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Screening of Different Wheat Varieties against Rice Weevil (*Sitophilus oryzae Linn*.) and their Management

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A B S T R A C T

The wheat varieties HD-2733 and K-307 were found moderately resistant against *Sitophilus oryzae* in which higher hardness, lower moisture, lesser eggs, progeny and population with longer developmental period and lesser grain weight loss and damaged grain were recorded. Rest wheat varieties found susceptible to *Sitophilus oryzae.* Hardness having negative association with pest infestation. While moisture showed positive relation. The fecundity and progeny were positive relation with percent weight loss and damaged grain. The results on management of *Sitophilus oryzae* through plant products showed that the Neem seed kernel, Turmeric powder was found most effective against *S. oryzae.*Thus these protectants recommended to the farmers for the grain protection in the storage.

Introduction

Wheat (*Triticuma estivum L.*) is physiologically categorized as C3 plant.There are certain post-harvest losses, which are simultaneously observed from 9-20% due to insect, pest, microorganisms, and rodents in storage of food grain (John 1981).

S. oryzae,is commonly known as Rice weevil is the predominant insect pest. It is of cosmopolitan in nature, attributing about 50% loss in wheat in storage (Mansoor *et al.*, 2004). *Sitophilous oryzae L.* has been reported as one of the serious pest of cereals and their products (Baloch, 1992). The pest prefers soft varieties of wheat grains (Zakladnoi and Retanova, 1987) attempts have been made to get complete control of stored grain insects by insecticidal application. Moreover, fumigation is the most widely adopted method and has been practise. None of these methods and products can be declared as safe of the precious lives of human being, birds, beneficial insects, animals and to the environment (Metcalf, 1982).

Materials and Methods

The present investigation was done at the Dept. of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur during 2018-2019.

The procedure and techniques applied during the course of investigations were elucidated as below.

Rearing of Insect

Adults of *S. oryzae* were initially collected from infested stock of local granaries and brought to the laboratory, department of entomology, CSAUA & T, Kanpur for mass culture rearing and placed in two glass jars of 100gm capacity filled with 50gm wheat grains. After 10 days the newly emerged 1-2 days adults were taken as parental population for the study.

Wheat varieties/ cultivars

Twenty wheat varieties/ cultivars viz. K-9006, K-1502, K-9465, K-1501, K-9162, K-1401, K-307, K-9533, K-1507, K-9107, K-8434, K-1414, K-402, K-1402, K-1512, K-1405, HD-2733, K-1214, NW-2036, K-1508 were collected from, CSAUA & T, Kanpur (UP), and tested against *S. oryzae.*

Test weight

The 100 grains of each wheat varieties were weighted with the help of physical balance and the noted weight of each sample for test weight.

Biological observations of test insect

Experiments were conducted under controlled conditions at 27±2 ^{0}C temperature and 75± 5 per cent relative humidity.

Fecundity

Five pairs of male and female were introduced in specimen tubes, having 50g stained grains of each varieties under controlled conditions in three replications. The egg laying plugs were detected by hand lens with the help of acid fuchsin colouring reagent technique (Ragunathan, 1974). The observations on total number of eggs laid per tube were noted and the total number of eggs laid by single female in her life was recorded from each tube.

Incubation period

Wheat grains of different varieties with rice weevil eggs so obtained were maintained in a glass vials for incubation. Daily twenty grains from the day of oviposition to egg hatching were dissected to determine the incubation period.

Larval period

On hatching the larvae of rice weevil were allowed to feed individually inside the grains in specimen tube of 7.5 cm x 2.5 cm size having 5gm wheat grains. Five grains per day were dissected out to see the different stages of the larvae. The dissection of grains was made up to pupal stage.

Developmental period

With a view to study the developmental period 50 pairs of freshly emerged weevils were released in specimen jar containing 100g grains of each variety to get sufficient number of grains containing one egg of each within 24 hour for the experiment. The emerged adults were removed now the total development period was calculated by using the formula-

$$\text{Weighted mean} = \frac{\Sigma wx}{\Sigma w}$$

Where,
X = Value of an item or observation (days)
W = Weight of X (Number of emerged adults)

The percentage of adult emergence was recorded on the basis of total number of adults emerged.

Weight loss

The percentage weight loss was recorded by counting a weight of 100 healthy grains and damaged grains. The loss in weight was calculated by using the following formula-

$$\text{Loss (Per cent)} = \frac{O - P \times 100}{Q}$$

Where,
P= weight of 100 damaged grains
Q= weight of 100 undamaged grains
O= weight of equal (to damaged) no. of undamaged grains

Protectants used

The eight plant products were collected and dried under shade condition. The dried leaves and other materials were grind with the help of grinder machine (Table 1). These plant powders were applied for the management of *S. oryzae.*

Effect on germination

Hundred seeds of each treatment were counted and spread out over the germination paper (Towel paper) in 2 cm apart and covered it with a layer of moist same germinating paper and rolled upward direction. The rolled paper kept as such at room temperature for 5 days. The light watering was done daily to provide appropriate moisture to seeds. On fifth day, rolled paper was opened and counted the germinated and ungerminated seeds and recorded the percentage germination of seeds.

