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Repellency Action of Certain Plant Products Against Rice Weevil, *Sitophilus oryzae* L. (Coleoptera ; Curculionidae) in Milled Rice

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Abstract A study was carried out to find out the repllency action of certain plant products against rice weevil, *Sitophilus oryzae* L. in milled rice during 2015-16. Fifteen different plant products were taken at three different doses in form of leaf powders are @ 1.5%, 2.0% and 2.5% and oils and fruits or seeds @ 0.5%, 1.0% and 1.5%. The result revealed that *Curcuma longa* was the most effective repellent product against the adults of *S. oryzae* in milled rice having mean repellency rate of 60.88% with the repellency class IV followed by *Capsicum annuum* having mean repellency rate of 40.89% with repellency class III. *Nicotiana tabacum* and *Piper nigrum* both in repellency class II with mean repellency rate of 32.88% and 28.43%. The rest other plant products are in repellency class I with varying mean repellency rate.

Keywords Plant products, Repellency, *Sitophilus oryzae* L., Milled rice.

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Introduction

The storage of cereals is a major problem due to attack of number of stored grain insect pests. So there is an urge to protect them qualitative and quantiative losses [1], which is resulted from environmental conditions favoring the feeding and waste materials production by insects, mites, rodents or microorganisms [2]. The post harvest losses by stored insect pests are around 9% in developed countries and 20 % or more in developing countries [3]. It has been reported that more than 1200 species of pests destroy stored products [4]. *Sitophilus oryzae* L. commonly called rice weevil has become primary pest of stored grains of warm climatic areas which causes 18.30% losses to stored grains [5].

The increasing serious problems of resistance and residue to pesticides and contamination of the biosphere associated with large scale use of broad spectrum synthetic pesticides have led to the need for effective biodegradable pesticides with greater selectivity. Plants, due to their co-evolutionary history with pests, are sources of defensive natural insecticides and antimicrobial chemicals compounds which is having repellent, feeding deterrent/ antifeedant and toxicant effect over the insect pests. The repellents are desirable chemicals as they offer protection with minimal impact on the ecosystem and drive away the insect pest from the treated materials by stimulating oil factory or other receptors. Repellents from plant origins are considered safe in

Table 1. List of plant products usd for repellency test.

Treat-ments	Plant spp	Plant part used
T_1	*Aegle marmelos*	Leaf powder
T_2	*Chrysanthemum morifolium*	Leaf powder
T_3	*Ocimum tenuiflorum*	Leaf powder
T_4	*Allium sativum*	Bulb (Cut pieces)
T_5	*Millettia pinnata*	Oil
T_6	*Ricinus communis*	Oil
T_7	*Trigonella foenumgraecum*	Seed powder
T_8	*Curcuma longa*	Rhizome powder
T_9	*Capsicum annuum*	Fruit powder
T_{10}	*Cinnamonum verum*	Bark (Crushed cut pieces)
T_{11}	*Syzygium aromaticum*	Fruit
T_{12}	*Piper nigrum*	Seed powder
T_{13}	*Nicotiana tabacum*	Leaf powder
T_{14}	*Coriandrum sativum*	Crushed seeds
T_{15}	*Eucalyptus globulu*	Oil

pest control; minimise pesticide residue; ensure safety of the people food and environment [6, 7]. The plant extracts, powders and essential oil from the different bioactive plants were reported as repellent against stored grain insect pests. So the present study was carried out to evaluate the repellency action of fifteen plant products against *S. oryzae*.

Materials and Methods

Plant products for repellency test

Fifteen plant species with well established bio-toxicity have been taken in the present study. Different parts of those selected plant materials are given in Table 1.

Preparation of treated rice samples

The OUAT released Jyotirmayee variety of rice was selected for the bioassay test. The leaf powders were taken at 1.5%, 2.0% and 2.5% whereas oils and fruits or seeds were both taken at 0.5%, 1.0% and 1.5% for the study. The treated grains were prepared by mixing the specified dose of plant products to 1kg of milled rice grains and it was kept as such in a flask for 24 h . Then the treated grains were ready for the experiment.

