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Efficacy of different biopesticides against pigeonpea pod borer complex

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Abstract

The field experiment on pigeonpea (*Cajanus cajan* L. Millsp.) entitled "Efficacy of different biopesticides against pigeonpea pod borer complex" was conducted at Pulses Improvement Project, MPKV, Rahuri during *Kharif* 2021. The experiment was Layed out in Randomized Block Design with nine treatments and three replication with view to find out the efficacy of different biopesticides against pigeonpea pod borers *i.e. Helicoverpa armigera*, *Exelastis atomosa*, *Melanagromyza obtusa* and *Maruca vitrata.*

The performance of each treatment was judged on the basis of survival larval population of pod borer, per cent pod infestation, grain yield and ICBR. In each treatment, three sprays were given at an interval of 15 days initiating the first spray at 50 per cent flowering.

Studies on evaluation of different biopesticides against *H. armigera*, *E. atomosa*, *M. obtusa* and *M. vitrata* in comparison with chemical insecticide (Chlorantraniliprole 18.5%) at fortnightly interval. The treatments Azadirachtin (1500 ppm) and NSE (5%) were found most effective in controlling with Maximum yield of pigeonpea and ICBR, respectively. The results of present investigation revealed that, Azadirachtin (1500 ppm), NSE (5%), and Neem Leaf Extract were highly effective by recording lowest survival of larval population and per cent pod damage.

Maximum grain yield (30.54 q/ha) was recorded from the plot treated with (Chlorantraniliprole 18.5%) with ultimately registered maximum net profit Rs.105819/-. Amongst the biopesticides higher grain yield (27.18 q/ha) registered from treatments Azadirachtin (1500 ppm) with maximum net profit of Rs. 84375/-. The maximum Incremental cost benefit ratio was however obtained from the plot treated Azadirachtin (1500 ppm) (1:8.01) and Chlorantraniliprole (1:9.50).

Keywords: biopesticides, pigeonpea, pod borer, *Cajanus cajan* L.

Introduction

Pigeonpea, scientifically known as *Cajanus cajan* (Linnaeus) Millspaugh, is a widely cultivated pulse crop in India during the *kharif* season. It is commonly referred to as 'Red gram,' 'Tur,' or 'Arhar.' This crop is renowned for its high protein content, ranging from 16.2 to 35 per cent, and it also contains abundant amino acids (Anonymous, 1985) [2]. On a dry basis, pulses, on average, contain 20-25 percent protein, which is approximately 2.5-3.0 times higher than the protein content typically found in cereals. Numerous studies in the field of medical science have demonstrated that vegetable protein contributes to better health and longevity compared to animal protein. Locally, pigeonpea is predominantly consumed in the form of split pulses, commonly known as 'dal,' and its green pods are seasonally used as a vegetable. Furthermore, the husk of the pods, along with the seeds and a portion of the kernel, is considered valuable fodder for cattle. The dry stalks of the plant serve multiple purposes such as thatching, fuel, or as material for basket making. In addition to its high nutritional value, pigeonpea possesses a unique characteristic of restoring soil fertility through biological nitrogen fixation. Furthermore, it is well-suited for crop rotation, intercropping, and is found to be suitable for dry farming practices.

Pigeonpea cultivation is primarily concentrated in Maharashtra, Uttar Pradesh, Andhra Pradesh, Gujarat, and certain regions of Rajasthan in India. In fact, India's total pigeonpea cultivation covered approximately 4.80 million hectares, resulting in an annual production of around 4.28 million tonnes (Anonymous, 2021a) [3]. Maharashtra alone accounted for an area of 1.24 million hectares and an annual grain production of 1.28 million tonnes. However, despite the increasing cultivation area, the yield of pigeonpea remains unsatisfactory. Several factors contribute to this issue, with one of them being significant yield losses caused by pest infestations (Anonymous, 2021b) [4].

