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BV Patoliya
Asstt. Research Scientist, Pearl Millet Research Station, Junagadh Agril. University, Air Force Road, Jamnagar, Gujarat, India

KK Dhedhi
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

NN Chaudhary
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

YH Ghelani
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

MK Ghelani
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

NM Kachhadiya
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

MD Khanpara
Pearl millet Research Station, Junagadh Agricultural University, Jamnagar, Gujarat, India

Correspondence
BV Patoliya
Asstt. Research Scientist, Pearl Millet Research Station, Junagadh Agril. University, Air Force Road, Jamnagar, Gujarat, India

Effect of insecticidal seed treatment on seed viability and seed damage during storage under ambient condition. Crop: chickpea (*Cicer arietinum* L.)

BV Patoliya, KK Dhedhi, NN Chaudhary, YH Ghelani, MK Ghelani, NM Kachhadiya and MD Khanpara

Abstract
The experiment was conducted at Seed Technology Research Unit, Main Pearl Millet Research Station, J.A.U., Jamnagar during 2015 on chickpea with an objective to ascertain new insecticidal chemical agaist *Callosobruchus chinensis*, a major pests of stored chickpea seed. The observation on moisture content, germination and insect infestation were recorded at interval of three months of storage period. Moisture content in chick pea was found non-significant up to 9 months of storage period. The effect of different treatments on germination was found non-significant at up to 6 months of storage period. Among different insecticides, At 9 months, majority of the chick pea treated seeds were from damage except Rynaxypyr @ 2 ppm (1.00%) and control (18.67%). At 12 months, lowest incidence was recorded in Emamectin benzoate @ 2 ppm (1.00%). While in control it was 29.27 % seed damage.

Keywords: chickpea, pulse beetle (*Callosobruchus chinensis* L.), seed damage, management

Introduction
Chickpea (*Cicer arietinum* L.) is a important pulse crop in India and is the main source of protein for vegetarian. India is the largest producer of this pulse contributing to around 63 per cent of the world's total production (Anonymous, 2007) [10]. However, nearly 8.5 per cent of total annual production is lost during post harvest handling and storage (Agrawal *et al*., 1988) [1]. The pulse seed suffer a great damage during storage due to insect attack (Sherma, 1989) [7]. Among the insect pest attacking stored product the pulse beetle *Callosobruchus chinensis* L. (Coleoptera : *Bruchidae*) is serious one causing weight loss, lower germination potential and quality deterioration (*Mukherjee et al*., 1970 ; Singal and Singh, 1985) [6, 8]. Both qualitative as well as quantitative losses occur due to *C. chinensis* infestation. Singh and Sharma (1982) [9] estimated 47.53-79.60 per cent loss of germination due to damaged grains by the beetle. This insect has been reported from the Philippines, Japan, Indonesia, Sri Lanka, Burma and India. It is a notorious pest of chickpea, mung, cowpea, lentil and pigeon pea (Aslam *et al*., 2002) [4]. Its attack is normally noticed when considerable damage is already done. To avoid such losses, periodic surveillance of godawons with monitoring devices is required for taking timely control measures. Under our condition it is not feasible for farmer to provide ideal condition of seed storage, when seed are to be stored under ambient conditions. Some pre storage seed treatment is needed to take care of insect pests during storage with the aim of improving the shelf life of seed. Keeping the above facts in view, investigations were carried out on efficacy of newer insecticides for control of storage insects and viability of chickpea seed during storage under ambient conditions.

Materials and Methods
A laboratory experiment conducted at Seed Technology Research Unit, Main Pearl Millet Research Station, J.A.U., Jamnagar during 2015-16. The different insecticides viz., Emamectin benzoate @ 2 ppm (40.0 mg/kg seed), Spinosad @ 2 ppm (4.4 mg/kg seed), Indoxacarb @ 2 ppm (13.8 mg/kg seed), Rynaxypyr @2ppm (9.9 mg/kg seed), Chlorfenapyr @2ppm (0.02ml/kg seed), Profenophos @2ppm (0.004 ml/kg seed), Novaluron @ 5ppm (0.05ml/kg seed), Deltamethrin 2. 8 EC @ 1.0 ppm (0.04 ml/kg seed) and Untreated control. Freshly harvested 1 kg certified chickpea seed (GG-3) with very high germination percentage and low moisture content was taken for each treatment. Required quantity of insecticide was diluted in 5 milliliter of water to treat 1 kg of seed for proper coating. After drying in shade,

seeds were packed in 2 kg capacity gunny bag lets and kept in storage under ambient conditions. Germination was determined as per ISTA rules (Anonymous, 1985) [2]. Insect infestation was carried out by counting damaged seed. The data were analyzed using CRD design with three replications. Samples of treated seed were drawn and observation of per cent germination and per cent infestation was recorded at three months interval i.e. 0, 3, 6, 9 and 12 months of storage period.

