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Effect of seed protectants on quantity losses in mung bean against bruchids in mung bean seed

Himanshu Singh, Radha Binod Singh and Shivangi Negi

Abstract
Seven seed protectants *viz.*, Emamectin benzoate (Procliam 5 SG) @ 40 mg/kg seed, Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed, Malathion (Malathion 5% Dust)@ 2.5 mg/kg seed, Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed, Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed and Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seedwere assessed for their effectiveness in mung bean variety, IPM 2-3.Minimum per cent weight loss (0.68) with minimum insect infestation (0.33) was observed when the seed treated with Emamectin Benzoate (Procliam 5 SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seedand up to 6 months of storage under ambient condition. The minimum seed moisture was found in Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 13.767 per cent followed by Malathion (Malathion 5% Dust) @ 2.5mg/kg seed and Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed. The results showed that seed protectants *viz.*, Emamectin benzoate (Procliam 5SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seedmay be used as suitable seed protectants for storing seed of mung bean under ambient storage condition.

Keywords: Seed Protectant, Bruchids, pulse beetle, damage, weight loss

Introduction
Pulses are an important group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population in India and other countries. Although, being the largest pulse crop cultivating country in the world, India's production of pulses is relatively low in comparison to total cereal crops productions. Mung bean is botanically recognized as *Vigna radiata* (L.) Wilczek and belongs to the family *Fabaceae*. The genus *Vignaradiata* has been broadened to include about 150 species but only twenty two species are native to India, where they are grown in large numbers and are often grouped under distinct varieties and sub species (Polhill and Maesen Vander, 1985) [11]. Mung bean is grown on more than 6 million ha worldwide (about 8.5% of global pulse area) of which about 90% is confined toAsia. India is the largest producer of mung bean having about 3.83 million ha cultivated land with the total production of 2.01 million tonnes of grain with an average productivity of 418 kg/ ha and 7.96% share in total production (Anonymous, 2019) [2]. The most important product of the mung bean plant is its seed. Mung bean is used in several food products, both as a whole seed and in processed form (Myers, 2000) [10]. In a country like India where a large population is vegetarian, pulses are the cheapest and best source of total dietary protein (Swaminathan, 1937) [13].
Pulse beetles, *Callosobruchus chinensis* is a common species on mung bean which belonging to the family, bruchidae. This pest was first of all described in china in the year 1758 where the beetle gets its species name. This beetle is a common pest targeting many different species of

stored legume and it is distributed across the tropical and subtropical regions of the world (Thembhare, 2007) [15].
Pulse beetle causes infestation to pulses both in field as well as in ambient storage and thus pulse grains are become unsuitable for human consumption, viability as seeds, or for the production of sprouts (*Anonymous*, 2016) [1]. Adults do not require food or water and spend their limited lifespan (one-two weeks) (Kergoat *et al.*,2007) [5]. The bruchid is cosmopolitan in nature and capable of attacking wide range of legume namely green gram, black gram, chickpea, pigeon pea and lentils (Sharma, 1984) [14]. Bruchids are the most notorious among the insects of chick pea and cause 50 per cent damage during storage in three to four months (Caswell, 1981) [3] although the infestation starts in the field and continues in storage and after a period of six months the loss has been estimated to be around 30-40 per cent, sometimes even in the severe cases of infestation the damage can reach even up to 100 per cent (Lal and Raj, 2012) [8]. Insecticides are one of the most effective weapons for disinfesting and protecting stored products from infestation. However, resistance of many storage pests against traditional insecticides stressed upon the need to use some substitute insecticides which are potent and safe.
In view of these aspects, literature related to the management of pulse beetles by newer insecticides and maintaining the quantity losses of mung bean seed during ambient storage condition.

Material and Methods

Mung bean seed (*Vigna radiate* L.) variety IPM-2-3 was acquired from Seed Processing unit of Acharya Narendra Deva University of Agriculture & Technology, Ayodhya. Seed of mung bean for experiments was fumigated with aluminium phosphide (3g Tab each) @ 1 Tab/ 3q seed with seven days of exposure periods to disinfested mung bean seed before start the experiments under ambient storage condition. There were total eight treatments with three replications for each where 500 g. mung bean seed in each replication in each treatment were mixed with seed protectants as per treatment. Thus treated mung bean seed packed in 1kg capacity gunny (jute) bags and kept them on racks in lab under ambient storage condition for further observations.

The experiment the required number of seed was randomly obtained from each gunny (jute) bags of each treatment in each replication.

