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Short Research Article

Comparative Evaluation of Different Insecticides against Damage Caused by *Sitophilus oryzae* L. in Stored Wheat Seed

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Abstract

Today in the era of increasing population of country has intensified the enhanced need for higher food production. The intensification of food production has led to several problems in the post-harvest phase including the major concern of pest infestation during storage. Therefore, seven insecticides, viz., neem seed kernel powder (NSKP), neem cake, dry neem leaf powder (all @ 10 g kg^{-1}), neem oil (10 ml kg^{-1}), nimbecidine (5 and 10 ml kg^{-1}) and deltamethrin 2.5 WP (40 mg kg^{-1}) were evaluated as seed protectant against *Sitophilus oryzae* L. in stored wheat seed (HUW 234). In a sample size of two kg in gunny bags, adult were released @ 10 pairs bag^{-1} and bags were stored at room temperature. Data on infestation, weight loss and germination percentage were recorded at an interval of 3, 6 and 9 months after storage. The results revealed that deltamethrin was found most effective insecticides without harming germination for controlling of gain infestation and weight loss followed by neem India, at higher and lower doses, nimbecidine at higher and lower dose, neem oil, neem cake, dry neem leaf powder and NSKP treatments.

1. Introduction

Wheat (*Triticum aestivum* L.) belonging to family Graminae is the main cereal crop in World. India is the second most populated and developed country. To feed its masses, India produced an estimated 95.85 mt of wheat between 2013 and 2014, exporting only about 5.56 mt of that supply to other countries (Stallard, 2014). The major increase in the productivity of wheat has been observed in the states of Haryana, Punjab and Uttar Pradesh. Higher area coverage is reported from Madhya Pradesh in recent years. The intensification of food production has led to several problems in the post-harvest phase including the major concern of pest infestation during storage (Khalequzzaman and Khanom, 2006). This is further aggravated by the increased attention paid to maintenance of buffer stocks to provide food security for a country. Pest problems have increased side by side with the increase in the quantity of food stockpiled and the longer duration of storage. Such pest problems are more acute in the tropics than in temperate zones because the environment in the former is more conducive to the growth and development of pests. As wheat has only few insect-pests under field conditions, but it is susceptible to storage pests which cause substantial qualitative/nutritional and quantitative losses of various magnitudes depending on the pest species and duration of storage (De Lima, 1979; Singhamony et al., 1985; Hell et al., 2000). Rice weevil (*Sitophilus oryzae* Linn.), a serious pest of stored wheat and feeds on rice, corn, oat, barley, sorghum, buck wheat ear and their products. It belongs to family curculionidae and order coleoptera and was first seen breeding on rice hence named as rice weevil way back in 1763. The adult female rice weevil lays an average of 4 eggs day^{-1} and may live for four to five months. The full life cycle may take only 26 to 32 days during hot summer months, but requires a much longer period during cooler weather. The eggs hatch in about 3 days. The larvae feed inside the grain kernel for an average of 18 days. The pupa is naked and the pupal stage lasts an average of 6 days. The new adult will remain in the seed for 3 to 4 days while it hardens and matures. It feeds voraciously, so much so that the grain is rendered unfit for human consumption.

Several attempts have been made by the earlier workers viz., Rai et al., 1987; Yadav and Singh, 1994, Campion et al., 1987, Shaaya et al., 1997, Niber, 1992 and Furiatti et al., 1999 in the Asian subcontinent to control the losses of wheat

due to insect-pest in stored grain by the use of pesticides like Synthetic sex pheromones, palm oil, peanut oil, extracts of *Cissampelos pareira* (Menispermaceae), *Erythrophleum suaveolens* (Leguminosae), neem (*A. indica*) extracts, *Ricinus communis* (Euphorbiaceae), *Solanum nigra* (Solanaceae) and synthetic chemicals likes malathion, chlorpyrifos-methyl, fenitrothion, deltamethrin, Esfenvalerate etc. But, very meagre work has been done earlier regarding their comparative evaluation. Therefore, present investigations were carried out with the objective to see the comparative efficacy of different insecticides against the damage caused by rice weevil in stored wheat seed in laboratory conditions.

2. Materials and Methods

The present investigations were carried out at Seed Storage Laboratory, Department of Entomology, Narendra Deva University of Agriculture and Technology, Narender Nagar, Faizabad, Uttar Pradesh, India situated at 82.12^0 E longitude and 26.47^0 N latitude during 2005.

Large number of adults of *Sitophilus oryzae* were collected from godown of seed processing plant of the University and were released @ 100 pairs jar^{-1} in two cylindrical glass jars of 10×15 cm^2 size each containing 1 kg pre-sterilized wheat of variety HUW 234. The jars were kept in Biological Oxygen Demand (BOD) incubator at 30^0C and RH 75% after covering their mouths with muslin cloth tied with rubber band. Leaves plucked from neem tree were sun dried and neem seed kernal purchased from M/S Maurya Oil mill Jagdishpur, Sultanpur were grind with the help of mixer and grinder to make them fine powder.

