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Evaluation of some botanicals against *Sitophilus oryzae* (L.) on stored wheat

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ABSTRACT

Amongst the various botanicals tested, against *Sitophilus oryzae* (L.) the higher mean corrected adult mortality of *S. oryzae* was observed with vekhand (30.7%), eucalyptus (29.2%), neem (27.7%) and pongam (27.5%) leaf powders. The mean mortality followed a trend of effectiveness as vekhnad powder> eucalyptus leaf powder> neem leaf powder> pongam leaf powder>tulsi leaf powder>turmeric rhizome powder>garlic clove powder. After 6 months of storage, the highest germination was recorded in eucalyptus leaf powder (69.6%) followed by pongam leaf powder (68.1%). The germination recorded before treatment ranged from 70.8% to 77.5% and the differences were non-significant among different treatments. The loss in germination was highest (20.5%) in treatment of garlic clove powder and lowest in treatment of pongam leaf powder (9.9%).

Key words : Botanicals, efficacy, *Sitophilus oryzae*, seed protectant, wheat.

INTRODUCTION

More than 20,000 species of field and storage pests have been reported to destroy approximately one-third of the world's food production, valued annually at more than $100 billion among which the highest losses (43%) occurring in the developing world (Ahmed and Grainge, 1986; Dubey *et al.*, 2008). Wheat grain is considered as highly vulnerable to insect infestation because it is harvested in midsummer when stored-grain insects have high activity within and outside storage facilities. The damage inflicted by insects not only includes the direct consumption of kernels, but also accumulation of exuviae, webbing, and cadavers. This infestation-induced changes in the storage leads to development of warm moist "hotspots" that provide suitable conditions for storage fungi that cause further losses (Rajashekar *et al.*, 2012). Almost all the insect-pests of stored grains have a remarkably high rate of multiplication, and within one season they may destroy 10-15 per cent of the grains and contaminate the rest with undesirable odours and flavours.

The major primary stored grain pests in wheat are rice weevil, *Sitophilus oryzae* (L.), lesser grain borer, *Rhyzopertha dominica* (F.), and Khapra beetle, *Trogoderma granarium* (Everts). The secondary pests are rust-red flour beetle, *Tribolium castaneum* (Herbst), rusty grain beetle, *Cryptolestes ferrugineus* (L.), saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.). For the control of storage pests, fumigation is still considered as one of the most effective methods for the prevention of damage from storage insect pests. However, repeated use of synthetic insecticides in grain facilities, has led to problems like residual toxicity, pest resistance, environmental pollution and an adverse effect on food besides side effect on humans (Dubey *et al.*, 2007; Kumar, *et al.*, 2007; Rajashekhar *et al.*, 2012). To counter these problems, there is a worldwide drive to develop alternative strategies, including the discovery of newer insecticides which are pest specific, non-phytotoxic, non-toxic to mammals, eco-friendly, less prone to pesticide resistance, relatively less expensive, and locally available (Hermawan *et al.*, 1997).

In this direction, plant derived materials are more readily biodegradable, less likely to contaminate the environment and may be less toxic to mammals. There are large numbers of natural products consisting of different plant parts that have been explored for their insecticidal activities both in field and during storage (Prakash and Rao, 1997).

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But before recommending them for use as seed protectant, it is pertinent to identify their toxicity, persistence and effect on seed germination. With this perspective, the present investigation was carried out to determine the efficacy of few selected botanical materials against the common storage insect pest of wheat, rice weevil, *Sitophilus oryzae* (L.). The findings of the study can be helpful in eco-friendly management of insect-pests without any harmful effect on the environment and will lead pest management strategy that might be compatible with newer pest control approaches.

MATERIALS AND METHODS

The experiments were conducted in Entomology Laboratory of ICAR-Indian Institute of Wheat and Barley Research (IIWBR), Karnal. The cultures of *Sitophilus oryzae* was initially procured from Storage Entomology Laboratory of ICAR-IARI in year 2016 and now are regularly maintained in Entomology laboratory on wheat and barley at ICAR-IIWBR, Karnal. For the experiment, wheat variety DBW 88 was chosen based on its high susceptibility reaction found in varietal resistance studies.

Botanical test materials : Seven different botanical products (Table 1) *viz*., leaf powder of neem (*Azadirachta indica* L.), leaf powder of pongam (*Pongamia pinnata* L.), tulsi (*Ocimum sanctum* Linnaeus) and eucalyptus (*Eucalyptus globules*), powder of turmeric rhizomes (*Curcuma longa* Linnaeus) and garlic cloves (*Allium sativum* Linnaeus), were evaluated @ 10% W/W for their grain protection efficacy based on adult (*S. oryzae*) mortality at different intervals. Leaves, rhizomes and cloves were shade dried for a week and ground into powder with the help of mixer. The powders were stored in airtight plastic containers at room temperature before use. All the experiments were carried out in Completely Randomized Design (CRD) with three repetitions. The grains of wheat were disinfested at 55˚C temperature in an oven for 4 hrs before use.

