RESEARCH ARTICLE

EVALUATION OF VARIOUS INSECTICIDES AS SEED PROTECTANTS AGAINST PULSE BEETLE, *CALLOSOBRUCHUS CHINENSIS* L. CHRYSOMELIDAE ON PIGEONPEA *CAJANUS CAJAN L. SEED UNDER* AMBIENT STORAGE

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Abstract: Eight common insecticides were used as seed protectants Emamectin benzoate (Proclaim 5SG) @2ppm (40.0mg/kg seed), Spinosad (Tracer 45SC) @2ppm (4.4mg/kg seed), Indoxacarb (Avaunt14.5SC) @2ppm (13.8mg/kg seed), Rynaxypyr (Coragen20SC) @2ppm (0.01ml/kg seed), Chlorfenapyr (Intrepid 10EC) @2ppm (0.02ml/kg seed), Profenofos (Curacron50EC) @2ppm (0.004ml/kg seed), Novaluron (Rimon10EC) @5ppm0.05ml/kg seed), Delltamethrin2.8EC @1.0 ppm (0.04 ml/kg seed) along with one untreated control. All the chemicals were tested for their effectiveness in term of seed moisture, damage by test insect, weight loss, germination and vigour against *C. chinensis* under ambient condition for a period of 9 months. After 9 months of storage the results revealed that insecticides namely Novaluron 10 EC@ 0.05ml/kg with 1.33 per cent infestation, 7.08 per cent weight loss and other measuring traits followed by Emamectin Benzoate 5 SG@ 40mg/kg with 1.67 per cent infestation and 8.16 per cent weight loss showed best results. Infestation, weight loss increased significantly along with the increase in moisture per cent.

Keywords: Seed, Germination, Vigour, Infestation, Pulse beetle, Chrysomelidae

INTRODUCTION

In a country like India where a large population is vegetarian, pulses have an important role in their daily diet because they totally depend upon pulses to fulfil their requirements of Protein. For the vegetarian peoples, cereals are the staple food to provide energy but they are poor in nutrition which may be covered by including pulses in diet. Pulses contain 24-27 per cent protein on dry seed basis, which is almost a greater value than normally found in cereals. Pulses are also the major source of different types of vitamins like riboflavin, thiamine, niacin and folic acid. In addition, they also contain a quantity of fibre, which is desirable in human diet (Swaminathan, 1937). Pulses are the third important group of crops in Indian agriculture after cereals and oilseeds. They are also important for sustainable agriculture as they improve soil fertility by fixing atmospheric nitrogen with the help of nitrogen fixing bacteria that found in their root nodules, for it they are known as mini nitrogen factory.

From the Start of 19th century, agriculturists growing a hardy drought-tolerant legume, native of India known as red gram or pigeonpea (*Cajanuscajan* L.) belong to family Fabaceae. It is an often-cross pollinated crop. Today, in terms of global production of legume crops, pigeonpea is sixth after Phaseolus species (common beans), peas, chickpea, broad beans and lentil. Globally pigeon pea is cultivated on about 4.58 million hectares of land with annual production of 3.27 million tonnes and productivity is about 830 kg hectare respectably. India is the major pigeon pea growing country and accounts about 3.1-million-hectare area with 2.12 million tonnes of annual production (Anonymous, 2019-20).

According to an estimate, 60 per cent of the whole production that produced is destroyed by insect pest in which storage insect-pest play an important role. The insects causing damage to stored pulses are pulse beetle (*Callosobruchus chinensis*), Khapra beetle (*Trogoderma granarium*) and lesser grain borer (*Rhizopertha dominica*). Among these, the pulse beetle is most important insect-pest due to causing infestation to pulses both in field as well as in ambient storage. The bruchids are most degraded stored grain pest, causing loss of nearly 10-90 per cent (Rathore and Sharma, 2002).

The bruchids breed exclusively on pulses having a very short life span with high degree of reproductive potential. The pest developed during storage within the grains and detected only when adult beetles come out. Its infestation is maximum from July to August is up to 50 per cent losses. *Callosobruchuschinensis* is a common species of beetle and is known to be a pest to many stored legumes belonging to the leaf beetle family, Chrysomelidae. Other common names included as pulse beetle, Chinese bruchid and cowpea bruchid. This species has a very similar lifespan and habitat to *Callosobruchusmaculatus* and their identities are often mistaken for each other. This beetle is a common pest targeting many different species of stored legumes and it is distributed across the tropical and subtropical regions of the world. Pulse beetle is one of the most damaging crop pests to the stored legume due to their generalized legume

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diets and wide distribution. The first recorded sighting and description of *C. chinensis* was in China in 1758 where the beetle gets its species name (Thembhare, 2007).