Treatment	Name of seed protectant	Trade name	Dose (mg or ml/ kg Seed)
T_1	Emamectin benzoate	Procliam (5 SG)	40 mg
T_2	Spinosad	Tracer (45 SC)	3.5 mg
T_3	Indoxacarb	Avaunt (14.5SC)	13.8mg
T_4	Malathion	Malathion (5% Dust)	2.5mg
T_5	Novaluron	Rimon (10 EC)	0.05 ml
T_6	Nimbecidine	Nimbecidine (0.03%EC)	1.5 ml
T_7	Deltamethrin	Decis (2.8 EC)	0.04ml
T_8	Control		Untreated

For observations in the experiment the required number of seed was randomly obtained from each gunny (jute) bags of each treatment in each replication. The observation will be recorded at 0, 3 and 6 month after treatment with seed protectants. From each replication of seed treatments hundred seed will be randomly selected to short out healthy and unhealthy seed with the help of magnifying lens (10x). Thus the data obtained will be used for calculating insect infestation per cent by using given formula (Mohan and Sundar babu, 1999) [9].

$$\text{Per cent seed damage (bored seed)} = \frac{\text{No. of bored seed in sample}}{\text{Total number of seed in sample}} \times 100$$

To evaluate the quantity losses of mung bean seed, 300 seed will be taken from each replication of each treatment. The observations were recorded at the end of experiment (180 days). Thus the data obtained will be used for calculating quantity (weight) loss per cent by using given formula.

$$\text{Per cent weigh t loss in seed} = \frac{\text{Weight of damage seed of sample}}{\text{Total weight of seed in sample}} \times 100$$

Moisture content of mung bean seed in each replication was recorded with the help of Digital moisture meter at 0, 3 & 6 months after treatment with seed protectants under ambient storage condition.

Result

Efficacy of seed protectants against bruchids in mung bean seed

The data (Table-1) of insect infestation (%) at different storage period showed variation in mung bean seed. All the Seed protectants after 3 and 6 months of storage were significantly superior over control. After 3 months of storage period the seed insect infestation per cent with in the seed protectants was ranged between 0.00 – 2.66 per cent. The maximum seed insect infestation per cent in treatments was observed in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 2.66 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 2.33 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 1.66 per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 1 per cent seed damage. The minimum seed infestation 0 % was observed in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 0.33 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 0.66 per cent infestation.

Table 1: Efficacy of seed protectants against bruchids in mung bean seed

Treatment	Seed protectant	Dose (mg or ml/ kg Seed)	Storage Months After Treatment (Insect Damage %)	
			3	6
T_1	Emamectin benzoate (procliam 5 SG)	40 mg	0.00 (0.00)	0.33 (1.91)
T_2	Spinosad (Tracer 45 SC)	3.5 mg	1.00 (5.73)	1.66 (7.33)
T_3	Indoxacarb (Avaunt 14.5 SC)	13.8 mg	1.66 (7.33)	2.66 (9.35)
T_4	Malathion (Malathion 5% Dust)	2.5 mg	2.33 (8.74)	4.33 (11.93)
T_5	Novaluron (Rimon 10 EC)	0.05 ml	0.66 (3.82)	1.33 (6.53)
T_6	Nimbecidine (Nimbecidine 0.03% EC)	1.5 ml	2.66 (9.35)	5.66 (13.75)
T_7	Deltamethrin (Decis 2.8 EC)	0.04 ml	0.33 (1.91)	1.00 (4.62)
T_8	Control	Untreated	4.66 (12.45)	9.33 (17.75)
S.E(m)±			1.05	1.26
C.D. (5%)			3.19	3.81

After 6 months of storage the per cent seed infestation ranged from 0.33 – 5.66%. The maximum insect infestation per cent in treatment was recorded in Nimbecidine (Nimbecidine 0.03% EC) @ 1.5ml/kg seed with 5.66 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 4.33 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 2.66 per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 1.66 per cent seed damage.

