Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

JEZS Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(4): 1533-1538

Received: 10-05-2018
Accepted: 11-06-2018

Manish Kumar Yadav
Ph.D. Scholar, Department of Entomology, Rajendra Prasad Central Agricultural University Pusa Samastipur Bihar, India

Ram Kumar
Ph.D. Scholar, Department of Entomology, Rajendra Prasad Central Agricultural University Pusa Samastipur Bihar, India

Shiv Prakash
MSc. (Ag) Department of Entomology, Allahabad University, Allahabad, Uttar Pradesh, India

RB Singh
Associate Professor, Department of Entomology, Narendra Deva University of Agriculture and Technology, Kumarganj Faizabad, Uttar Pradesh, India

Correspondence
Manish Kumar Yadav
Ph.D. Scholar, Department of Entomology, Rajendra Prasad Central Agricultural University Pusa Samastipur Bihar, India

Assessment of durability and effectiveness of insecticides as seed protectants against *Callosobruchus chinensis* under ambient storage of pigeonpea seed

Manish Kumar Yadav, Ram Kumar, Shiv Prakash and RB Singh

Abstract
A total number of eight chemical seed protectants namely emamectin benzoate (Proclaim 5SG) @2ppm (40.0mg/kg seed), spinosad (Tracer 45SC) @2ppm (4.4mg/kg seed), indoxacarb (Avaunt 14.5SC) @2ppm (13.8mg/kg seed), rynaxypyr (Coragen 20SC) @2ppm (0.01ml/kg seed), chlorfenapyr (Intrepid 10EC) @2ppm (0.02ml/kg seed), profenofos (Curacron 50EC) @2ppm (0.004ml/kg seed), novaluron (Rimon 10EC) @5ppm (0.05ml/kg seed), delltamethrin (Decis 2.8 EC) @1.0 ppm (0.04 ml/kg seed) along with one untreated control were used against *C. chinensis* under ambient condition were assessed for a period of 9 months to evaluate their ability to maintain toxicity in order to protect seed. The experiment was conducted with the help of the bioassay method of testing pesticidal residues in which the direct exposure method was adopted. The maximum mortality of bruchids was recorded (43.30%) when seed was treated with novaluron 10 EC@0.05ml/kg and followed by emamectin benzoate 5 SG@40mg/kg with 40.00 percent mortality after 9 months of storage.

Keywords: Bioassay, pulse beetle, storage, seed protection, ambient

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 the diet. Pulses contain 24-27 percent 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 fibers, which is desirable in the human diet. (Swaminathan, 1937) [12]

Pulses are the third most 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 are found in their root nodules, this is why, they are known as mini nitrogen factory. (Mishra *et al.*, 2007) [6]

From the beginning of 19th century, agriculturists started growing a hardy drought-tolerant legume which is a native of India and is known as red gram or pigeonpea (*Cajanus cajan* L.) belonging to the 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 ha^{-1}. India is the major pigeon pea growing country and accounts about 3.1-million-hectare area with 2.12 million tonnes of annual production [3, 5]

According to an estimate, 60 percent of the whole production is destroyed by insect-pests in which storage insect-pests 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 the most important insect-pest as it causes infestation to pulses both in the field as well as in ambient storage. The bruchids are most degraded stored grain pest, causing loss of nearly 10-90 percent [10]

The pulse beetle *Callosobruchus chinensis* is one of most important pest of stored legumes and causes considerable damage to seeds and grains during storage as well in field.

The first recorded sighting and description of *C. chinensis* was in China in 1758 from where the beetle got its species name. [13]

The beetle's natural distribution is in the tropics and subtropics of Asia, and their population extensively depends on the cultivation and distribution of legumes. The bruchids breed exclusively on pulses and has a very short life span with a high degree of reproductive potential. The pests are developed during storage within the grains and are detected only when adult beetles come out. Its infestation is maximum from July to August which causes up to 50 percent loss [2]. The storage period of pigeonpea or red gram is of much importance because good storability period (sown up to two planting seasons or more) provides much more time for pulse beetle infestation. To protect the seed from pulse beetle for a longer period there is a need of such seed protectants, which have a longer persistence period on seed. Therefore, a study was undertaken to assess the residual toxicity of different seed protectants at different storage periods in order to obtain a long lasting and cheap way to protect valuable seed upto next sowing season.