The beetle's natural ranges are in the tropics and subtropics of Asia, and their population extensively dependent on the cultivation and distribution of legumes. Their distribution is heavily influenced by human production and they live in legumes that are suitable for them to mate on and to feed on. Some of their common host include green gram, lentil, cowpea, pigeon pea, chickpea and other pea species though they are known to live on many more legume hosts. The species most preferred habitat is in the tropics on chickpeas (Adhikary and Barik, 2012). They reach to the height of egg production and legume infestation in July–August. The female lay egg after 3-4 day of copulation. The eggs are laid on the grain in storage or in field at the time of pod development, eggs are singly laid and yellowish white in colour. A single female lay about 60-90 egg in her life span, they hatch in 4-5 days. The grubs are oligopod, cylindrical, 5 mm. long and brown in colour. They pupate within the grain making an exit hole with the lid and pupate after 4 larval moults. Pupae are brown in colour. Adults emerge after 4 weeks of pupal period; they are small chocolate colour and about 3.2 mm long. Adults are harmless and do not feed on storage produce. Life cycle complete in 28-58 day and there are 7-8 over lapping generation found in one year (Mathur and Upadhyay, 1997).

To increase our pulses production, it is necessary to protect seed during storage form the infestation of several pests including bruchids because they feed on whole grain internally and make them unusual for sowing in next crop season. To maintain the seed quality which is deteriorated by infestation of insect during ambient storage is managed by using various insecticides to arrest the life of bruchid in ambient storage. Thus, seed can be protected from insect pests during storage by applying suitable insecticidal treatments. The use of common contact insecticides under storage such as emamectin benzoate, malathion, spinosad etc. can maintain the seed germination, viability and vigour. (Patil *et al*. 2006).

MATERIALS AND METHODS

The laboratory experiments under the title "Evaluation of Various Insecticides as Seed Protectants against Pulse Beetle, *Callosobruchus chinensis* L., Chrysomelidae on Pigeonpea *Cajanus cajan* L. seed Under Ambient Storage" were conducted in the seed Entomological laboratory of seed technology section and Department of Entomology, Narendra Deva University of Agriculture and Technology, Narendranagar, Kumarganj, Faizabad, U.P.

The detailed account of materials used and methods employed in the present investigations are described here as follows:

Rearing of test insect:

Five hundred pairs of adults *Callosobruchus chinensis* were collected from godowns of seed processing unit of N.D.U.A. & T., Kumarganj, Faizabad and were released in containers (plastic jars) having one kg disinfested pigeonpea, variety NDA 1. The mouths of containers were covered with muslin cloth and tied with the help of rubber band and were kept in B.O.D. incubator at 28 ± 20 C and 75 ± 5 per cent RH to conduct the experiment assessment of residual toxicity. The male and female bruchids were shorted on the basis of morphological character given as follow:

Species	Distinguishing characters	Male	Female
C. chinensis	1. Antennae	Long and pectinate type	Short and serrate type
	2. Body	Small in size than female having black small markings on elytra.	Bigger in size than male and having dark black spots on elytra.

Disinfestations of seed:

Collected seed of var. NDA1 from seed processing unit of NDUAT, Kumarganj, Faizabad was fumigated with aluminium phosphate (3g tab. each) @ 3 tab./t. in airtight container and disinfested, before starting the experiments.

Experimental Details:

Experimental design	:	CRD
Treatments	:	9
Replications	:	3
Variety	:	NDA 1
Packing material	:	Gunny bags of 2 kg capacity
Experimental condition	:	Ambient

Treatments:

S.No.	Seed protectants		Rate (Per Kg of seed)
	Trade name	**Common name**	
1.	Proclaim (5 SG)	Emamectin benzoate	2ppm (40.0 mg)
2.	Tracer (45 SC)	Spinosad	2ppm (4.4 mg)
3.	Avaunt (14.5 SC)	Indoxacarb	2ppm (13.8 mg)
4.	Coragen (20 SC)	Rynaxypyr	2ppm (0.01ml)
5.	Intrepid (10 EC)	Chlorfenapyr	2ppm (0.02 ml)
6.	Curacron (50 EC)	Profenofos	2ppm (0.004ml)
7.	Rimon (10 EC)	Novaluron	5ppm (0.05ml)
8.	Decis (2.8 EC)	Deltamethrin	1.0 ppm (0.04 ml)
9.	Control		Untreated

One kg. seed of pigeonpea (NDA 1) for each replication was taken under each treatment. Required quantity of pesticide was diluted in 5 ml. of water for proper coating on seed. Thus, treated seeds were packed in 2 kg gunny bag and placed in racks in laboratory under ambient condition for further investigations.

