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Efficacy of insecticides against major insect pests of pigeon pea in Nagaland

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Abstract
A study on "Efficacy of insecticides against major insect pest of pigeon pea in Nagaland" was conducted during the *Kharif* season of 2017 and 2018 in the Entomology Experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland. There were 7 treatments arranged in randomized block design with three replications. During the investigation, Maruca *vitrata*, *Apion* sp., *Aphis craccivora*, *Riptortus* sp. and *Helicoverpa armigera* were the major insect pests of Pigeon pea. Out of the 6 insecticide treatments, Indoxacarb 4.5 + Novaluron 5.25 SC were effective against *Maruca vitrata*, while Cypermethrin 25 EC showed its efficacy against *Apion* sp., and *Helicoverpa armigera*. The treatment from Cypermethrin 25 EC exhibited the lowest pod damage with a mean of 24.77%, and the highest grain yield of 1460 kg/ha with the highest Benefit Cost ratio (10.88: 1).

Keywords: pigeon pea, Maruca *vitrata*, *Apion* sp., and *Helicoverpa armigera* and cypermethrin

Introduction

Pigeon pea (*Cajanus cajan*) is a perennial legume from the family Fabaceae. It is also known as arhar, tur and redgram, is highly nutritious and a rich source of dietary protein (22.3%), carbohydrates (57.6%), fibre (1.5%) and minerals (3.5%) (Gupta *et al*., 2006) [9]. It is an important pulse crop in the semi-arid Tropics and sub-tropical farming systems, providing high quality vegetable protein, animal feed and firewood (Mittal and Ujagir, 2005) [14]. Pigeon pea is the second most important pulse crop next to chickpea, covering an area of around 4.42 m ha (occupying about 14.5% of area under pulses) and production of 2.89 MT (contributing to 16% of total pulse production) and productivity of about 707 kg/ha (FAOSTAT, 2011) [7].

More than 300 insect species belonging to 8 orders and 61 families have been found to infest pigeon pea starting from seedling stage and continues till harvesting and even during the storage condition (Kevel *et al*., 2010) [10] however, about 60% damage is solely caused by the pod borer complex (Wadasker *et al*., 2013, Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [31, 19, 20, 21, 22, 23, 24, 25]. The pod borer complex of pigeon pea includes *Helicoverpa armigera*, *Exelastis atomosa*, *Lampides boeticus*, *Nanaguna breviscula*, *Maruca vitrata*. The pod borer complex which attack at the reproductive stage caused more yield loss as compared to the insect pests attacking at the vegetative stage.

Crop protection with chemicals is desirable and unavoidable part of integrated pest management (Mohyuddin *et al*., 1997) [15]. The idea of controlling insect pests by using various agro-techniques in combination with selective use of insecticides making compatible with other components of the management of pigeon pea insect pests are gaining importance as the most effective measure. The main aim of this paper is to determine the Efficacy of insecticides against major insect pest of pigeon pea in Nagaland.

Materials and methods

A field experiment was conducted during the *Kharif* season of 2017 and 2018 in the Entomology Experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland to study the efficacy of insecticides against major insect pest of pigeon pea in Nagaland. The experimental plot was situated at 25.7566° N latitude and 93.8681° E longitudes at an elevation of 360 meters above sea level (MSL). The climate was humid with an average rainfall ranging from 2000 – 2500 mm annually. The mean temperature ranged from 28 to 32° C during summer and winter from 10 -15° C that rarely went below 8° C. The soil was sandy loam, acidic in nature with pH ranging from 4.5 - 6.5. The experiment was laid out in Randomized Block Design (RBD) with 7 treatments each replicated thrice. Pigeon pea variety UPAS 120 at a seed rate of 15 kg per hectare was sown at a spacing of 45 X 30 cm. All the plots were given uniform intercultural operations during the entire growth period in both the years of study. Irrigation was given every day during the initial stage of the plant growth. Two sprays were given using 625 litres of spray volume per hectare; 1st spray was given at 50% flowering stage and 2nd spraying at 15 days interval. Pre-treatment count was done one day before both first and second sprayings and post-treatment count was recorded at 3, 7, 10, and 14 days after spraying for both the sprayings to observe the efficacy of different insecticides.