Materials and Method

In order to assess the residual toxicity, the test seed of the cultivar NDA-1 was obtained from the seed processing unit of Narendra Deva University of Agriculture and Technology, Kumarganj and Krishi Vigyan Kendra Masaudha, Faizabad. The total amount of obtained seed was first fumigated with aluminium phosphide (3g) and treated as @3 tab/t in airtight containers and disinfested before starting the experiment. There were total nine treatments with three replications for each. The amount of seed was 1 kg, taken under each replication. The treatments were as follow:

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

Raring of test insect:

Approximately five hundred pairs of adult pulse beetles, *Callosobruchus chinensis* were collected from godowns of university seed processing unit and were released in containers (plastic jars) containing one kg of disinfested pigeonpea, cultivar NDA-1. The mouth of containers was covered with muslin cloth and tied with the help of rubber bands and were kept in B.O.D. incubator at 28 ± 2^0 C and 75 ± 5 percent RH to conduct the experiment assessment of residual toxicity. The male and female bruchids were sorted out on the basis of morphological characters as mentioned below:

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.

The layout of the experiment was as follow:

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

Required quantity of chemical pesticides were diluted in 5 ml of water for proper coating on seed. The treated seeds were packed in 2 kg gunny bag (1 kg seed in each bag) and placed in racks of the laboratory under ambient condition for further investigations. The data of residual toxicity as mortality of pulse beetle in treatments was recorded at an interval of 3 months, upto a period of nine months of ambient storage.

Different treatments and their doses were as follows:

The corrected mortality was calculated by the formula given by abbott, 1925. [1]

Corrected percent mortality $= \frac{T-C}{100-C} \times 100$

Where,

T= mortality percent in treatment

C= mortality percent in control

Mortality percent $= \frac{\text{number of dead beetles}}{\text{number of total release beetles}} \times 100$

Results

Assessment of residual toxicity of newer molecule on pigeonpea seed at different storage intervals:

The effects of different treatments at different storage periods for assessment of residual toxicity in the term of mortality of pulse beetles are given in table 1, 4 and 7 (mortality in number) 2, 5 and 8 (percent mortality) and 3, 6 and 9 (corrected mortality).

The result presented in Table 1, 2 and 3, revealed that at 3 months, the mortality of pulse beetle ranged from 86.7-100 percent. The maximum mortality of beetles was recorded in novaluron 10 EC@ 0.05 ml/Kg 100 percent followed by profenofos 50 EC@ 0.004 ml/Kg, emamectin benzoate 5 SG@ 40 mg/Kg with 96.7 percent, indoxacarb 14.5 SC@ 13.8 mg/Kg, rynaxypyr, chlorfenapyr 10EC@ 0.02 ml/Kg and deltamethrin 2.8 EC@ 0.04 ml/Kg with 90 percent mortality and they are statistically at par with each other.

Table 1: Residual effect of different seed protectants after three months of storage periods. (Mean Mortality of Pulse beetle)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after three Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	8.67	9.00	9.67
T_2	Spinosad	Tracer (45 SC)	4.4 mg	8.00	9.00	8.67
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	7.67	8.33	9.00
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	8.00	8.00	9.00
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	8.00	8.67	9.00
T_6	Profenofos	Curacron (50 EC)	0.004ml	8.33	8.67	9.67
T_7	Novaluron	Rimon (10 EC)	0.05ml	8.66	9.33	10.00
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	8.00	8.33	9.00
T_9	Control	Untreated	--	2.33	3.67	4.33
CD				0.415	0.521	0.384
SEm±				0.873	1.094	0.808

A comparative perusal of the data, presented in Table 1 shows that the maximum residual toxicity was found in novaluron 10 EC (@ 90.05 ml kg^{-1}) treated seed, as it had maximum mortality (10.00) of pulse beetles on the ninth day of release, followed by profenofos 50 EC (@ 0.004 ml kg^{-1}), emamectin benzoate 5 SG (@ 40 mg kg^{-1}) and was statistically at par with each other. The lowest number of dead beetles (4.33) was found in untreated control.