Under field conditions, pigeonpea is susceptible to damage from numerous insect pests. Approximately 250 species of insects from 8 orders and 61 families have been reported, although only a few of them result in significant yield losses (Sachan *et al*., 1994) [13]. The most significant threats come from insect pests that feed on buds, flowers, and pods. The pod borer (*Helicoverpa armigera*), plume moth (*Exelastis atomosa*), and pod fly (*Melanagromyza obtusa*) collectively known as pod borers, are particularly problematic as they directly damage the developing grains inside the pods. The pigeonpea spot borer (*Maruca testulalis*) is also occasionally found in flower buds and leaves webs. In India, these borers have been reported to cause pod damage ranging from 20 to 60 percent (Tuwafe *et al*., 1974) [15], 20 percent (Argikar and Thobbi, 1977) [15], 40 percent (Rai and Singh, 1976) [12], and as high as 95 percent (Odak, 1972) [9].

In Maharashtra, multiple varieties of pigeonpea are available; however, none of them exhibit resistance to all pests. There are instances where a particular variety shows resistance to one pest, but another pest becomes more destructive, resulting in significant losses. In such situations, it becomes crucial to protect the crop from infestations by implementing various methods. The regular and indiscriminate use of insecticides can lead to resistance, pest resurgence, secondary pest outbreaks, and pose health hazards. Therefore, it is of utmost importance to identify alternatives to chemical insecticides in plant protection that do not compromise the productivity and profitability of agriculture.

Given the circumstances, the need for an environmentally friendly pest control agent to address the problem is evident. It is crucial that insecticides used for pest control are eco-friendly, meaning they are safe for natural enemies, target-specific, biodegradable, and do not leave toxic residues. In this regard, selective biorational insecticides, microbial pesticides, and botanicals have gained significance due to their promising management of pest levels and their potential for maintaining an economical balance. Keeping this in view, research was undertaken entitled with “Efficacy of different biopesticides against pigeonpea pod borer complex”.

Materials and Methods

During the course of the present investigation entitled experiment was carried out during *kharif*, 2021 at field of Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (MS) to evaluate different biopesticides against pod borer (*Helicoverpa armigera*), plume moth (*Exelastis atomosa*), and pod fly (*Melanagromyza obtusa*) spot borer (*Maruca vitrata*) on pigeonpea. Nine treatments with three replications were imposed in Randomized Block Design (RBD). The pigeonpea variety Rajeshwari sown last week of June with spacing 90×60 cm. The crop was raised by following all the recommended package of practices except plant protection measures against pod borers.

Details of treatments

T_1: Azadirachtin 1500 ppm (5 ml/lit)
T_2: *Bt. var. kurastaki* 85 WG (2 gm/lit)
T_3: *Ha*NPV 500 LE (1 ml/lit)
T_4: *Metarhizium anisopliae* 1.15 WP (5 gm/lit)
T_5: *Beauveria bassiana* 1.15 WP (5 gm/lit)
T_6: Neem Leaf Extract 5%
T_7: Neem Seed Extract 5%
T_8: Chlorantraniliprole 18.5% (0.3 ml/lit)
T_9: Untreated control

The spraying was done by battery operated knapsack sprayer using the spray fluid at the rate of 500 L/ha, for each spray. Each biopesticides treatment consisted of three sprays. The first spray was given at 50% flowering and subsequent sprays were given at 15 days interval. In all, three sprays of biopesticides were applied. The efficacy of biopesticides was evaluated by selecting five plants randomly from each treated plot for recording observations on number of pod borer larvae before each application and at 3, 7 and 14 days after the application of biopesticides treatment. Five plants selected earlier randomly from each plot were observed for pod damage at the time of harvesting. Number of damaged pods and healthy pods were counted. The yield of pigeonpea grains obtained from the total plants from each of the net plot was recorded separately. The yield per plot was converted into the yield per hectare. And analyzed statistically for variance to compare the treatments.

Results and Discussion

Cumulative effect of biopesticides on larval population of pod borers on pigeonpea ecosystem

Helicoverpa armigera

Based on the pooled average of three sprays over the course of the experiment, the data reported in Table 1 and shown in Fig 1 represent the final performance of various treatments. The initial *H. armigera* larval population varied between 1.53 and 2.03 larvae per plant for all treatments including the untreated control.

