Research Paper

Eco-friendly approaches for management of bruchid beetle *Callosobruchus chinensis* (Coleoptera: Bruchidae) infesting faba bean and cowpea under laboratory conditions

Tufail Ahmad*, Adugna Haile, Ande Ermias, Robel Etbarek, Selam Habteab and Selam Teklai

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

Received 16 October, 2014; Accepted 9 February, 2015

Eco-friendly management of bruchid beetle, *Callosobruchus chinensis* infesting faba bean (*Vicia faba*) and cowpea (*Vigna angulculata*) under laboratory conditions were conducted at Department of Plant Protection, Hamelmalo Agricultural College, Keren, Eritrea, to evaluate the effectiveness of four environment friendly treatments, that is, sesame oil, neem seed powder, hot water salt solution and cold water salt solution were applied to faba bean and cowpea seeds. The lowest percent grain damage by *C. chinensis* was recorded in cold water salt solution for cowpea (18.7%) followed by faba beans (56.7%) compared with control treatments (62.1% in cowpea and 65.3% in faba beans). However, the sesame oil, neem seed powder and hot water salt solution are significantly (P =0.05) affecting damage of bruchid beetle in both, faba bean and cowpea. The maximum percent weight loss was found in control and cold water salt solution in comparison to other treatment.

Key words: Bruchid beetle, faba bean, cowpea, neem seed powder, sesame oil, Eritrea.

INTRODUCTION

Pulse beetle, *Callosobruchus chinensis* L. is one of the most destructive pests of chickpea in storage. Generally, infestation was found in ripened pods from the field, where it is carried to storage and godowns. Specially, cowpea (*Vigna angulculata)* grains are used for human consumption and green pod as vegetables in Africa (90%) and Nigeria is the world's largest producer of cowpea. It is a serious pest of cowpea in storage often 100% infestation occurs within six months of storage at the farm level. *C. chinensis* attack the crop when they reach fruiting stage and this seed could be deteriorated (Haines, 1998). The loss caused by this pest to the pulse has been estimated to the tone of 40 to 50% in storage. Bruchids cause a potential loss in legume by feeding on the protein content of the grain and their damage ranges from 12 to 30% in developing countries (Tsedeke and Adhanom, 1985; FAO, 1994). Adult bruchids beetle do not feed and make damage themselves. Female deposit

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

eggs on the seeds;and the newly hatched larva bore into the legume seeds and feed inside. The first visible signs are the hole made in the seed by the emerging adult and this is perceived as damage (Koona and Koona, 2006). The grub causes damage by eating out the entire content of grain leaving only the shell. The damaged seed is unfit for human consumption as well as sowing purpose.

On-farm storage studies in Eritrea showed that staple grains of cereals and pulses produced by small farmers in Eritrea are attacked by different storage pest and the germination loss due to the attack of storage pests on cereals and pulse grains ranges from 3 to 37 and 4 to 88%, respectively (Adugna, 2007). Adugna (2006) investigated that one of the main problems of storage in Eritrea is management of the store and a continuous source of infestation in the stored areas and farmers in most areas keep old and new harvested grains in the same vicinity, which causes an easy migration or infestation of the new grains from the old grains. Farmers in Eritrea use different pest control methods; some are using internationally banned chemicals like DDT, chemicals that leave residue; others use kerosene and some farmers use different traditional methods such as mixing of grain with ash, sand, chilly pepper, and smoke and plant materials (Adugna, 2007). Taking all these into account, there is no any stable method for storing the pulses as it is obvious to say that the grains are base for their life. If we look it also at the national context, it could be a base for the growth of the economy. If a subsistent farmer produces a lot, they can satisfy himself and also for the nation. So, at least to minimize the losses caused by storage pest, it is highly desirable to understand loss caused by storage pest under laboratory that can be used later on guide to extension workers with respect to storage grains.

MATERIALS AND METHODS

Rearing of bruchid beetle

The infested pulses were brought from Keren Grain market to Department of Plant Protection, Hamelmalo Agricultural College for rearing the bruchid beetle in laboratory condition. The bruchid beetle began emerging from the infested stock after 10 days. 50 adults bruchid beetle were transferred into another container in 500 g with fresh faba bean and cowpea. This phenomenon was repeated several times to maintain the culture of bruchid beetle throughout experimental period. The bruchid beetle was used from maintaining culture for entire investigation.

