

Efficacy of Different Grain Protectants on the Mortality of Adults, Emergence of F1 adults, Weight loss in Rice Grain and Infestation in Rice Grains of *Rhizoperthadominica* (Fabricius)

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ABSTRACT

To find out of some non-toxic material for the protection of stored rice against *R. dominica*, efficacy of various grain protectants were evaluated. The rice grains treated with deltamethrin was found significantly superior (49.39 per cent) in comparison to all other protectants and untreated check. The response of protectants viz DDVP, neem oil, camphor and mentha oil viz. 42.04, 35.33, 26.91 and 20.29 per cent, mortality, respectively, were also found significantly superior than diflubenzuron (13.53 per cent) and Tulsi oil (10.23 per cent). The protectants deltamethrin, DDVP, camphor, mentha oil neem oil after two month of application showed significant reduction in F1 adult emergence being 4.57, 6.33, 12.00, 12.33 and 13.33 adults in comparison to untreated check 114.67 adults. The grain protectants Tulsi oil, diflubenzuron and mercury tablets were proved to be at par regarding adult emergence of *R. dominica* giving 24.33, 36.67 and 44.33 adults, respectively. The loss in weight of rice grains in various protectants after 60 days of treatment due to attack of lesser grain borer are ranged from 0.20 to 5.67 per cent. The minimum loss 0.20 per cent was observed in deltamethrin and it was significantly superior to DDVP, Tulsi oil, neem oil, camphor, mentha oil, diflubenzuron, mercury tablets and turmeric powder providing 1.81, 2.74, 3.24, 3.47, 4.04, 4.53, 5.54 and 5.67 per cent, respectively. The protectants tulsi oil, neem oil and camphor were superior to mentha oil, diflubenzuron and mercury tablet which provide 2.74, 3.24 and 3.47 per cent weight loss.

Keywords: Grain Protectants, Diflubenzuron, Deltamethrin, Mercury tablet, DDVP, Camphor, Turmeric, Neem oil, Tulsi oil, Mentha oil, *Rhizoperthadominica*.

I. INTRODUCTION

India is the main rice growing country covering about 45 million hectares of land with about produce of 65 million tons of rice. Girish et al. (1990) declared that about 70 to 80 million tons of rice grains are utilized in the country. Thus, we may conclude that rice has an important place in Agricultural industry and national economy. In India An average of 13.98 million tons of food grains worth of Rs. 6845 crores lost every year (Mohan and Kavitharaghavan, 2008). The storage losses are measured around 10 per cent (Narang, 2002), which were directly correlated with insect population. Insects are not present in the grains, but are infested through old gunny bags, cracks in the floor and walls etc., where inoculum is already present. Once the inoculum is spread in the grains it becomes absolutely difficult to control on account of higher multiplication rate and shorter life span of the insects. Insects feed on grain, bore the Kernel, destroy the germ portion lowering the value of entire lot.

Rice is damaged by a number of stored grain pests, in which the chief pest in store is *Rhizoperthadominica* (Fabricius) (Coleoptera, bostrichidae) which commonly known as lesser grain borer has an important position among the stored grain pest, which is observed causing considerable damage to rice in storage (Kennard 1965). It is largely responsible for damage and frequently found in the stores, mills and warehouses according to Takahasi (1931), Douglas (1942), Adams (1995), Brease (1964), Cogburn (1974), Prakash et al. (1980), Prakash et al. (1981) and Damardauti and Barette (1986). According to Potter (1935), this insect having various choice of food and distribution, produces serious devastation in various stored products including wood also.

Plant product as grain protectants are one of the eco-friendly and economic approaches to keep the stored food grains free from insect attack. Use of botanicals with stored products has been in practice since ages which are known to repel insects or deter them from feeding (Yahaya *et al.*, 2013).