Results and Discussion

Insect pest complex and their incidence on pigeon pea

During the period of investigation, ten insects pests were found feeding on pigeon pea crop, *viz*., Spotted pod borer, *Maruca vitrata* Fabricius (Lepidoptera: Crambidae); Apion weevil, *Apion* sp. (Coleoptera: Curculionidae); Aphids, *Aphis craccivora* Koch (Homoptera: Aphididae); Chafer beetle, *Amphimallon majale* (Coleoptera: Scarabaeidae); Pod bug, *Riptortus* sp. Fabricius (Heteroptera: Alydidae); Pod borer, *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae); Gold dust weevil, *Hypomeces squamosus* (Coleoptera: Curculionidae); Blue butterfly, *Lampides boeticus* Linn. (Lepidoptera: Lycaenidae); Hairy caterpillar, *Euproctis fraterna* Moore (Lepidoptera: Lymantriidae) and Plume moth, Exelastis *atomosa* wall (Lepidoptera: Pterophoridae) (Table 1). Out of these ten insect pests, 3 major insect pests were observed feeding actively at different stages of the crop, out of which *Maruca vitrata* comprised the highest population followed by, *Apion* sp. and *Helicoverpa armigera*. The incidence of these 3 major insect pests and their correlation with weather parameters are presented in Table 2a and Table 2b.

Fig 1: Larva of *Maruca vitrata*, *Apion* sp. and *Helicoverpa armigera*

Table 1: Insect pests recorded on pigeon pea during December 2017 to February 2018

Sl. No.	Common Name	Scientific Name	Crop Phenology	Feeding Site
1.	Spotted pod borer	*Maruca vitrata* Fabricius (Lepidoptera: Crambidae)	Vegetative stage till harvest	Web the Leaves, flowers and pods
2.	Apion weevil	*Apion* sp. (Coleoptera: Curculionidae)	Vegetative stage till harvest	Adult: Leaves and tender parts of the plant Grub: on grain or seed.
3.	Aphid	*Aphis craccivora* Koch (Homoptera: Aphididae)	Vegetative stage till harvest	Leaves and tender parts of the plant
4.	Chafer beetle	*Amphimallon majale* (Coleoptera: Scarabaeidae)	Vegetative stage till harvest	Adult: Leaves and tender parts of the plant. Grub: feeds on the roots.
5.	Pod bug	*Riptortus* sp. (Heteroptera: Alydidae)	Pod formation stage	Pod
6.	Gram Pod borer	*Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae)	Pod formation stage	Pod
7.	Gold-dust weevil	*Hypomeces squamosus* (Coleoptera: Curculionidae)	Vegetative stage till harvest	Leaves and tender parts of the plant
8.	Blue butterfly	*Lampides boeticus* Linn. (Lepidoptera: Lycaenidae)	Flowering to pod maturity	Pod
9.	Hairy caterpillar	*Euproctis fraterna* Moore (Lepidoptera: Lymantriidae)	Vegetative to pod maturity	Leaves
10.	Plume moth	*Exelastis atomosa* wall (Lepidoptera: Pterophoridae)	Flowering to pod maturity	Buds, Flowers & Pods

During the investigation, *Maruca vitrata* population ranged from 1.93-2.67 (Table 2a). The population gradually increased with a mean number of 2.40 on 8th December and reached a peak on 15th December (51st SMW) with a mean population of 2.67 webs/plant. Thereafter the population started to decline and the population gradually disappeared from 26th January. The above finding are in conformity with the observation of Bruner (1931) who recorded that *Maruca vitrata* in lima bean in September and its peak during November and December and other workers like Chetan *et al*. (2013) [4] observed the peak activity of *Maruca vitrata* occurred during mid December to mid January with 3.49 larvae per plant on Pigeon pea. However, the study slightly differs from the findings of Bruner (1931). This slight

variation might be due to change in crops, different sowing time and geographical factors in the place where investigation had been carried out. The correlation of *Maruca vitrata* population with weather parameters exhibited significant positive correlation (r=0.734) with minimum Relative humidity (Table 2b). Minimum relative humidity had a greater influence on the population dynamics of webworm. However, these results were in contrast with the observations made by Mallikarjunappa (1989) [13] who reported a non-significant relationship with all weather parameters for all pod borers in pigeon pea.

