

Original Research Article

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## Evaluation of Efficacy of Different Grain Protectants against *Sitophilus oryzae* Infesting Paddy, Wheat and Maize Grains

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### ABSTRACT

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The efficacy of sixteen grain protectants @ 5% was compared against *Sitophilus oryzae* in storage. Adult weevils were exposed to the paddy, wheat and maize grains treated with the protectants. The mortality was recorded at 1, 2, 7, 14, 21 and 28 days of exposure. Subsequently, all adults were removed and the treated grains remained at the same condition for 56 days. After this interval, the F1 adult female progeny was counted. The protectants caused equally higher insect mortality on paddy and maize grain at 1 day of application. At 28 days mortality was highest in paddy grains. The protectants like camphor, coconut oil and malathion 50 EC caused complete mortality of the insect in 7 days of treatment. The inhibition rate was highest with camphor; cow dung ash and clove oil indicate lower level of F1 female. The rate was lowest on custard apple and nishinda leaf powder suggesting higher F1 adult progeny. The seed weight loss was highest in wheat. The seed weight loss was highest with custard apple and bay leaf powder and lowest on malathion 50 EC, camphor, coconut oil and tobacco leaf powder. The weight loss was moderate with karanja and neem leaf powder.

### Introduction

In India, in the years of 2010-2011, food grain production attained 250 mT, and insect pests caused nearly 20-25% damage of the grains (Nattudurai *et al.*, 2015). Seventy percent of the insect infesting stored grains are Coleopterans and the most damaging species of storage insect are in the genera *Sitophilus* and *Tribolium* (Khan and Suleman, 1988; Pinto *et al.*, 1997). *Sitophilus oryzae* (L.) has become primary pest of stored grains of warm

climatic conditions. Females oviposit directly into the seeds and development was completed inside the seeds and emerged as adults. Weight loss of paddy grain, after 20 days of *Sitophilus* infestation, was found to be the 20-29.27% in different rice cultivars (Das Choudhury and Chakraborty, 2014). In stored maize, heavy infestation of weevil caused 30-40% weight loss (Paneru *et al.*, 1996). Wheat and polished rice was found most preferred host and loss recorded up to 42.00% on number basis by Sharma *et al.*, (2016).

To control this pest, synthetic insecticides are being used during storage of grains. Common use of chemical agents, namely synthetic insecticides and fumigants, in the control of insect storage pests, resulted in serious problems such as development of insect resistance to insecticides (Zettler and Cuperus, 1990; Pereira *et al.*, 1997; Ribeiro *et al.*, 2003; Athie and Mills, 2005; Lorini *et al.*, 2007), presence of toxic residues, harmful for the consumers, in food as well as increasing costs of agents application (Sighamony *et al.*, 1990).

Moreover, *S. oryzae* became resistance to synthetic insecticides (Benhalima *et al.*, 2004). For the above reasons, integrated pest management (IPM), taking advantage primarily of natural factors in prevention and control of storage pests, has become more popular.

The farmers in North Bengal are mainly dominated by resource-poor small and marginal (88%) one. They are not capable of procuring costly seeds from private agencies. They are forced to store their seeds by their own rather to opt for buying it. Protection of seeds from insect damage in storage is most important factor which not only minimizes the cost of cultivation, but also ensures timely sowing for good vigor, producing higher yield. The plant derived chemicals have been used as potential seed protectant often begins with the screening of plant extracts (Pavela, 2007).

Research related to seed storage considering present awareness towards health hazard due to application of highly persistent insecticides and their effect on seed viability and overall health have been severely ignored. Moreover, no systematic work has been conducted on insect-pests in storage and their management for high humid, prolong rainy season and cloudy climate of terai, West Bengal, India. With view to find out safe and organic grain

protectants, present investigation was taken up to evaluate the different grain protectants available locally for their ability to protect paddy, wheat and maize grains in storage against Rice Weevil.

## **Materials and Methods**

The experiment was carried out during Kharif season 2016.

### **Collection of grains**

Grains were collected from the Farm, UBKV, Pundibari, Cooch Behar and Department of Seed Science and Technology, UBKV, Pundibari, Cooch Behar. The grains of test varieties were thoroughly cleaned to remove dirt and inert matter. They were disinfected in hot air oven at 60<sup>0</sup>C for 2 h and stored in plastic jars under laboratory conditions.

### **Maintenance of stock culture**

The infected grains of paddy, wheat and maize were collected from the local sources. The grains were kept in the laboratory for the emergence of the test insect *Sitophilus oryzae*. After emergence the insects were transferred to the respective grains. The stock culture of the test insect was then maintained in different grains.