Stored products can be protected from insect pest by the using insecticides as grain protectants and for seed treatment (Athanassiou *et al.* 2005; Kavallieratos *et al.* 2011; Derbalah *et al.* 2012). Judicious use of insecticides is not safe for environmental issues as well as for human health, and insect developing resistance against these insecticides, due to these issues researchers trying to find some safe and economical solutions like using insecticides of natural origin that are eco-friendly and safer than traditional ones such as natural oils (Ileke *et al.* 2014).

Therefore, this study attempted to evaluate the efficacy of some insecticides (Diflubenzuron, Delta methrin, Mercury tablet and DDVP,) that are relatively safe compared to other chemical insecticides against *R. dominica* in rice grain with respect to mortality of adults, progeny and weight loss of treated wheat grain.

We also evaluated the efficacy of Camphor, Turmeric powder, Neem oil, Tulsi oil and Mentha oil a safe alternative to chemical insecticides against *R. dominica*. Our final aim was to evaluate the combined effect of examined chemical insecticides and some plant products against *R. dominica* in rice grain as a way to reduce the side effects of chemical insecticides on human health and to overcome insect resistance towards these insecticides.

II. MATERIAL AND METHODS

Rearing of the test insect:

This study was conducted at Narain college Shikohabad, Firozabad, India. *Rhizoperthadominica* (Fabricius) Bostrichidae- Coleoptera, which is commonly known as lesser grain borer was selected as test insect for the

present studies. For mass rearing the adults were collected from the local granaries and kept for egg laying in jars. The top of which covered with black paper. Large number of eggs laid on the grains were isolated carefully with camel hair brush and transferred into bejars (18 cm. diameter) containing rice grains to obtain the enough number of adults. The newly emerged adults were taken as parental population for the study. The newly emerged adults were separated for sexing. The males are small, cylindrical and dark brown in colour having shallow groove on the fifth abdominal sternum, while females are less dark brown and without shallow groove. The pest population was maintained at an optimum temperature of $32 \pm 1^\circ \text{C}$ and 75 per cent relative humidity throughout the period of investigation (Andrewartha, 1961). For this study Sona variety of rice was used.

Test insecticides:

To find out of some non-toxic material for the protection of stored rice against *R. dominica*, the following grain protectants were evaluated Diflubenzuron 10 wp, Deltamethrin 2.5wp, Mercury tablet, DDVP 76%, Camphor, Turmeric, Neem oil, Tulsi oil, Mentha oil.

Selected grain protectants were measured with the help of micropipette and by weighing with electronic balance in every vial containing 100 gram of rice grain and 10 pairs (1:1 Sex ratio) of newly emerged adults were released in each vial. The mouth of every vial was closed with a plastic lid having small holes and kept in laboratory.

To assess the toxic effect of selected protectants, mortality count 1, 3 and 7 days after release of adults, was recorded. The dead ones could be easily distinguish from the living ones after examination with naked eyes and with the help of hand lens and provoking them with the fine needle and camel hair brush. The rice of each vial was spread over a white paper daily from 20th days after release till the end of experiment and number of adults emerged in each treatment was recorded in each replication. Loss in weight was recorded after 45 days at end of the experiment. The loss in weight of seed was obtained after removing all the dead/alive insects. The loss in weight of seed was worked out by subtracting the final weight from the initial weight. The percentage in loss was calculated recorded. At the end of experiment per cent of seed damage was also recorded in each case.

Statistical analysis:

The data of each character (adult mortality, emergence of F1 adult, grain weight loss, and per cent germination) were subject to analysis of standard statistical method suggested by Chandel (1975). The calculation was performed in Completely Randomized Design. The differences between protectants were compared with C.D. values for their significance.