As the result shown in tables, the minimum mortality was recorded in spinosad 45 SC@

Table 2: Residual effect of different seed protectants after three months of storage periods. (Mortality of Pulse beetle in percent)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Three Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	86.7	90.0	97.7
T_2	Spinosad	Tracer (45 SC)	4.4 mg	80.0	90.0	86.7
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	76.7	83.3	90.0
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	80.0	80.0	90.0
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	80.0	86.7	90.0
T_6	Profenofos	Curacron (50 EC)	0.004ml	83.4	86.7	96.7
T_7	Novaluron	Rimon (10 EC)	0.05ml	80.0	93.3	100.0
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	80.	83.3	90.0
T_9	Control	Untreated	--	23.33	36.7	43.3

4.4mg/kg was 86.7 percent which was significantly higher than control, 43.3 percent mortality or natural death of beetles.

The data on percent dead beetles due to residual toxicity of different seed protectents, summarized in Table 2, and indicated a significant variation among different treatments under test. The percent dead beetles due to residual effect of seed protectent varied among treatments and ranged between 43.3 to 100.0 percent. The maximum and minimum percent mortality was found in treatments, novaluron 10 EC (@ 0.05 ml kg^{-1}) and untreated control (43.3). Among the various seed protectents, emamectin benzoate 5 SG (@ 40 mg) and profenofos 50 EC (@ 0.004. ml kg^{-1}) recorded (97.7%) and (96.7%) percent mortality of beetles, respectively and were statistically at par with novaluron 10 EC (@ 0.05 ml kg^{-1}).

Table 3: Residual effect of different seed protectants after three months of storage periods. (Corrected Mortality of Pulse beetles).

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Three Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	83.95	84.20	94.17
T_2	Spinosad	Tracer (45 SC)	4.4 mg	73.91	84.20	76.54
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	69.61	73.61	82.36
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	73.91	68.40	82.36
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	73.91	78.98	82.36
T_6	Profenofos	Curacron (50 EC)	0.004ml	78.34	78.98	94.17
T_7	Novaluron	Rimon (10 EC)	0.05ml	73.91	89.41	100
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	73.91	73.61	82.36
T_9	Control	Untreated	--	00	00	00

It was evident from Table 3, that the extent of corrected mortality of pulse beetles over untreated control had brought down effectively due to the application of different treatments. Based on corrected mortality over control, novaluron 10 EC (@ 0.05 ml kg^{-1}) was regarded as the best seed protectent and was at par with emamectin benzoate 5 SG (@ 40 mg) and profenofos 50 EC (@ 0.004 ml kg^{-1}). The least corrected mortality was recorded in spinosad 45 SC (@ 4.4 mg).

Table 4: Residual effect of different seed protectants after six months of storage periods. (Mean Mortality of Pulse beetle)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Six Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	4.33	4.67	5.33
T_2	Spinosad	Tracer (45 SC)	4.4 mg	4.00	4.00	4.67
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	2.67	3.67	4.00
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	3.67	4.00	4.33
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	4.00	3.67	4.33
T_6	Profenofos	Curacron (50 EC)	0.004ml	4.67	4.67	5.00
T_7	Novaluron	Rimon (10 EC)	0.05ml	5.00	5.33	5.67
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	4.34	4.33	4.33
T_9	Control	Untreated	--	1.67	2.67	2.67
CD				0.351	0.384	0.384
SEm±				0.738	0.808	0.808

The mean number of dead beetle at ninth day of release was found maximum (5.67) in novaluron 10 EC (@ 0.05 ml kg^{-1}), followed by emamectin benzoate 5 SG (@ 40 mg) (5.33) and was statistically at par with each other. Among all treatments, the maximum number of dead beetles (2.67) found in untreated control.