Description of treatments

Four treatments, that is, sesame oil, neem seed powder, hot water salt solution and cold water salt solution were applied on faba bean and cowpea. Uninfected faba bean and cowpea were collected from market and kept 250 g in separate container with three replicate for each treatments. Before storing, five drops of sesame oil admixed on faba bean as well as cowpea. Neem seed powder (at 10 g) mixed with faba bean and cowpea and kept for observation. Both faba bean and cowpea pulses were dipped in boiled water (500 ml water + 50 g salt) for fifteen minutes and left for sun drying. Similarly, 100 ml of water mixed with 50 g of salt and ad mix with both beans and sun dried for three days. On the other hand, the samples were kept in cold water salt solution with the proportion of 50 g of salt dissolved in 500 ml of cold water for fifteen minutes and were properly dried before storing.

Weight loss assessment

Weight loss assessment percentage was conducted on 250 g of seeds in each container. The damaged grain legumes (grains with characteristic holes) were separated from undamaged portions. The grains in each portion were counted and weighted by using appropriate balance. Petri dish, light bulb and simple microscope were used in experiment. Percent weight loss was calculated using the formula given by Adams (1976) as follows:

$$\% \text{ weight loss} = [(UNd) - (DNu)] / [U(Nd+Nu)] \times 100$$

Where U- the weight of undamaged grains; Nu- the number of undamaged grains; Nd- the number of damaged grains; D- the weight of damaged grains.

Statistical analysis

The data collected by different means were analysed statistically by the application of software Web Agri Stat Package (WASP) developed by Indian Council of Agricultural Research, Goa and significant test by Duncan's Multiple Range Test (DMRT).

RESULTS

Effect of different treatments on bruchid beetle on faba bean

Effect of different treatments, that is, sesame oil, neem seed powder, hot water and cold water were found significantly/non significantly (P=0.05) affecting the infestation of bruchid beetle in laboratory condition on faba bean. The result revealed that there was no significant difference among the treatments in the first month (November). The highest percent mean damage was recorded in control (14.33%) and lowest percent damaged grain was recorded in sesame oil (0.33%) during the first month storing (Table 1). There was no significant (P=0.05) difference in grain percent damage between control and cold water salt solution treatments with mean of 42.81, 71.3 85.3 99.3 and 37.31, 68.30, 82.3, 96.30% followed by second, third, fourth and fifth months respectively. Similarly there was no significant difference (P=0.05) within the treatments sesame oil, neem seed powder, and hot water salt solution treatments across the three months with mean of 0.33, 3.00 and 7.00% respectively.

Effect of different treatments on bruchid beetle on cowpea

Effect of different treatments on cowpea were recorded

Table 1. Percent damage of faba bean by bruchid beetle under laboratory condition.

Treatments/month	1st	2nd	3rd	4th	5th	% damage
Fababean+ Sesame oil	0.33	0.31	0.30	0.48	0.66	0.33[b]
Fababean + Neem seed powder	2.00	3.15	4.30	3.81	3.33	3.00[b]
Fababean + Hot water salt solution	2.00	5.50	9.00	9.30	9.60	7.00[b]
Fababean + Cold water salt solution	6.33	37.31	68.30	82.30	96.30	56.66[a]
Control (untreated check)	14.33	42.81	71.30	85.30	99.30	65.33[a]
CD 0.05%						**29.45**
CV						**84.85**

Means followed by the same letters are not significantly different (P =0.05); DMRT.

and revealed that treatments were significantly/non significantly (P=0.05) controlling the infestation of bruchid beetle in laboratory condition. The average percent damage showed that the treatments of sesame oil and neem seed powder significantly affects the infestation of bruchid beetle whereas hot water and cold water was non significant (P=0.05) controlling bruchid beetle with each other. However, treatments of sesame oil, neem seed powder and hot water salt solution did significant difference in the first two months. In a similar way, the third, fourth and fifth months storage check treatments of sesame oil, neem seed powder and hot water salt solution did not show significant difference across the months with 0.6, 0.95, 1.3, and 1.6, 2.45.3.3 and 9.66, 10.3, 10.6 respectively.

However, there was no further damage observed in the fourth and fifth months in cold water salt solution treatment with mean damage of 24.65 and 21 respectively. Control treatment had shown significant difference in the third and fourth months compared to others. Generally, data of cowpea storage under the laboratory condition without treated (control) showed more number of damaged grain followed by cold water salt solution and hot water salt solution treatments with average mean of 59.33, 17.66 and 11.66% respectively.

