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Evaluation of various plant products against angoumois grain moth, *sitotroga cerealella* olivier on stored rice

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ABSTRACT

Rice is one of the most important crops of the world. During storage, rice is attacked by insect pests and causes economic losses. Angoumois grain moth, Sitotroga cerealella Oliveris one of the important insect pest during storage. The management of this pest depends on chemical pesticides which have many ill effects. Plant products play an important role in the management of stored grain pests. The results of present experiment on the evaluation of leaf powders showed that all the powders were found effective in reducing pest infestation over control. The neem leaf powder @5g/kg was found most effective and was followed by neem kernel powder 5g/kg, and karanj leaf powder 5g/kg as it causes higher mortality, less weight loss, and less adult emergence.

Keywords: *Angoumois grain moth, Sitotroga cerealella, plant products, rice, storage*

INTRODUCTION

Rice (*Oryza sativa*) is the most important cereal food crop in India. It occupies about 23.3 per cent of the gross cropped area of the country. It plays a vital role in the national food grain supply and food security. Food grains after harvest are stored for shorter or longer periods in different traditional and primitive storage structures, where colossal losses occur both in terms of quality and quantity. Certain abiotic and biotic factors are responsible for such storage losses. Amongst abiotic factors, temperature, grain moisture, and relative humidity are responsible for such losses. Insects, rodents, birds and microorganisms are the biotic factors causing enormous losses in stored food grains. Insects, infest the crop and cause damage both in the field and in storage [1]. In India, according to an expert committee 9.33 per cent of the total food grains produced are lost during post-harvest operations, of which 1.68 per cent is at the threshing yard, 0.15 per cent in transport, 0.92 per cent in processing and 6.58 per cent in storage. In India, the annual storage losses were estimated as 14 million tonnes of food grains worth $16,000 million every year. Out of this, food grain losses due to insects alone account for a monetary loss of $300 million [2]. During storage, paddy is highly vulnerable to infestation by a variety of insect pests. Among seventeen species of insect pests reported so far infesting stored rice, Angoumois grain moth (*Sitotroga cerealella* Olivier) is of major significance in India [3]. This pest is often placed at the top of the list as a major insect pest of stored rice. This pest is not only infests the grains in storage but also in field conditions, which enhances its ability to damage more [4]. The pest is so destructive that one gravid female can completely destroy 50 grams of paddy in storage within three subsequent generations [5]. The chemical control method has got great value for the management of Angoumois grain moth in storage. Several reports are available on the efficacy of different chemicals [6] to reduce this insect. But the use of chemical insecticides against the attack of paddy insect pests in storage may cause serious health hazards. The residues of the chemical insecticides remain in the stored grain and also in the environment. Moreover, serious environmental imbalance results due to the development of resistance in pest population and subsequent resurgence as well as the destruction of beneficial insects. Hence, search for the alternative method of Angoumois grain moth control utilizing some non-toxic, environment-friendly and human health hazard-free methods are being pursued nowadays. Most of the farmers store small quantities of edible rice and cannot practice expensive control measures. Therefore, they essentially need some cheap, easy-to-use, readily available but effective methods for safe storing of rice. Plant products are liberally available as indigenous sources of insecticides and insect repellents have been in use for more than one century. The insecticidal property is not very quick as compared to that of synthetic insecticides and fumigants. The plant products certainly possess surface persistence for a long period, have the least or no adverse effect on the germination ability of seed, cooking quality and milling, are easily available with less cost and some of the products like natural pyrethrums have rapid killing action[7]. A number of plant products have been reported as being in use against insect pests in stored grains including rice to minimize storage losses due to insects [8]. With a view to the above aspects, the experiment was conducted to assess the effectiveness of various plant products against Angoumois grain moth, *S. cerealella* in stored rice.

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MATERIALS AND METHODS

This experiment was conducted to evaluate the efficacy of some promising botanicals applied against Angoumois grain moth, S. cerealella infesting stored rice in laboratory condition. The experiment was laid out in the ambient condition in the laboratory in a completely randomized design and the treatments were repeated three times. Collected rice grains were sun-dried on the cemented floor for three consecutive days in the month of May. The rice grains were kept treatment-wise in plastic jars maintaining one kilogram per jar and the jars were kept in ambient room temperature in the post-graduate research laboratory under the Department of Entomology of N.M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India. The details of various plant product treatments were presented in Table 1.