III. RESULTS

Efficacy of grain protectants on the mortality of adults of *R. dominica* :

To assess the effect of grain protectants, the mortality count was made after 1, 3- and 7-days release of the adults. After one day of release, the data portrayed in Table 1 and Fig.1 indicated that various protectants were significantly superior regarding the mortality of adults of *R. dominica* in comparison to untreated check. The protectants deltamethrin, DDVP, neem oil, camphor and mentha oil were significantly superior to rest of protectants providing 9.12, 8.28, 8.17, 7.47 and 5.77 per cent mortality of the pest, respectively, but they did not differ to each other. The effectiveness of Tulsi oil, mercury tablets and turmeric powder, was at par to each other in reducing population of *R. dominica* viz 0.35, 1.18 and 1.19 per cent, respectively. The diflubenzuron was also found significantly effective in comparison of untreated check giving 3.24 per cent mortality.

The data presented in Table 1 and Fig. 1 after 3 days of release, depicted that all the treatments showed significant mortality over untreated check. The rice grains treated with deltamethrin was found significantly superior by giving highest mortality 49.39 per cent in comparison to all other protectants and untreated check. The response of protectants viz DDVP, neem oil, camphor and mentha oil viz. 42.04, 35.33, 26.91 and 20.29 per cent, mortality, respectively, were also found significantly superior than the diflubenzuron (13.53 per cent) and Tulsi oil (10.23 per cent).

The protectants turmeric and mercury tablets providing 6.59 and 6.49 per cent mortality were at par but there were superior to untreated check.

The observations recorded on adult mortality after 7 days of release of insect are given in Table 1 and Fig. 1. The data indicated that the effect of various treatments significantly increase the adults mortality of lesser grain borer in comparison to untreated check. The seed treated with deltamethrin was found to be significantly superior in causing the adult mortality 92.57 per cent in comparison to DDVP, camphor, neem oil, mentha oil, diflubenzuron Tulsi oil, mercury tablets and turmeric powder giving 86.78, 61.17, 48.81, 42.13, 33.34, 28.27, 26.49, and 21.23 per cent mortality, respectively.

The efficacy of neem oil, camphor and DDVP providing 48.81, 61.17 and 86.78 per cent mortality, respectively, were found significantly superior to turmeric powder, mercury tablets, Tulsi oil, diflubenzuron, mentha oil and deltamethrin. The treatment mentha oil and diflubenzuron were found significantly better over Tulsi oil and mercury tablets giving 28.28 and 26.49 per cent mortality, respectively. The seed of rice treated with Tulsi oil and mercury tablets were at par in the mortality of lesser grain borer provided 28.27 and 26.49 per cent, respectively.

Efficacy of grain protectants on the emergence of F1 adults of *Rhizoperthadominica*(Fabricius)

The data on the effect of grain protectants on the adult emergence of *R. dominica* after one month of treatment are given in Table 2 and Fig. 2. It is evident from the data that treatments deltamethrin, DDVP, camphor, neem oil and mentha oil, were at par in F1 adults emergence giving 2.33, 3.33, 5.67, 7.00 and 10.33 adults, respectively. These treatments were significantly better to diflubenzuron, mercury tablets, Tulsi oil, and turmeric powder giving 17.33, 20.33, 22.33 and 24.67 adults, respectively, but did not differ to each other. In untreated check 114.67 adults, were emerged after one month of treatment.

The protectants deltamethrin, DDVP, camphor, mentha oil neem oil after two month of application (Table 2 and Fig. 2) showed significant reduction in F1 adult emergence being 4.57, 6.33, 12.00, 12.33 and 13.33 adults. The grain protectants Tulsi oil, diflubenzuron and mercury tablets were proved to be at par regarding adult emergence of *R. dominica* giving 24.33, 36.67 and 44.33 adults, respectively. All the grain protectants were found effective in reducing the pest population in comparison to untreated check in which the adult population was 234.33.