Results and Discussion

Moisture per cent in grains

Moisture of different wheat varieties showed that the varieties K-9162, K-1402, K-1501, K-1401 and K-1512 having 13.00, 13.00, 12.90, 12.60 and 11.90 respectively per-cent moisture content proved to be most susceptible to the *S. oryzae*. Wheat varieties K-1414, K-1507, K-9465, K-402, NW-2036, K-1508, K-1405, K-8434, K-9107 and K-1214 having intermediate moisture percentage i.e. 11.50, 11.40, 11.25, 11.23, 10.90, 10.50, 10.23, 10.10, 10.00 and 10.00 respectively, indicating to susceptible performance of wheat varieties against *S. oryzae*. The lesser moisture content i.e. 9.70, 9.50, 9.50, 9.10 and 9.05 were found in varieties K-307, K-9533, HD-2733, K-9006 and K-1502, respectively, and are moderate resistant against *S. oryzae*. The physical character of wheat grains, biology and infestation of *S.oryzae* was studied using 20 wheat genotypes(Fig-1). Our findings are in accordance to the findings by Priyanka *et al.,* (2013), who reported that moisture had positive correlation with the infestation of stored grain pest.

Hardness of grains

The wheat varieties K-1502, HD-2733, K-9162, K-9006, K-1401, K-307, K-9465, K-1501, K-9107 and K-9533 having higher breaking strength i.e. 24.00, 23.00, 22.30, 22.18, 22.00, 21.90, 21.45, 21.23, 21.00 and 20.00 kg/grains respectively. It showed moderate resistance against *S. oryzae.* Varieties K-1214, K-1507, K-402, K-8434, NW-2036, K-1405, K-1402 and K-1407 having intermediate hardness i.e. 16.90, 16.45, 16.00, 16.00, 15.90, 14.90, 14.70 and 14.70 Kg/grains respectively it indicates the susceptibility of wheat varieties. The culture of K-1508 and K-1512 having 12.80 and 11.53 kg/grain breaking strength respectively

are lesser hard. The correlation between physical characters of wheat grains and biology of *S. oryzae* was studied using 20 wheat genotypes(Fig-1).

Our results are also similar in the finding of Priyanka *et al.,* (2013),who reported that hardness of the wheat cultivars had significant negative correlation.

Fecundity

The variety K-9006, superior over other varieties which gave 108.59 least eggs/female followed by K-1502, HD-2733, K-1501, K-9162, K-9465, K-307 and K-1401 found moderate resistant having lesser fecundity i.e. 127.35, 127.66, 130.79, 131.96, 131.06, 132.48 and 140.62 eggs/female, respectively. Genotypes of K-9107, K-9533, K-1507, K-1214 and K-8434 showed medium number of eggs laid by *Sitophilus oryzae* with 187.65, 191.85, 236.82, 238.35 and 239.92ggs/female, respectively, recorded as susceptible wheat varieties. Sample K-1414, K-402, K-1512, K-1402, K-1508, K-1405 and NW-2036 showed higher fecundity of pest i.e. 52.72, 252.82, 253.82, 259.00, 259.55, 369.69 and 380.32 eggs/female, respectively, proved the most susceptible varieties(Fig.-2).

Our results are supported by Verma *et al.*, *(*2012), who reported the five cultivars of wheat (K-9006, K-9162, K-9107, K-307 and K-9465) were evaluated for resistance against *Sitophilus oryzae.* Data were recorded for moisture content, average breaking strength (hardness), per cent of damaged grains and weight loss. The wheat cultivars K-9162, K-307 and K-9006 were moderately resistant.

The variety K-9465 was found most susceptible due to more eggs/female, adult emergence and weight loss. The moisture content is highly significantly correlated with fecundity.

Incubation Period

The variety K-1508 gave maximum incubation period (10.50 days) followed by K-1414, NW-2036, K-1215, K-1402, HD-2733, K-1401, K-8434 and K-9006 by giving 9.10, 8.94, 8.91, 8.87, 8.46, 8.44, 8.25 and 8.00 days, respectively, and are remarked as moderate resistant to against *Sitophilus oryzae*. Wheat varieties K-307, K-9533, K-9107, K-1214, K-1405, K-9465 and K-1501 giving incubation period as 7.96, 7.96, 7.79, 7.47, 7.37, 7.34 and 7.21, respectively, hence, are less susceptible. Varieties K-1502, K-402, K-1507 and K-9162 by giving 7.10, 7.02, 7.02 and 6.94 days, respectively are highly susceptible (Fig.-2). Verma *et al.,* (2012) also reported that Four cultivar of wheat K-9006, K-9107, K-307 and K-9465 and found that hardness of the varieties is high which is negative relation with incubation period and moisture in relation with incubation.

