Bioefficacy of Synthetic Pyrethroid and Organophosphate Insecticide against H.armigera on Pigeonpea (Cajanus Cajan)

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ABSTRACT

The synthetic pesticides have been employed to increase the agrarian produce and quality. However excessive use of pesticides results in their persistence, toxicity and is known to have potential adverse effects on the environment and human health at even very minute concentration levels also. To address this problem a field experiment based on a Randomized Block Design (RBD) with three replications of seven treatments was conducted over two consecutive years to assess the bioefficacy of two insecticides namely profenofos 50 EC (an organophosphate) and deltamethrin 2.8 EC (a synthetic pyrethroid) against Helicoverpa armigera (pod borer) infesting pigeonpea (Cajanus cajan). Profenofos was applied at concentrations of 0.09% (low), 0.125% (recommended), and 0.13% (high), while deltamethrin was tested at 0.0012%, 0.0028%, and 0.0040%. Observations were recorded by sampling five plants per plot, and data were statistically analyzed. All insecticidal treatments significantly reduced H.armigera infestation compared to the untreated control. The highest efficacy was recorded with profenofos at 0.13%, resulting in the lowest pod damage (13.17%), followed by 0.125% (15%) and 0.09% (16.67%). Deltamethrin at 0.0040%, 0.0028%, and 0.0012% led to pod damage levels of 17.35%, 18.65%, and 19.84%, respectively. The untreated control recorded the highest damage at 29.33%. These results highlight profenofos as more effective than deltamethrin in managing H. armigera infestation in pigeonpea.

KEYWORDS: RBD, profenofos, deltamethrin, pigeonpea, H.armigera

1. INTRODUCTION

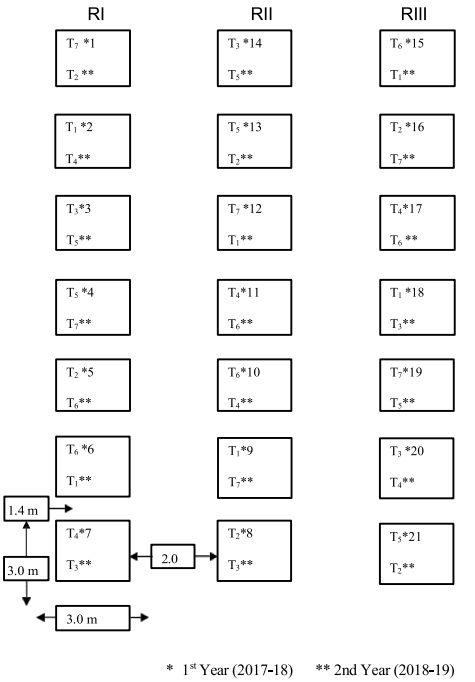
Vidarbha region of Maharashtra is a major pigeonpea growing area. Growers generally cultivate pigeonpea as a stand-alone crop or as an intercrop with groundnuts, cotton, maize, soybeans, urdbean, mung bean and castor. Studies have shown that pigeonpea is infested by over 250 insect species from 8 orders and 61 families as a result pigeonpea yields have remained stagnated over the past few decades. The severe infestation of a variety of insect complexes is the limitation for the low yield [1, 2]. Of the various insect species that infest pigeonpea, the pod borer complex is known to decrease yield. Of these, Helicoverpa armigera, Maruca vitrata, and Melanagromyza obtuse are significant obstacles in achieving the targeted productivity and production of pigeonpea, and as such, they are regarded as major pest problems. Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae) is responsible for huge crop loss amounting to 80–90%. Pests such as the tur plume moth (Exelastis atomosa), tur pod fly (Melanogromyza obtusa), and gram pod borer (Helicoverpa armigera) can be successfully controlled with the right use of recommended insecticides. Pigeonpea has been observed to be infested by H.armigera from the seedling stage until harvesting, and almost no plant section is free from insect infestation causing significant loss, which in turn affects the yields of the crop. [3, 4]. The economic threshold level for pod borers is 2-3 eggs or 1 larva per plant during the flowering stage of the crop. At this stage, pesticide application is required because an average infestation of one larva per plant may result in a yield loss of 10-15 kg ha-1 as pod borers are more common during this time [5]. Around the world, a variety of insecticides from various classes are used to control this pest. Deltamethrin and profenofos are leading and extensively used insecticides in the Maharashtra region of Vidarbha belonging to class synthetic pyrethroid and organophosphorus group, respectively recommended against control of Helicoverpa armigera pests.

