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Botanical management of *Sitophilus oryzae* (L.) in sorghum seeds

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Abstract
Laboratory experiment was conducted to study the efficacy of botanicals against the management of *Sitophilus oryzae* (L.) in sorghum seeds. Leaf powders of *Catharanthus roseus* (Periwinkle), *Vitex negundo* (Nochi), *Calotropis gigantea* (Milkweed), *Azadirachta indica* (Neem), *Annona squamosa* (Custard apple) and *Acorus calamus* TNAU formulation @ 10 ml / kg of seeds were evaluated. Leaf powders at the rate of 10 g/kg of seeds were admixed with 500 g of sorghum seeds. Immediately after treatment and at monthly intervals up to a period of six months, mortality was recorded after 3, 7 and 15 days. Seed damage, weight loss and germination was assessed after six months. Higher mortality of *S. oryzae*, lower seed damage and lower weight loss were observed in *A. calamus* formulation treatment and less than 20.0 per cent mortality in botanical leaf powder treatments.

Keywords: Botanical formulation, *Sitophilus oryzae*, mortality, seed damage, weight loss

Introduction
The rice weevil, *Sitophilus oryzae* (L.) is one of the most critical and pervasive insect, which devastated the storage legumes and cereals (Park *et al.*, 2003) [10]. The weevil causes huge losses to the storage produce even upto 100 per cent (Singh *et al*., 1975) [12]. Essential oils are used against the management of *S. oryzae* (Idouaarame *et al*., 2018) [5]. Pal *et al*., 2018 [9] reported botanical powders are most effective to control rice weevil. To manage this insect, bountiful number of insecticides will pave way to increases the possibility of human illness, detrimental effect to the environment (Prasannath, 2016) [11]. In Nepal, Aluminium phosphide and EDCT mixtures are extensively used chemicals to manage this particular insect (Neupane, 2018) [8]. In addition, the toxic chemicals also affect the stored grains in terms of residues. To avoid the environmental and residual problem, botanical products are the finest solution with traditional storage facilities (Belmain *et al*. 2001) [3]. Kathirvelu and Raja, 2015 [6] stated that bio-fumigants are safer to the human and the environment. The botanicals are not as much of poisonous to humans, easily degradable and ecofriendly (Guzzo *et al*., 2006) [4]. Most of the plant products are acquiring insecticidal and repellent property (Uma Reddy and Shoba Reddy, 1987) [15] without affecting the storage produce and natural ecosystem. Keeping in this view, the present study was planned to know the efficacy of different botanicals against rice weevil.

Materials and Methods
Laboratory experiment was conducted at Agricultural College and Research Institute, Vazhavachanur, Tamil Nadu to study the efficacy of botanicals against the management of *Sitophilus oryzae* (L.) in sorghum seeds. Leaf powders of *Catharanthus roseus* (Periwinkle), *Vitex negundo* (Nochi), *Calotropis gigantea* (Milkweed), *Azadirachta indica* (Neem), *Annona squamosa* (Custard apple) and *Acorus calamus* TNAU formulation @ 10 ml / kg of seeds were evaluated in the study. Untreated check was maintained and each treatment was replicated thrice. Design of the experiment was Completely Randomized Design was followed. A. calamus TNAU formulation was obtained from Department of Agricultural Entomology, TNAU, Coimbatore. Freshly harvested and untreated sorghum seeds were used

for this study. Initial germination percentage of sorghum seeds was recorded. Leaves of the above mentioned botanicals were collected, shade dried, powdered and stored in ambient condition.

Leaf powders at the rate of 10 g / kg of seeds were admixed with 500 g of sorghum seeds. The treatment *Acorus calamus* TNAU formulation @ 10 ml / kg of seed was the check. The treated seeds were placed in a plastic container (1 kg capacity) and stored under ambient condition. Immediately after treatment and at monthly intervals up to a period of six months, 50 g of seeds were taken from each replication, stored in a small container and ten pairs of newly emerged *S. oryzae* adults were released. Immediately after treatment and at monthly intervals up to a period of six months, 50 g of seeds were taken from each replication in a small container, 10 pairs of newly emerged *S. oryzae* adults were released and mortality was recorded after 3, 7 and 15 days. After recording mortality up to 3 months, 50 g seeds was left as such for six months and per cent seed damage and weight loss were assessed. Germination was assessed after six months by taking 100 seeds from each replication of 500 g treated seeds, to know the treatment effect.

