Efficacy of non-edible oils against cowpea pulse beetle, *Callosobruchus maculatus Fab.* under storage

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ABSTRACT

There are many natural/plant products, which can serve as an alternative to chemical pesticides. In this study efforts were made to find the optimal and effective dose of Neem and Karanj oil reportedly having pesticidal value against the cowpea beetle, *Callosobruchus maculatus*, on stored cowpea. The non-edible oils (Neem oil and Karanj oil) were evaluated for their efficacy in management of cowpea beetle. Treatments with different doses of Neem oil (0.10%, 0.25%, 0.5% and 1.0%) and Karanj oil (0.25%, 0.5%, 0.75% and 1.0%) were given. The data was recorded for % seeds with eggs laid, number of eggs per seed, perforations per seed, % damaged seeds as well as Weevil Perforation Index (WPI). The efficacy of the treatment has been worked out on the basis of adult emergence holes and WPI. Neem oil (0.5 and 1.0%) and Karanj oil (1.0%) provided absolute protection of stored seeds as these treatments did not show a single damaged seed. The percent germination in all treated seeds was also worked out. The results of this study suggested that the non-edible oils (Neem oil and Karanj oil) were found to be able to provide protection from seed weevil. So non-edible oils can be explored as an alternative to chemical insecticides against pulse beetle, *Callosobruchus maculatus fab.* in cowpea seed under storage.

Keywords: *Callosobruchus maculatus*; Cowpea; Insecticide; Neem oil; Karanj oil

INTRODUCTION

Cowpea is an essential food legume in the tropics. It can be grown in the drier regions and has high protein content. Insects are a serious constraint to cowpea, *Vigna unguiculata* (L.) production and to their storage during the post harvest period. The postharvest grain storage, however, is a major constraint for crop expansion and year-round availability. The cowpea weevil, *Callosobruchus maculatus* F. (Coleoptera: Bruchidae), is the main storage pest of cowpea seeds throughout the tropics (Huignard et al., 1985; Singh et al., 1990; Appleby and Credland, 2003). Adult bruchids deposit eggs on legume seeds and the hatched larvae penetrate into the seeds and develop inside them. The bruchids are able to destroy all the grains within a few months of storage (Shade et al., 1999). Damage, which appears as holes in the grains, a significant loss in grain weight, and reduced seed germination rate, reduces market value and are not suitable for consumption. Cowpea seed is subject to serious infestation from this pest during storage and as high as 100% infestation could occur on unprotected cowpea following 3-5 months storage (Fig. 1). Therefore, the difficulty in storing cowpeas in the presence of bruchids has led farmers to sell their cowpeas at reduced prices, shortly after harvest (Sanon et al., 2010).

Current control methods are mainly based on chemical control (Bandara et al., 2005). The use of synthetic fumigants (e.g., phosphine and methyl bromide) has been the prevailing control strategy against pest infestation in stored products. However, insect resistance to phosphine is a serious problem, and in some countries control failures have been reported in field situations. Methyl bromide has been classified as an ozone depleter and therefore is being phased out (Rajendran and Sriranjini 2008). Owing to unfavorable effects of these conventional fumigants, alternative pest control tactics one being developed (Aboua et al., 2010; Karabörklü et al., 2011).

The indigenous materials of botanical origin have been found to possess toxic, deterrent and / or repellent properties against insects when mixed with grain. Many naturally occurring substances and plant products having insecticidal properties can serve as an alternative to chemical pesticides in agriculture. Among current alternatives, in terms of decreasing the use of chemical insecticides, one of the most promising methods is non-edible oil based pest control. In the present study, an effort was made to work out the optimal and effective dose of Neem and Karanj oil reportedly having pesticidal value. These products are economic, effective and are available at the users end at every town/village.

MATERIALS AND METHODS

Cowpea germ plasm having desired production potential and representing diverse seed characteristics *viz* seed shape, length, width, eye pattern, seed coat texture, seed coat colour and 100 seed weight was obtained from Indian Grassland and Fodder Research Institute (IGFRI), Jhansi and used in the present study. Neem oil and Karanj oil were used as supplied by manufacturer without further modification.

Treatments

1. Neem oil- Uninfested seeds of known quantity (250 g) of susceptible variety EC-4216 were mixed with Neem oil 0.10%, 0.25%, 0.50% and 1.00%, respectively and kept in a transparent polypropylene container.
2. Karanj oil- Uninfested seeds of known quantity (250 g) of susceptible variety EC-4216 were mixed with Karanj oil 0.25% and 0.50%, 0.75% and 1.00%, respectively and kept in a transparent polypropylene container.

3. Control (Untreated)- 250 g uninfested seeds of susceptible variety EC-4216 were kept in a transparent polypropylene container.

Methodology

Susceptible variety EC-4216 was used in the present study. Uninfected seeds (250 g) were treated with four doses of Neem oil (0.10, 0.25, 0.50 and 1.0%) and Karanj oil (0.25, 0.50, 0.75 and 1.0%). In all containers of each group, five pairs of freshly emerged (0-24h old) adults of bruchid were released and the top was covered with muslin cloth. These jars were kept under ambient storage conditions for 4 months (April-July), allowing the time for the development of the population in relation to the treatments. All these treatments were at par with the chemically treated seeds with 0.1% Malathion. The data recorded included % seeds with eggs laid, number of eggs per seed, perforations per seed, % adult emergence etc. All the data collected in this study was subjected to computer based statistical analysis software M stat C programme. Analysis of variance was calculated for percent seeds with eggs and percent seeds with emergence holes.