Percent weight loss of stored grain legume in laboratory condition

The weight of stored legume were significantly (P=0.05) decreasing continuously from first month to last month during the study. It could be due to long duration of storage period, building up pest population as a result of increasing number of damaged grains; weight loss goes corresponding to it (Table 3). Overall, the percent weight loss for faba bean was recorded in cold water treatment and hot water salt solution treatment with average mean of 33.8 and 28.00% respectively whereas percent weight loss was found in sesame oil and neem seed powder treatment as 4.67 and 6.80%.

The weight loss of cowpea in storage under laboratory had gone in similar fashion as faba bean. There was no significant (P=0.05) difference among the treatments of sesame oil, neem seed powder, cold and hot water salt solutions with mean of 4.46, 8.36, 25.16 and 24.83% respectively. However, there was significant (P=0.05) weight loss in control treatment with mean of 62.80%.

DISCUSSION

The storage of faba bean and cowpea treatment with different physical, neem seed powder and sesame oil were found significantly/non significantly (P=0.05) managing the bruchid beetle in laboratory condition. Homan and Yubak (2011) found that botanical materials resulted in significant difference over other treatments in terms of adult mortality, adult emergence, percent grain damage, percent weight loss, moisture content, and germination percent. Among them, *Sesamum* oil, *Cinnamomum camphora* balls and *Acorus calamus* rhizome dust were found to have excellent efficacy in terms of different seeds qualities. The present study is supported with similar finding of Grima (2006) who reported that *Azadirachta indica*, *Melia azadarach*, *Eucalyptus* and *Xanthidium armatum* were not effective in reducing weevil population, moisture content, grain damage and weight loss. The storage of grain legume showed that there were no significant differences among the treatments in first month probably due to pests being at egg stage as a result of very low population with an observed rise in pest population in the second month in some treatments. However there was increasing pest population in an increasing rate in the third and fourth months, which brought up significant difference in grain damage, weight loss and germination among the treatments.

Sesame oil and neem seed powder treated containers had significantly lower insect population than the other treatments in all the study grain legumes. But sesame oil is considered to be the one most effective and all of the treatments used. Sesame oil have medicinal effect on crop which protects the grain when it intermingles with the seed grain managing the storage pest infestation because of its sesamin and sesmalin synergetic property

Table 2. Percent damage of cowpea by bruchid beetle under laboratory condition.

Treatments/month	1st	2nd	3rd	4th	5th	% damage
Cowpea + sesame oil	0.70	0.65	0.60	0.95	1.30	0.84[c]
Cowpea +Neem seed powder	1.30	1.45	1.60	2.45	3.30	2.02[c]
Cowpea + Hot water salt solution	6.00	7.83	9.66	10.13	10.60	8.84[b]
Cowpea + cold water salt solution	3.66	15.98	28.30	24.65	21.00	18.71[b]
Control(untreated check)	13.66	42.48	71.30	84.8	98.30	62.10[a]
CD 0.05						**20.92**
CV						**85.55**

Means followed by the same letters are not significantly different (P =0.05); DMRT.

Table 3. Weight loss by bruchid beetle on fababean and cowpea**.**

Treatments/average	% Weight loss	
	Faba bean	Cowpea
sesame oil	4.66[c]	4.46[b]
neem seed powder	6.8[bc]	8.36[b]
hot water salt solution	28[bc]	25.16[b]
cold water salt solution	33.8[ab]	24.83[b]
Control	68.33[a]	62.80[b]
CD 0.05	**34.76**	**21.93**
CV	**8.321**	**65.65**

Means followed by the same letters are not significantly different (P =0.05); DMRT.