Damage:

Randomly selected hundred seeds of each sample in each replication from experimental seed were carefully examined with the help of magnifying lens. Healthy and damage seed were separated on the basis of damage nature of bruchids. The observations were recorded after 9 months of ambient storage and calculated by given formula. (Kumar, 2008).

$$\text{Per cent seed damage} = \frac{\text{number of damage seed in sample}}{\text{total number of seed in sample}} \times 100$$

Per cent weight loss:

Weight loss in seed of pigeonpea after 9 months of storage periods was calculated by following formula. (Daware, 2008)

$$\text{Per cent seed weight loss} = \frac{\text{Weight of damaged seed}}{\text{total weight of seed in sample}} \times 100$$

Per cent germination:

The germination was recorded after 9 months of storage as per ISTA procedure by adopting the towel paper (germination paper) method. One hundred randomly selected seed of pigeonpea from each treatment of each replication were placed on water-soaked germination paper. The rolled germination paper were covered with butter paper and placed in germinator at 70-75 per cent RH and 28±20C temperature for a period of 7 day for proper germination. At 7th day the germinated seed were counted and workout germination percentage for each replication of each treatment

Seed vigour index:

Seed vigour index was calculated by adopting the following formula as suggested by Abdul Baki and Anderson, (1973) and was expressed in whole number. For seed vigour index, standard germination percentage is multiplied by seedling length.

Seed vigour index = germination (%) × seedling length (cm)

Per cent seed moisture content:

Per cent seed moisture contents of pigeonpea seed of each treatment in all three replications was recorded after 9 months of storage with the help of moisture meter (MT-PROTM).

RESULTS AND DISCUSSION

Damage:

The results (Table-1) showed variations in percent seed damage in pigeon pea after 9 months were found significant over control.

After 9 months of storage, the percent seed damage ranged 1.33-3.00 per cent. The maximum damage was observed in rynaxypyr 20 SC@ 0.01ml/Kg with 3.00 per cent damage followed by deltamethrin 2.8 EC@ 0.04ml/Kg with 2.67 per cent and Indoxacarb 14.5 SC@ 13.8mg/Kg with 2.33 per cent seed damage. The minimum damage observed in novaluron 10 EC@ 0.05ml/Kg with 1.33 per cent followed by emamectin benzoate 5 SG@ 40mg/Kg with 1.67 per cent, spinosad 45 SC@ 4.4mg/Kg, chlorfenpyer 10 EC@0.02ml/Kg 10 EC@0.02ml/Kg and indoxacarb 14.5 SC@ 13.8mg/Kg with 2.00 per cent seed damage. All treatment were significantly superior then the untreated control that have maximum insect damage (5.33%) at nine month of storage period. The effect of storage period significant for insect damage.Seed damage increased significantly as storage period increased and the value of the damage percent less to higher from starting to till 9 months of storage.In present study, it was cleared that the considerable grain damage increased progressively with increased in storage period along with the combined effects of moisture content and seed protectants' nature. These results are also supported by Longnathan *et al.* 2011;Adhikary and Barik, 2012 and Tripathy *et al.* 2020.

Table 1. Effect of Seed Protectants on Seed Qualitative and Quantitative Parameters

Treatment	Seed Protectant	Trade Name	Damage	Weight Loss	Germination	Vigour	Moisture
T_1	Emamectin benzoate	Proclaim (5SG)	1.67	8.16	85.67	1913.87	11.8
T_2	Spinosad	Tracer (45 SC)	2.00	9.67	79.67	1783.24	14.1
T_3	Indoxacarb	Avaunt (14.5 SC)	2.33	10.33	77.67	1449.14	14.1
T_4	Rynaxypyr	Coragen (20 SC)	3.00	10.67	78.67	1825.3	14.1
T_5	Chlorfenapyr	Intrepid (10 EC)	2.00	9.67	84.67	1758.12	13.77
T_6	Profenofos	Curacron (50 EC)	2.00	8.16	83.33	1779.74	11.9
T_7	Novaluron	Rimon (10 EC)	1.33	7.08	86.67	1893.46	11.44
T_8	Delltamethrin	Decis (2.8 EC)	2.67	10.33	83.33	1772.14	12.2
T_9	Control	Untreated	5.33	15.16	70.67	1518.4	12.7
CV			**1.67**	**3.11**	**4.31**	**29.96**	**3.64**
CD			**0.57**	**0.73**	**0.93**	**48.78**	**0.15**
SEm±			**0.27**	**0.53**	**0.44**	**23.22**	**0.07**

Per cent weight loss:

The results (Table-1) also showed seed weight loss per cent in pigeonpea seed after 9 months of storage periods.