Larval Period

The minimum larval period (19.33 days) was found in K-402 which was followed by varieties K-1402, K-9107, K-8434, K-9533, K-1507, K-1512, NW-2036, K-1214 and K-1502 being 19.67, 20.00, 20.02, 20.64, 21.33, 21.48, 32.33, 22.67 and 24.11 days, respectively, showed to more preference to the test insect indicating most susceptible wheat varieties.

The wheat varieties K-1414, K-9162, K-1501 and K-307 showed 26.67, 28.15, 28.33 and 28.49 days, respectively, demonstrated intermediate larval period denoting to the lesser preference to the pest.

Maximum larval period (31.24 days) was observed in variety K-1401 which was at par with K-1508, K-9006, K-1405, K-9465 and HD-2733, in which 29.33, 29.34, 30.00, 30.09, 30.01 days of larval period was recorded,

respectively, hence showed less preference to infestation of the varieties (Fig.-2). Our results are supported by Priyanka *et al.,* (2013), who reported that physical factor of wheat grain, moisture is negative relation and hardness show positive relation in case of larval period.

Pupal Period

The varieties K-9533 and K-1401 was found significantly superior over rest of the varieties by showing maximum pupal period (10.60 and 9.59 days, respectively), followed by K-9006, K-1507, HD-2733, K-1512, NW-2036, K-9162, K-307 and K-9465 being 9.14, 8.67, 8.67, 8.31, 7.67, 7.56, 7.53 and 7.44 days, respectively, proved moderate resistance against *S. oryzae*. Varieties K-1501, K-402, K-1502, K-1214, K-1414, K-1508 and K-1405 being 6.67, 6.60, 6.07, 6.00, 5.67, 5.67 and 5.06 days, respectively, proved less susceptible. Varieties K-1402, K-9107 and K-8434 being 4.67, 4.33 and 3.67, respectively, were most susceptible against *S. oryzae* (Fig.-2). Yadav *et al.,* (2008) also reported that wheat cultivars Raj-4037, HD-2329, Raj-3765, Lok-1, Raj-3077, PBW-343, Raj-6062, PBW-502, HD-2687 and Raj-1482 were tested against *S. oryzae* in relation to fecundity, incubation period, egg viability, pupal period, developmental period, adult emergence, sex ratio, longevity of adult, grain damage and weight loss, F1 progeny and index of susceptibility based on biological parameters and physiochemical characters. Varieties Raj-4037, Lok-1, Raj-3765, and Raj-6062 were less susceptible and HD-2687, Raj-1482 and PBW-502 were highly susceptible.

F_1- Progeny

The minimum number i.e. 31.00 and 32.06 adults were emerged in the varieties HD-2733 and K-9533 followed by K-307, K-9107, K-1401, K-8434 having 41.65, 41.89, 43.03 and 47.33 adults, respectively, proved to be moderate resistant while K-402, K-1414, K-9162 and K-1501 found susceptible provided intermediate emergence i.e. 72.33, 74.00, 82.62 and 91.15 adults, respectively. The wheat varieties K-9465, K-1512, K-1402, K-1502, NW-2036, K-1405 and K-1214 showed higher emergence i.e. 104.54, 105.33, 106.33, 106.56, 111.00, 115.00, 122.32, 122.42, 122.43 and 122.48 adults, respectively, recorded as highly susceptible varieties(Fig-3)**.** Verma *et al.,* (2012) studied correlation between physical characters of wheat grains and biology of *Sitophilus oryzae* by using 20 wheat genotypes. The hardness of the wheat cultivars had significant negative correlation, while the moisture content had positive correlation, with fecundity, F1 progeny and susceptibility index.

Developmental Period

Sitophilus oryzae has longer developmental period i.e. 60.30, 59.01 and 58.92 days recorded in K-9006, K-307 and HD-2733, respectively, showed moderately resistant of wheat varieties. Varieties K-1414, K-402, K-9162, K-1214, K-1502, K-1501, K-9465, K-1402 and K-9533 showed 58.92, 58.90, 58.67, 58.60, 58.35, 57.74, 55.81, 55.25, 54.57 and 53.94 days, respectively, intermediate developmental period proved as susceptible. Wheat varieties K-1401, K-1507, K-1508, K-1512, K-9107, K-1405, K-8434 and NW-2036 have shorter developmental period of insect i.e. 42.91, 42.54, 41.88, 40.81, 40.37, 37.69, 30.74 and 29.87 days, respectively, and proved most susceptible wheat varieties. These observations are in agreement with result of Verma *et al.,* (2012), who tested fourteen cultivars of wheat i.e. HUW-234, K-7903, PBW-343, K-8962, Raj-3765, K-9006, K-9162, NW-1014, K-9107, K-307, K-9465, K-9644, U.P-2338 and Mandakini-9351 against *Sitophilus oryzae*. Data were recorded for moisture content, average breaking strength (hardness), per cent of damaged