Table 1: Cumulative effect of biopesticides on larval population of *H. armigera* (average of three spray) on pigeonpea

Tr. No	Treatments	Dose/lit	Precount	Larval count/ plant			
				3 DAS	7 DAS	14 DAS	Mean
T_1	Azadirachtin 1500 ppm	5.0 ml	1.80 (1.51)	0.72 (1.10)	0.57 (1.03)	0.51 (1.00)	0.60 (1.04)
T_2	*Bt. var. kurstaki*	2.0 g	1.73 (1.46)	1.39 (1.37)	1.24 (1.31)	1.10 (1.26)	1.24 (1.31)
T_3	*Ha*NPV	1.0 ml	1.78 (1.51)	1.34 (1.36)	1.17 (1.29)	1.03 (1.23)	1.18 (1.29)
T_4	*Metarhizium anisopliae*	5.0 g	1.70 (1.48)	1.30 (1.34)	1.09 (1.26)	0.98 (1.21)	1.12 (1.27)
T_5	*Beauveria bassiana*	5.0 g	1.75 (1.50)	1.43 (1.38)	1.31 (1.34)	1.18 (1.29)	1.31 (1.35)
T_6	Neem Leaf Extract 5%	---	1.78 (1.51)	0.98 (1.21)	0.81 (1.14)	0.64 (1.06)	0.81 (1.14)
T_7	NSE 5%	---	1.80 (1.52)	0.89 (1.18)	0.68 (1.08)	0.56 (1.03)	0.71 (1.1)

T8	Chlorantraniliprole	0.3 ml	1.70 (1.48)	0.29 (0.89)	0.20 (0.84)	0.15 (0.81)	0.21 (0.84)
T9	Untreated Control	---	1.53 (1.24)	1.84 (1.53)	1.92 (1.55)	1.99 (1.58)	1.92 (1.55)
SE (±)			0.08	0.05	0.07	0.05	0.04
CD @ 5%			N.S.	0.15	0.21	0.13	0.13

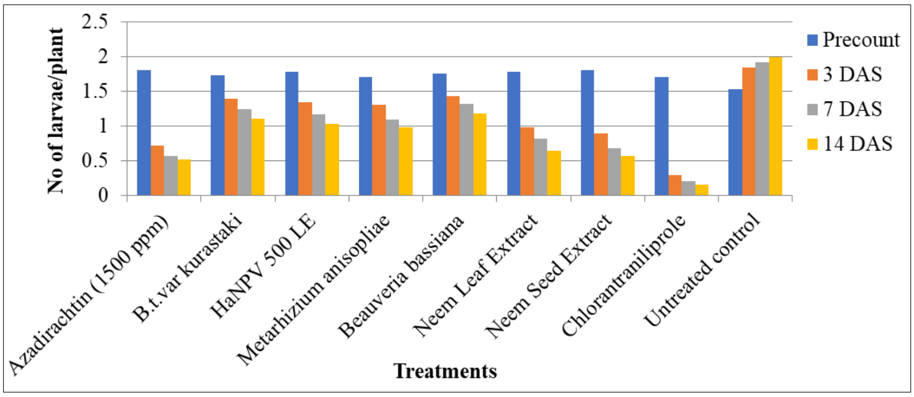

Fig 1: Cumulative effect of biopesticides on larval population of *H. armigera* after three spray on pigeonpea

Table 2: Cumulative effect of biopesticides on larval population of *E. atomosa* (average of three spray) on Pigeonpea