After 9 months of storage, the weight loss ranged 10.67-7.08 per cent. The maximum weight loss was recorded in rynaxypyr 20 SC@ 0.01ml/Kg 10.67 per cent followed by indoxacarb 14.5 SC@ 13.8mg/Kg, deltamethrin 2.8 EC@ 0.04ml/Kg with 10.33 per cent and statistically at par for each other and Spinosad 45 SC@ 4.4mg/Kg, chlorfenapyr 10 EC@ 0.02ml/Kg at par with 9.67 per cent weight loss. The minimum weight loss was recorded in novaluron 10 EC@ 0.05ml/Kg 7.08 per cent followed by emamectin benzoate and profenofos 50 EC@ 0.004ml/Kg with 8.16 per cent weight loss and statistically at par. The weight loss in control was higher (15.16 per cent) than all the treatments. The differences in weight loss among the treatments were found significant over control up to 9 month of storage and these findings are also supported by Sinha and Singh, 1998.

Per cent germination:

After 9 months of storage, the highest germination within seed protectants was ranged 86.67-77.67. The highest germination was recorded in novaluron 10 EC@ 0.05ml/Kg 86.67 per cent followed by emamectin benzoate 5 SG@ 40mg/Kg with 85.67 per cent and chlorfenpyer 10 EC@0.02ml/Kg 10 EC@0.02ml/Kg with 84.67 per cent. The minimum germination was recorded in indoxacarb 14.5 SC@ 13.8mg/Kg 77.67 per cent followed by rynaxypyr 20 SC@ 0.01ml/Kg78.67 and spinosad 45 SC@ 4.4mg/Kg with 79.67. All the treatments are superior than control that having 70.67 per cent germination. Significantly decrease process in germination percentage were recorded in all treatment including untreated control but the highest reduction was recorded in untreated control and the lot failed due to having germination level below the standard. The results indicated that all the seed protectants showed better performance in respect to germination with significant level over control at different storage periods. The germination level decreased simultaneously as storage period increased in all treatments, but maintained above IMSCS except control up to 9 months of storage.

Seed vigour index:

After 9 months of storage numerically, highest seed vigour recorded in emamectin benzoate 5S G@ 40mg/Kg with 1913.87 followed by novaluron 10 EC@ 0.05ml/Kg with 1893.46 and rynaxypyr 20 SC@ 0.01ml/Kg with 1825.3 vigour index. The minimum vigour was recorded in chlorfenpyer 10 EC@0.02ml/Kg with 1758.12 vigour index followed by profenofos 50 EC@ 0.004ml/Kg 1779.74 and deltamethrin 2.8 EC@ 0.04ml/Kg with 1772.14 vigour index. The vigour index is higher at nine months of storage. The vigour was found significant over control up to 9 months of storage in all the seed protectants. These results are also supported by Mandeep and Thakur, 2011; Raheem*et al.*2011and Dash *et al*. 2021.

Per cent seed moisture content:

After 9 month of storage periods numerically, the higher value of moisture recorded in indoxacarb 14.5 SC@13.8mg/Kg, with 14.1 per cent, followed by rynaxypyr 20 SC@0.01ml/Kg and spinosad 45 SC@ 4.4mg/Kg with 14.1 per cent. They all are at par for each other. The minimum moisture content was observed in novaluron 10 EC@ 0.05ml/Kg with 11.44 per cent and followed by emamectin benzoate 5 SG@ 40mg/Kg with 11.8 per cent.

The significant difference on seed moisture content percent due to insecticidal treatment and month of storage was seen throughout the storage period. The level of seed moisture was directly related to environmental condition with a significant effect of seed coating. Moisture content of seed is mainly depending upon the condition of storage environments and nature of seed protectants. These findings are also supported by Raheem*et al*. 2011; Ghelani*et al*. 2009 and Dash *et al*. 2021.

CONCLUSION

There was significant difference among all the treatments over control in case of all the experimental parameters. Among all tested newer insecticides as seed protectants, the novaluron 10 EC@0.05ml/kg emamectin benzoate 5 SG@40mg/kg and profenofos 50 EC@0.004ml/kg seed were found more effective due to minimum insect infestation and percent weight loss. In case of seed germination, all tested seed protectants were able to maintain the seed germination above IMSCS level up to 9 months of storage. The maximum seed germination was maintained by novaluron 10 EC@0.05ml/kg followed by emamectin benzoate 5 SG@40mg/kg and Chlorfenapyr at 3, 6 & 9 months of ambient storage. The maximum vigour was obtained in emamectin benzoate 5 SG@40mg/kg treated seed followed by novaluron 10 EC@0.05ml/kg up to 9 months of ambient storage. The moisture content of seed directly related with storage condition and nature of seed protectants. On the basis of above we can say that novaluron 10 EC@0.05ml/kg seed was best among all the tested seed protectants to protect the seed effectively and can be used to protect the pigeonpea seed above IMSCS Level up to 9 months of ambient storage.

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