Table 5: Residual effect of different seed protectants after six months of storage periods. (Mortality of Pulse beetle in percent)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Six Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	43.3	46.7	53.3
T_2	Spinosad	Tracer (45 SC)	4.4 mg	40.0	40.0	46.7
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	26.7	36.7	40.0
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	36.7	40.0	43.3
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	40.0	36.7	43.3
T_6	Profenofos	Curacron (50 EC)	0.004ml	46.7	46.7	50.0
T_7	Novaluron	Rimon (10 EC)	0.05ml	50.0	53.3	56.7
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	43.4	43.3	43.3
T_9	Control	Untreated	--	16.7	26.7	26.7

The data given in table 5 shows that after 6 months of storage, the mortality of bruchids was ranged 56.7-36.7 percent. The maximum mortality of beetles was observed in novaluron 10 EC@ 0.05ml/Kg with 56.7 percent mortality followed by emamectin benzoate 5 SG@ 40mg/Kg 53.3 and profenofos 50 EC@ 0.004ml/Kg with 50.0 percent mortality. The minimum mortality was recorded in rynaxypyr, chlorfenapyr 10 EC@ 0.02ml/Kg and deltamethrin 2.8 EC@ 0.04ml/Kg with 43.3 percent mortality and statistically at par and followed by spinosad 45 SC@ 4.4mg/Kg with 46.7 percent mortality which was significantly higher than mortality in control 26.7 percent.

Table 6: Residual effect of different seed protectants after six months of storage periods. (Corrected Mortality of Pulse beetles)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Six Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	31.21	27.28	37.24
T_2	Spinosad	Tracer (45 SC)	4.4 mg	27.97	18.14	27.28
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	12.00	13.64	18.14
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	24.00	18.14	22.64
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	27.97	13.64	22.64
T_6	Profenofos	Curacron (50 EC)	0.004ml	36.01	27.28	31.78
T_7	Novaluron	Rimon (10 EC)	0.05ml	39.97	36.28	40.92
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	31.93	22.64	22.64
T_9	Control	Untreated	--	00	00	00

It was clear from the Table 6, that all the treatments were significantly superior over control at ninth day of release. However, among the different treatments novaluron 10 EC (@ 0.05 ml kg^{-1}) (40.92), emamectin benzoate 5 SG (@ 40 mg) (37.24), profenofos 50 EC (@ 0.004 ml kg^{-1}) (31.78) and spinosad 45 SC (@ 4.4 mg) 27.28 were found superior over others. The next to follow were rynaxypyr 20 SC (@ 0.01 ml kg^{-1}), chlorfenapyr 10 EC (@ 0.02 ml kg^{-1}), deltamethrin 2.8 EC (@ 0.04 ml kg^{-1}) and indoxacarb 14.5 (@ mg kg^{-1}) which recorded 22.64, 22.64, 22.64 and 18.14 corrected, respectively.

Table 7: Residual effect of different seed protectants after nine months of storage periods. (Mean mortality of Pulse beetle).

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Nine Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	3.34	3.67	4.00
T_2	Spinosad	Tracer (45 SC)	4.4 mg	3.00	3.33	3.33
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	3.00	3.67	4.00
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	2.34	2.67	3.00
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	2.67	2.67	2.67
T_6	Profenofos	Curacron (50 EC)	0.004ml	3.00	3.33	3.67
T_7	Novaluron	Rimon (10 EC)	90.05ml	3.33	4.00	4.33
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	2.67	3.00	3.33
T_9	Control	Untreated	--	1.34	2.00	2.33
CD				0.314	0.384	0.351
SEm±				0.660	0.808	0.738

The data presented in Table 7, indicated that pulse beetle mortality at ninth day of release was found maximum (4.33) in novaluron 10 EC (@ 0.05 ml kg^{-1}) followed by indoxacarb 14.5 (@ mg kg^{-1}) (4.00), emamectin benzoate 5 SG (@ 40 mg) (4.00) was at par with each other. The minimum mortality (2.33) was found in untreated control.

