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Field Bio Efficiency of Insect Growth Regulators and Insecticides against Pod Fly, *Melanagromyza obtusa* in Pigeonpea (*Cajanus cajan,* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study on the bio efficacy of insect growth regulators and insecticides on pod fly was carried out during *kharif* 2021 in pigeonpea using Co 7 variety. An experiment was laid out using a randomized block design (RBD) with seven treatments and three replications. Insecticidal treatments consisted of four insect growth regulators and two insecticides along with untreated check and applications were made twice. Among the seven treatments tested, T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} proved to be effective in reducing pod fly population (3.67 No/25 pods). The other treatments tested were found to be on par except T_1: Buprofezin 25 SC @ 200 g a.i. ha^{-1}

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treated plots (6.33 Nos), whereas untreated check reported with 14.67 Nos at 14 DAS. At the same time, pod damage was also calculated and the lowest pod damage was recorded in T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} and T_5: Lufenuron 5.4 EC @ 30 g a.i. ha^{-1} treated plots and were significantly superior over other treatments and found to be on par with each other with 10.00 and 11.33 per cent, respectively. At two applications of treatments also, T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} treated plots was superior over other treatments and recorded 3.15 Nos per 25 pods with 3.72 and 11.88 per cent pod and seed damage, respectively.
After two applications of T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} the pod fly damage reduction was upto 80.1 per cent and other treatments reported the damage between 42.2 – 78.0 per cent over untreated check. The highest yield was reported in plots treated with T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} for its highest grain yield of 757.7 kg ha^{-1} with 43.2 per cent increase over untreated check. The other treated plots reported between 478.3 - 680.0 kg of grain yield ha^{-1} with 10.82-75.56 per cent increase over untreated check. The highest Benefit: Cost ratio was obtained in the plots treated with T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} (1:1.6) and other treatments reported between 1:1.0 – 1:1.4 whereas untreated plots reported with lowest benefit cost ratio of 1:0.9.

Keywords: Insect growth regulators; insecticides; efficacy; pod fly; pod damage; Pigeonpea.

1. INTRODUCTION

Redgram or Tur or Pigeonpea, or *Cajanus cajan* L. is a significant pulse crop that is grown on 4.65 million hectares worldwide. It produces 3.43 million tonnes annually and has an average productivity of 780 kg per hectare. Among the biotic constraints, there are nearly three hundred species of insect-pests known to infest at various growth stages of crop growth. In the recent years, among all, pod fly is the important pest of Pigeonpea (Lal et al., 2018). Pod fly, *Melanagromyza obtusa* (Malloch) is a hidden pest occurring at pod formation stage without external symptom of damage and causes yield loss upto 60 to 80 per cent (Durairaj, 2006). Pod flies alone cause 20–80% of seed damage, while India accounts for almost 25% of global pulse production. The female pod fly does not exhibit any outward signs of injury; instead, she oviposits separately in the growing pods. The infested immature pods do not show external evidence of damage until the fully-grown larvae make an exit hole in the pod walls which results in complexity of their management (Sharma et al., 2010). Hence, continuous monitoring and special management practices were required to overcome this problem.

The pod fly attack remains unnoticed by the farmers owing to the concealed mode of life and thus poses challenge for management, since the oviposition occurs at the inner surface of the pod wall involving anatomical, morphological and biochemical basis of preference. In spite of application of three to four rounds of application of insecticides against other pod borers also resulted in the failure of control of *M. obtusa* which requires timely application. In order to manage this hidden insect, evaluation of insect growth regulators and insecticide molecules with different modes of action were studied to identify the level of protection of each molecule against pod fly in pigeonpea ecosystem.

2. MATERIALS AND METHODS

To ascertain the bio-efficacy of insect growth regulators and insecticides with various modes of action molecules against pod-flies, a field experiment was carried out during the *Kharif* season of 2021–2022 at Agricultural Research Station, Virinjipuram, Vellore, Tamil Nadu. Using the CO 7 variety, an experiment was set up in a randomized block design (RBD) with three replications, seven treatments with a plot size of 25 m^2 with 60 cm x 30 cm spacing. The crop was grown using rainfed circumstances and throughout the flowering stage, it received irrigation based on need. Two sprays were administered in total, starting at the pod initiation stage and spaced fifteen days apart. Using destructive sampling, the number of pod flies, *M. obtusa*, maggots and pupae from 25 randomly selected pods per plant was determined.