Given that deltamethrin and profenofos are employed to fight pests of various crops, their efficacy against pests, persistence in food and environment is regarded as crucial in reducing or eliminating the negative impacts of these insecticides. In order to reduce the expenses associated with the chemical management of pigeonpea infestations by gram pod borer and prevent overuse, field trials were conducted to assess the bioefficacy of deltamethrin 2.8 EC and profenofos 50 EC over the course of two consecutive seasons with different concentrations in the year 2013-14 and 2014-15 [6]. Since excessive use of pesticides results in their persistence that has detrimental effects on the environment and human health at even very minute concentration levels also, this study was undertaken at further lower concentrations in the year 2017-18 and 2018-19.

2. MATERIAL AND METHOD

To investigate the effectiveness of deltamethrin and profenofos in controlling pigeonpea infestations by Helicoverpa armigera, field studies were carried out mahurzari, Katol road, Nagpur for two consecutive years. Three replications of each of the seven treatments were included in the randomized block design layout of the trail (Fig. 1). Every treatment plot measured three by three meters, with a replication and inter-plot distance of 2.0 and 1.4 meters. (Fig. 2). During both trial seasons, split pigeonpeas were sown in the second week of July with a 65 × 35 cm spacing. The remaining agricultural methods were carried out in accordance with Maharashtra's recommendations. (Table 1)

Fig: 1 Randomized block design



* 1st Year (2017-18) ** 2nd Year (2018-19)

Fig. 2: Plan of layout pigeonpea

Table 1 : Treatment

T_1- Profenofos- 0.09 %	T_4 Deltamethrin -0.0012 %
T_2-Profenofos -0.125%	T_5-Deltamethrin -0.0028%
T_3-Profenofos- 0.13 %	T_6- Deltamethrin-0.0040 %
T_7 -Untreated control	

Table 2: Details of the field experiment

Particulars	Pigeon pea
Plan of layout	Figure.1
Design	Randomized Block Design
Number. of Treatments	07
Number of Replications	03
Total Number of plots	21
Size of plot	3m x 3m
Crop	Split Pigeon peas
Spacing	65 x 35 cms
Inter Replication spacing	2.0 m
Inter plot spacing	1.4 m
Total number of plants per plot	Fifty
Method of sowing	Dibbling
Date of sowing	
1st year	10th July 2017
2nd year	15th July 2018
Cultural practices (weeding, Nutrients, etc.)	As Recommended
Application of pesticides	
1st Year	19th Nov 2017 & 3rd Dec 2017
2nd Year	23rd Nov 2018 & 7th Dec 2018
No. of sprays	Two

On pigeonpea, Profenofos 50 EC was tested at concentrations of 0.09, 0.125, and 0.13 percent against the H. armigera pod borer. Deltamethrin 2.8 EC, on the other hand, was assessed at 0.0012, 0.0028, and 0.0040 percent concentrations. Using manual knapsack sprayer with spray rate of 500 liters per hectare. Every pesticide spray treatment included of two applications spaced 15 days apart. Initial spraying was done at 50% flowering stage when infestation was observed. The damaged pods with the typical large hole caused by the larvae feeding were used to evaluate the effectiveness of the treatment (Fig.3). Observations were recorded by collecting representative samples from five plants which were selected from each treatment plot as shown in (Fig. 4).From the composite samples, nearly 100 pods were separated to find the percentage of pod damage. The data was then statistically analyzed to compare the treatments based on the essential difference. The specifics of the pigeonpea insecticidal treatments is presented in (Table 2)