Efficacy of grain protectants on damage by *R. dominica* :

Loss in grain weight :

It is clear from the data presented in Table 3 and Fig. 3 that the loss in weight in rice grains in different treatments after 30 days due to attack of *R. dominica* ranged from 0.11 to 2.78 per cent, while it was 8.0 per cent in untreated check. The minimum loss 0.11 was observed in deltamethrin and it was followed by DDVP. The treatment deltamethrin and DDVP were found to be significantly superior from neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablets, turmeric powder and untreated check having 1.49, 1.76, 1.7, 1.98, 2.20, 2.74, 2.78 and 8.00 per cent weight loss respectively. The response of neem oil, camphor, Tulsi oil and

mentha oil on the weight loss in rice grain was found statistically at par having 1.49, 1.76, 1.77 and 1.98 per cent, respectively.

The maximum loss in weight was recorded in turmeric treatment (2.78 per cent) which was significantly higher than deltamethrin DDVP. All the treatments were found statistically superior over untreated check, for decreasing loss in weight after one month of storage period.

The loss in weight of rice grains in various protectants after 60 days of treatment due to attack of lesser grain borer are given in Table 3 and Fig.3. Which ranged from 0.20 to 5.67 per cent. The minimum loss 0.20 per cent was observed in deltamethrin and it was significantly superior to DDVP, Tulsi oil, neem oil, camphor, mentha oil, diflubenzuron, mercury tablets and turmeric powder providing 1.81, 2.74, 3.24, 3.47, 4.04, 4.53, 5.54 and 5.67 per cent, respectively. The protectants tulsi oil, neem oil and camphor were superior to mentha oil, diflubenzuron and mercury tablet which provide 2.74, 3.24 and 3.47 per cent weight loss. Treatments mentha oil, diflubenzuron and mercury tablets did not differ significantly with each other. All the treatment were found to be significantly superior to untreated check in which it was 16.17 per cent, loss in weight was recorded.

Grains damage:

It is clear from the data presented in Table 4 and Fig.4 that the rice grain damage by the pest in different treatment after 30 days of treatment ranged from 1.75 to 13.05 per cent, being minimum in deltamethrin and maximum in turmeric powder, while it was 48.06 per cent in untreated check. The higher seed damage 13.05 per cent was recorded in turmeric powder, which was significantly higher than deltamethrin, DDVP, neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron and mercury tablets providing 1.75, 3.89, 6.00, 6.97, 8.51, 9.60, 10.65 and 11.02 per cent damage, respectively. The minimum damage (1.75 per cent) was observed in deltamethrin, which was at par with DDVP (3.89 per cent), these treatments were significantly superior to neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablets and turmeric powder providing 6.0, 6.97, 8.51, 9.60, 10.65, 11.02 and 13.05 per cent, respectively. The neem oil and camphor were found to be superior to Tulsi and mentha oil.

Tulsi and mentha oil were observed to be significantly different from diflubenzuron, mercury tablets and turmeric powder. The treatment mentha oil, diflubenzuron and mercury tablet were at par in which grain damage was viz. 9.60, 10.65 and 11.02 per cent, respectively. All the treatments were found statistically superior over untreated check for decreasing seed damage after one month of storage period.

The seed damage in different treatments in rice after 60 days of treatment due to attack *R. dominica* are given in Table-4 and Fig.4. Significantly higher seed damage was found in turmeric as compared to mercury tablets, diflubenzuron, mentha oil, Tulsi oil, camphor, neem oil, DDVP and deltamethrin providing 25.02, 23.50, 21.21, 18.24, 16.12, 13.14, 10.95, 6.04 and 5.94 per cent, respectively. The minimum 5.94 per cent seed damage was observed in deltamethrin and it was at par with DDVP treatment (6.04 per cent). They were significantly superior to neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablets and turmeric powder providing 10.95, 13.14, 16.12, 18.24, 21.21, 23.50 and 25.02 per cent seed damage, respectively. The neem oil (10.95) and camphor (13.14) were found at par and they were superior to others. The protectants Tulsi oil and mentha oil were found more effective than diflubenzuron, mercury tablets and turmeric powder in reducing the seed damage. All the treatment, which have 0.20 to 5.67 per cent grain damage were found statistically superior over untreated check (16.17 per cent).