Bioefficacy evaluation : To evaluate the efficacy of various botanicals against *S. oryzae* based on adult mortality, the wheat, variety DBW 88 (100 gm) were kept in glass jars (10 × 7.0 cm) and 10 gram of each test materials (seed protectant in powder form) were mixed thoroughly manually until the materials were evenly distributed among the grains and it

Table 1. Effectiveness of botanicals against *S. oryzae* during storage of wheat.

Treatment No.	Treatments details	Dosage (%) w/w	Adult mortality (%)					Mean corrected mortality (%)
			4 DAT	7 DAT	15 DAT	30 DAT	60 DAT	
T1	Neem leaves powder	10	36.2	32.7	31.0	23.0	8.1	27.7
	(*Azadirachta indica*)		(35.0)*	(29.3)	(26.6)	(15.4)	(2.0)	(21.6)
T2	Vekhand powder	10	40.5	36.4	32.1	23.8	18.6	30.9
	(*Acorus calamus*)		(42.3)	(35.3)	(28.4)	(16.4)	(10.3)	(26.5)
T3	Tulsi leaf powder	10	34.5	32.8	26.0	21.3	10.7	26.2
	(*Ocimum sanctu*)		(32.2)	(29.4)	(19.3)	(13.3)	(3.5)	(19.5)
T4	Turmeric rhizome powder	10	32.7	29.4	26.6	19.6	11.8	24.9
	(*Curcuma longa*)		(29.3)	(24.2)	(20.1)	(11.3)	(4.2)	(17.8)
T5	Eucalyptus leaf powder	10	38.1	33.4	32.2	25.4	12.3	29.2
	(*Eucalyptus globulus*)		(38.0)	(30.3)	(28.4)	(18.4)	(4.5)	(23.9)
T6	Pongam leaf powder	10	35.82	32.11	30.8	20.7	13.2	27.5
	(*Pongamia pinnata*)		(34.3)	(28.3)	(26.4)	(12.6)	(5.3)	(21.3)
T7	Garlic clove powder	10	32.81	27.44	20.4	17.1	13.1	23.0
	(*Allium sativum*)		(29.4)	(21.2)	(12.3)	(8.7)	(5.2)	(15.3)
		SEm±	0.74	0.85	0.82	0.64	0.47	0.99
		CD at 5%	2.49	2.51	2.45	1.99	1.52	2.35
		CV (%)	5.58	7.25	9.25	8.32	9.32	-

*Figures in parentheses retransformed values, those outside are arc sine transformed values

was considered as one repetition. Four repetitions were maintained in each case. Twenty adults (2 to 3 days old) of *S. oryzae* obtained from laboratory culture were released into each of the jar at an interval of 4, 7, 15, 30 and 60 days of treatment. The jars were covered with two-fold muslin cloth and tied with rubber band to ensure ventilation and prevent escape of adults. The observations on number of dead adults were made after 48 hours of release of adults at each interval. Insects showing movement of legs and antennae were considered as alive. The percentage mortality of the adults was corrected by using following formula given by Abbott's (1925) and then subjected to ANOVA after transforming them to arc sine and then analyzed statistically.

Seed germination : To study the effect of botanicals on seed germination, three samples (one sample as one replication) of wheat grains (100 seeds) were drawn from each treatment. The evaluation was carried out on circular Whatman no. 1 filter paper kept in Petri-plates by standard germination test in a seed germinator. The number of grains germinated was counted after 7 days of incubation and the percentage germination calculated. Based on per cent germination before seed treatment, per cent loss in germination was worked out.