The adults of *Sitophilus oryzae* taken from already maintained culture, and their sex determination was done on the basis of size and intensity of curve of rostrum. The adults having shorter and less curved rostrum were identified as males and those of having longer and more curved rostrum were identified as females. After determining their sexes the beetles were released @ 10 pair (One male and one female) in each bag.

Twenty kg freshly harvested insect free grains of wheat variety HUW 234 obtained from seed processing plant of University, divided into 10 equal parts, weighing two kg each and was used for the evaluation of different insecticides against *Sitophilus oryzae* Linn. in stored wheat seed in laboratory conditions. Required amount of N.S.K. Powder, Neem Cake, Dry Neem Leaf Powder was weighted with the help of electronic balance and Neem Oil, Nimbecidine and Neem India was measured and mixed with the help measuring cylinder in 2 kg grain separately. However as per treatment Deltamethrin was weighed and diluted into 10 ml of water and mixed in 2 kg wheat sample kept for this purpose. Then this treated wheat grain was again divided into four equal parts, each weighing 500 g and was kept in gunny bags of two kg capacity. *Sitophilus oryzae* taken out from already maintained culture were sexed and released @ 10 pairs bag^{-1} and the bags were kept in steel racks at room temperature for further observations. The details of treatment used have been given in Table 1. Observations on infestation, weight and germination losses caused by of *Sitophilus oryzae* was recorded after 3, 6 and 9 months of storage.

For the recording of data each and every grain of sample was carefully observed with the help of magnifying lens (10×) and healthy and damaged grains were separated. The weight and number of healthy and damaged grains were recorded. The data, thus obtained were used for computing infestation and weight loss percentage by using following formulae

$$\text{Infestation (\%)} = \frac{\text{Number of damaged grains}}{\text{Total number of grains}} \times 100$$

$$\text{Infestation (\%)} = \frac{N_1\text{-}N}{N_1} \times 100$$

Where,

N_1 = weight of grain when stored

N = weight of grain after 3, 6 & 9 months of storage.

The germination of wheat seeds was tested by the towel paper (germination paper) method (ISTA, 1976). Four hundred healthy seeds were placed on towel paper already soaked with

Table 1: Details of the treatments used in the present studies

Sl. No.	Treatments	Dose kg^{-1} seed	Source
1	N.S.K. Powder	10 g	M/S Maurya Oil mill Jagadishpur
2	Neem Cake	10 g	M/S Maurya Oil mill Jagadishpur
3	Dry Neem Leaf Powder	10 g	Prepared in Laboratory
4	Neem Oil	10 ml	M/S Maurya Oil Mill Jagadishpur
5	Nimbecidine (0.03% EC Azadarichtin)	5 ml	M/S T. Stanes Company Ltd Coimbatore
6	Nimbecidine (0.03% EC Azadarichtin)	10 ml	M/S T. Stanes Company Ltd Coimbatore
7	Neem India (1500 ppm Azadarichtin)	5 ml	M/S ITC Ltd Kolkata
8	Neem India (1500 ppm Azadarichtin)	10 ml	M/S ITC Ltd Kolkata
9	Deltamethrin (2.5 WP)	40 mg	M/S Gharda chemicals Ltd. Thane Maharashtra
10	Untreated check	-	-

water and covered with another water soaked towel paper. The rolled towels were kept in germinator cabinet at 20^{0}C and 85% R.H. After 7 days the germination was recorded by counting the germinated and un-germinated seeds. The data thus obtained were used for computing germination percent.

$$\text{Germination (\%)} = \frac{G-G_1}{G} \times 100$$

Where,

G = Total number of seeds

G_1 = Number of un-germinated seeds

The data obtained from present investigation ware subjected to analysis of variance as suggested by Gomez and Gomez (1984) for complete Randomized Design.