S.No.	Treatment No.	Insecticide	Concentration of insecticide (Trade product)	Concentration used (%)
1	T_1	Profenonofos	50 EC	0.09
2	T_2	Profenonofos	50 EC	0.125
3	T_3	Profenonofos	50 EC	0.13
4	T_4	Deltamethrin	2.8 EC	0.0012
5	T_5	Deltamethrin	2.8 EC	0.0028
6	T_6	Deltamethrin	2.8 EC	0.0040
7	T_7	Untreated	-	-

Fig: 3 Pod damage due to Helicoverpa armigera

Fig.4: Tagged observational plants

3. RESULTS AND DISCUSSION

The Web Agri Stat Package was utilized to convert the data from two years of experiments regarding the percentage of damage caused by podborer in pigeonpea into arcsin values. These arcsin values were then subjected to statistical analysis of the data for the test of significance (CD at 5.0 percent level) as presented in (Fig. 5 & Fig. 6). The data on H. armigera borer infestation of pods from two years of trials was pooled and the mean percentage of pod damage in crops treated with spray treatments and untreated (control) is shown in (Table 3). 29.33% of the pigeon pea pods in the untreated control plot were damaged. When it came to reducing pod damage, which ranged from 13.17 to 19.84%, all pesticide spray treatments were noticeably better. Profenofos, which caused the least amount of pod damage (13.17 percent), was found to be the most effective pesticide at 0.13 percent. Profenofos, on the other hand, was found to be less effective at 0.125 and 0.09 recording 15 and 16.67 per cent infestation followed by, deltamethrin at 0.0040, 0.0028 and 0.0012 per cent recording 17.35, 18.65, 19.84 per cent infestation of the pod borer, H. armigera on pigeonpea, respectively. The reduction of infestation was noted as the concentrations of both insecticides increased. It is proposed that a spray concentration of 0.09 to 0.125% profenofos and 0.0012 to 0.0028% deltamethrin is more suitable for minimizing pesticide quantity and toxicant load than a higher concentration of 0.13% profenofos and 0.0040% deltamethrin.

Treatment means	
S.No	Average
Treatment 1	24.590
Treatment 2	23.050
Treatment 3	21.965
Treatment 4	27.258
Treatment 5	26.315
Treatment 6	25.099
Treatment 7	33.407

Fig: 6
Arc sin mean percent
Year 2018-19

Anova Table					
Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal	F prob
Replications	2	1.803	0.902	0.718	0.507
Treatments	6	252.945	42.157	33.588	0.000
Error	12	15.061	1.255	-	-
Total	20	-	-	-	-

Coefficient of Variation = 4.316

Treatments found Significant at 1% and 5% level of significance CD(0.01) = 2.795 CD(0.05) = 1.993

Comparison of Treatment Means with Critical Difference (0.05)

Treatment No.	T 7	T 4	T 5	T 6	T 1	T 2	T 3
Treatment Average	33.407	27.258	26.315	25.099	24.590	23.050	21.965
Critical Difference (CD) Compared	a	b	bc	c	cd	de	e

Treatment means	
S.No	Average
Treatment 1	23.552
Treatment 2	22.500
Treatment 3	20.537
Treatment 4	25.586
Treatment 5	24.601
Treatment 6	24.080
Treatment 7	32.146

Fig: 5
Arc sin mean percent
Year 2017-18

Anova Table					
Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal	F prob
Replications	2	7.333	3.666	2.932	0.092
Treatments	6	240.344	40.057	32.036	0.000
Error	12	15.004	1.250	-	-
Total	20	-	-	-	-

Coefficient of Variation = 4.524

Treatments found Significant at 1% and 5% level of significance CD(0.01) = 2.789 CD(0.05) = 1.989