The data presented in Table 2a revealed that the mean population of *Apion* sp. ranged from 0.53-1.60 per plant during the study period. The peak population was observed on 29th December (1st std. week) with mean population of 1.60 per plant. Thereafter the population showed a decreasing trend with a mean of 0.73, 0.60 and 0.80 on 5th January (2nd std. week), 12th January (3rd std. week) and 19th January (4th std. week) then it increased again to 1.20 on 26th January (5th std. week). The above findings are more or less in confirmation with Adimani (1976) [1] who reported that *Apion* sp. was noticed on soybean crop during June to January. Dhuri and Singh (1983) [6] stated that *Apion* sp. occurred during flowering to pod formation stage on black gram in *Kharif* season. The correlation of *Apion* sp. population with weather parameters exhibit significant positive correlation (r=0.647) with rainfall (Table 2b). These findings are in contrast with Sunil Kumar and Singh (2003) who reported significant correlation of maximum, minimum temperature and relative humidity with *Apion clavipes* on Pigeon pea. These variations may be due to variety, climate, sowing time and other ecological parameters of the pest abundance.

The data presented in Table 2a revealed that the mean population of *Helicoverpa armigera* ranged from 0.20-2.00 per plant during the study period. The insect pest population was observed from flowering stage till the end cropping stage. The above findings are in agreement with the findings of Rana *et al*. (2008) who observed that *Helicoverpa armigera* was noticed from flowering to podding stage of pigeon pea crop i.e. from Dec-Feb. The population of *Helicoverpa armigera* showed a negative non-significant correlation with maximum temperature (r= -0.463) and minimum temperature (r= -0.322), while positive non-significant correlation with maximum, minimum relative humidity (r=0.347, r=0.411) and rainfall (r=0.009). Deshmukh *et al*. (2005) also reported that none of the weather parameters showed any effect on the population buildup.

Table 2a: Incidence of pest complex in pigeon pea during December 2017 to February 2018

Standard Mean week	Date of observation	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	Pest incidence		
		Max.	Min.	Max.	Min.		*Maruca vitrata* (No of webs/plant)	*Apion* sp. (No/plant)	*Helicoverpa armigera* (No/plant)
49	1 Dec. 2017	26.00	10.90	95.29	56.29	0.00	2.13	1.20	0.00
50	8 Dec. 2017	24.89	15.26	97.71	73.00	31.80	2.40	1.40	0.00
51	15 Dec. 2017	25.57	11.50	95.14	67.43	0.00	2.67	0.87	0.40
52	22 Dec. 2017	25.73	11.49	96.88	69.13	0.00	2.53	1.33	1.67
1	29 Dec. 2017	23.66	10.76	97.00	68.71	23.00	2.33	1.60	2.00
2	5 Jan. 2018	22.54	7.50	97.14	60.29	0.00	2.13	0.73	1.60
3	12 Jan. 2018	24.19	11.54	97.00	68.86	0.00	2.00	0.60	1.53
4	19 Jan. 2018	24.67	9.97	97.00	57.71	0.00	1.93	0.80	0.47
5	26 Jan. 2018	22.91	8.93	96.00	54.57	0.00	0.00	1.20	0.40
6	2 Feb. 2018	26.29	10.91	97.00	53.86	0.00	0.00	0.53	0.20

*mean value of five plants

Table 2b: Correlation coefficient (r) of major insect pests with abiotic factors in pigeon pea during December 2017 to February 2018

Pests	Pearson's correlation coefficient				
	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
Maruca vitrata	0.091^{NS}	0.331^{NS}	0.007^{NS}	0.734*	0.295^{NS}
Apion sp.	-0.084^{NS}	0.334^{NS}	0.005^{NS}	0.405^{NS}	0.647*
Helicoverpa armigera	-0.463^{NS}	-0.322^{NS}	0.347^{NS}	0.411^{NS}	0.009^{NS}

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* Significant at 5% NS: Non-significant at 5%

Efficacy of insecticides against *Maruca vitrata*

The data pertaining to *Maruca vitrata* population on one day before spraying and the per cent reduction at 3,7,10 and 14 days on two different spray schedules are presented in Table 3. From the findings, it is evident that all the treatments had significantly reduced the population of *Maruca vitrata*. The results are in line with the findings of Sunitha *et al*. (2008) [30] who observed the relative efficacy of newer insecticides with conventional insecticides, bio insecticides and botanicals against 3rd instars larvae of *Maruca vitrata* and found that Indoxacarb was highly effective in reducing the larval population. Srihari and Patnaik (2006) [28] also found that indoxacarb (0.0075%) gave the highest reduction in larval population. This study is more or less similar to the findings of Rao *et al*. (2007) [18] who reported about 72% reduction in larval population of *Maruca vitrata* with Indoxacarb.