Results and Discussion

Moisture Per cent: Results in table-1 revealed that the effect of different treatments on moisture content in chick pea was found non-significant up to 3,6 & 9 months. However, after at 12 months the difference was found significant and lowest moisture per cent was recorded in emamectin benzoate @ 2 ppm (7.13%) and Spinosad @ 2 ppm (7.13%). However, it was at par with rest of the treatments except control (7.23%).

Germination: Results in table-2 revealed that the effect of different treatments on germination was found non-significant at 3 & 6 months storage period. At 9 months storage period, highest germination percentage was recorded in Emamectin benzoate @ 2 ppm (88.00%) and Spinosad @ 2 ppm (88.00%) and it was at par with rest of the treatments except control (83.67%) After 12 months of storage germination was recorded below IMSCS (85.00 %) in all treatments.

Seed damage: There was no seed damage in any of the treatments (Table-3) up to 6 months except control (9.67%). At 9 months, majority of the chick pea treated seeds were from damage except Rynaxypyr @ 2 ppm (1.00%) and control (18.67%). At 12 months, lowest incidence was recorded in Emamectin benzoate @ 2 ppm (1.00%) and it was at par with aal of the treatment except control it was 29.27 % seed damage.

Adult population: There was no presence of insect in any of the treatments (Table-4) up to 9 months except control (71.67 pulse beetles/ 100 g seed). At 12 months, Emamectin benzoate @ 2 ppm, Spinosad @ 2 ppm, Indoxacarb @ 2 ppm, Profenophos @2ppm and Deltamethrin @ 1.0 ppm treated seed has no insect population. Whereas, Chlorfenapyr @ 2 ppm recorded lowest insect population (2.00 adults/100 g seed) and it was at par with Novaluron @ 5 ppm (3.33 adults/100 g seed).

Residual toxicity: Result of the residual toxicity of different insecticides (Table-5) against pulse beetle in chick pea showed that after three month of storage, 100 per cent mortality was observed at 15 days of release in all the treatments except control. After 6 months (Table-5), 100 per cent mortality was observed Emamectin benzoate @ 2 ppm, Spinosad @ 2 ppm, Indoxacarb @ 2 ppm and Profenophos @2ppm. However, all the treatments were at par with Deltamethrin @ 1.0 ppm (96.67%). After nine month of storage period (Table-5), highest adult mortality was observed in Emamectin benzoate @ 2 ppm (90.00%) and it was at par with Spinosad @ 2 ppm, Indoxacarb @ 2ppm, Profenophos @2ppm and Deltamethrin @ 1.0 ppm. At 12 months storage period (Table-5), again. highest adult mortality (86.67%) was recorded in Emamectin benzoate @ 2 ppm and it was at par with Spinosad @ 2 ppm, Profenophos @2ppm and Deltamethrin @ 1.0 ppm. The effectiveness of deltamethrin has been reported in literature (Bareh and Gupta, 1989) [5]. Study conducted at various centre of National Seed project showed that emamectin benzoate and lufenuron were found equally effective as deltamethrin and provided appreciable control of storage insect infesting chickpea, mung under different agro climatic conditions for 9 months (Anonymous, 2012) [3]. Thus, the study brought out the significance of storing chickpea seed with minimum seed certification standards of 85 per cent up to 9 months in gunny bag under ambient storage condition after seed treatment either with deltamethrin 2.8 Ec @ 0.04 ml/kg, emamectin benzoate 5SG @ @40mg/kg or lufenuron 5EC @ 0.1ml/kg seed by protecting them from infestation caused by *C.chinensis*.