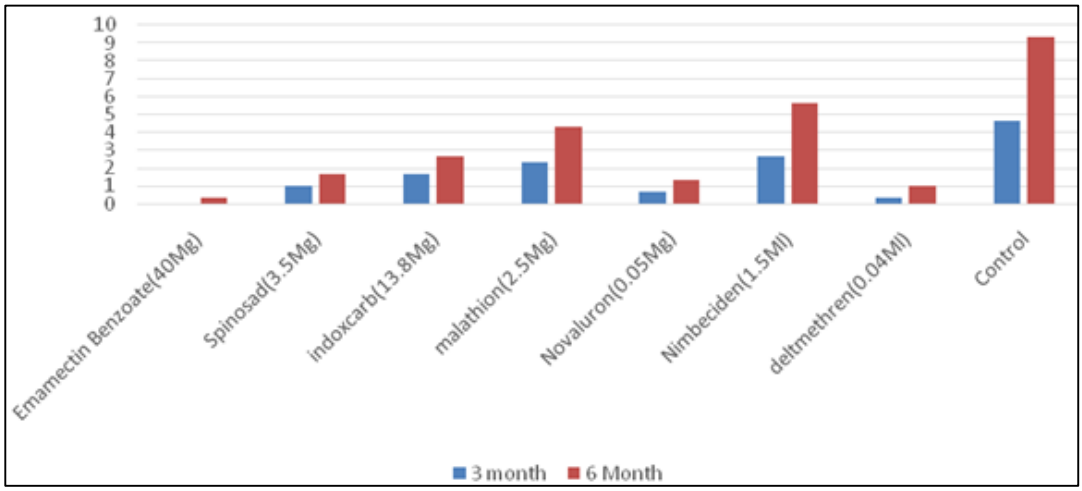

Fig 1: Efficacy of seed protectants against bruchids in mung bean seed

The minimum insect infestation 0.33% was recorded in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 1.0 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 1.33 per cent damage. The maximum insect infestation (4.66%) at 3 month and (9.33%) at 6 months of storage period. The infestation percent at 6 months in control was higher in compared to treatments which was 9.33%. Seed infestation increased significantly as storage period increased.

Efficacy of seed protectants on quantity losses in mung bean

The data (Table-2 and Fig-2) of weight loss (%) at different storage period showed variation in weight loss per cent in mung bean seed. All the seed protectants after 3 to 6 months were found significant over control.

After 3 months of storage, the weight loss was ranged from 0.00 - 9.52 per cent. The maximum weight loss was recorded in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 4.67 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 4.02 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 2.53 per cent seed damage. The minimum seed weight loss was observed in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 0% followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 0 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 1.0 (0.988) per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 1.29 per cent seed damage. The weight loss in control was higher in compare to treatment which was 9.52 per cent.

Table 2: Efficacy of seed protectants on quantity losses in mung bean

Treatment	Seed protectant	Dose (mg or ml/ kg Seed)	Storage Months After Treatment (Weight loss %)	
			3	6
T_1	Emamectin benzoate (procliam 5 SG)	40 mg	0.00	0.68
T_2	Spinosad (Tracer 45 SC)	3.5 mg	1.29	2.35
T_3	Indoxacarb (Avaunt 14.5 SC)	13.8 mg	2.53	3.31
T_4	Malathion (Malathion 5% Dust)	2.5 mg	4.02	6.33
T_5	Novaluron (Rimon 10 EC)	0.05 ml	0.99	2.29
T_6	Nimbecidine (Nimbecidine 0.03% EC)	1.5 ml	4.67	7.30
T_7	Deltamethrin (Decis 2.8 EC)	0.04 ml	0.00	1.07
T_8	Control	Untreated	9.52	18.88
S.E(m)±			0.19	0.21
C.D. (5%)			0.58	0.65

After 6 months of storage the seed weight loss was ranged from 0.68 - 18.88 per cent. The maximum seed weight loss was observed in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 7.30 per cent followed by Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 6.33 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 3.31 per cent seed infestation respectively.