The pod and seed damage, per cent reduction over untreated check and increased yield over untreated check were also worked out using the formula. Thus the data obtained on the population, pod and seed damage and grain yield in different treatments were analyzed statistically using AGRES (Gomez and Gomez 1984).

$$Pod\ damage\ (\%) = \frac{Number\ of\ damaged\ pods}{Total\ number\ of\ pods} X100$$

$$Seed\ damage\ (\%) = \frac{Number\ of\ damaged\ seeds}{Total\ number\ of\ seeds} X100$$

$$Pod\ damage\ reduction\ over\ untreated\ check\ (\%) =$$

$$\frac{Mean\ pod\ damage\ in\ untreated\ check\ -\ Mean\ pod\ damage\ in\ treatment}{Mean\ pod\ damage\ in\ untreated\ check} X100$$

$$Seed\ damage\ reduction\ over\ untreated\ check\ (\%) =$$

$$\frac{Mean\ seed\ damage\ in\ untreated\ check\ -\ Mean\ seed\ damage\ in\ treatment}{Mean\ seed\ damage\ in\ untreated\ check} X100$$

$$Increase\ over\ untreated\ check\ (\%) = \frac{Yield\ in\ treatment - Yield\ in\ untreated\ check}{Yield\ in\ untreated\ check} X100$$

3. RESULTS AND DISCUSSION

The data on the population of pod fly maggots and pupae, pod and seed damage were presented in Table 1. The pre-count population of maggots and pupae ranged from 12.00 -12.67 Nos per 25 pods and found to be non-significant. After the first application of treatments, at pod initiation stage, at 14 DAS (Days after Spray), there existed significant difference among the various treated plots. Among the seven treatments tested,T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} was found to be superior over other and recorded 3.67 Nos per 25 pods followed by other treatments *viz*., T_5: Lufenuron 5.4 % EC @ 30 g a.i. ha^{-1} , T_3: Dinotefuran 20 % SG @ 40 g a.i.ha^{-1} , T_2:Diafenthiuron50% WP @ 350 g a.i. ha^{-1} T_6:Thiamethoxam 25% WG @ 50 g a.i. ha^{-1} were found to be on par with each other and recorded with 4.33 - 5.33 Nos per 25 pods, respectively. The highest population of pod fly was recorded in T_1: Buprofezin 25 % SC @ 200 g a.i.ha^{-1} (6.33 Nos./25 pods) treated plots, whereas the untreated plots recorded 14.67 Nos per 25 pods at 14 days after first spray. At the same time, pod damage was also calculated and the lowest pod damage was recorded in T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} and T_5: Lufenuron 5.4 EC @ 30 g a.i. ha^{-1} treated plots and were significantly superior over other treatments and found to be on par with each other with 10.00 per cent and 11.33 per cent damages, respectively. Almost, similar trend of efficacy of different treatments was also observed with respect to seed damage and the highest seed damage was reported in untreated check (41.58 %). Before the second application of treatments, there existed significant difference in the pre-count population of pod fly maggots and pupae and ranged between 6.67 – 16.00 Nos per 25 pods. Even after the second application of treatments also, T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} treated plots was superior over other treatments and recorded 3.15 Nos per 25 pods with 3.72 per cent pod damage and 11.88 per cent seed damage.

The mean per cent pod and seed damage was worked out after imposing the two applications of treatments and the mean per cent pod damage ranged between 6.90 – 34.6 with its lowest in T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} treated plots and the highest in untreated check. Likewise, the mean per cent seed damage was also ranged from 12.2 – 40.4 with its lowest in T_4: Flubendiamide 480 Sc @ 30 g a.i. ha^{-1} treated plots and the highest in untreated check.

After two applications of T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} the pod fly damage reduction over untreated control was up to 80.1 per cent and other treatments reported the damage reduction between 42.2 – 78.0 per cent over untreated check. The highest yield was reported in plots treated with T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} for its highest grain yield of 757.7 kg ha^{-1} with 75.56 per cent increase over untreated check. The other treated plots reported between 478.3 - 680 kg of grain yield per ha with 17.52 - 36.53 per cent increase over untreated check. The highest Benefit :Cost ratio was obtained in the plots treated with T_4: Flubendiamide 480 SC @ 30 g a.i. ha^{-1} (1:1.6) and other treatments reported between 1: 1.1 – 1:1.4 whereas untreated reported with lowest benefit cost ratio of 1:0.9 (Table 2).

Table 1. Evaluation of insect growth regulators and insecticides against pod fly, *Melanagromyza obtusa* in pigeonpea