Table 8: Residual effect of different seed protectants after nine months of storage periods. (Mortality of Pulse beetle in percent)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Nine Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	33.4	36.7	40.0
T_2	Spinosad	Tracer (45 SC)	4.4 mg	30.0	33.3	33.3
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	30.0	36.7	40.0
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	23.4	26.7	30.0
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	26.7	26.7	26.7
T_6	Profenofos	Curacron (50 EC)	0.004ml	30.0	33.3	36.7
T_7	Novaluron	Rimon (10 EC)	0.05ml	33.3	40.0	43.3
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	26.7	30.0	33.3
T_9	Control	Untreated	--	13.4	20.0	23.3

The data presented in Table 8 evinced that after 9 months of storage, the mortality of pulse beetle (table number 7, 8 and 9) was ranged 43.3-30.0 percent. The higher mortality was recorded in novaluron 10 EC@ 0.05ml/Kg with 43.3 percent followed by emamectin benzoate 5 SG@ 40mg/Kg 40.0 percent and indoxacarb 14.5 SC@ 13.8mg/Kg with 40.0 percent. The minimum mortality was recorded in rynaxypyr 20 SC@ 0.01ml/Kg30.0 percent followed by spinosad 45 SC@ 4.4mg/Kg and deltamethrin 2.8 EC@ 0.04ml/Kg with 33.3 percent mortality but it was significantly higher than control that was 23.33 and known as natural death.

Table 9: Residual effect of different seed protectants after nine months of storage periods. (Corrected Mortality of Pulse beetles)

Treatments	Seed Protectant (Insecticides) Common Name	Trade Name	Dose (Per kg Seed)	Residual Toxicity of treatments after Nine Months		
				Third day of release	Sixth day of release	Ninth day of release
T_1	Emamectin benzoate	Proclaim (5SG)	40 mg	23.06	20.87	21.77
T_2	Spinosad	Tracer (45 SC)	4.4 mg	19.26	16.62	13.03
T_3	Indoxacarb	Avaunt (14.5 SC)	13.8 mg	19.26	20.87	2177
T_4	Rynaxypyr	Coragen (20 SC)	0.01ml	11.53	08.37	8.73
T_5	Chlorfenapyr	Intrepid (10 EC)	0.02ml	15.45	08.37	4.43
T_6	Profenofos	Curacron (50 EC)	0.004ml	19.26	16.62	17.47
T_7	Novaluron	Rimon (10 EC)	0.05ml	23.06	25.00	26.07
T_8	Delltamethrin	Decis (2.8 EC)	0.04 ml	15.45	12.50	13.03
T_9	Control	Untreated	--	00.00	00.00	00.00

It was evident from Table 9, that the percentage of corrected mortality of pulse beetles over untreated control had been brought down effectively by applying different treatments. The maximum (26.07) and minimum (4.43) corrected mortality was found in novaluron 10 EC (@ 0.05 ml kg^{-1}) and chlorfenapyr 10 EC (@ 0.02 ml kg^{-1}), respectively.

Discussion

All insecticides achieved very good results as seed protactants and were able to protect seed upto 9 month or next sowing season. After 3 months, the maximum mortality of bruchids was recorded in novaluron 10 EC@0.05ml/kg 100 percent followed by profenofos 50 EC@0.004ml/kg, emamectin benzoate 5 SG@ 40mg/Kg with 96.7 percent, indoxacarb, rynaxypyr 20 SC@0.01ml/kg, chlorfenapyr 10 EC@0.02ml/kg and deltamethrin 2.8 EC@0.04ml/kg with 90 percent mortality and they were statistically at par for each other [11].

It happened because the insecticides were in their primary exposure period and have very high toxicity against test insect and kill immediately after release. The mortality in control was very low as there was nothing to kill insects but sometimes pulse beetles show thanatosis and crates confusion. After 6 months, mortality of bruchids was ranged 56.7-36.7 percent and maximum mortality was observed in novaluron 10 EC@0.05ml/kg, with 56.7 percent mortality followed by emamectin benzoate 5 SG@ 40mg/Kg 53.3 percent and profenofos 50 EC@0.004ml/kg with 50.0 percent mortality and after 9 months, the mortality of pulse beetle ranged 43.3-30.0 percent and the higher mortality was recorded in novaluron 10 EC@0.05ml/kg, with 43.3 percent followed by emamectin benzoate 5 SG@ 40mg/Kg 40.0 percent and Indoxacarb with 40.0 percent. The mortality was decreasing significantly from 3-9 months of storage according to exposure period of insecticides but the mortality in all treatments were much higher in compare to control. These results are also supported by Raheem *et al.*2011 [9] and Patil *et al* 2006 [8].