Repellent activity bioassay test

Repellency of different plant products was tested by following the method described by Talukder and Howse [8]. 10 cm diameter petri dishes were divided in to three parts i.e. treated zone,untreated zone and a clearance zone. A space of 2 cm was left in between the treated and untreated zone as clearance zone. In the treated zone 5 g of treated rice samples were kept and in the untreated zone plain milled rice without mixing any plant products were placed. Ten adult weevils were released in each dish at the center of the two zones i.e. in the clearance zone. *S. oryzae* present in each half circle, were counted at hourly intervals up to 5 h after treatment. Data from all treatments was converted to express percentage repulsion (PR) using the following formula :

$$PR\ (\%) = (Nc - 50) \times 2$$

Where Nc is the percentage of beetles present in the control half.

Positive values (+) indicated repellency and negative values (-) attractancy. Five replications were made of each treatment. Mean values were classified according to the following scale by Mc Donald et al. [9].

Class	Repellency rate
0	>0.01 to 0.1
I	0.1 to 20
II	20.1 to 40
III	40.1 to 60
IV	60.1 to 80
V	80.1 to 100

Data obtained from all experiments were subjected to the statistical analysis by ANOVA at appropriate levels of probability (p<- 0.05) to determine differences between means.

Results and Discussion

The result of the repellency rate of the tested plant

Table 2. Repellency action of plant products against adults of *S. oryzae* at different concentrations in milled rice.

Treatments	Conc	Repellency (%) 1h	2h	3h	4h	5h	Mean repellency (%)	Repellency class of individual conc	Mean repellency of treatments (%)	Overall repellency class of treatments
T_1	1.5%	-6.6	-6.6	6.6	13.4	20	5.36	I		
	2%	6.6	0	6.6	13.4	20	9.36	I	10.69^{c}	I
	2.5%	13.4	20	20	13.4	20	17.36	I		
T_2	1.5%	-6.6	-6.6	0	13.4	20	4.04	I		
	2%	6.6	-6.6	-6.6	20	13.4	5.36	I	6.24^{cd}	I
	2.5%	0	6.6	13.4	20	6.6	9.32	I		
T_3	1.5%	-6.6	-6.6	-6.6	13.4	13.4	1.40	I		
	2%	-6.6	13.4	-6.6	6.6	20	5.36	I	4.92^{d}	I
	2.5%	26.6	20	0	0	-6.6	8.00	I		
T_4	0.5%	20	6.6	13.4	6.6	0	9.32	I		
	1.0%	33.4	13.4	6.6	6.6	0	12.00	I	12.89^{c}	I
	1.5%	20	20	20	13.4	13.4	17.36	I		
T_5	0.5%	33.4	13.4	6.6	0	6.6	12.00	I		
	1.0%	13.4	13.4	20	20	20	17.36	I	16.89^{c}	I
	1.5%	33.4	13.4	6.6	6.6	0	21.32	I		
T_6	0.5%	26.6	20.0	-6.6	0	0	8.00			
	1.0%	33.4	13.4	6.6	6.6	0	12.00	I	12.45^{c}	I
	1.5%	20	13.4	20	13.4	20	17.36	I		
T_7	0.5%	0	0	0	0	0	0	I		
	1.0%	-6.6	13.4	13.4	-6.6	-6.6	1.40	I	2.25^{d}	I
	1.5%	6.6	-6.6	20	-6.6	13.4	5.36	I		
T_8	0.5%	73.4	60	66.6	46.6	46.6	58.64	III		
	1.0%	73.4	66.6	60.0	53.4	46.6	60.00	III	60.88^{a}	IV
	1.5%	73.4	60.0	66.6	66.6	53.4	64.00	IV		
T_9	0.5%	46.6	40	33.4	26.6	20	33.32	II		
	1.0%	53.4	46.6	46.6	33.4	33.4	42.68	III	40.89^{ab}	III
	1.5%	53.4	53.4	46.6	46.6	33.4	46.68	III		
T_{10}	0.5%	-6.6	13.4	-6.6	13.4	-6.6	1.40	I		
	1.0%	20	13.4	6.6	0	6.6	9.32	I	9.36^{c}	I
	1.5%	20	13.4	20	20	13.4	17.36	I		
T_{11}	0.5%	13.4	13.4	-6.6	-6.6	-6.6	1.40	I		
	1.0%	26.6	20.0	0	-6.6	0	8.00	I	7.13^{c}	I
	1.5%	33.4	13.4	6.6	6.6	0	12.00	I		
T_{12}	0.5%	26.6	26.6	20	20	13.4	21.32	II		
	1.0%	40	33.4	26.6	20	26.6	29.32	II	28.43^{bc}	II
	1.5%	46.6	40	33.4	26.6	26.6	34.64	II		
T_{13}	1.5%	33.4	33.4	26.6	20	20	26.68	II		
	2%	40.0	46.6	26.6	33.4	26.6	34.64	II	32.88^{b}	II
	2.5%	46.6	40.0	40.0	33.4	26.6	37.32	II		
T_{14}	0.5%	13.4	13.4	-6.6	-6.6	-6.6	1.40	I		
	1.0%	13.4	-6.6	13.4	-6.6	-6.6	1.40	I	1.40^{d}	I
	1.5%	13.4	-6.6	-6.6	-6.6	13.4	1.40	I		
T_{15}	0.5%	6.6	-6.6	-6.6	13.4	20	5.36	I		
	1.0%	13.4	20.0	6.6	6.6	0	9.32	I	8.89^{c}	I
	1.5%	33.4	13.4	6.6	6.6	0	12.0	I		
SEm	–	–	–	–	–	–	–	–	7.96	–
CD (0.05)	–	–	–	–	–	–	–	–	22.99	–