### **Grain protectants**

Leaves of neem (T1), nishinda (T2), bay leaf (T3), karanja (T4), tobacco (T5), and custard apple (T6) were Collected and washed with distilled water and sun dried for six days and powdered in grinder and stored in plastic jars. Dry chillies (T7) and turmeric rhizome (T8) were also sun dried and stored. Clove oil (T12), citronelle oil (T13), coconut oil (T14), camphor (T11), azadirachtin (T15) (commercial grade) and malathion 50 EC (T16) were purchased from the market. Cow

dung ash (T9) and sand (T10) were sun dried and stored. The untreated control was the 17<sup>th</sup> treatment.

### Procedure

To evaluate the efficacy of different grain protectants collected from locally available sources against *Sitophilus oryzae* infesting paddy, wheat and maize grains in stored condition, 100 grams of paddy grains were taken in plastic jars. 10 pairs of *Sitophilus oryzae* adults were released in the grains treated with the seed protectants @ 5%. Seed protectants T1-T11 were applied directly, T12-T14 was diluted into acetone and T15-T16 was diluted into water for application.

The experiment was conducted in a completely randomized block design with each treatment replicated three times.

### Observations were taken as follows

To estimate mortality, the number of dead insects in each treatment was counted at 1, 2, 7, 14, 21 and 28 days after treatment. % reduction in *Sitophilus* population over control was worked out using Henderson and Tilton Formula (1955):

$$\text{Corrected \% of Insect Population reduction} = \left(1 - \frac{n \text{ in Co before treatment} \times n \text{ in T after treatment}}{n \text{ in Co after treatment} \times n \text{ in T before treatment}}\right) \times 100$$

Where, n =insect population; T = Treated; Co = Control

Weight loss was calculated as the difference between the final and initial weights of treated or untreated grain after 56 days of treatment, and expressed as a percentage of initial weight of grains. The following equation was used:

$$\% WL = (IW - FW) \times 100 / IW$$

Where, WL: Weight loss, IW: Initial weight and FW is the final weight

The number of F1 female emerged were counted from day 35 to 49 after the treatment and based on that Inhibition rate was calculated as  $[(Cn - Tn) / Cn] \times 100$  (where Cn = Number of insects in control, Tn = Number of insects in treatments)

### Statistical analysis

SAS software (Ver 9.2) was used for data analysis. Two way anova was performed for each of the parameters and separation of the means was done using the Least Significant Difference (LSD) test at 5% significant level.