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total of number of seeds kept}} \times 100$$

RESULTS AND DISCUSSION

The data indicated in Table 1 revealed that after 4 days after treatment, vekhnad powder @ 10% W/W recorded significantly highest mortality of rice weevil i.e. 40.5% followed by treatment of eucalyptus leaf powder @ 10% w/w (38.1%) and neem leaf powder @ 10% w/w (36.2%). The lowest mortality was recorded in treatment of garlic clove powder (32.8%) and turmeric rhizome powder (32.7%). After 7 days of treatment, the highest mortality of 36.4% was observed in vekhnad powder @ 10% w/w followed by eucalyptus leaf powder @ 10% w/w (33.4%) and tulsi leaf powder @ 10% w/w (32.8%). After 15 days of treatment, the efficacy of four treatments; eucalyptus leaf powder, vekhnad powder, neem leaf powder and pongam leaf powder was significantly at par with each other against *S. oryzae* with respective mortalities as 30.8, 32.1, 31.0 and 30.8%. Similar trends of efficacy were recorded after 30 and 60 days after treatment. The mean corrected mortality followed a trend of effectiveness as vekhnad powder > eucalyptus leaf powder > neem leaf powder > pongam leaf powder > tulsi leaf powder > turmeric rhizome powder > garlic clove powder. Except treatment of garlic clove powder, the mean corrected mortality of each treatment was significantly similar to each other (Table 1).The data on germination percentage in Table 2 indicated highest germination in treatment of eucalyptus leaf powder (69.6%) followed by pongam leaf powder (68.1%) after 60 days of treatment. The germination recorded before treatment ranged from 70.8% to 77.5% and the differences were non-significant among different treatments. The loss in germination was highest (20.5%) in treatment of garlic clove powder and lowest in treatment of pongam leaf powder (9.9%).

The present finding on efficacy of few selected botanical material reveals that leaf powder formulations of vekhnad, eucalyptus, neem and pongam were quite effective for providing protection against *S. oryzae* in wheat during storage upto 60 days period. These results are similar with the findings of other workers. The insecticidal activity of many plant derivatives against cereal stored product pests has been reported by several scientists (Rao and Sarangi, 1998; Weaver and Subramanyam, 2003; Rao *et al.*, 2004). Ethanol extracts of Eucalyptus, Lantana, Neem and Pawpaw leaves was also most effective against stored grain pests; *S. oryzae* and *S. zeamays* (Mulungu *et al.*, 2007). Seed treatment with Vekhand powder @ 10 g/kg seed was found most effective and promising in reducing the per cent grain weevil (*S. oryzae*) population (99.21%) in stored wheat (Patil *et al.,* 2014). Neem Azal formulation of neem caused 100% mortality to *S. oryzae* adults at rates 100 and 200 ppm in rye and oats after 7 or 14 days. It also reduced significantly the progeny production of *Rhizopertha dominica* (F.) *S. oryzae* and *Tribolium confusum* in rye, oats, wheat and maize (Athanassiou *et al.*, 2005; Kavallieratos *et al.*, 2007). Oikos 32 EC (3.2% azadirachtin), another formulation of neem caused a reduction in progeny production of *S. oryzae* in wheat and maize, although not complete suppression (Kavallieratos *et al.*, 2007). Khoshnoud and Khayamy (2008) evaluated the insecticidal and progeny production effect of ethanol extract of *Verbascum cheiranthifoliun* against *S. oryzae* and

Table 2. Effect of botanicals on germination of wheat (Variety DBW 88).

Treatment no.	Treatments details	Dosage (%) w/w	Germination (%)		Loss in germination (%)
			Before	60 DAT	
T1	Neem leaves powder	10	72.6	66.0	18.5
	(*Azadirachta indica*)		(91.0)*	(83.5)	(0.7)
T2	Vekhand powder	10	77.4	67.5	9.9
	(*Acorus calamus*)		(95.2)	(85.4)	(5.6)
T3	Tulsi leaf powder	10	73.6	66.8	17.2
	(*Ocimum sanctu*)		(92.0)	(84.5)	(0.2)
T4	Turmeric rhizome powder	10	71.8	65.4	19.4
	(*Curcuma longa*)		(90.2)	(82.7)	(1.5)
T5	Eucalyptus leaf powder	10	77.5	64.7	12.3
	(*Eucalyptus globulus*)	10	(95.3)	(81.7)	(3.2)
T6	Pongam leaf powder		76.1	68.6	14.1
	(*Pongamia pinnata*)	10	(94.2)	(86.7)	(2.2)
T7	Garlic clove powder	10	70.8	69.6	20.5
	(*Allium sativum*)		(89.2)	(87.8)	(2.4)
		SEm±	1.26	2.29	0.96
		CD at 5%	NS	4.55	1.23
		CV (%)	10.23	12.23	7.85

*Figures in parentheses retransformed values, those outside are arc sine transformed values

T. castineum, and observed significant mortality and suppression of progeny production. Akob and Ewete (2009) found that the ethanolic extracts of *Ocimum gratissimum* and *Eucalyptus grandis* leaves had significant toxicity against *S. zeamais.*

The present findings suggest that the leaves of these plants possess certain bioactive components which require further investigation to determine the exact mode of action of these active components and their effect on non-target organisms.

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