grains and weight loss(Fig-3). The wheat cultivars K-9162, HW-234, K-307 and K-9006 were moderately resistant. The cultivars K-7903, NW-1014, PBW-343 and K-9465 were found most susceptible due to more eggs per female, adult emergence and weight loss. The moisture content is highly significantly positively correlated with fecundity (+0.9508), adult emergence (+0.9536) and weight loss (+0.8882) while developmental period showed significant negative correlation.

Adult emergence

The emergence of adults varied from 65.91-81.54 per cent in different wheat varieties. The maximum beetles were emerged from the varieties K-9465 (81.54%) which is followed by K-1414, K-402, K-8434, K-1501, K-1508, K-9162, K-1502, K-1402, K-1401, K-9006, K-1214 and K-1507 having 80.72, 79.31, 75.67, 75.67, 75.36, 74.24, 73.24, 72.84, 72.47, 71.06 and 70.14 per cent, respectively. Varieties K-307, K-9533, K-9107, K-1405 and NW-2036 had moderate adult emergence i.e. 68.91, 68.72, 68.36, 68.17and 68.14 per cent, respectively. The minimum per cent of adult beetles was recorded from varieties HD-2733 (65.91 per cent) which was at par with K-1512 (67.68 %) (Fig-3). Our results are supported by Singh *et al.,* (1992) also worked on adults emergence of weevil attacking Barley varieties and found maximum population on the most susceptible varieties which is more or less similar to present results.

Weight loss

The varieties K-9533, K-307, K-1401, HD-2733, K-1507 and K-1402 were found moderate resistant by providing lesser 3.64, 4.08, 4.15, 4.19, 4.57 and 4.71 per cent weight loss, respectively. The varieties K-9162, K-402, K-1501, K-1502, K-1512, K-9465, K-1414 and K-1214 also found susceptible to weevil by loss i.e. 5.46, 5.84, 5.98, 6.57, 6.72, 6.81, 7.65 and 7.84 per cent, respectively. Varieties NW-2036, K-15008, K-8434, K-9006, K-1405 and K-9107 were found most susceptible against *Sitophilus oryzae* to show higher in weight loss 8.68, 8.05, 9.24, 9.67, 10.01 and 10.21 per cent, respectively(Fig. 4). Our results are supported by Verma *et al.*, (2012), who also reported that the loss in weight had negative association with hardness of grain but the moisture content showed positive impact on loss in weight due to infestation.

Damaged grain

The varieties NW-2036, K-9107 and K-9465 with damaged i.e. 2.68, 2.69 and 2.99 per cent, respectively, were found moderately resistant, hence showed lesser grain damage against *Sitophilus oryzae*. The intermediate damaged grain showed 3.01, 3.05, 3.06, 3.11, 3.11, 3.35, 3.38 and 3.44 susceptible wheat varieties i.e. K-402, K-1502, K-1214, K-1507, HD-2733, K-9533, K-1512 and K-1414, respectively. Varieties K-1401, K-9162, K-1508, K-9006, K-1405, K-1501, K-8434 and K-307 having higher infested grain damage 3.64, 3.87, 4.18, 4.57, 5.02, 5.14, 5.14 and 5.47 per cent, respectively, showed most susceptible wheat varieties against *S. oryzae* (Fig. 4). Our results are supported by Verma *et al.*, (2012), who reported that the grain damage was negatively influenced by hardness to a great extent but the cultivars having high moisture content showed good positive relationship with grain damage.

Management of *Sitophilus oryzae* infesting wheat varieties

All grain protectants proved their superiority over untreated check (239.43 eggs). The female laid least number of eggs (79.88) on grain treated with *Dhatura* leaf powder which was found to be significantly superior in comparison to other treatments.