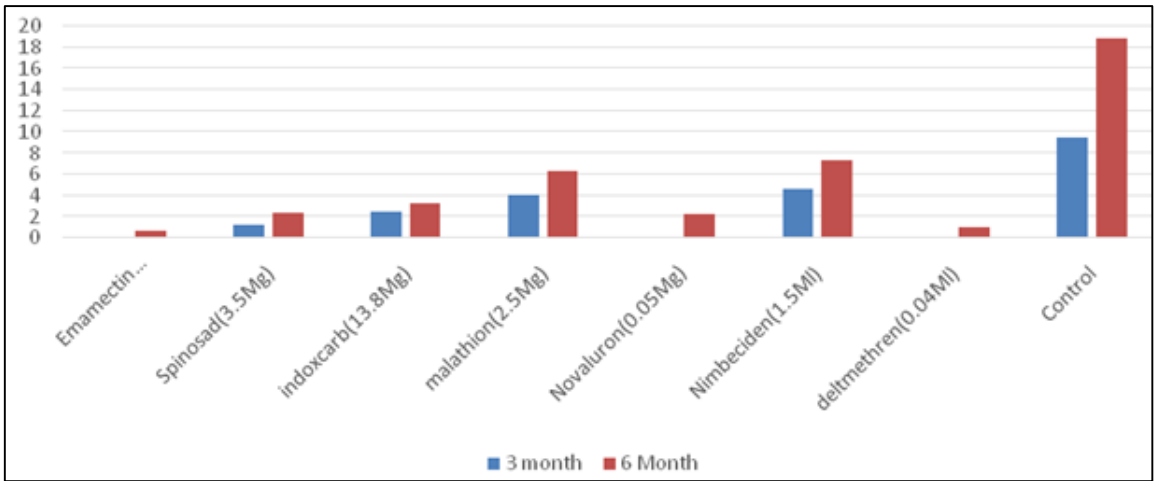

Fig 2: Efficacy of seed protectants on quantity losses in mung bean

The minimum seed weight loss was found in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 0.68 per cent followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 1.07 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 2.29 per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 2.35 per cent. The weight loss in control was 18.88 per cent significantly higher than all control.

Efficacy of seed protectants on Mung bean seed moisture content at different storage period

The data pertaining to moisture content of seed influenced by seed protectants, storage period and metrological conditions, presented in the table (3 and figure 3). Seed moisture content regarding effect of seed treatments was found significant according to nature of seed protectants and the time of storage period.

After 3 months of storage, seed moisture content in treatment ranged from 13.03 per cent to 13.93 per cent. The higher per cent of seed moisture was recorded in Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 13.90 per cent followed by Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 13.46 per cent, Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 13.40 per cent. The minimum seed moisture was recorded in Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 13.03 per cent followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seedwith 13.10 per cent and Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 13.13 per cent. The moisture content in control was highest with 13.93 per cent.

Table 3: Efficacy of seed protectant on Mung bean seed moisture content at different storage period

Treatment	Seed protectant	Dose (mg or ml/ kg Seed)	Storage Months After Treatment (Seed Moisture Content %)	
			3	6
T_1	Emamectin benzoate (procliam 5 SG)	40 mg	13.46	14.20
T_2	Spinosad (Tracer 45 SC)	3.5 mg	13.03	14.30
T_3	Indoxacarb (Avaunt 14.5 SC)	13.8 mg	13.90	14.10
T_4	Malathion (Malathion 5% Dust)	2.5 mg	13.13	14.03
T_5	Novaluron (Rimon 10 EC)	0.05 ml	13.16	13.76
T_6	Nimbecidine (Nimbecidine 0.03% EC)	1.5 ml	13.40	14.30
T_7	Deltamethrin (Decis 2.8 EC)	0.04 ml	13.10	14.06
T_8	Control	Untreated	13.93	14.63
S.E(m)±			0.02	0.11
C.D. (5%)			0.08	0.33

After 6 months of storage the seed moisture content in treatments ranged from 13.76 per cent to 14.63 per cent. The highest seed moisture content was recorded 14.30 per cent in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed followed by Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 14.20 per cent moisture content which was at par.

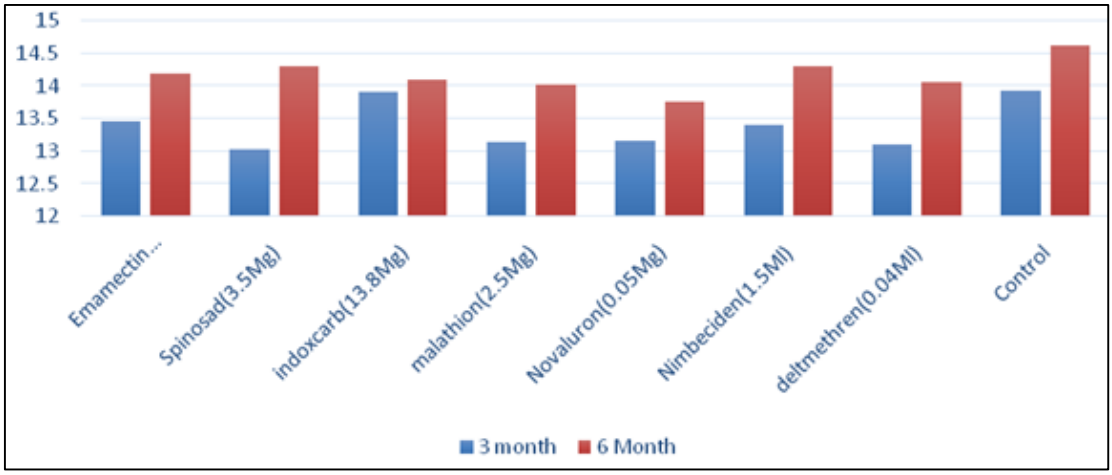

Fig 3: Efficacy of seed protectants on Mung bean seed moisture content at different storage period