RESULTS AND DISCUSSION

In the present study four doses of non-edible oils Neem oil (0.10, 0.25, 0.50 and 1.0%) and Karanj oil (0.25, 0.50, 0.75 and 1.0%) were used. The results obtained in all these treatments indicated different degree of control against this pest as compared to untreated seeds. The observations were recorded for number of seeds with eggs, and the emergence holes for adult weevils. The percent seeds with eggs and seeds (%) with number of eggs were tabulated for each treatment (Table 1). The percent of damaged grains was calculated with the following formula:

$$\% \text{ Damaged grains} = \frac{\text{Number of bored grains}}{\text{Total number of grain counted}} \times 100$$

Table 1: % seeds with eggs, number of eggs/seed and % damaged seeds in different treatments

S. No.	Treatment	% Seeds with eggs	Number of eggs/seed			% Damaged seeds
			1-4	5-9	10-15	
1	Neem oil (0.10%)	21.00	2.67	10.00	9.33	12.33
2	Neem oil (0.25%)	6.33	1.00	3.00	3.00	4.00
3	Neem oil (0.50%)	0.00	0.00	0.00	0.00	0.00
4	Neem oil (1.0%)	0.00	0.00	0.00	0.00	0.00
5	Karanj oil (0.25%)	95.00	59.00	32.33	4.00	72.67
6	Karanj oil (0.50%)	91.00	1.33	7.00	11.67	79.00
7	Karanj oil (0.75%)	51.67	28.33	15.00	3.00	42.33
8	Karanj oil (1.0%)	0.00	0.00	0.00	0.00	0.00
9	Untreated control	100.00	9.00	78.33	12.33	80.33

The number of cowpea seeds perforated in treated and control were counted for determination of Weevil Perforation Index (WPI) (Table 2). This was determined by using the following formula:

$$WPI = \frac{\text{\% of treated cowpea seeds perforated}}{\text{\% of control seeds perforated + \% of treated cowpea seeds perforated}} \times 100$$

Neem oil 0.5% & 1.0% and Karanj oil 1.0% are the most effective as oviposition deterrent. No egg lying noticed and at par Malathion 0.1% and 0.5%. On the basis of WPI, Neem oil 0.5 and 1.0, Karanj oil 1.0% provided absolute control showing the WPI as zero. Other showed the damage as –Neem oil 0.25% (4.00%), Neem oil 0.1% (12.33%), Karanj oil 0.75% (42.33%), Karanj oil 0.5% (72.67%), Karanj oil 0.25% (79.00%) and Control (80.33%).

Table 2: Weevil perforation index (WPI) in different treatments during storage

S. No.	Treatment	% Seeds with eggs	% Damaged seeds	Weevil perforation index (WPI)
1	Neem oil (0.10%)	21.00	12.33	13.30
2	Neem oil (0.25%)	6.33	4.00	4.74
3	Neem oil (0.50%)	0.00	0.00	0.00
4	Neem oil (1.0%)	0.00	0.00	0.00
5	Karanj oil (0.25%)	95.00	79.00	47.49
6	Karanj oil (0.5%)	91.00	72.67	49.58
7	Karanj oil (0.75%)	51.67	42.33	34.51
8	Karanj oil (1.0%)	0.00	0.00	0.00
9	Untreated control	100.00	80.33	--

The most effective results obtained in the study are in the treatments with Neem oil (0.5 and 1.0%), Karanj oil (1.0%), which showed absolute protection of stored seeds in terms of oviposition and seed damage with zero WPI. The percent germination in these treatments came out 83.33% in Neem oil (0.5%), 79.33 in Neem oil (1.0%), 57.33% in Karanj oil (1.0%), as against 87.33% in untreated control. The treatment like Neem oil 1.0% or Karanj oil 1.0% is able to provide 100% protection to the seeds but affects the germination adversely (Table 3).

Table 3: % Seed germination in cowpea seed under different treatments

S. No.	Treatment	% Seed germination
1	Neem oil (0.10%)	81.33
2	Neem oil (0.25%)	86.66
3	Neem oil (0.50%)	83.33
4	Neem oil (1.0%)	79.33
5	Karanj oil (0.25%)	73.33
6	Karanj oil (0.5%)	69.66
7	Karanj oil (0.75%)	67.66
8	Karanj oil (1.0%)	57.33
9	Untreated control	87.33

CONCLUSION

There is a vast scope for replacement of chemical pesticides with materials of plant origin and other origin for the management of commonly occurring insect pests in commodities under storage. These could be studied further for application/ packaging as technology. It is also important while making a recommendation, to ascertain the availability of these

particular materials locally. The ethnic knowledge at farmers' level as well as at household level needs to be properly documented, scientifically validated for use and integrated in different agricultural package of practices.

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