Use of Plant Leaf Powders for the Management of *Sitophilus oryzae* (Coleoptera: Curculionidae) in Maize

P Lakshmi Soujanya, J C Sekhar, P Kumar[1] and S B Suby[1]

Winter Nursery Centre, Directorate of Maize Research, Rajendranagar, Hyderabad - 500 030, Andhra Pradesh, India.
[1]Directorate of Maize Research, Pusa Campus, New Delhi -110 012 India.
E mail: soujanyak.scientist@gmail.com

Abstract

The leaf powders of Vitex negundo *(Five leaved chaste tree:Verbenaceae),* Adathoda vasica *(Malabarnut tree: Acanthaceae),* Catharanthus roseus *(Periwinkle:Apocynaceae) and* Lantana camara *(Wild sage:Verbenaceae) @ 5% w/w were evaluated for their efficacy against field carry over infestation of* Sitophilus oryzae *(L.) in stored maize during five months storage period. All leaf powders reduced insect population density, grain damage and grain weight loss compared to control. These plant materials have good potential for use as grain protectant botanicals against the weevil.*

Keywords: *Sitophilus oryzae*, botanicals, field carry over infestation, storage losses

Introduction

In India annual storage losses have been estimated to be 14 million tones of food grains worth Rs 7,000 crore in which insects alone account for nearly Rs 1,300 crores. The most economically important post harvest pests of maize are rice weevil (*Sitophilus oryzae* L.) (Coleoptera: Curculionidae), angoumois grain moth (*Sitotroga cerealella* Oliv.) (Lepidoptera: Gelechidae) causing both quantitative (weight loss, economic loss) and qualitative (chemical changes, seed viability, contamination, nutritional) losses by feeding inside the grains. The losses due to insect pests are dependent upon storage time, moisture content of grain, insect population density and proper storage structures. Continuous use of synthetic insecticides for control of insect pests led to number of problems such as resistance, resurgence, ecological imbalance and residual effect on stored grains. Moreover there has been a ban on use of methyl bromide as fumigant against stored insect pests under international agreement of montreal protocol (Thomas Phillips and James Throne, 2010). Plant product derivatives of *Annona squamosa, Lantana camara, Azadirachta indica* etc., have been proved to be effective for managing various stored grain pests by delaying the developmental stages through interfering with their apolytic and molting processes (Morya *et al.*, 2010). Keeping this in view, study was carried out to evaluate the efficacy of five leaf powders of selected botanicals against field carry over infestation of *S. oryzae* in maize stored for five month period.

Materials and methods

Freshly harvested grains of sweetcorn were sieved to remove dust, dirt or broken grains. The plant materials of *Vitex negundo*, *Adathoda vasica*, *Catharanthus roseus* were collected from Herbal Garden, Andhra Pradesh Horticultural University and *L. camara* was collected locally as it is a weed occurring almost every where. The leaves were shade dried in a well ventilated area in the laboratory for one week before milling into fine powder and stored in refrigerator for further use. Five hundred grams of maize grain was taken in 1 l plastic jar and covered with muslin cloth to ensure proper aeration. The cloth was tightly secured with rubber bands. The plant powders of *V. negundo*, *A. vasica*, *C. roseus* and *L. camara* @ 5 % w/w were added to maize grains and shaken thoroughly for proper admixture. A control experiment was set up with no plant material powder added. Each treatment was replicated four times and kept for five months under the ambient conditions. The experiment was arranged in completely randomized design. Data were collected every month starting from July to November 2011. At each sampling date the plastic jars were opened and the contents separated into grains and insects using U.S. standard sieve No 10. Number of adult weevils obtained was counted and returned to the grains. After sieving 100 seeds were taken at random and the number of damaged, undamaged kernels, weight of damaged and undamaged kernels were recorded. Grain damage was expressed as proportion of total number of grains. Grain

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weight loss was determined using the count and weight method of Gwinner *et al.* (1996).

$$\text{Weight loss (\%)} = \frac{(Wu \times Nd) - (Wd \times Nu) \times 100}{Wu \times (Nd + Nu)}$$

where,

Wu = Weight of undamaged grain; Wd = Weight of damaged grain

Nd = Number of damaged grain; Nu = Number of undamaged grain

Per cent Inhibition rates were calculated using the following formula (Rahman *et al.*, 2003)

$$\text{Inhibition rate (\%)} = \frac{Cn - Tn \times 100}{Cn}$$

Where,

Cn = number of insects in control; Tn = number of insects in treated

The data pertaining to the observations in the laboratory were transformed using angular transformation and were subjected to one way analysis of varience (ANOVA) and treatment means were compared at 0.05 significant level using Duncans Multiple Range test (Gomez and Gomez, 1984).