The minimum seed moisture content was recorded in Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 13.76 per cent followed by Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 14.03 per cent and Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 14.06 per cent. The moisture content in control higher was 14.63 per cent recorded.

Discussion

After 3 months of storage insect infestation per cent with the seed protectants was ranged between 0 – 2.66 percent. The minimum insect infestation was observed 0% in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 0.33 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 0.66 per cent insect infestation. The highest seed insect infestation in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 2.66 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 2.33 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 1.66 per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 1 per cent seed infestation.

After 6 months of storage the percent seed infestation ranged 0.33 – 5.66%. The minimum insect damage 0.33% was observed in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 1.0 per cent and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 1.33 per cent infestation. All treatment was significantly superior over the control. The maximum insect infestation was observed in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 5.66 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 4.33 per cent.Seed infestation percent was increased in all the treatments as period increased in storage period and nature of seed protectants. These results were also supported by Kumari *et al.* (2014) [7] and Kadam *et al.* (2013) [6].

Seed weight loss after 3 months of storage was ranged 0- 9.52 per cent. The minimum seed weight loss was observed in treated with Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 0% followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seedwith 0 per cent, Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 1.0 (0.988) per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 1.29 per cent weight loss. The seed weight loss within treatments (Seed protectants) higher in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 4.67 per cent followed by Malathion (Malathion 5% Dust) @ 2.5 mg/kg seed with 4.02 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 2.53 per cent seed infestation.

After 6 months of storage, the seed weight loss was ranged from 0.68-18.88 per cent. The minimum weight loss in Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 0.68 per cent followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seedwith 1.07 per cent, Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 2.29 per cent and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 2.35 per cent. The maximum seed weight loss was recorded in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 7.30 per cent followed by Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 6.33 per cent, Indoxacarb (Avaunt 14.5 SC) @ 13.8 mg/kg seed with 3.31 per cent.

Above findings have been reported by several workers, Kumari *et al.* (2014) [7], Gawade *et al.* (2009) [4] and Pramanik and Sardar (2006) [12].

Moisture content of seed is mainly depends upon the condition of storage environment, storage period and nature of seed protectants. After 3 months of storage seed moisture content was ranged from 13.03 per cent to 13.93 per cent. The minimum seed moisture per cent was recorded in Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed with 13.03 per cent followed by Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 13.10 per cent, Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 13.13 per cent that was significantly lower than the control. The highest per cent of moisture was observed in Indoxacarb @ 13.8 mg/kg seed with 13.90 per cent followed by Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 13.46 per cent, Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed with 13.40 per cent.

After 6 months of storage the moisture ranged from 13.76 per cent to 14.63 per cent. The minimum seed moisture was recorded in Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed with 13.76 per cent followed by Malathion (Malathion 5% Dust) @ 2.5mg/kg seed with 14.03 per cent and Deltamethrin (Decis 2.8 EC) @ 0.04 ml/kg seed with 14.06 per cent. The maximum moisture was recorded 14.30 per cent in Nimbecidine (Nimbecidine 0.03% EC) @1.5ml/kg seed and Spinosad (Tracer 45 SC) @ 3.5 mg/kg seed followed by Emamectin benzoate (procliam 5 SG) @ 40 mg/kg seed with 14.20 per cent moisture content which was at par, more or less. Similar work has also been reported by Pal and Katiyar (2013), Patole and Mahajan (2008).

Conclusion

All evaluated seed protectants, the Emamectin Benzoate (Procliam 5 SG) @ 40mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04ml/kg seed and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed found more effective due to minimum weight loss and insect infestation per cent.

This investigation revealed that seed protectants *viz.*, Emamectin benzoate (Procliam 5 SG) @ 40mg/kg seed followed by Deltamethrin (Decis 2.8 EC) @ 0.04ml/kg seed and Novaluron (Rimon 10 EC) @ 0.05 ml/kg seed may be used as suitable seed protectants under ambient storage condition for storage of mung bean seed above Indian minimum seed certification standards for at least 6 months.

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