Tr. No	Treatments	Dose /lit	Precount	Larval count/ plant			
				3 DAS	7 DAS	14 DAS	Mean
T1	Azadirachtin 1500 ppm	5.0 ml	6.33 (2.61)	2.40 (1.70)	1.78 (1.51)	1.42 (1.39)	1.87 (1.54)
T2	*Bt. var. kurstaki*	2.0 g	5.93 (2.53)	3.47 (1.99)	2.62 (1.77)	1.93 (1.59)	2.67 (1.78)
T3	*Ha*NPV	1.0 ml	5.87 (2.52)	4.44 (2.22)	4.07 (2.13)	3.66 (2.03)	4.06 (2.13)
T4	*Metarhizium anisopliae*	5.0 g	6.20 (2.58)	3.41 (1.98)	2.54 (1.74)	1.84 (1.53)	2.60 (1.76)
T5	*Beauveria bassiana*	5.0 g	6.13 (2.57)	3.58 (2.02)	2.73 (1.80)	2.04 (1.60)	2.78 (1.81)
T6	Neem Leaf Extract 5%	-	6.27 (2.60)	2.71 (1.79)	2.20 (2.70)	1.73 (1.49)	2.21 (1.65)
T7	NSE 5%	-	6.33 (2.61)	2.60 (1.76)	2.01 (1.58)	1.60 (1.45)	2.07 (1.60)
T8	Chlorantraniliprole	0.3 ml	6.80 (2.70)	1.46 (1.40)	0.84 (1.16)	0.65 (1.07)	0.98 (1.22)
T9	Untreated Control	---	5.86 (2.52)	7.29 (2.79)	7.72 (2.86)	8.04 (2.92)	7.68 (2.86)
SE (±)			0.08	0.05	0.07	0.04	0.07
CD @ 5%			N.S.	0.15	0.21	0.13	0.22

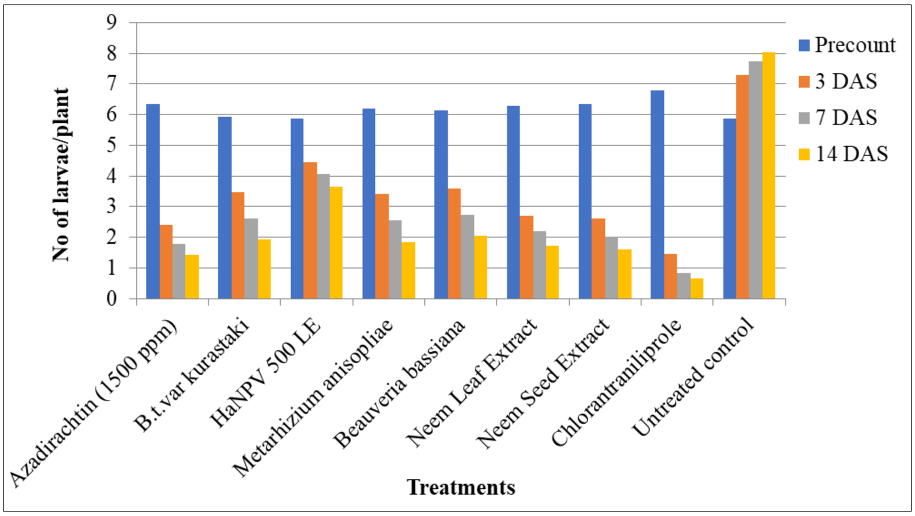

Fig 2: Cumulative effect of biopesticides on larval population of *E. atomosa* after three spray on pigeonpea

Data on the survival of the larval population at 3 DAS revealed that treatment T_8 (Chlorantraniliprole) had the lowest average combined larval population at 0.29 larvae per plant, which was significantly better than other treatments. The next best treatment was T_1 (Azadirachtin) with 0.72 larvae per plant. T_7 recorded 0.89 larvae per plant, followed by T_6. The treatments in descending order of superiority, were $T_4 > T_3 > T_2 > T_5$, with recorded counts of 1.30, 1.34, 1.39, and 1.43 larvae per plant, respectively. These treatments differed significantly from the untreated control, which had a larval population of 2.07 larvae per plant.

At 7 DAS, The treatment T_8 (Chlorantraniliprole) had the least larval population, with 0.20 larvae per plant. It was followed by treatments T_1 (Azadirachtin) and T_7 (NSE) had larval population, with 0.57 and 0.68 larvae per plant, respectively. The next best treatment was T_6, which recorded 0.81 larvae per plant. The treatment T_2 was at par with T_4 (*M. anisopliae)*, with recorded counts of 1.09 and 1.24 larvae per plant, respectively. The treatment T_5 was the least effective, showing 1.31 larvae per plant, but it was still better than the untreated control, which had a larval population of 1.92 larvae per plant.