IV. DISCUSSION

Efficacy of grain protectants on the mortality of adults of *R.dominica*:

To know the effect of grain protectants on the mortality of *R.dominica*. The mortality count was made after 1, 3 and 7 days release of the adults. After one day of release, the various protectants were significantly superior untreated check regarding the mortality of the pest. The protectants deltamethrin, DDVP, neem oil, camphor and mentha oil were significantly superior to rest of protectants and untreated check, providing 9.12, 8.28, 8.17, 7.47 and 5.77 per cent mortality of the pest, respectively, but they did not differ to each other. The effectiveness of other protectants viz. Tulsi oil, mercury tables and turmeric powder, was at par to each other in reducing population of *R.dominica* viz 0.35, 1.18 and 1.19 per cent, respectively. The diflubenzuron was also found significantly effective in comparison of untreated check giving 3.24 per cent mortality.

The after 3 days of release of adults all the treatments showed significant mortality over untreated check. The rice treated with deltamethrin was found significantly superior by giving highest mortality 49.39 per cent in comparison to all other protectants and untreated check. The protectants DDVP, neem oil, camphor and mentha oil gave 42.04, 35.33, 26.91 and 20.29 per cent mortality, respectively, which were also found significantly superior than diflubenzuron (13.53 per cent) and Tulsi oil (10.23 per cent) and they were also significantly superior than turmeric and mercury tablets in mortality of adults of *R.dominica*. The protectants turmeric and mercury tablets providing 6.59 and 6.49 per cent mortality were at par but there were superior to untreated check.

The observations recorded on adult mortality after 7 days of release of insect the effect of various treatments significantly increased the adult mortality of lesser grain borer in comparison to untreated check. The rice seed treated with deltamethrin was found to be significantly superior in causing the adult mortality 92.57 per cent in comparison to DDVP, camphor, neem oil, mentha oil, diflubenzuron, Tulsi oil, mercury tablets and turmeric powder giving 86.78, 61.17, 48.81, 42.13, 33.34, 28.27, 26.49 and 21.23 per cent mortality, respectively. The neem oil, camphor and DDVP providing 48.81, 61.17 and 86.78 per cent mortality, respectively, were found significantly superior to turmeric powder, mercury tablets, Tulsi oil, diflubenzuron mentha oil and deltamethrin. The treatment mentha oil (42.13) and diflubenzuro (33.24) were found significantly better over tulsi oil and mercury tablets giving 28.28 and 26.49 per cent mortality, respectively. The seed of rice treated with Tulsi oil and mercury tablets were at par in the mortality of lesser grain borer provided 28.27 and 26.49 per cent mortality, respectively.

Our finding are supported by the results of Verma *et al.* (1983) they tested toxicities of neem oil, castor and mustard against storage pests and found that the deltamethrin was the most toxic to *R. dominica*. Saxena and Singh (1994) found that the grain protectants, where found to be best to affect the fecundity, incubation, hatching percentage, larval, pupal period and longevity of the *R. dominica* over untreated check. Neem cake was found to be most effective in reducing the number of eggs laid by beetle while dharek was least effective. Oforoi and Reichmuth (1999) found that the filter papers impregnated with the camphor @ 100 mg / filter paper caused 93 to 100 per cent mortality of *S. oryzae*. Kumar (2002) found that highest mortality of the pest was in seed treated with deltamethrin, which was followed by neem oil, camphor and mentha oil. Kathirvelu (2003) found that mixing of neem oil @ 30 ml/kg of grains was effective against the pest, recording 57.95 per cent mortality of the borer, followed by neem leaf dust at 30 per cent (50.90 per cent borer mortality) and pongamia oil at 30 ml/kg of grains (46.74 per cent mortality).