Table.1 List of botanicals used as protectant:

S.No.	Protectant (powder)	Botanical name	Sources from	Dose	Process of use
1	Turmeric	*Curcuma longa*	Behaya plant	20g/kg	thoroughly mixed with seed
2	Madar leaf	*Calotropis gigantea*	Behaya plant	20g/kg	thoroughly mixed with seed
3	Kali tulsi leaf	*Ocimum sanctum*	Behaya plant	20g/kg	thoroughly mixed with seed
4	Neem seed kernel extract	*Azadirachta indica*	Behaya plant	20g/kg	thoroughly mixed with seed
5	Castor leaf	*Ricinus communis*	Behaya plant	20g/kg	thoroughly mixed with seed
6	Dhatura leaf	*Datura stramonium*	Behaya plant	20g/kg	thoroughly mixed with seed
7	Behaya leaf	*Ipomea carnea*	Behaya plant	20g/kg	thoroughly mixed with seed

Fig.1 Wheat varieties with their moisture and hardness content

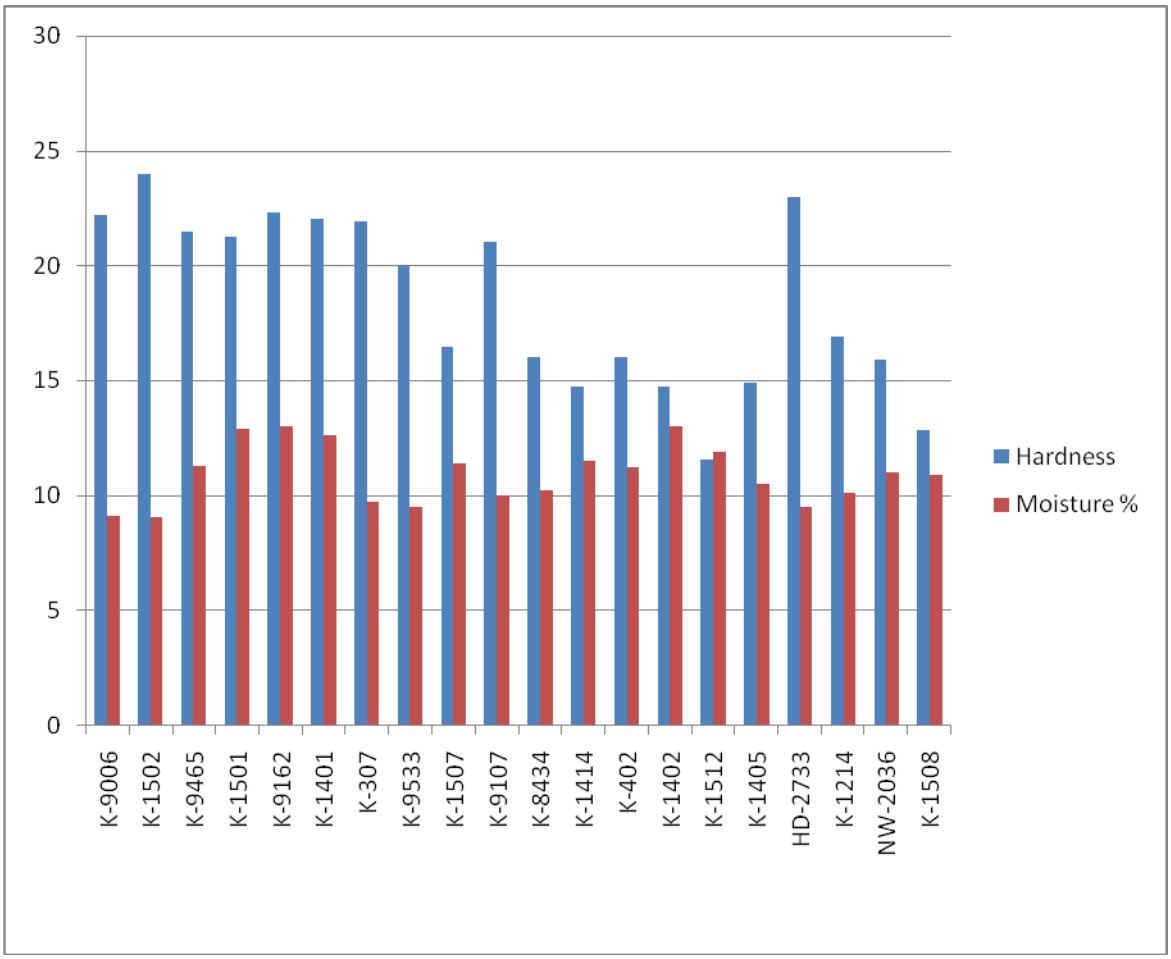


Fig.2 Fecundity, incubation, larval and pupal period of rice weevil in different wheat varieties