Table 1: Effect of different treatment on moisture in chickpea seed during storage under ambient conditions

Treatments		Moisture content (%)			
		Observation recorded after months			
		3	6	9	12
T_1	Emamectin benzoate @ 2 ppm (40 mg/kg seed)	6.79	6.87	7.03	7.13
T_2	Spinosad @ 2 ppm (4.4 mg/kg seed)	6.70	6.83	7.04	7.13
T_3	Indoxacarb @ 2 ppm (13.8 ml/kg seed)	6.63	6.81	7.03	7.14
T_4	Rynaxypyr @ 2 ppm (9.9 mg/kg seed)	6.75	6.87	7.04	7.14
T_5	Chlorfenapyr @ 2 ppm (0.02ml/kg seed)	6.79	6.80	7.06	7.16
T_6	Profenophos @2ppm (0.004 ml/kg seed)	6.78	6.85	7.05	7.14
T_7	Novaluron @ 5 ppm (0.05ml/kg seed	6.87	6.87	7.05	7.15
T_8	Deltamethrin @ 1.0 ppm (0.04 ml/kg seed)	6.88	6.91	7.05	7.16
T_9	Untreated control	7.03	6.96	7.10	7.23
S. Em		0.09	0.04	0.02	0.02
C.D. at 5 %		NS	NS	NS	0.05
C.V. %		2.39	1.02	0.40	0.45

Table 2: Effect of different treatment on germination of chickpea seed during storage under ambient conditions

Treatments		Germination (%)			
		Observation recorded after months			
		3	6	9	12
T_1	Emamectin benzoate @ 2 ppm (40 mg/kg seed	93.00	91.67	88.00	84.00
T_2	Spinosad @ 2 ppm (4.4 mg/kg seed)	92.67	91.67	88.00	83.67
T_3	Indoxacarb @ 2 ppm (13.8 ml/kg seed)	93.67	91.00	87.33	84.00
T_4	Rynaxypyr @ 2 ppm (9.9 mg/kg seed)	92.33	91.00	87.00	83.67

T_5	Chlorfenapyr @ 2 ppm (0.02ml/kg seed)	93.33	91.00	86.67	83.33
T_6	Profenophos @2ppm (0.004 ml/kg seed)	92.00	91.33	87.67	83.67
T_7	Novaluron @ 5 ppm (0.05ml/kg seed	93.00	91.67	87.00	84.00
T_8	Deltamethrin @ 1.0 ppm (0.04 ml/kg seed)	92.67	91.00	87.00	83.00
T_9	Untreated control	90.00	89.67	83.67	76.67
S. Em		0.74	0.60	0.75	0.71
C.D. at 5 %		NS	NS	2.24	2.11
C.V. %		1.38	1.14	1.50	1.49

Table 3: Effect of different treatment on infestation of pulse beetle in chickpea seed during storage under ambient conditions

Treatments	Seed damage (%) Observation recorded after							
	3 months		6 months		9 months		12 months	
	Mean values	Arcsine values	Mean values	Arcsine values	Mean values	Arcsine values	Mean values	Arcsine values
T_1	0.00	2.87	0.00	2.87	0.00	2.87	1.00	5.74
T_2	0.00	2.87	0.00	2.87	0.00	2.87	2.17	8.47
T_3	0.00	2.87	0.00	2.87	0.00	2.87	1.91	7.95
T_4	0.00	2.87	0.00	2.87	1.00	5.74	2.94	9.88
T_5	0.00	2.87	0.00	2.87	0.67	4.78	2.94	9.88
T_6	0.00	2.87	0.00	2.87	0.00	2.87	1.30	6.54
T_7	0.00	2.87	0.00	2.87	0.67	3.82	3.55	10.86
T_8	0.00	2.87	0.00	2.87	0.00	2.87	1.91	7.95
T_9	6.00	14.14	9.67	18.08	18.67	25.52	23.90	29.27
S. Em	--	0.23	--	0.29	--	0.79	--	1.23
C.D. at 5 %	--	0.69	--	0.87	--	2.36	--	3.65
C.V. %	--	9.79	--	39.28	--	23.23	--	19.81

* Figures in parentheses are original value and those outside are Arc sin transformed value

Table 4: Effect of different treatment on population of pulse beetle in chickpea seed during storage under ambient conditions

Treatments	Insect population/ 100 g seed							
	3 months		6 months		9 months		12 months	
	Mean values	SQR X+0.5	Mean values	SQR X+0.5	Mean values	SQR X+0.5	Mean values	SQR X+0.5
T_1	0.00	0.71	0.00	0.71	0.00	0.71	0.00	0.71
T_2	0.00	0.71	0.00	0.71	0.00	0.71	0.00	0.71
T_3	0.00	0.71	0.00	0.71	0.00	0.71	0.00	0.71
T_4	0.00	0.71	0.00	0.71	0.00	0.71	8.67	2.99
T_5	0.00	0.71	0.00	0.71	0.00	0.71	2.00	1.56
T_6	0.00	0.71	0.00	0.71	0.00	0.71	0.00	0.71
T_7	0.00	0.71	0.00	0.71	0.00	0.71	3.33	1.90
T_8	0.00	0.71	0.00	0.71	0.00	0.71	0.00	0.71
T_9	10.00	3.24	33.67	5.82	71.67	8.33	218.33	14.76
S. Em	--	0.03	--	0.14	--	0.40	--	0.30
C.D. at 5 %	--	0.08	--	0.40	--	1.18	--	0.90
C.V. %	--	5.21	--	18.48	--	44.39	--	18.99