Efficacy of grain protectants on the emergence of F₁ adults of *R. dominica*.(Fabricius) :

The effect of grains protectants on the adult emergence of *R. dominica* after one month of treatment, showed that deltamethrin, DDVP, camphor, neem oil and mentha oil, were at par in F1 adults emergence giving 2.33, 3.33, 5.67, 7.00 and 10.33 adults, respectively but these were significantly better to diflubenzuron, mercury tablets, Tulsi oil and turmeric powder giving 17.33, 20.33, 22.33 and 24.67 adults, respectively. The treatment diflubenzuron, mercury tablets, tulsi oil and turmeric powder did not differ significantly among themselves.

The grain protectants viz deltamethrin, DDVP, camphor, mentha oil and neem oil after two month of application, significantly reduced F₁ adult emergence being 4.57, 6.33, 12.00, 12.33 and 13.33 in respective treatments than the Tulsi oil, diflubenzuron, mercury tablets and turmeric powder giving 24.33, 36.67, 44.33 and 54.33 adults, respectively. The grain protectant Tulsi oil, diflubenzuron and mercury tablets were proved to be at par regarding adult emergence of *R. dominica* giving 24.33, 36.67, and 44.33 adults, respectively. All the grain protectants were found effective in reducing the pest population in comparison to untreated check in which the adult population was 234.33. Similar results were also obtained by Majumdar (1977) he found DDVP very effective for controlling *S.oryzae*. Ranpalet *al.*(1985) reported that the vegetable oils of mustard and soyabean used @ 1ml and 3 ml/kg seed reduced the emergence of adults, when reared on the seeds treated with them. Chander *et al.* (1992) evaluated the effectiveness of turmeric powder and mustard oil in different combination as protectants for milled rice against infestation by *T. castaneum*. turmeric powder and mustard oil alone did not cause significant adult mortality. Singh *et al.* (1996) tested coconut, groundnut and mustard oil, as protectants for gram seed against *C. chinensis*, at 5ml and 7.5 ml/kg of seed, provide to be highly effective in protecting the seeds even up to 8 months storage in terms of seed damage and weight loss. Rahman *et al.*(1997) found 10 ml/kg of neem oil as effective treatment for stored rice against the infestation by *S.cerealella*, *S.oryzae* and *T. castaneum*. Huang *et al.* (2000) found that cardamom oil did not have any growth inhibitory or feeding deterrence effect on either adults or larvae of *T.castaneum*.

Efficacy of grain protectants on damage by *R. dominica*

Loss in grain weight :

The loss in weight in rice grains in different treatments after 30 days due to attack of *R. dominica* ranged from 0.11 to 2.78 per cent, while it was 8.0 per cent in untreated check. The minimum loss 0.11 per cent was observed in deltamethrin and it was followed by DDVP. The treatment deltamethrin and DDVP were found to be significantly superior from neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablets, turmeric powder and untreated check having 1.49, 1.76, 1.77, 1.98, 2.20, 2.74, 2.78 and 8.00 per cent, respectively the response of neem oil camphor, Tulsi oil and mentha oil on the weight loss in rice grain was found statistically at par having 1.49, 1.76, 1.77 and 1.98 per cent, respectively. The maximum loss in weight was recorded in turmeric treatment (2.78 per cent), which was significantly higher than the rest of the treatment. All the treatments were found statistically superior over untreated check, for decreasing loss in weight after one month of storage period.

The loss in weight of rice grains in various protectants after 60 days of treatment due to attack of lesser grain borer ranged from 0.20 to 5.67 per cent. The minimum loss 0.20 per cent was observed in deltamethrin and it was significantly superior to Tulsi oil, neem oil, camphor, mentha oil, diflubenzuron, mercury tablet and turmeric powder providing 2.74, 3.24, 3.47, 4.04, 4.53, 5.54 and 5.67 per cent respectively. The protectants Tulsi oil, neem oil and camphor were superior to mentha oil, diflubuzuron and mercury tablets which provide 2.74, 3.24 and 3.47 per cent weight loss. Treatment mentha oil, diflubenzuron and mercury tablets did not differ significantly with each other. All the treatment were found to be significantly superior to untreated check in which the loss in weight was 16.17 per cent. In present findings deltamethrin and DDVP proved to