Efficacy of insecticides against *Apion sp.*

The data concerning to the *Apion* population are presented in Table 4. It is evident from the findings that, all the insecticides were effective in reducing the *Apion* sp. population. The observation indicated that Cypermethrin 25 EC (66.88) proved to be significantly superior in controlling the insect pest. The findings are in agreement with Gimeno and Peridiguer (1995) [8] who stated that application of Cypermethrin was found effective with more than 90 per cent control on *Apion* sp. in Lucerne.

Efficacy of insecticides against *Helicoverpa armigera.*

The data obtained from the *Helicoverpa armigera* population are depicted in Table 5. The observation indicated that Cypermethrin 25 EC (70.79%) proved to be significantly superior in controlling *Helicoverpa armigera* population. The results are in agreement with the findings of Ram Ujagir (1999) [17], Kumar and Nath (2003) [12] who stated that Cypermethrin was the most effective treatment against the pest of *Maruca vitrata* and *Helicoverpa armigera* in Pigeon pea.

Effect of insecticides on extent of pod and grain damage as well as yield of pigeon pea.

The data determining the effect of insecticides on the extent of pod and grain damage as well as yield of pigeon pea is depicted in Fig. 2. From the findings, it was observed that the plot treated with Cypermethrin 25 EC have the lowest (24.77%) pod damage. All the insecticides were at par with each other except Multineem. Highest pod damage was recorded in untreated control plot with a mean of 57.67%. However, the lowest grain damage was observed in the plot treated with Lambda-cyhalothrin 5 EC with a mean of 24.67 %. The highest grain yield was found in the plots treated with Cypermethrin 25 EC (1460 kg/ha). It is evident that the Cypermethrin treated plot exhibited the lowest pod damage and the highest grain yield. The results are in agreement with the findings of Ram Ujagir (1999) [17], Kumar and Nath (2003) [12] and Kripal Singh Sharma *et al*. (2003) [11] who reported that Cypermethrin showed the lowest pod damage on Pigeon pea.

Table 3: Efficacy of different insecticides against *Maruca vitrata* on pigeon pea during December 2017 to February 2018

Treatments	First spray					Second spray					Cumulative mean reduction (%)
	Pre-treatment count	Per cent reduction				Pre-treatment count	Per cent reduction				
		3 DAS	7 DAS	10 DAS	14 DAS		3 DAS	7 DAS	10 DAS	14 DAS	
Deltamethrin 2.8 EC @ 0.7 ml/lit	1.53	68.69 (56.00)	70.20 (57.00)	67.42 (55.35)	64.65 (53.71)	1.40	70.37 (57.12)	74.07 (60.00)	72.22 (58.46)	68.52 (55.89)	69.52
Azadirachtin 0.03% EC @ 4 ml/lit	1.93	48.48 (44.13)	51.52 (45.87)	47.35 (43.46)	45.83 (42.59)	1.80	48.15 (43.94)	51.85 (46.06)	47.92 (43.80)	46.06 (42.74)	48.39
Flubendiamide 39.35% SC @ 0.16 ml/lit	1.93	65.56 (54.10)	72.59 (58.48)	77.59 (61.77)	79.26 (62,91)	1.67	63.89 (53.07)	68.06 (55.66)	75.93 (60.62)	80.09 (63.72)	72.87
Cypermethrin 25 EC @ 0.3 ml/lit	1.33	72.22 (58.25)	74.31 (59.69)	72.22 (58.25)	69.44 (56.49)	1.07	75.00 (60.21)	77.78 (61.97)	75.00 (60.00)	72.22 (58.25)	73.52
Lambda-cyhalothrin 5 EC @ 0.8 ml/lit	1.40	62.10 (52.03)	66.27 (54.61)	64.19 (53.28)	62.10 (52.03)	1.00	63.33 (52.78)	66.67 (54.78)	63.33 (52.86)	60.00 (50.85)	63.49
Indoxacarb 4.5 + Novaluron 5.25% SC @1.2 ml/lit	1.20	72.22 (58.46)	75.00 (60.21)	77.78 (62.18)	83.33 (65.91)	1.07	69.44 (58.25)	75.00 (60.21)	79.17 (63.31)	84.72 (67.04)	77.08
Untreated control	1.27	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	2.40	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	
SEm ±	0.16	2.68	2.90	4.08	3.37	0.13	3.31	3.83	3.93	3.16	
CD (P=0.05)	0.48	8.26	8.95	12.43	10.38	0.41	9.61	11.81	12.23	9.73	

DAS: Days after spraying

Figures in the table are mean values and those in parenthesis are angular transformed values.