Conclusion

The pulse beetle, *Callosobruchus chinensis* L. is the most important species of bruchids belonging to family Chrysomelidae and are reported to cause considerable damage to all legumes including pigeonpea. Pulse beetle is economically very important as it causes loss of pulses both in storage conditions as well as in field. This experiment was done with the help of bioassay method for testing pesticidal residues in which the direct exposure method was adopted. Maximum mortality of bruchids was recorded (43.30%) when seed was treated with novaluron 10 EC@90.05ml/kg and followed by emamectin benzoate 5 SG@40mg/kg with 40.00 percent mortality after 9 months of storage. (Okunola, 2003) [7] The residual effect of all seed protectants on seed decreased as storage period increased. However, effect of all seed protectants was significantly superior over control. The maximum mortality observed in novaluron 10 EC@0.05ml/kg treated seed followed by emamectin benzoate 5SG@40mg/kg and Indoxacarb in which emamectin benzoate 5 SG@40mg/kg and indoxacarb 14.5 SC@13.8mg/kg seed were at par with each other.

On the basis of the above scenario, 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.

Acknowledgements

The authors would like to thank Seed Processing Unit of NDUAT Kumarganj for providing seed and to the Professor and Head, department of Entomology, Narendra Deva University of Agriculture and Technology, Kumarganj for providing necessary facilities.

References

1. Abbott WS. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925; 18:265-267.
2. Ahmed KS, Itino T, Ichikawa T. Duration of developmental stages of Callosobruchus chinensis L. (Coleoptera: Bruchidae) on azuki bean and the effects of neem and sesame oils at different stages of their development. Pakistan Journal of Biological Sciences. 2003; 6:932-935.
3. Anonymous. Annual report, AICRP-NSP (crops), Directorate of Seed Research, ICAR, Kushmaur, Mau, 2013-14, 433-478.
4. Bajpai VP, Khan AAV, Yas RP, Tiwari LP, Tripathi RA. Effect of bio insecticide on viability of urdbean seed stored in different container. Seed Res. 2002; 30(2):331-334.
5. Booker RH. Observation on three bruchids associated with cowpea in Northern Nigeria. Journal of Stored Product Research. 1967; 3:1-15
6. Mishra D, Shukla AK, Tripathi KK, Singh A, Dixit AK, Singh K. Efficacy of application of vegetable oils as grain protectant against infestation by Callosobruchus chinensis and its effect on milling fractions and apparent degree of dehusking of legume pulses. Journal of Oleo Science. 2007; 56:1-7.
7. Okunola CO. Use of melon oil for the control of bruchid damage in cowpea. In Proceedings of African Crop Science Society, Ondo State, Nigeria. 2003; 6:238-240.
8. Patil SK, Kadam UK, Dumbre AD. Varietal susceptibility of deltamethrin-treated chickpea seeds against C. maculatus under ambient condition. Seed Research. 2006; 34(1):113-115.
9. Raheem, Amtul, Sridevi D. Evaluation of selected insecticides as seed protectants against the pulse beetle. CAB Abstracts Journal Research ANGRAU. 2011; 39(4):94-100.
10. Rathore YS, Sharma V. Management of bruchid infestation in pulses. Indian Institute of pulses Research, Kanpur, U.P., India, 2002, 136.
11. Singh CB, Katiyar M, Pal RK, Singh SK, Singh A. Relative efficacy of neem-based insecticides on seed viability and quality of pigeonpea (*Cajanus cajan* L.) during storage. *Trends in Biosciences.* 2014; **7**(16):2322-2326
12. Swaminathan MS. The relative value of certain food stats. Indian Journal of Medicinal. Research. 1937; 25:381-387.
13. Tembhare DB. Modern Entomology, pest of other crops and stored grains, 2007; II:337