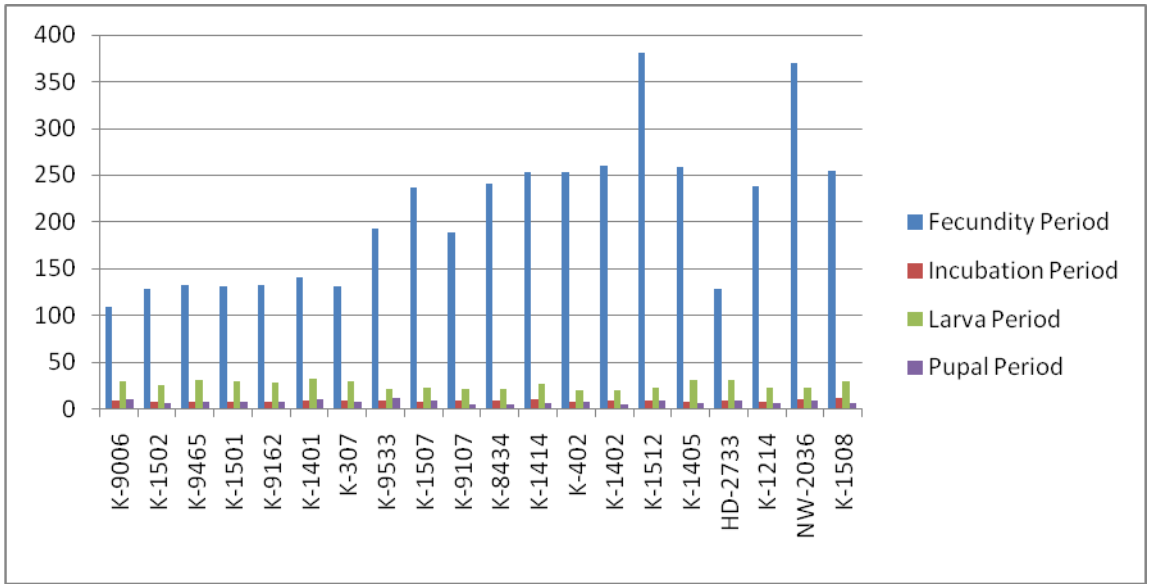


Fig.3 F_1 progeny, developmental period and adult emergence of rice weevil in different wheat varieties.

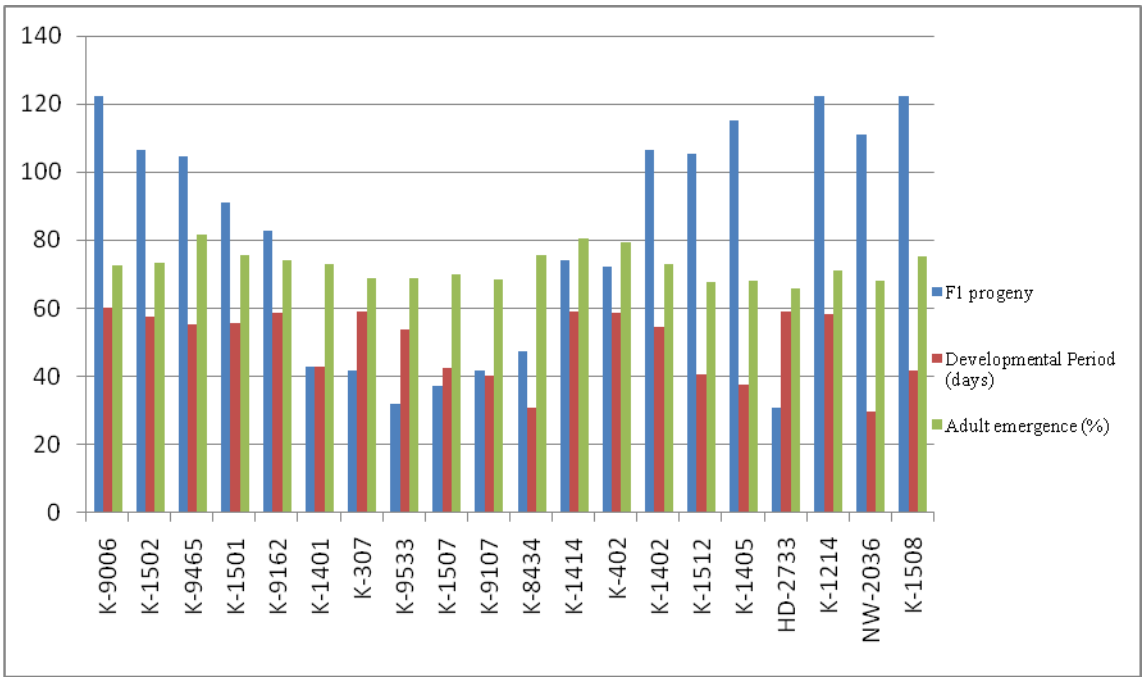


Fig.4 Per cent damaged grain and weight loss caused by rice weevil in different wheat varieties