Results and discussion

Significant differences were observed between the initial insect density and the final insect density of *S.oryzae* on maize grains treated with different plant powders at first, second, third, fourth and fifth months of storage. The insect population density increased with the extension of storage time of the grain (Fig 1.). The growth in the number of insects from first month to fifth month indicated that it was low to moderate level in grain treated with *A.vasica* (8.75 to 145) followed by *L. camera* (9.5 to 163) , *V. negundo* (14 to 190) and *C. roseus* (17.25 to 256) over five months storage time compared to untreated control (19.25 to 374.50). There were significant differences among treatments in per cent grain damage throughout the storage period (Table 1). The increase in number of damaged grain from first to fifth month was least recorded in *A. vasica* (0 to 18.25) followed by *L. camara* (2.25 to 22.75), *V. negundo* (10.5 to 26.25) and *C. roseus* (13 to 28) while it was highest in untreated control (16.25 to 51.75). The present findings are in agreement with the study by Mishra *et al.* (1992) who observed 19.7 % grain damage and 12.7% weight loss in maize grains treated

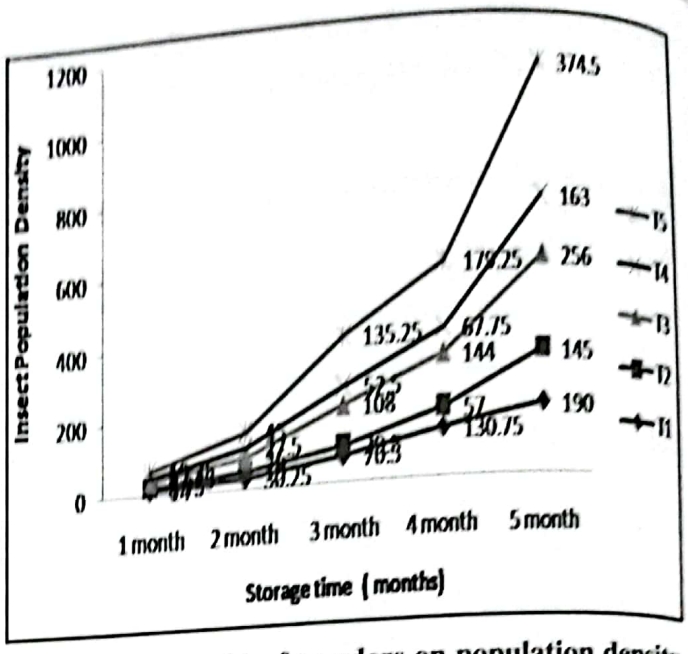

Figure 1. Effect of leaf powders on population density of *Sitophilus oryzae* during five months storage

with *V. negundo* leaf powder @ 5 per per cent w/w during 90 days of storage. Ogendo *et al.* (2004) observed that the use of *L. camara* and *Tephrosia vogelii* powders in maize storage significantly reduced grain damage due to *S. zeamais* with no adverse effects on seed germination. Various plant powders used in the study significantly suppressed the grain weight loss when compared with the control (Table 2). Similar to grain damage it was observed during the study that the grain weight loss also increased with the increase in storage period . The percent weight loss was low in *A.vasica* (0 to 2.43), *L. camara* (0 to 2.57) followed by *V. negundo* (0.17 to 3.04) and *C. roseus* (0.42 to 3.79) while the per cent weight loss was high in untreated check (1.30 to 5.95) throughout the storage period. The results showed that all plant materials had varying degree of insecticidal activities mainly due to contact toxicity of the powders on the weevil. The present findings are in agreement with Hodges *et al.* (1983) who reported 9% storage losses over a period of six months. Abdul (2011) also reported that larvae and adult rice weevil were susceptible to crude aqueous extract of *C. roseus* leaf. Vanmathi *et al.* (2010) stated that *C. roseus, A. indica, Tephrosia purpurea, V. negundo* caused more than 50% oviposition deterrent effects on *Callosobruchus maculatus*. F. Figure 2 shows the effects of plant products on per cent inhibition rate of *A.vasica* gave the highest per cent inhibition rate of *S. oryzae* (57.74 to 61.90) followed by *L.camara* (38.91 to 62.15), *V. negundo* (26.24 to 48.99) and *C. roseus* (10.71 to 31.32) during five months storage period. The better performance of the above said treatments may be due to their insecticidal and antioxidant property which might have reduced the insect infestation. The powder

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Table1. Effect of leaf powders on per cent grain damage by *S. oryzae* during five months storage period