Table 1: Details of different plant products used against S. cerealella

Tr. No.	Common Name	Scientificname	Plantpartused as powder	Dosage g/ kg
T_1	Neem	*Azadirachta indica* (A.Juss)	Leaves(50meshsieved)	5.0
T_2	Karanj	*Pondamia pinnata* L.	Leaves(50meshsieved)	5.0
T_3	Tulsi	*Oscimum basilicum* L.	Leaves(50meshsieved)	5.0
T_4	Blackpepper	*Piper nigrum* L.	Seed(50meshsieved)	2.0
T_5	Neem	*A. indica*	Kernel(50meshsieved)	2.5
T_6	Garlic	*Allium sativum* L.	Clove(50meshsieved)	2.0
T_7	Onion	*Allium cepa* L.	Bulb(50neshsieved)	2.0
T_8	Turmeric	*Curcuma longa* L.	Rhizome(50meshsieved)	2.0
T_9	Mahua	*Madhuca longifolia* (L.) J.F.Macbr.	Leaves(50meshsieved)	5.0
T_{10}	Control	--	--	--

Procedure for the preparation of powders: The leaves of neem, karanj, tulsi and mahua free from pesticides application were collected from college farm and turmeric rhizomes, seeds of black pepper and neem, bulb of onion, cloves of garlic were purchased from local market.The plant materials were washed under tap water and cut into small pieces and dried for a week under shade.Thereafter, grind into fine powder with the help of the electric mixer grinder.

To evaluate the efficacy of different botanicals against Angoumois grain moth, *S. cerealella*, 1.0kg sterilized grains of paddy were treated by mixing with the powders of various plants thoroughly at above-mentioned dosages with 5ml acetone in such a way to get uniform coating and placed in transparent plastic jars. 100 adults were released in each treatment to study their efficacy against *S. cerealella* at 7, 14, 21 and 28 days after treatment. Observation on mortality was recorded at respective days, while after two months of infestation, weight loss and adult emergence were recorded. Observations on residual toxicity were recorded after 2 and 15 days and thereafter at an interval of one month to a period of six months.The mortality counts were recorded after 72 hours of release at each interval. Aside from the dead, a moribund insect was also considered dead. The morality of adults was corrected using the formula [9].

$$\text{Per cent corrected mortality } \frac{\text{Mortality in treatment } - \text{Mortality in control}}{100 - \text{Mortality in control}} \times 100$$

The adults were removed from the sample after two months, and the damaged and healthy grains were weighed with an electric balance and the weight loss was calculated [10].Mean number of adults emerged from each repetitions were recorded after 60 days of imposing treatments. The grains were examined after 60 days of treatment to study the effect on first generation.

RESULTS AND DISCUSSION

The data in terms of per cent corrected mortality, weight loss, and adult emergence are presented Table 2. The data on corrected per cent mortality, weight loss and adult emergence indicated that in the year 2021-22 all the plant powders were found superior in preventing pest damage. On the basis of cumulative corrected mortality, the neem leaf powder recorded highest mortality of *S. cerealella* adult after 7, 14, 21 and 28 days (63.75,65.69, 70.04 and 76.05%) and was significantly superior over rest of the treatments. The treatment neem kernel powder was found next as it causes 56.99, 60.01, 61.12 and 68.04 per cent mortality after 7, 14, 21, and 28-day days, respectively. Regarding per cent weight loss, the treatment neem leaf powder (5g/kg) recorded the lowest weight loss (9.63%) and was significantly superior over the rest of the treatments. The maximum weight loss was recorded in the control (35.98%). The maximum number of adult emergence was also recorded in the control (91.67adults) whereas the lowest number of adult emergence i.e. 33.33 adults was noticed in neem leaf powder.