and he sesame are also oily and slippery in nature. Singh et al. (1994), reported that the vegetable oil is active against eggs and larva and result in inability to oviposit or cause mortality of the adult bruchids as only small amount of oil is needed to preserve the grains for months (1 to 5 ml oil kg^{-1} of grains). Credland (1992) studied the physical structure of bruchid eggs and suggested that the funnel structure at the posterior pole may be the major route for gaseous exchange and proposed that application of different oil on grain legumes might occlude the funnel, and thus lead to death of the developing insect by asphyxiation. Neem is a botanical with tree presence of active ingredient called Azadarichtin and seed of neem have potential for controlling pest of stored. It has repellent property that can modify the pest behavior and influencing the biological process. Singh and Sharma (2003) tested the efficacy of six different oils, that is, neem (*A. indica*), mehandi (*Lawsonia inetmis* J, castor (*R. cvmmunis*) karanj (*Pvngami pinncata*), mustard (*Brassica juncea*) and olive (*O. Europea*) against pulses beetle and found that among the oils, neem and mehandi oils were effective at 10 ml/kg seeds even beyond 150 days after treatment and the rest of the oils reverse effective even after 280 days of oil treatment, and also germination test result carried out with the oil treated seeds at 4 different time intervals (6 to 8 h, 90, 150 and 210 days after treatment) revealed significant difference among the treatments and untreated control. Tripathy et al. (2001) studied the efficacy of different vegetable oils (castor, neem, pongamia coconut, mustard, sesame, soybean and sunflower) and found that oil treatments were superior in protecting the seeds from Pulses beetle attack than malathion treatment or control and the oils of neem, castor and coconut at both the doses plowed most effective in protecting the seeds for about 9 months after treatment. Singal and Chauhan (1997) tested the effect of some plant products and other materials on the development of pulses beetle attacking stored grains.

Neem seed oil and neem seed kernel powder individually prevented egg-laying for up to 8 months of storage and a negligible adult population developed after this period. Hot water and cold water salt solution are physical treatments used in the grain legumes of the present study. Cold water salt solution inhibits egg laying of adult bruchid with presence of acidic in property. In case of hot water salt solution, the hot water kills the internal seed infection which already occurred before application of treatments and the salt solution are inhibiting oviposition of bruchid beetle.

Conclusion

Legume grains, that is, faba bean and cowpea treatment with physical (cold water and hot water with salt), neem seed powder and sesame oil revealed that the different treatments significantly reduced the infestation of bruchid beetle from the first month to fifth month study. All in all it can be concluded that the severity of grain legumes damage by the insect pest increase across the successive months which resulted in a significant percent weight loss in all the grains studied. The most effective treatments was found to be sesame oil at 5 drops, Neem seed powder at 10 g and hot water salt solution at 50 g each in 250 g grains.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Adams JM (1976). A guide to the objective and reliable estimation of food losses in the small scale farmer storage Trop. Stored Prod. 32:5-12.

Adugna H (2006). On-farm storage studies on Sorghum and Chickpea in Eritrea. Afr. J. Biotechnol. 5:1537-1544.

Adugna H (2007). Wheat grain on-farm storage studies in Eritrea. African Crop Sci. Confer. Proceed. 8:1917-1921.

Credland P (1992). The structure of bruchid eggs may explain the ovicidal effect of oils. J. Stored. Prod. Prot. 28(1):1-9.

FAO (1994). Grain storage techniques, evaluation and trends in developing countries. FAO Agricultural service bulletin, Rome, Italy pp. 1-109.

Haines C (1982). Pest management in stored products. Prot. Ecol. 4:321-330.

Homan R, Yubak Dhoj GC (2011). Eco-friendly management of pulse beetle The J. Agric. Environ.12:1-10.

Grima D (2006). Field infestation by *Sithpillus zeamais* Mostch. (Coleopteran: Curculionidae) and it management on stored maize at Bako western Ethiopia. M.Sc. Thesis presented to school graduate studies, University. pp. 3-8.

Koona P, Koona OES (2006). Testing fractionated extracts grained form the Ethano botanical *Pachypodanthinum staudtii* (Annocaceae) for bruchid insect control (Coleoptera: Bruchidae). Res. J. Agric. Bio. Sci. 2(6):410-414.

Singal SK, Chauhan R (1997). Effect of some plant products and other materials on the development of pulse beetle, *Callosobruchus chinensis* (L.) on stored pigeon pea. J. Insect Sci. 10: 196-197.

Singh VN, Pandey ND, Singh YP (1994). Effectiveness of vegetable oils on the development of *Callosobruchus chinensis* L. infesting stored grain. Indian J. Entomol. 56(3):216-219.

Singh S, Sharma G (2003). Efficacy of different oils against *Callosobruchus chinensis* in green gram and their effect on seed germination. Indian J. Entomol. 65(4):281-286.

Tripathy MKP, Sahoo BC, Das, Mohanty S (2001). Efficacy of botanical oils, plant powders and extracts against *Callosobruchus chinensis* Linn. attacking blackgram. Legume Res. 24(2):82-86.

Tsedeke A, Adhanom N (1985). Current state of stored product management research. In: (Tsedeke Abate ed.) A Review of Crop Protection Research in Ethiopia: Proceedings of the First Ethiopian Crop Protection Symposium, 4-7 Feb, pp. 645-652.