Treatment	Per cent grain damage				
	1st month	2nd month	3rd month	4th month	5th month
Vitex negundo	10.5^{c}±0.64(18.9)	13.50^{c}±0.69(21.6)	20.50^{bc}±1.04(26.9)	25.00^{b}±0.04(30.0)	26.25^{c}±0.47(30.8)
Adathoda vasica	0.00^{a}±0.00(0.0)	4.25^{a}±0.25(11.9)	14.00^{a}±0.81(22.0)	17.50^{a}±1.04(24.7)	18.25^{a}±0.85(25.3)
Catharanthus roseus	13.00^{d}±0.40(21.1)	17.75^{b}±1.10(24.9)	22.75^{bc}±1.10(28.5)	26.00^{b}±1.68(30.7)	28.00^{c}±1.29(31.9)
Lantana camara	2.25^{b}±0.85(8.6)	7.75^{b}±1.10(16.2)	17.00^{ab}±0.91(24.4)	20.75^{a}±0.75(27.1)	22.75^{b}±0.75(28.5)
Control	16.25^{e}±0.47(23.8)	24.25^{e}±0.85(29.5)	35.75^{d}±1.37(36.7)	43.75^{c}±1.75(41.4)	51.75^{d}±0.85(46.0)

Each value is mean of four replicates. Figures in parantheses are angular transformed values. Means followed by the same letter are not significantly different (P> 0.05) from each other using Duncan's Multiple Range Test

Table 2. Effect of leaf powders on per cent grain weight loss due to *S. oryzae* during five months storage period

Treatment	Per cent grain weight loss				
	1st month	2nd month	3rd month	4th month	5th month
Vitex negundo	0.17^{b}±0.03(2.36)	0.27^{b}±0.03(2.97)	1.41^{b}±0.20(6.81)	2.42^{ab}±0.08(8.94)	3.04^{b}±0.13(10.04)
Adathoda vasica	0.00^{a}±0.00(0.00)	0.00^{a}±0.00(0.00)	1.06^{a}±0.85(5.90)	2.04^{a}±0.19(8.21)	2.43^{a}±0.17(8.96)
Catharanthus roseus	0.42^{c}±0.03(3.71)	0.54^{c}±0.03(4.21)	2.04^{b}±0.19(8.21)	3.35^{b}±0.18(10.54)	3.79^{c}±0.14(11.22)
Lantana camera	0.00^{a}±0.00(0.00)	0.18^{b}±0.02(2.43)	1.23^{a}±0.09(6.36)	2.25^{ab}±0.10(8.62)	2.57^{ab}±0.03(9.22)
Control	0.69^{d}±0.04(4.76)	1.30^{d}±0.01(6.54)	4.01^{c}±0.33(11.55)	5.39^{c}±0.2113.42)	5.95^{d}±0.26(14.11)

Each value is mean of four replicates. Figures in parantheses are angular transformed values. Means followed by the same letter are not significantly different (P> 0.05) from each other using Duncan's Multiple Range Test

has the tendency of blocking the spiracles of the insects thus impairing respiration leading to the death of insect this might contribute for the poor performance of *S.oryzae* on treated grains. Toxicity, either through fumigation or through direct contact is usually the major action of plant powders against adult insect pests in laboratory tests. The multiple effects of the plant leaf powders and their accessibility to farmers particularly in small scale storage system as well as simple technique involved in their application makes suitable for inclusion in integrated pest management programme for storage.

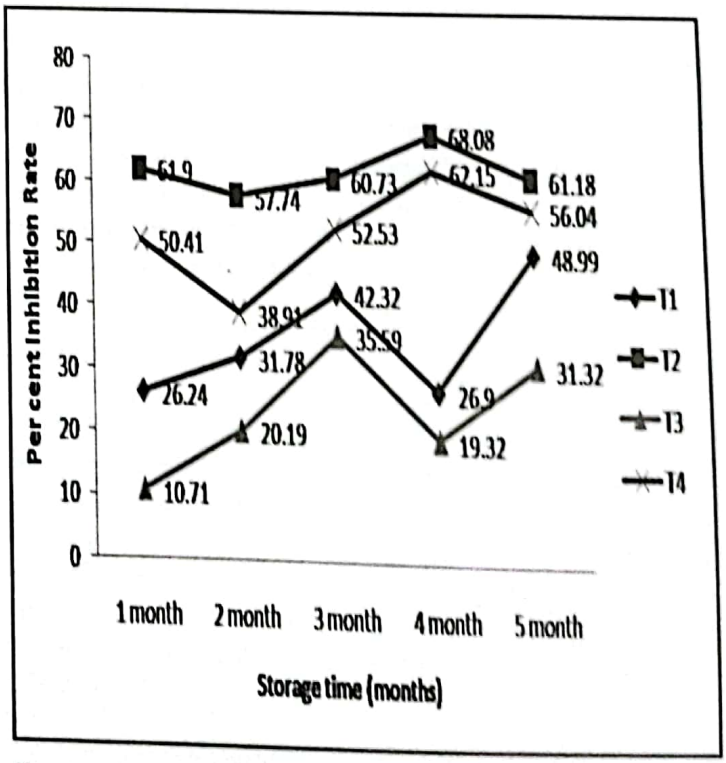

Figure 2. Effect of leaf powders on percent inhibition rate of *Sitophilus oryzae* during five months storage

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