All the plant powders were found superior over control in preventing pest damage during the year 2022-23 (Table 1). On the basis of corrected per cent mortality, the treatment comprises of neem leaf powder (5g/kg) recorded highest adult mortality of *S. cerealella* after 7, 14, 21 and 28 days (65.53,73.31, 80.41 and 85.50%)and was significantly superior over rest of the treatments. The treatment neem kernel powder (2.5g/kg) was found second most effective treatment against *S. cerealella* with 58.47, 63.34, 66.28 and 77.03 per cent mortality after 7, 14,

21 and 28 days. The lowest weight loss was recorded in neem leaf powder (5g/kg and was significantly superior over the rest of the treatment, however, it was followed by neem kernel powder (13.59%). The maximum weight loss was recorded in control (48.88%). The maximum number of adult emergence was recorded in control (93.00adults), whereas the neem leaf powder recorded the lowest number of adult emergence (32.00 adults).

The two years of pooled data showed that all the plant products were superior over control in preventing pest damage (Table 2). On the basis of cumulative corrected mortality, the treatment neem leaf powder (5g/kg) recorded maximum mortality of *S. cerealella* after 7, 14, 21, and 28 days (64.64, 69.45, 75.22, and 80.77%)and was found significantly superior over rest of the treatments and at par with treatment neem kernel powder after 28th day. The treatment of neem kernel powder was found second best in the managing *S. cerealella*and was at par with the treatment of karanj leaf powder. The lowest weight loss was recorded in the treatment of neem leaf powder (5g/kg) (9.63%). The maximum weight loss was recorded in the control (42.43%). Further, the maximum number of adult emergence was noticed in the control (92.33adults) whereas, the lowest number of adult emergence was recorded in neem leaf powder (5g/kg)(32.67 adults).It is observed from data that, all the treatments protect the grain against *S. cerealella* over control. On the basis of cumulative corrected mortality, the treatment neem leaf powder recorded maximum mortality of *S. cerealella* after 7, 14, 21, and 28 days and was significantly superior over rest of the treatments and at par with neem kernel powder (5g/kg) after 21 and 28 days (Table 2).The treatment comprises karanj leaf powder also protects the grain against *S. cerealella* up to 28 days but it was at par with mahualeafpowder till 14 days.

The neem leaf powder was found effective against *S. cerealella* [11]. Neem kernel powder when admixed to the wheat gave effective protection from infestation of stored grain pestsand found a good source to protectant the cereal grains for prolonged periods because it has adverse effects on egg hatching and adult mortality [12 and 13]. Dried neem leaf powder @ 5 gm/kg paddy reduced the highest grain infestation by number (72.77%) and weight (62.07%), respectively, and also considered the most economic tool and provided the highest (11.65) benefit-cost ratio than other plant products [14].It was reported that when mixed with stored grains, leaf, neem seed powder, or oil extracts of plants reduced oviposition rate and suppress adult emergence of bruchids, and also reduced seed damage rate [15]. The efficacy of plant materials like *Mentha crispate*, *O.gratissimum*, *Artemisia absinthium* and *Curcuma longa* were evaluated. The survival rate of *S. cerealella* was significantly affected by *M. crispate*, *A. absinthium,* and *C. longa*. Moreover, *O. gratissimum*treatment significantly reduced the fecundity and the hatchability of *S. cerealella*[16]. The present findings are in agreement with earlier reports which suggest minimum grain damage by *S. cerealella* when mixed with neem kernel powder [17].