Treatments	Dose /L	Pod fly maggots + Pupae per 25 pods, pod damage (%) and grain damage (%)								Grain Yield (Kg/ha)
		First application				Second application				
		Precount	14 DAS	Pod damage	Seed damage	Precount	14 DAS	Pod damage	Seed damage	
T_1:Buprofezin 25 % SC	200	11.67 (3.41)	6.33 (2.52)^{c}	29.33^{d}	27.46^{d}	9.33 (3.06)^{b}	4.76 (2.18)^{ab}	10.67^{d}	24.33^{c}	478.3
T_2:Diafenthiuron 50 % WP	350	12.67 (3.55)	5.33 (2.31)^{ab}	16.67^{c}	20.88^{c}	8.00 (2.83)^{ab}	5.21 (2.28)^{b}	8.70^{c}	21.63^{c}	581.7
T_3:Dinotefuran 20% SG	40	11.67 (3.41)	4.67 (2.16)^{ab}	15.33^{bc}	16.38^{bc}	8.00 (2.83)^{ab}	4.46 (2.11)^{ab}	6.49^{b}	15.88^{b}	576.7
T_4:Flubendiamide 480 SC	30	11.67 (3.41)	3.67 (1.91)^{a}	10.00^{a}	12.42^{a}	6.67 (2.58)^{a}	3.15 (1.77^{a}	3.72^{a}	11.88^{a}	757.7
T_5:Lufenuron 5.4 % EC	30	12.00 (3.46)	5.33 (2.31)^{ab}	11.33^{ab}	16.77^{ab}	8.00 (2.83)^{ab}	4.71 (2.17)^{ab}	3.82^{bc}	12.85^{a}	680.0
T_6:Thiamethoxam 25 % WG	50	12.33 (3.51)	4.33 (2.08)^{ab}	14.67^{bc}	14.92^{bc}	7.33 (2.71)^{ab}	4.18 (2.04)^{ab}	4.28^{a}	14.96^{b}	523.3
T_7:Untreated Check	-	12.67 (3.55)	14.67 (3.83)^{d}	45.33^{e}	41.58^{e}	16.00 (4.00)^{c}	16.00 (4.00)^{c}	23.78^{e}	39.21^{d}	431.6
SEd		NS	0.20	1.69	2.08	0.19	0.28	1.75	1.50	
CD<0.5 %			0.44	3.68	4.54	0.42	0.61	3.83	3.28	

Table 2. Cost Economics studies for insecticides on podfly, *M. obtusa damage* in pigeonpea

Treatments	Dose g a.i ha^{-1}	Mean damage after two applications (%)		Reduction over control (%)		Grain Yield (Kg/ha)	Increase over check (%)	B: C ratio
		Pod damage	Seed damage	Pod damage	Seed damage			
T_1:Buprofezin 25 % SC	200	20.0	25.9	42.2	35.9	478.3	10.82	1:1.1
T_2:Diafenthiuron 50 % WP	350	12.7	21.3	63.3	47.3	581.7	34.78	1:1.3
T_3:Dinotefuran 20% SG	40	10.9	16.1	68.5	60.1	576.7	33.62	1:1.3
T_4:Flubendiamide 480 SC	30	6.9	12.2	80.1	69.8	757.7	75.56	1:1.6
T_5:Lufenuron 5.4 % EC	30	7.6	14.8	78.0	63.4	680.0	57.65	1:1.4
T_6:Thiamethoxam 25 % WG	50	9.5	14.9	72.5	63.1	523.3	21.25	1:1.2
T_9:Untreated Check	-	34.6	40.4	-	-	431.6	-	1:0.9
SEd						12.2	-	
CD<0.5 %						24.6		

The current results corroborate those of (Chiranjeevi and Sarnaik 2014) who found that the novel pesticide Chlorantraniliprole 8.5 SC @ 30 g a.i. ha^{-1} reduced pod flies more effectively due to the similar diamide group. The results of (Sreekanth et al., 2013) were likewise consistent with the timing of insecticide application, which was first applied during the pod start phases and then at a 15-day interval.

(Singh, 2014) also reported the efficacy of newer insecticides proved to be very effective against pod fly in pigeonpea. Applying the insecticide dimethoate 30 EC @ 2 ml l^{-1} at 2, 3, 4, and 5 weeks after 50% flowering was found to be beneficial in minimizing pod fly-induced damage to pods and grains while increasing yield (Reddy et al., 2010). The pod age was 13 to 25 days, and oviposition which produced the most eggs, was facilitated by 10 to 15 days, according to (Das and Odak 1991) and (Durairaj, 2000). Among different insecticides, thiacloprid 21.7 SC, followed by diafenthiuron 50 WP, flubendiamide 480 SC and dimethoate 30 EC were very effective against pod fly with more grain yield and registered highest incremental cost benefit ratio (ICBR) was reported by (Sreekanth et al., 2020).

Therefore, it can be said that using Flubendiamide 480 SC @ 30 g a.i. ha-1 twice throughout the pod-initiation stages was very helpful in reducing pod fly infestation and boosting grain yield in order to achieve the maximum Benefit: Cost ratio.

4. CONCLUSION

Application of flubendiamide 480 SC @ 30 g a.i. ha^{-1} at the pod initiation stage with 15 days interval helps to minimize the losses in pigeonpea caused due to podfly incidence. Like wise application of Lufenuron 5.4% EC, Diafenthiuron 50 % WP and Dinotefuran 20 % SG also helps to control the podfly up to 50 per cent.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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