* Figures in parentheses are original value and those outside are Squreroot transformed value

Table 5: Periodical residual toxicity of different insecticides against pulse beetle in chickpea seed.

Treatments		Adult mortality (%) at 3 months			Adult mortality (%) at 6 months			Adult mortality (%) at 9 months			Adult mortality (%) at 12 months		
		After 3 Days	After 7 Days	After 15 Days	After 3 Days	After 7 Days	After 15 Days	After 3 Days	After 7 Days	After 15 Days	After 3 Days	After 7 Days	After 15 Days
T_1	Emamectin benzoate @ 2 ppm	80.90 (100.0)	80.90 (100.0)	80.90 (100.0)	77.79 (96.67)	80.90 (100.0)	80.90 (100.0)	66.14 (83.33)	68.86 (86.67)	71.57 (90.0)	63.43 (80.00)	66.14 (83.33)	68.86 (86.67)
T_2	Spinosad @ 2 ppm	80.90 (100.0)	80.90 (100.0)	80.90 (100.0)	77.79 (96.67)	80.90 (100.0)	80.90 (100.0)	63.93 (80.0)	66.64 (83.33)	68.86 (86.67)	59.00 (73.33)	61.22 (76.67)	63.93 (80.00)
T_3	Indoxacarb @ 2 ppm	80.90 (100.0)	80.90 (100.0)	80.90 (100.0)	77.79 (96.67)	80.90 (100.0)	80.90 (100.0)	61.22 (76.67)	63.93 (80.00)	66.14 (83.33)	56.79 (70.00)	59.00 (73.33)	61.22 (76.67)
T_4	Rynaxypyr @ 2 ppm	80.90 (100.0)	80.90 (100.0)	80.90 (100.0)	74.68 (93.33)	74.68 (93.33)	74.68 (93.33)	56.79 (70.00)	59.00 (73.33)	61.22 (76.67)	54.78 (66.67)	57.00 (70.00)	59.00 (73.33)
T_5	Chlorfenapyr @ 2 ppm	80.90 (100.0)	80.90 (100.0)	80.90 (100.0)	71.57 (90.0)	71.57 (90.0)	77.79 (96.67)	56.79 (70.00)	59.00 (73.33)	61.22 (76.67)	52.78 (63.33)	54.78 (66.67)	56.79 (70.00)
T_6	Profenophos @2ppm	63.93 (80.0)	74.68 (93.33)	80.90 (100.0)	77.79 (96.67)	80.90 (100)	80.90 (100.0)	63.43 (80.00)	66.14 (83.33)	68.86 (86.67)	61.22 (76.67)	63.43 (80.00)	66.14 (83.33)
T_7	Novaluron @ 5 ppm	52.78 (63.33)	59.00 (73.33)	80.90 (100.0)	50.77 (60.0)	50.77 (66.67)	66.14 (83.33)	48.85 (56.67)	50.85 (60.00)	52.86 (63.33)	46.92 (53.33)	48.85 (56.67)	50.77 (60.00)
T_8	Deltamethrin @	71.97	80.90	80.90	71.97	71.97	77.79	61.22	63.93	66.64	59.00	61.22	63.43

	1.0 ppm	(90.0)	(100.0)	(100.0)	(90.0)	(93.33)	(96.67)	(76.67)	(80.00)	(83.33)	(73.33)	(76.67)	(80.00)
T9	Untreated control	9.10 (0.00)	12.21 (3.33)	37.22 (3.33)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)	9.10 (0.00)
	S.Em.	2.30	1.64	0.67	2.87	2.87	2.01	2.08	3.28	2.82	2.04	2.19	2.18
	CD at 5 %	6.84	4.88	1.99	8.51	8.51	5.98	6.19	9.75	8.38	6.07	6.51	6.48
	CV%	5.96	4.06	1.52	7.58	7.58	4.98	6.67	10.08	8.35	6.88	7.10	6.81

* Figures in parentheses are original value and those outside are Arc sin transformed value

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