Table 4: Efficacy of different insecticides against *Apion* sp. on pigeon pea during December 2017 to February 2018

Treatments	First spray					Second spray					Cumulative mean reduction (%)
	Pre-treatment count	Per cent reduction				Pre-treatment count	Per cent reduction				
		3 DAS	7 DAS	10 DAS	14 DAS		3 DAS	7 DAS	10 DAS	14 DAS	
Deltamethrin 2.8 EC @ 0.7 ml/lit	1.87	64.26 (53.29)	67.78 (54.42)	53.70 (47.13)	50.00 (45.00)	1.73	65.28 (53.90)	67.36 (55.16)	57.41 (49.31)	53.70 (47.13)	59.93
Azadirachtin 0.03% EC @ 4 ml/lit	2.27	45.45 (42.38)	49.75 (44.86)	42.68 (40.79)	39.65 (39.02)	2.00	43.33 (41.15)	46.67 (43.08)	43.33 (41.15)	40.00 (39.23)	43.86
Flubendiamide 39.35% SC @ 0.16 ml/lit	2.00	59.73 (50.62)	62.76 (52.49)	56.70 (48.86)	53.37 (46.93)	1.60	57.94 (49.61)	62.10 (52.03)	57.94 (49.61)	52.38 (46.37)	57.86
Cypermethrin 25 EC @ 0.3 ml/lit	1.87	67.78 (55.42)	71.48 (57.73)	64.44 (53.41)	60.74 (51.23)	1.40	66.87 (54.89)	73.41 (59.05)	66.57 (54.68)	63.79 (53.04)	66.88
Lambda-cyhalothrin 5 EC @ 0.8 ml/lit	2.07	60.94 (51.34)	63.97 (53.21)	54.88 (47.80)	51.85 (46.06)	1.60	61.46 (51.63)	66.67 (54.75)	60.42 (51.08)	56.25 (48.67)	59.55
Indoxacarb 4.5 + Novaluron 5.25% SC @1.2 ml/lit	1.93	70.49 (57.11)	72.16 (58.18)	61.21 (51.57)	57.88 (49.56)	1.73	68.98 (56.28)	72.92 (58.69)	65.28 (53.90)	61.57 (51.72)	66.31
Untreated control	1.87	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	2.13	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	
SEm ±	0.07	1.60	2.88	2.65	2.71	0.09	3.25	2.62	3.24	2.96	
CD (P=0.05)	0.22	4.94	8.88	8.17	8.36	0.28	10.01	8.06	10.00	9.11	

DAS: Days after spraying

Figures in the table are mean values and those in parenthesis are angular transformed values.

Table 5: Efficacy of different insecticides against *Helicoverpa armigera* on pigeon pea during December 2017 to February 2018

Treatments	First spray					Second spray					Cumulative mean reduction (%)
	Pre-treatment count	Per cent reduction				Pre-treatment count	Per cent reduction				
		3 DAS	7 DAS	10 DAS	14 DAS		3 DAS	7 DAS	10 DAS	14 DAS	
Deltamethrin 2.8 EC @ 0.7 ml/lit	1.00	67.22 (55.17)	70.56 (57.17)	64.44 (53.52)	60.28 (50.93)	1.00	70.56 (57.29)	72.22 (58.36)	66.39 (54.59)	60.14 (50.98)	66.47
Azadirachtin 0.03% EC @ 4 ml/lit	1.33	50.00 (45.00)	54.76 (47.86)	45.24 (42.26)	41.07 (39.85)	1.07	46.67 (43.08)	52.78 (46.60)	40.00 (39.15)	40.00 (39.15)	46.32
Flubendiamide 39.35% SC @ 0.16 ml/lit	1.20	61.11 (51.49)	66.67 (54.74)	58.33 (49.84)	55.56 (48.25)	1.00	60.00 (50.77)	63.33 (52.78)	56.67 (48.85)	50.00 (45.00)	58.96
Cypermethrin 25 EC @ 0.3 ml/lit	1.27	73.81 (59.44)	76.19 (61.02)	68.25 (55.72)	63.10 (52.61)	1.07	75.56 (60.54)	78.33 (62.29)	68.89 (56.31)	62.22 (52.09)	70.79
Lambda-cyhalothrin 5 EC @ 0.8 ml/lit	1.07	68.89 (56.31)	71.67 (58.07)	62.22 (52.09)	58.89 (50.17)	1.00	65.83 (54.34)	69.17 (56.34)	61.67 (51.92)	58.89 (50.17)	64.65
Indoxacarb 4.5 + Novaluron 5.25% SC @1.2 ml/lit	1.40	71.43 (57.69)	73.81 (59.27)	66.67 (54.83)	64.29 (53.37)	0.93	71.67 (58.07)	75.00 (60.07)	67.50 (55.48)	60.83 (51.26)	68.9
Untreated control	1.13	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	1.20	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	
SEm ±	0.07	4.33	4.41	3.72	3.60	0.07	4.23	3.36	5.41	5.03	
CD (P=0.05)	0.20	13.35	13.57	11.46	11.09	NS	13.03	10.34	16.67	15.50	