3. Results and Discussion

3.1. Insect infestation

All the treatments were effective and significantly superior over control at all intervals for all the observations under study regarding insect infestation percentage. The most effective treatment was Deltamethrin having least per cent insect infestation (Table 2). After 3 months of storage minimum and significantly less infestation was found in Deltamethrin. Singh et al. (1998) and Pathak et al. (2002) when used as dust @ 3 ppm was also found effective. Pathak and Jha (2001) had also reported that Deltamethrin was most effective insecticides after 180 days of storage. Data recorded 6 months after treatment revealed that Deltamethrin (6.65%) was most effective, however it did not differ significantly with Nimbecidine @ 10 ml, Neem India @ 5 ml and Neem India @ 10 ml. Similarly, mixing neem seed powder @ 0.5, 1.0 and 2.5 g 50 g^{-1} seed gave protection for six months against *Sitophilus oryzae* also reported by Ivbijaro (1983).The order of efficacy in descending order at 9 months was Deltamethrin (11.38%), Neem India (13.36%), Neem India (13.62%) @ 5 and 10 ml, Nembecidine (14.08%), Nimbecidine (14.46%) @ 10 and 5ml kg^{-1}, Neem Oil (14.65%) @ 10 ml, Neem Cake (15.45%), Dry Neem Leaf powder (16.02%), N.S.K. Powder (19.41%) 10 g kg^{-1} and Control (29.60%). Pensook et al. 1992 had also reported that deltamethrin was effective for at least 9 months of storage.In present studies rest of all the treatments other than deltamethrin were also found effective than control. All the neem treatments showed potential, when compared with insecticidal treatments in storage against *Sitophilus oryzae* and *Rhizopertha dominica* (Muda, 1986).

3.2. Weight losses

All the treatments were effective and significantly different with each other and superior to control at all intervals of observations (Table 3). Deltamethrin was most effective and significantly superior than rest of the treatments in respect to reduced weight losses. It was followed by Neem India @ 10 ml kg^{-1}, Neem India @ 5 ml kg^{-1}, Nimbecidine 5 ml kg^{-1}, Nimbecidine 10 ml kg^{-1}, Neem Oil, Dry Neem Leaf Powder, Neem Cake and N.S.K. Powder, each @ 10 g kg^{-1} seed, 3.25, 3.72, 4.37, 4.50, 5.04, 5.36, 5.38 and 5.77% weight loss, respectively, when observation made 3 months after the seed treatment. Earlier, Islam et al. (1989) had also tested the 2 insecticides and two plant materials in the laboratory against *Sitophilus oryzae*. The treatment with decis 2.5 EC (deltamethrin) at 3 ppm was effective over a period of 9 months of storage. Similar trend in weight loss was record 6 and 9 months after treatment except that of Nimbecidine @ 10 ml kg^{-1} which became numerically better than Nimbecidine @ 5 ml kg^{-1} seed earlier by several workers (Sharma, 1999; Bowry et al., 1984 and Ahmed et al., 1980), hence, confirm our findings. A higher concentration of NSKP (10% w/w) was effective against *Sitophilus oryzae* over longer periods of time (Sharma, 1995). Rahman and Gupta (1997) reported that neem oil (10 ml kg^{-1}) treated rice showed minimum weight loss and free from attack of *Sitophilus oryzae* and *S. cerealella* after three months of storage.

3.3. Germination

Table 2: Effect of Insecticides on the infestation percentage of wheat grains after 3, 6 and 9 months of storage

Sl . No.	Treatments	% infestation after months		
		3	6	9
1.	N.S.K. Powder 10 g kg^{-1} seed	7.83 *(0.94)	12.42 (1.12)	19.41 (1.29)
2.	Neem cake 10 g kg^{-1} seed	6.98 (0.90)	8.55 (0.98)	15.45 (1.19)
3.	Dry Neem leaf powder 10 g kg^{-1} seed	5.36 (0.80)	8.43 (0.97)	16.02 (1.20)
4.	Neem oil 10 ml kg^{-1} seed	5.48 (0.81)	7.49 (0.93)	14.65 (1.17)
5.	Nimbecidine (0.03% EC Azadirachtin) 5 ml kg^{-1} seed	4.52 (0.75)	7.07 (0.91)	14.46 (1.16)
6.	Nimbecidine (0.03% EC Azadirachtin) 10 ml kg^{-1} seed	4.32 (0.72)	6.80 (0.89)	14.08 (1.15)
7.	Neem India (1500 ppm Azadirachtin) 5 ml kg^{-1} seed	4.41 (0.73)	6.85 (0.89)	13.62 (1.13)
8.	Neem India (1500 ppm Azadirachtin)10 ml kg^{-1} seed	4.12 (0.71)	6.85 (0.89)	13.36 (1.12)
9.	Deltamethrin 2.5 WP 40 mg kg^{-1}	3.49 (0.65)	6.65 (0.88)	11.38 (1.06)
10.	Untreated check	9.20 (1.01)	18.55 (1.30)	29.60 (1.47)
	CD (p=0.05)	(0.06)	(0.02)	(0.02)

*The figure in parentheses are logarithmic transformed values

Table 3: Effect of Insecticides on weight loss of wheat grains due to infestation of *Sitophilus oryzae* after 3, 6 and 9 months of storage