At 14 DAS, the larval population was very low, ranging from 0.15 to 1.18 larvae per plant in various treatments, including the control. The treatment T_8 (Chlorantraniliprole) had the least larval population of 0.15, showing superiority over the other treatments. Among the biopesticides T_1 (Azadirachtin) and T_7 (NSE) was superior treatments recorded 0.51 and 0.56 larvae per plant, respectively. The next best treatment was T_6 with 0.64 larvae per plant. The treatment T_4 was at par with T_3, recording 0.98 and 1.03 larvae per plant, respectively. T_5 and T_2 exhibited the least effectiveness compared to all the other treatments, but they were statistically different from the larval population of 2.02 larvae per plant in the untreated control.

Exelastis atomosa

The information shown in Table 2 and represented in Fig. 2 illustrates the effects of three sprays on *E. atomosa* on average. The range of the larval pre count in several treatments, including the untreated control, was 5.86 to 6.80 larvae per plant.

All biopesticide treatments at 3 DAS were more effective at controlling the population of *E. atomosa* than the untreated control except for T_3, which proved to be the least effective. The average larval population ranged from 1.46 to 3.58 larvae per plant in the treated plots, compared to 7.29 larvae per plant in the untreated control. The treatments with T_1 (Azadirachtin) and T_7 (NSE) were the most successful in lowering the larval population of *E. atomosa* 2.40 and 2.60 larvae per plant, respectively. T_6 recorded 2.71 larvae per plant, which was the second-best treatment. T_4 and T_5 displayed 3.41 and 3.58 larvae per plant, respectively.

At 7 DAS, The treatment T_8 (Chlorantraniliprole) had the least larval 0.84 larvae per plant. The minimum larval population was observed in treatment T_1 (Azadirachtin) and T_7 (NSE), with 1.78 and 2.01 larvae per plant, respectively. This was followed by T_8 (Chlorantraniliprole). The next best treatments, in descending order, were $T_6 > T_4 > T_2 > T_5$, with larval populations of 2.20, 2.54, 2.62, and 2.73 larvae per plant, respectively. Treatment T_3 was the least effective, with a larval population of 4.07 larvae per plant.

At 14 DAS, a comparable patterns of outcomes was observed as at 7 DAS. At both time points, T_1 (Azadirachtin) and T_7 (NSE) were found be the next better treatments after T_8 (Chlorantraniliprole).

Conclusion

It is to be concluded that spraying of chlorantraniliprole 18.5% (0.30 ml/lit.) at fortnightly interval was found to be most effective controlling pod borers in pigeonpea. Among the biopesticides Azadirachtin 1500 ppm (5 ml/lit.) was superior among the all other treatments which recorded lowest no of larvae/plant. It is in agreement with Latif *et al.* (1996) [8]. The similar finding was reported by Abbas Ahmed (2020) [1]. The effectiveness of Azadirachtin against another pod borer *M. vitrata* in pigeonpea is in agreement with finding of Patel *et al*. (1997) [10].

Srivastava *et al*. (1984) [14] revealed that performance of neem seed extract 5% was quite comparable to those of synthetic pesticides, *viz*; fenvalerate and quinolphos. Similarly, Degaonkar *et al.* (1998) [6] found that neem extract 5% gave good control of pigeonpea pod borers.

Pillai *et al*. (2013) [11] investigated various treatments against *M. vitrata* in pigeonpea. It revealed that larval reduction in *M. vitrata* was the least in NSKE 5 per cent (5.3 larvae/25 shoots).

Deshpande *et al.* (2001) [7] reported that entomopathogenic fungi as mycoinsecticides were useful against lepidopteron pest in pulses.

Tyagi *et al.* (2010) [16] evaluated three microbial insecticides *viz*., *Bacillus thuringiensis*, *B. bassiana* (conidia/ml) and NPV (POB/ml) with four doses of concentration (1×10^9, 1×10^8, 1×10^7, 1×10^6) against *H. armigera*. They stated that maximum mortality was observed with *B. thuringiensis* followed by NPV.

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