Comparison of Treatment Means with Critical Difference (0.05)

Treatment No.	T 7	T 4	T 5	T 6	T 1	T 2	T 3
Treatment Average	32.146	25.586	24.601	24.080	23.552	22.500	20.537
Critical Difference (CD) Compared	a	b	bc	bcd	cd	de	e

Fig: 5, 6: Statistical analysis of the data by Web Agri Stat Package

On evaluation of two pesticides, the performance of profenofos was superior in minimizing the pod damage by pod borer. Effective control of pigeonpea pod borer infestation by spraying of profenofos and deltamethrin was earlier reported by many authors on different crops with slight variations in concentrations have been reported .Singh and Kumar [7, 8] found deltamethrin 2.8 EC (0.004%) most effective, as lowest percentage of pod damage against Helicoverpa armigera on pigeonpea was recorded . Fulshankar [9] reported that profenofos 50 EC (0.05) per cent proved the best in reducing the pod damage, while deltamethrin 2.8 EC at (0.0015) per cent was moderately effective against H. armigera on chickpea. Yadav et al. [10] reported that deltamethrin (0.007%), was more effective than other treatments against H.armigera in peas field. Baruah et al. [11] found deltamethrin (0.002%) effective against H. armigera infesting pigeonpea. Ambule et al. [12] found 0.075 per cent and Khorasiya et al. [13] found profenofos 0.07 per cent effective insecticide against H. armigera.

Results obtained in the present study are in agreement with work done by other workers. Deltamethrin 2.8 EC at 1ml/lit/10-12.5 g a.i. /ha and profenofos 50 EC at 2.5 ml/lit /1000-1250 g a.i. /ha is recommended for crop use [14].

4. CONCLUSION

The two-year field trial demonstrated that Helicoverpa armigera infestations in pigeonpea can be significantly minimized by applying either profenofos (50 EC) or deltamethrin (2.8 EC) in two rounds of spraying, initiated at 50% flowering. Among all treatments, profenofos at 0.13% showed the highest efficacy, with the lowest pod damage at 13.17%, followed by other doses and deltamethrin treatments.

Importantly, using moderate concentrations (0.09-0.125% for profenofos and 0.0012-0.0028% for deltamethrin) is not only cost effective but also helps minimize pesticide residues, delay resistance development, and reduce environmental impact. Adoption of such integrated chemical strategies, alongside good agricultural practices, can help pigeonpea growers in regions like Vidarbha to sustainably manage H. armigera infestations and improve yields.

Future research should explore eco-friendly combinations, such as integrating biopesticides or pest-resistant cultivars, to further reduce the reliance on synthetic chemicals and enhance long-term crop protection.

S/N	Treatment no.	Insecticidal Concentration (in percent a. i.)	Arc sin mean percent		Arc sin pooled mean percent	Original mean percent infestation		Original mean percent infestation
			Year 2017-18	Year 2018-19		Year 2017-18	Year 2018-19	
1	T_1	Profenofos 0.09	24.59	23.55	24.07	17.33	16.00	16.67
2	T_2	Profenofos 0.125	23.05	22.50	22.78	15.33	14.67	15
3	T_3	Profenofos 0.13	21.97	20.54	21.26	14.00	12.33	13.17
4	T_4	Deltamethrin 0.0012	27.26	25.59	26.43	21.00	18.67	19.84
5	T_5	Deltamethrin 0.0028	26.32	24.61	25.47	19.67	17.63	18.65
6	T_6	Deltamethrin 0.0040	25.1	24.08	24.59	18.00	16.67	17.35
7	T_7	Untreated control	33.41	32.15	32.78	30.33	28.33	29.33
	F Test		Significant	Significant	.	Significant	Significant	
	CD at 5%		1.993	2.168		2.866	2.633	
	CV		4.316	5.008		8.312	8.355	

Table 4: Mean percent infestation due to pod borer based on two years data

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