DAS: Days after spraying
Figures in the table are mean values and those in parenthesis are angular transformed values.

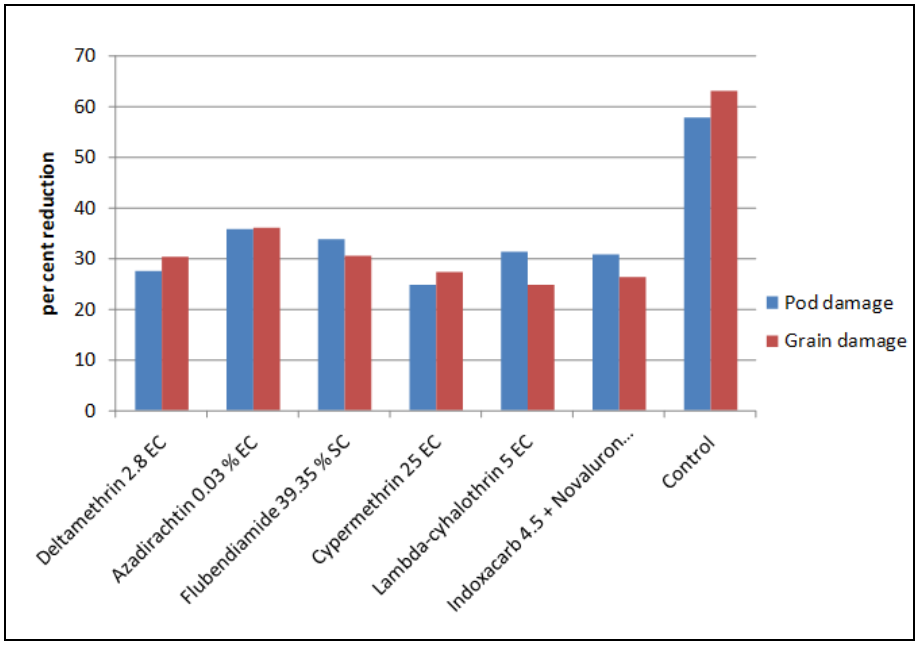

Fig 2: Efficacy of insecticides on reducing pod and grain damage during December to February, 2017-18.

Economics of insecticides treatment against major insect pests of Pigeon pea

In the context of economics of insecticides against major insect pests of Pigeon pea, it revealed that the maximum Benefit Cost Ratio was in the treatment Cypermethrin 25 EC (10.88: 1) followed by Lambda-cyhalothrin 5 EC (9.80: 1), Indoxacarb 4.5 + Novaluron 5.25 SC (3.32: 1) and Multineem (1.33: 1). The finding is in agreement with the findings of Rahman *et al*. (2014) [16] who reported the highest yield and Benefit cost ratio from Cypermethrin treated plots of pigeon pea. Bhavat and Magar (2017) [2] also recorded the highest Incremental benefit cost ratio from the plots treated with Cypermethrin.

Conclusion

Thus, it can be concluded that pigeon pea is attacked by several insect pests in all the stages from Vegetative till harvesting which needs serious attention of researchers. From this study, it is evident that synthetic insecticides are effective in minimizing the population of different pests of pigeon pea. It is suggested that further investigation should be carried out to study the reduced efficacy of certain insecticides so as to know the concrete results on their efficacy.

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