Sl. No.	Treatment	% weight loss after months		
		3	6	9
1.	N.S.K. Powder 10 g kg^{-1} seed	5.77 *(0.83)	8.54 (0.98)	13.74 (1.17)
2.	Neem cake 10 g kg^{-1} seed	5.38 (0.81)	7.8 (0.944)	12.75 (1.14)
3.	Dry Neem leaf powder 10 g kg^{-1}seed	5.36 (0.80)	7.87 (0.948)	13.13 (1.15)
4.	Neem oil 10 ml kg^{-1} seed	5.04 (0.78)	7.03 (0.90)	12.85 (1.14)
5.	Nimbecidine (0.03% EC Azadirachtin) ml kg^{-1} seed	4.37 (0.73)	6.82 (0.893)	12.48 (1.13)
6.	Nimbecidine (0.03% EC Azadirachtin) 10 ml kg^{-1} seed	4.50 (0.74)	6.46 (0.873)	12.06 (1.12)
7.	Neem India (1500 ppm Azadirachtin) 5 ml kg^{-1} seed	3.72 (0.67)	6.19 (0.857)	11.97 (1.11)
8.	Neem India (1500 ppm Azadirachtin)10 ml kg^{-1} seed	3.25 (0.63)	5.01 (0.779)	10.96 (1.08)
9.	Deltamethrin 2.5 WP 40 mg kg^{-1}	2.28 (0.52)	4.42 (0.735)	8.65 (0.98)
10.	Untreated check	8.72 (0.99)	14.40 (1.188)	20.99 (1.34)
	CD=(p=0.05)	(0.01)	(0.009)	(0.006)

*The figures in parentheses are logarithmic transformed values

Table 4: Effect of Insecticides on the germination of wheat grain before and after 3, 6, and 9 months of storage

Sl. No.	Treatments	% germination before and aftermonths			
		Be-fore	3	6	9
1.	N.S.K. Powder 10 g kg^{-1} seed	98.00	89.00	87.50	80.00
2.	Neem cake 10 g kg^{-1} seed	98.00	92.00	90.25	80.25
3.	Dry Neem leaf powder 10 g kg^{-1} seed	98.00	87.50	85.00	81.00
4.	Neem oil 10 ml kg^{-1} seed	98.00	79.50	76.00	71.00
5.	Nimbecidine (0.03% EC Azadirachtin) 5 ml kg^{-1} seed	98.00	80.50	76.00	72.50
6.	Nimbecidine (0.03% EC Azadirachtin) 10 ml kg^{-1} seed	98.00	82.00	75.75	71.50
7.	Neem India (1500 ppm Azadirachtin) 5ml kg^{-1} seed	98.00	88.50	81.00	72.50
8.	Neem India (1500 ppm Azadirachtin)10 ml kg^{-1} seed	98.00	88.50	86.00	78.50
9.	Deltamethrin 2.5 WP 40 mg kg^{-1}	98.00	94.50	90.50	87.50
10.	Untreated check	98.00	92.00	71.25	54.37
	CD=(p=0.05)	-	4.95	3.56	6.04

The perusal of data given in table 4 revealed that the germination of wheat used in different treatments was homogenous viz., 98%. Data also revealed that all the treatments had adversely affected the germination. Wheat treated with Neem Oil @ 10 ml kg^{-1} seed gave minimum germination, however, it did not differ significantly with Nimbecidine @ 5 ml kg^{-1} and Nimbecidine @ 10 ml kg^{-1} after 3 and 6 months and Nimbecidine 5 ml, Nimbecidine 10 ml kg^{-1} and Neem India 5 ml kg^{-1} after 9 months of storage. N.S.K. Powder with Neem Cake at six months interval and N.S.K. Powder with Neem Cake and Dry Neem Leaf Powder at 9 months observation were also *at par* with each other. Deltamethrin (2.5 WP) @ 40 mg kg^{-1} seed showed maximum germination, however, it did not differ significantly with untreated cheek at 3 months interval. In the present studies, all treatments including control showed germination losses associated with insect infestation which is not due to insecticidal properties of insecticides, but because of egg laying by *Sitophilus oryzae* inside the grain and hence, larvae feed within them. Jotwani and Sircar (1965) also reported that germination of the wheat was not impaired by neem compounds.

4. Conclusion

Deltamethrin 2.5 WP @ 40 mg kg^{-1} seed was found most effective in controlling grain infestation and weight loss, followed by Neem India @ 10 ml kg^{-1} >Neem India 5 ml kg^{-1} >Nimbecidine 10 ml kg^{-1}>Nimbecidine @ 5 ml kg^{-1} >Neem Oil @ 10 ml kg^{-1} >Neem cake @ 10 g kg^{-1}>Dry Neem Leaf Powder @ 10 g kg^{-1} > N.S.K. Powder @ 10 g kg^{-1} seed > control.

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