products against *S. oryzae* in milled rice at different concentration at hourly interval has been presented in Table 2. Among all the treatments the 1.5% concentration of *Curcuma longa* was the one with

strongest repellent effect on *S. oryzae* with a mean of 64.00% repellency followed by 1.0% and 0.5% concentration having mean repellency percent of 60.00% and 58.64%. On the basis of this mean repellency percent value the 1.5% concentration of *Curcuma longa* was in repellency class IV whereas the 1.0 and 0.5% concentrations are in class III. All together on an average *Curcuma longa* comes under the repellency class IV having a mean of 60.88% mean repellency rate. It was followed by *capsicum annuum* coming under repellency class III with a mean repellency rate of 40.89%. All the three concentrations of both *Piper nigrum* (0.5%, 1.0% and 1.0%) and *Nicotiana tabacum* (1.5%, 2.0% and 2.5%) having mean repellency rate of 28.43 and 32.88% respectively came under the repellency class II. The rest other treatments came under the class I with varying mean repellency rate.

The repellency result of tested plant products 5 h after treatment showed that *Curcuma longa* was the one with strongest repellency effect against adults of *S. oryzae* in milled rice which may be due to presence of some sesquiterpene ketones in the form of turmerone and α-turmerone that is very pungent and odoriferous [10]. The repellency action of *Piper nigrum* may be due to presence of some secondary metabolites like pipercide, dihydropipercide and guineensine [11]. Ishii et al. [12] reported that extracts of turmeric (*Curcuma longa*) and black pepper (*Piper nigrum*) showed moderate repellent activity at 20 or 50 mg/ml however dry chilli (*Capsicum annuum*) exhibited weak attractant activity @ 50 mg/ ml. He also reported extracts of cinnamon (*Cinnamomum verum*) showed strong repellent activity against *S. zeamais* @ 20 mg/ml which contradicts the present finding that *Cinnamomum verum* showing 9.36% mean repellency rate [12].

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