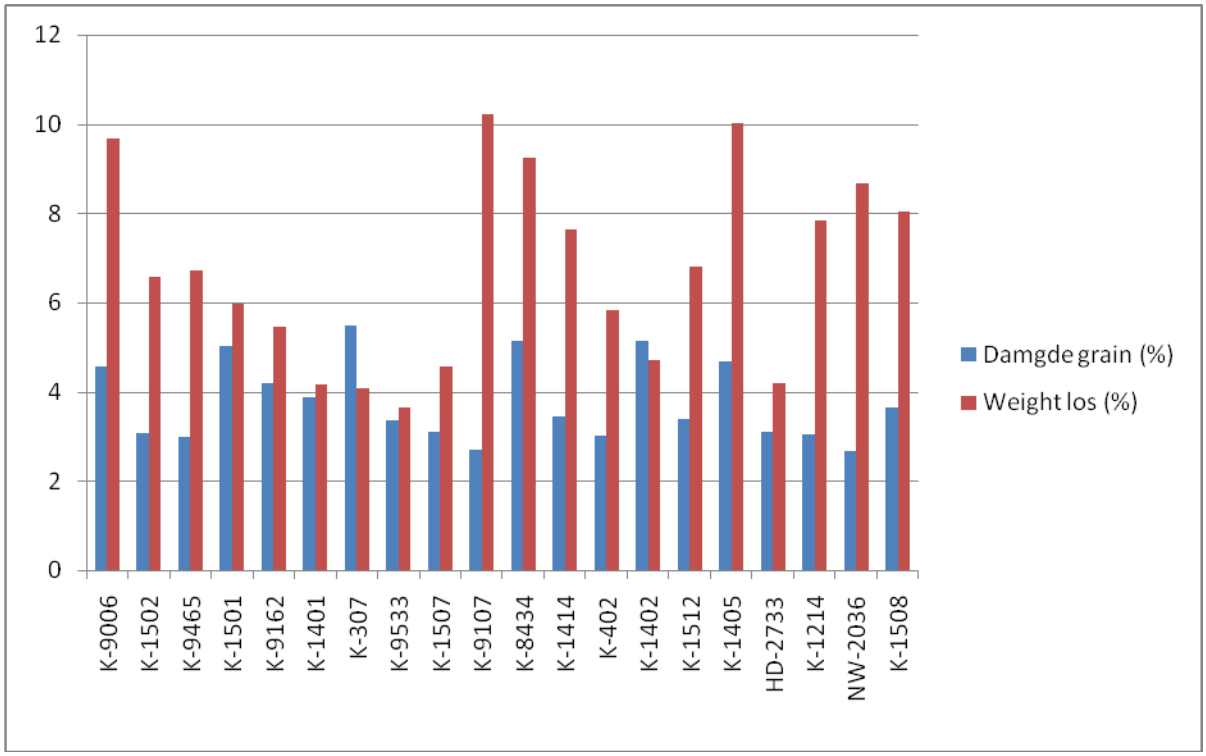
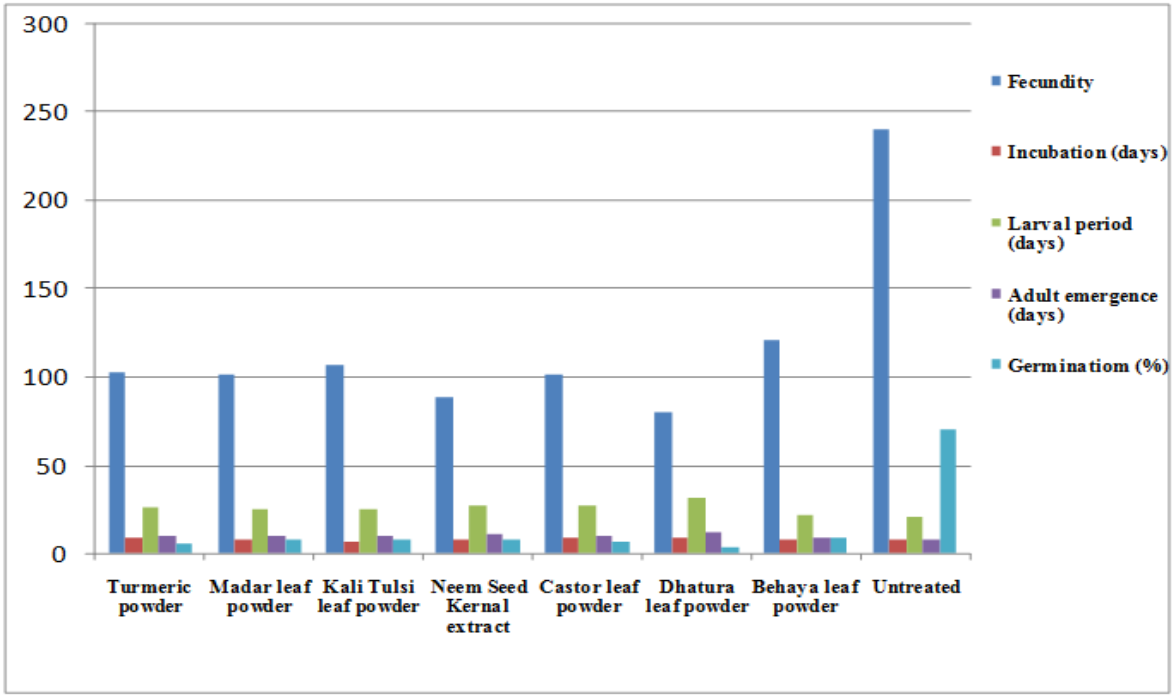