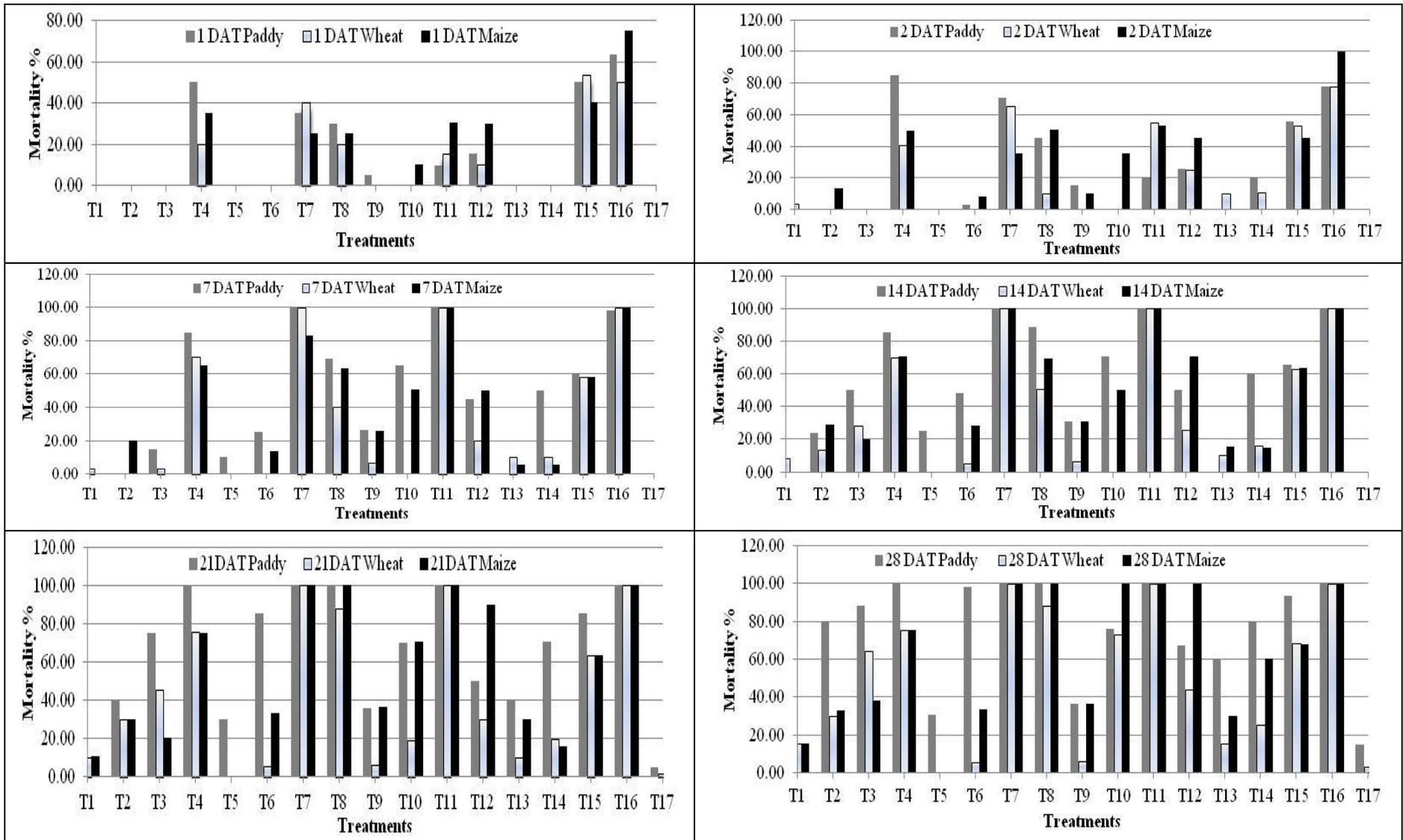
### Results and Discussion

The data regarding the effect of the different grain protectants on population mortality in different days of treatment, weight loss of different grains, inhibition rate of F1 female adult population are given in figure 1 and table 1-3.

The mortality of the test insect *Sitophilus oryzae* varied significantly in different grains and grain protectants in all the days of observation. Loss of activity of the test insect *i.e.* mortality was greater on paddy grains than on wheat and maize (Figure 1 and Table 1) and so relative potencies on wheat and maize in comparison with paddy were larger.

The mortality was ranged from 0.00-63.32%, 0.00-53.42% and 0.00-75.12% in paddy, wheat and maize in all the treatments after 1 day of treatment. It was 1.71-62.85% on sand, citronella, tobacco, camphor, cow dung ash, coconut oil, clove oil, azadirachtin and malathion treated grains. No mortality was found in other treatments.

Fig.1 Efficacy of different grain protectants on the mortality per cent of *Sitophilus oryzae* infesting paddy, wheat and maize



DAT= Days after treatment

**Table.1** Interaction of efficacy of different grain protectants on the mortality of *Sitophilus oryzae* infesting paddy, wheat and maize grains

Parameters	Mortality%											
	1 DAT		2 DAT		7 DAT		14 DAT		21 DAT		28 DAT	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Grain (G)	579.63	<.0001	1398.68	<.0001	10188.9	<.0001	20423.7	<.0001	20598.8	<.0001	17036.8	<.0001
Protectant (P)	11317.6	<.0001	20097.0	<.0001	38127.4	<.0001	38013.9	<.0001	20139.0	<.0001	13634.4	<.0001
G x P	419.34	<.0001	1578.71	<.0001	1478.20	<.0001	2159.36	<.0001	1939.50	<.0001	1499.50	<.0001

**Table.2** Efficacy of different grain protectants on the inhibition rate of *Sitophilus oryzae* and seed weight loss% of paddy, wheat and maize grains