be superior to all treatments as protectant of rice seed against *R.dominica*. Similar results were obtained by Majumdar (1977) in case of DDVP for controlling storage pests. Our findings revealed that the neem oil was also effective protecting the seed. These findings are in conformity with the findings of Verma *et al.* (1983), and Bowry *et al.* (1984) who have reported that oil of mustard and Neem reduced the population of *S.oryzae*. Pranta (1986), who has reported that turmeric powder was more toxic to *R.dominica* in storage. The neem oil @ 10 ml/kg was found effective against infestation of storage pests (Rahman, 1997), Oforoi and Reichmuth (1999) found that the filter papers impregnated with the camphor @ 100 mg/ filter paper caused 93 to 100 per cent, mortality of *S.oryzae*.

Grains damage:

The rice grain damage in different treatments after 30 days of treatment due to attack lesser grain borer ranged from 1.75 to 13.05 per cent, being minimum deltamethrin and maximum in turmeric powder, while it was 48.06 in untreated check. The higher seed damage 13.05 per cent was recorded in turmeric powder, which was significantly higher than the deltamethrin, DDVP, neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron and mercury tablets providing 1.75, 3.89, 6.00, 6.97, 8.51, 9.60, 10.65 and 11.02 per cent, respectively. The minimum damage (1.75 per cent) was observed in deltamethrin, which was at par with DDVP (3.89 per cent), these were significantly superior to neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablet and turmeric powder providing 6.00, 6.97, 8.51, 9.60, 10.65, 11.02 and 13.05 damage per cent, respectively. The neem oil and camphor were found to be superior to Tulsi and mentha oil. Tulsi and mentha oil were observed to be significantly different from d diflubenzuron, mercury tablets and turmeric powder. The treatment mentha oil, diflubenzuron and mercury tablet were at par in providing lesser grain damage viz 9.60, 10.65 and 11.02 per cent, respectively. All the treatments were found statistically superior over untreated check for decreasing seed damage after one month of storage period.

The rice seed damage in different grain protectants after 60 days of treatment due to attack *R. dominica* was significantly higher in turmeric (25.02 per cent) in comparison of mercury tablets, diflubenzuron mentha oil, Tulse oil camphor, neem oil, DDVP and deltamethrin providing 23.50, 21.21, 18.24, 16.12, 13.14, 10.95, 6.04 and 5.94 per cent, respectively. The minimum 5.94 per cent seed damage was observed in deltamethrin and it was at par with DDVP (6.04 per cent) treatment. These were significantly superior to neem oil, camphor, Tulsi oil, mentha oil, diflubenzuron, mercury tablets and turmeric powder providing 10.95, 13.14, 16.12, 18.24, 21.21, 23.50 and 25.02 per cent seed damage, respectively. The neem oil and camphor were found at par. The protectants Tulsi oil and mentha oil were found more effective than diflubenzuron, mercury tablets and turmeric powder in reducing the seed damage. All the treatment which have 0.20 to 5.67 per cent grain damage were found statistically superior over untreated check (16.17 per cent). Our finding are supported by Jotwani and Sircar (1965) who found that power of neem seed was effective to store grains against *R.dominica* @ 1 to 2 part /100 part of seed for at least 321 days. Pandey and Singh (1995) protected the seed of black gram, from the damage of *C.chinensis* by mixing in the seed with dried powder of neem leaf @ 100 to 400 mg/50g seed. Kumar (2002) tested protectants against *R. dominica* attacking wheat seed in storage. He found that highest mortality of pest was in seed treated with deltamethrin, which was followed by neem oil, camphor and mentha oil.

Authors' contribution: Every author has equal contribution in conducting experiments, data analysis and manuscript writing.

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