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

Table 2: Effect of various plant powder on the damage of S. cerealella

Treatments	Cumulative per cent corrected Mortality																	
	Year 2021-23						Year 2322-23								Pooled			
	7th Day	14th Day	21th Day	28th day	Weight loss	Adult Emergence	7th Day	14th Day	21th Day	28th day	Weight loss	Adult Emergence	7th Day	14th Day	21th Day	28th day	Weight loss	Adult Emergence
Neem leaf powder (5g/kg)	52.99 (63.75)	54.09 (65.59)	56.81 (70.04)	60.70 (76.05)	18.08 (9.63)	33.33	54.06 (65.53)	58.91 (73.31)	63.76 (80.41)	67.62 (85.50)	18.08 (9.63)	32.00	53.52 (64.64)	56.50 (69.45)	57.86 (75.22)	62.23 (80.77)	18.08 (9.63)	32.67
Karanj leaf powder (5g/kg)	43.16 (46.79)	45.00 (50.00)	46.04 (59.93)	48.36 (55.82)	(24.13 (16.72)	41.67	44.68 (49.44)	46.54 (52.69)	51.70 (59.23)	52.24 (62.50)	23.08 (15.37)	40.33	43.92 (48.11)	45.77 (51.34)	46.28 (56.70)	50.03 (59.16)	23.60 (16.04)	41.00
Tulsi leaf powder (5g/kg)	30.68 (26.03)	26.84 (20.40)	23.73 (16.19)	17.64 (9.23)	27.67 (21.56)	54.00	32.00 (28.09)	32.11 (28.25)	29.01 (23.53)	25.49 (18.53)	27.64 (21.52)	53.00	31.34 (27.06)	29.47 (24.32)	27.91 (19.86)	23.32 (13.88)	27.65 (21.54)	53.50
Black pepper powder (2g/kg)	39.68 (40.77)	36.87 (36.01)	34.69 (32.43)	31.13 (26.86)	26.16 (19.44)	61.67	39.93 (41.21)	39.04 (39.68)	33.09 (29.80)	21.57 (13.69)	26.15 (19.43)	60.33	39.81 (40.99)	37.96 (37.85)	36.86 (31.12)	32.11 (20.28)	26.15 (19.43)	61.00
Neem kernel powder (2.5g/kg)	49.04 (56.99)	50.78 (60.01)	61.12(51.43_	55.59 (68.04)	21.65 (13.70)	37.00	49.91 (58.47)	52.75 (63.34)	59.17 (66.28)	61.36 (77.03)	21.56 (13.59)	36.00	49.47 (57.73)	51.76 (61.68)	52.08 (67.42)	57.38 (72.54)	21.60 (13.64)	36.50
Garlic (2g/kg)	28.39 (22.62)	21.61 (13.59)	19.65 (11.33)	17.78 (9.64)	28.28 (22.46)	64.00	23.03 (15.34)	24.09 (16.77)	21.28 (13.31)	18.10 (9.66)	28.46 (22.73)	63.00	25.71 (18.98)	22.85 (15.18)	21.86 (12.32)	19.53 (9.65)	28.37 (22.59)	63.50
Onion (2g/kg)	25.38 (18.44)	19.75 (11.57)	17.82 (9.68)	17.78 (9.64)	27.37 (21.13)	55.67	29.44 (24.33)	24.64 (17.52)	26.47 (20.04)	21.38 (13.30)	27.40 (21.18)	53.67	27.41 (21.39)	22.19 (14.54)	21.22 (14.86)	22.13 (11.47)	27.38 (21.15)	54.67
Turmeric (2g/kg)	26.81 (20.42)	20.14 (11.98)	18.93 (10.53)	15.01 (6.72)	24.52 (17.22)	58.00	27.87 (22.10)	26.18 (19.48)	24.99 (18.06)	21.00 (12.91)	24.55 (17.26)	57.00	27.34 (21.26)	23.16 (15.73)	22.55 (14.30)	20.00 (9.81)	24.53 (17.24)	57.50
Mahua leaf powder (5g/kg)	36.57 (35.53)	35.67 (34.00)	39.03 (39.66)	46.92 (53.34)	22.78 (14.99)	48.33	37.94 (37.83)	37.94 (37.80)	40.14 (38.44)	48.71 (56.45)	22.80 (15.02)	47.00	37.25 (36.68)	36.80 (35.90)	38.48 (40.61)	43.53 (54.90)	22.78 (15.00)	47.67
Control	0.81 (0.00)	0.81 (0.00)	0.81 (0.00)	0.81 (0.00)	36.85 (35.98)	91.67	(0.00) 0.81	0.81 (0.00)	0.81 (0.00)	0.81 (0.00)	44.36 (48.88)	93.00	0.81 (0.00)	0.81 (0.00)	0.81 (0.00)	0.81 (0.00)	40.60 42.43)	92.33
S Em±	1.10	0.91	1.55	1.72	0.56	0.82	1.52	0.97	1.24	0.84	0.67	0.75	0.94	0.98	1.66	2.64	1.21	0.56
CD at 5%	3.26	2.69	4.58	5.07	1.65	2.41	4.47	2.86	3.65	2.49	1.96	2.22	2.68	3.14	5.32	8.43	3.89	1.59
CV (%)	5.74	5.08	7.40	7.89	3.75	2.59	7.73	4.89	6.12	4.32	4.37	2.44	6.82	4.98	5.12	7.38	4.08	2.52

Figures in parenthesis are retransformed values, those outside are angular transformed values.

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