Treatments	Inhibition %			% Seed wt loss				Mean
	Paddy	Wheat	Maize	Mean	Paddy	Wheat	Maize	
T1=Neem	98.47 (82.89)	56.68 (48.84)	93.66 (75.42)	<b>82.94i</b> <b>(65.60)</b>	6.00 (14.18)	12.50 (20.70)	9.51 (17.96)	<b>9.34g</b> <b>(17.79)</b>
T2=Nishinda	97.71 (81.30)	40.60 (39.58)	90.63 (72.18)	<b>76.31m</b> <b>(60.88)</b>	5.82 (13.96)	12.02 (20.29)	11.94 (20.21)	<b>9.93ef (18.36)</b>
T13=Bay leaf	98.47 (82.89)	79.56 (63.12)	93.11 (74.78)	<b>90.38g</b> <b>(71.93)</b>	6.45 (14.71)	13.12 (21.24)	9.24 (17.70)	<b>9.60fg</b> <b>(18.05)</b>
T3=Karanja	97.33 (80.60)	86.38 (68.34)	58.67 (49.99)	<b>80.79k</b> <b>(64.01)</b>	7.54 (15.94)	13.64 (21.67)	15.42 (23.12)	<b>12.20b</b> <b>(20.44)</b>
T4=Tobacco	99.24 (85.00)	89.92 (71.49)	98.62 (83.25)	<b>95.93e</b> <b>(78.36)</b>	3.21 (10.32)	8.45 (16.90)	4.81 (12.67)	<b>5.49k</b> <b>(13.55)</b>
T5=Custard Apple	85.50 (67.62)	46.60 (43.05)	92.29 (73.88)	<b>74.80n</b> <b>(59.87)</b>	9.15 (17.61)	15.12 (22.88)	13.25 (21.35)	<b>12.51b</b> <b>(20.71)</b>
T6=Dry chillies	98.85 (83.84)	54.72 (47.71)	85.13 (67.32)	<b>79.57l</b> <b>(63.13)</b>	6.14 (14.35)	14.64 (22.50)	10.60 (19.00)	<b>10.46 d</b> <b>(18.87)</b>
T14=Turmeric	99.26 (85.07)	56.95 (48.99)	93.94 (75.75)	<b>83.50h</b> <b>(65.94)</b>	6.82 (15.14)	14.81 (22.63)	11.70 (20.00)	<b>11.11c</b> <b>(19.47)</b>
T8=Cow dung ash	99.22 (84.93)	98.91 (84.01)	98.35 (82.62)	<b>98.96c</b> <b>(83.78)</b>	1.82 (7.75)	6.03 (14.21)	5.00 (12.92)	<b>4.28 l</b> <b>(11.94)</b>
T9=Sand	99.62 (86.47)	74.92 (59.95)	96.15 (78.68)	<b>90.23g</b> <b>(71.79)</b>	2.43 (8.97)	11.61 (19.92)	7.22 (15.59)	<b>7.09i</b> <b>(15.44)</b>
T7=Camphor	99.95 (88.72)	99.73 (87.02)	99.72 (86.97)	<b>99.56b</b> <b>(87.44)</b>	0.13 (2.07)	0.72 (4.87)	0.35 (3.39)	<b>0.40n</b> <b>(4.19)</b>
T12=Clove	99.15 (84.71)	95.91 (78.33)	98.90 (83.98)	<b>97.99d</b> <b>(81.84)</b>	5.44 (13.49)	8.20 (16.64)	6.05 (14.24)	<b>6.56j</b> <b>(14.84)</b>
T10=Citronella	99.14 (84.68)	87.74 (69.50)	98.35 (82.62)	<b>95.11f</b> <b>(77.18)</b>	7.40 (15.79)	10.82 (19.20)	12.51 (20.71)	<b>10.24de</b> <b>(18.67)</b>
T11=Coconut	99.42 (85.63)	86.38 (68.34)	98.34 (82.60)	<b>94.78f</b> <b>(76.71)</b>	3.00 (9.97)	3.55 (10.86)	3.33 (10.51)	<b>3.29 m</b> <b>(10.46)</b>
T15=Azadirachtin	97.43 (80.77)	53.13 (46.79)	93.11 (74.78)	<b>81.19j</b> <b>(64.32)</b>	7.31 (15.69)	7.53 (15.93)	9.16 (17.62)	<b>8.00h</b> <b>(16.43)</b>
T16=Malathion	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	<b>100.00a</b> <b>(90.00)</b>	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	<b>0.00o</b> <b>(0.00)</b>
T17=Control	-	-	-		18.92 (25.78)	23.00 (28.66)	21.01 (27.28)	<b>20.98a</b> <b>(27.26)</b>
Mean	<b>98.09a</b> <b>(82.06)</b>	<b>75.51c</b> <b>(60.34)</b>	<b>93.06b</b> <b>(74.73)</b>		<b>5.74c</b> <b>(13.86)</b>	<b>10.34a</b> <b>(18.76)</b>	<b>8.89b</b> <b>(17.35)</b>	

Figure in parenthesis indicates angular transformed value

**Table.3** Interaction of Efficacy of different seed protectants on the performance of *Sitophilus oryzae* on paddy, wheat and maize during kharif

	Grain (G)	Protectant (P)	G x P	Grain (G)	Protectant (P)	G x P
<i>F Value</i>	48559.7	5114.89	3295.35	1645.18	1314.19	53.1
<i>Pr &gt; F</i>	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Mortality was greater and at par on maize (15.99%) and paddy (15.24%) grains than on wheat (12.33%) and so relative potency on wheat in comparison with maize and paddy was larger immediately after application.