Fig.5 Effect of different grain protectants on fecundity, incubation, larval period, adult emergence and germination per cent of rice weevil:



The efficacy of *Neem* seed kernel powder (87.87 eggs) was also better than control. castor leaf powder, turmeric leaf powder and *Behaya* leaf powder having 101.35, 101.52 and 102.65 eggs, respectively, but they were significantly different from grains treated with *Mada*r and *Kali tulsi* leaf powder viz. 101.52 and 120.21 eggs, respectively(Fig-5).

Our results are supported by Mishra *et al.*, (2014), who reported that *Neem* seed kernel powder (NSKP), *Neem* cake, Dry *Neem* leaf powder (all at 10 g/kg), *Neem* oil (10 ml/kg) and nimbecidine (5 and 10 ml/kg) were found as seed protectants against *Sitophilus oryzae* in stored wheat.

Bakutis *et al.*, (2014), also reported that insecticidal activity of essential oils against rice weevil in stored grain. Our results are also supported by Nilesh *et al.*, (2016), who reported that *Datura stramonium* seed served as being a potential insecticidal agent, can be used to prevent infestation in wheat and even other grains during storage.

Incubation Period

Highest incubation period was observed in grains treated with castor leaf powder (8.89 days), followed by *Dhatura* leaf powder, turmeric powder, *Neem* seed kernel extract, *Madar* leaf powder, *Behaya* leaf powder and *Kali tulsi* leaf powder viz. 8.80, 8.12, 8.02, 7.26, 7.11 and 6.69 days, respectively(Fig-5).

Our results are also supported by Shivanna *et al*,. (1994), who reported that sweet flag leaf powder, gave maximum protection against stored pest.

Larval Period

Dhatura leaf powder showed the superiority overall other treatments to maximize the larval period of the pest i.e. 31.12 days. Significantly more larval period (27.19 days) was also recorded in grains treated with castor leaf powder followed by *Neem* seed kernel extract and turmeric powder i.e. 26.55 and 25.47 days, respectively. *Madar* leaf powder and *Kali tulsi* leaf powder were found to be at par with each other in increasing the larval period viz. 25.23 and 25.07 days, respectively, whereas *Behaya* leaf powder being 21.84 days was observed least effective but superior to the untreated check (20.19 days). Priyanka *et al.*, (2013), also reported that the seeds of *Azadirechta indica*, leaves of *A. indica*, *Ipomea carnea*, *Ocimum basilicum*, *Eucalyptus globules* and *Lantana camara*, roots of *Cyperus esculentus* were collected and dried in shade. The significantly minimum hatchability (37.10%) of rice weevil was observed in the grains treated with *A. indica* seed powder. The damaged grains by rice weevil in various treated grain samples ranged from 1.4 to 8.9 % being minimum in *Neem* seed kernel powder at 10 g/kg seed and increased in *E. globules* as compared to 44.44 per cent in control (Fig-5). Our results are also supported by Muhammad *et al.*, (2015), who also reported that *Nepeta clarkei* showed activity against *S. oryzae* larvae were not significant.

Adult emergence

The minimum adults emerged (3.71%) was observed in the grains treated with *Dhatura* leaf powder. The grain treated with *Kali tulsi* leaf powder, *Madar* leaf powder and *Neem* seed kernel extract minimize the adult emergence of pest by providing viz. 7.73, 7.36 and 7.82 % adult emergence, respectively. The treatments viz. *Kali tulsi* leaf powder, castor leaf powder, turmeric powder and *Behaya* leaf powder were found least effective having 6.29, 5.78 and 8.60 per cent adults emergence, respectively (Fig-5). Our results are supported by Raghav (2012), who reported that *Neem* leaf powder caused highest mortality.

Germination of seed

The powder of castor leaf adversely effected the germination which gave 81.90 per cent germination in comparison to other treatments.

Powders of *Neem* seed kernel, *Kali tulsi* leaf, turmeric, *Dhatura* leaf and *Madar* leaf gave minimum adverse effect in seed germination i.e. 83.62, 89.68, 89.86, 90.38 and 90.64 per cent, respectively. *Behaya* leaf powder and untreated grain having good germination showed 91.48 and 91.81 per cent germination, respectively. Ileke *et al.*, (2014) reported that the four plant powders including *Azadiracta indica*, *Alstonia boonei*, *Garcina kola* and *Moringa oleifera* on the Mortality of adults and emergence of maize weevil (*Sitophilus zeamais*) on stored wheat grains. The powders are found as not adverse effect on germination.

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