Per cent seed damage and weight loss were calculated by using the below mentioned equations.

$$\text{Per cent seed damage} = \frac{\text{Total no. of insect damaged seeds in 50 g sample}}{\text{Total no. of seeds in 50 g sample}} \text{ X } 100$$

Weight loss by Gravimetric or Count and Weigh method (Dick, 1987)

$$\text{Per cent weight loss} = \frac{(U.Nd) - (D.\ Nu)}{U\ (Nd + Nu)} X\ 100$$

Where U= Weight of undamaged seeds in 50 g sample
Nd= Number of damaged seeds in 50 g sample
D= Weight of damaged seeds in 50 g sample
Nu= Number of undamaged seeds in 50 g sample

Results and Discussion

Immediately after treatment, higher mortality of *S. oryzae* was observed in *A. calamus* formulation treatment and less than 20.0 per cent mortality in botanical leaf powder treatments. There was a gradual decline in mortality in *A. calamus* treatment over the storage period and after six months the mortality percentage ranged from 16.0 to 24.0 per cent. The mortality was either less than 5.0 per cent or nil in the botanical leaf powder treatments after four months. After six months of treatment, no live insects were observed in all the treatments baring *A. calamus* treatment. Overall minimum *S. oryzae* population was observed in *A. calamus* treatment. Lesser seed damage and weight loss were observed in *A. calamus* treatment. The germination was above 80.0 per cent in all the treatments which indicates that the leaf powder and *A. calamus* treatment did not have any effect on germination.

Tiwari *et al*. (2018) [14] reported that, *A. Calamus* performed lesser damage against weevil population. In addition, Asawalam *et al*., (2012) [2] stated that, the rhizome powder of *A. Calamus* leads to suffocation of the weevil, in turn it resulted as death of the storage insects were observed. The present study was also in accordance with the earlier studies. In contrast, the adults of *S. oryzae* population were reduced due to the application of basil oil (Lopez *et al*. 2008) [7]. Essential oils are suppressing the activity of *Sitophilus oryzae* (L.) and *Rhiyzopertha dominica* and it serves as an alternative for the chemical insecticides (Abo Arab *et al*., 2022) [1]. Certain plant materials *viz*., pomegranate peel and lemon grass powders (0.1g/100g rice grains) were showed high adult mortalities (Tayeb *et al*., 2018) [13]. The study concluded that, minimum seed damage as well as weight loss against *Acorus calamus* TNAU formulation treatment for the management of rice weevil.

Table 1: Efficacy of botanicals on the mortality of *Sitophilus oryzae*

Treatments	Mortality of *Sitophilus oryzae*							Seed damage (%)	Weight loss (%)	Germination (%)
	IAT	1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT			
T_1 – *Catharanthus roseus* @ 10 g / kg	18.33 (25.31)	16.67 (24.05)	11.67 (19.89)	6.67 (13.25)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	80.0 (63.68)
T_2 – *Vitex negundo* @ 10 g / kg	16.67 (24.05)	5.0 (16.6)	5.0 (11.41)	3.33 (8.06)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	81.0 (64.16)
T_3 – *Calotropis gigantea* @ 10 g / kg	16.67 (24.05)	11.67 (19.89)	1.67 (6.22)	3.33 (9.57)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	81.0 (63.92)
T_4 – *Azadirachta indica* @ 10 g / kg	16.67 (23.85)	11.67 (19.89)	5.0 (16.6)	6.67 (14.76)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	81.0 (63.92)
T_5 – *Annona squamosa* @ 10 g / kg	20.0 (26.45)	13.3 (21.15)	5.0 (16.6)	3.33 (9.57)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	81.0 (63.92)
T_6 – *Acorus calamus* TNAU Formulation @10ml/kg	96.67 (81.95)	93.33 (76.76)	73.33 (59.01)	65.0 (53.76)	55.0 (47.88)	33.7 (34.23)	23.3 (28.86)	3.3 (10.49)	1.0	81.0 (64.16)
T_7 - Control	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	0.0 (2.87)	100.0 (87.14)	#	80.0 (63.68)
S.Ed	3.52	3.52	3.62	4.04	0.89	0.54	0.61	0.28	--	0.52
CD	7.55	7.56	7.76	8.69	1.91	1.17	1.31	0.59	--	1.11

Data presented are mean of three replications
- Unable to assess weight loss because of cake formation and foul smell
IAT – Immediately after treatment; MAT- Months after treatment

Conclusion

Maximum *Sitophilus oryzae* mortality and minimum seed damage & weight loss were observed in *Acorus calamus* TNAU formulation treatment.

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