At 2 days after imposition of treatment (DAT) the mortality reached 100% in maize treated with malathion. The protectants cause significantly higher mortality of the pest fed on maize (26.25%) significantly followed by paddy (25.11%) and it was only 20.68% in wheat. Therefore, relative potency of the insect on wheat in comparison with maize and paddy was again larger.

At 7 and 14 DAT, 100% mortality was recorded from camphor, coconut oil and malathion in all the grains. It was followed by tobacco (73.47% and 75.20%). The protectants like custard apple (3.33% and 8.42%) and bay leaf (5.21% and 8.53%) powder showed lowest efficacy. In both the days of treatment mortality of the pest was higher when developed on paddy (46.21-55.82%) grains as compared to maize (37.73-44.85%) and wheat (30.71-35.17%) suggested higher relative potency of the insect in wheat than maize and paddy.

Lowest mortality was observed from grains treated with custard apple even at 28 DAT (17.43%). On 28 DAT in different treatments the mortality ranged between 5.42-100% in wheat. 100% mortality was achieved when tobacco powder and cow dung ash was applied in paddy grains. After 28 days of treatment the mortality was found highest in paddy

grain (77.59%) than maize (59.13%) and wheat (48.43%) suggested that the relative potency of the insect was least in paddy and highest in wheat irrespective of the seed protectants applied to control *Sitophilus*. The death of all released adults in grains treated with malathion 50 EC at 5% resulted into no adult emergence. In contrast, no powder treatment caused 100% insect death. The result followed Singh *et al.*, (2017). Their study showed 2% neem kernel powder as the most effective compound over the other compounds and untreated control, and it can be used as botanical against in stored wheat. In the present study neem leaf powder caused 38.50% mortality in average of three grains taken in the study.

Loss in seed weight was significantly higher in wheat (10.34%) as compared to maize (8.89%) and paddy (5.74%) as presented in table 2 and 3. The loss in weight was highest in grains treated with custard apple (9.15% in paddy; 15.12% in wheat and 13.25% in maize) followed non-significantly by bay leaf (6.82% in paddy; 14.81% in wheat and 11.70% in maize). It was lowest in camphor (0.13% in paddy; 0.72% in wheat and 0.35% in maize) followed by coconut oil (3.00% in paddy; 3.55% in wheat and 3.33% in maize), cow dung ash (1.82% in paddy; 6.03% in wheat and 5.00% in maize) and tobacco leaf powder (3.21% in paddy; 8.45% in wheat and 4.81% in maize). In the untreated control the seed weight loss was extended up to 18.92% in paddy, 23.00% in wheat and 21.01% in maize. Ileke and Bulus (2012) registered low weight loss of wheat, *i.e.* 2.5 and 1.3% in

neem leaf powder at 1.0 and 2.0%, respectively. Mishra and Pandey (2014) reported weight loss of wheat to 5.36, 7.87 and 13.13% with the application of neem leaf powder at 30, 60 and 90DAT. In the present study the loss was recorded 12.50% after 56 days of treatment.

The inhibition per cent of the F1 female adult progeny was lower in wheat (75.75%) followed by 93.06% in maize and it was significantly highest 98.09% in paddy (Table 2 and 3) suggested lower F1 female progeny from wheat. Among the seed protectants the inhibition rate was highest in camphor (99.56%) followed by cow dung ash (98.96%) and clove oil (98.14%) suggested lower F1 female progeny production. The rate was lowest when the protectant was custard apple leaf powder (74.79%) followed by nishinda leaf powder (76.31%) and dry chillies (79.58%) resulted higher level of F1 female progeny production. In case of malathion 50 EC the rate was 100% though development of resistance in *Sitophilus oryzae* (L.) to malathion in Punjab was reported by Joia and Kumar (1996).

It thus can be said that though synthetic pesticide malathion 50 EC was found most effective against *Sitophilus oryzae* but as per the objective of the present study the safe organic and eco-friendly protectants like camphor, cow dung ash, coconut oil, tobacco leaf powder and sand can be the best option to use in storage against the attack of *Sitophilus oryzae* to protect paddy, wheat and maize grains.

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