## Field efficiency of Growth Regulators and Insecticides against ~~on~~ Pod Fly, *MelanagromyzaObtusa* in Pigeonpea (*Cajanus Cajan*~~,L.~~)

## ABSTRACT


The present study on the efficacy of insect growth regulators and insecticides on pod fly was carried out during *kharif* 2021 in pigeonpea~~using~~ of the varietyCo 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~~and untreated ~~check~~checksand applications were made twice.Among the seven treatments tested, ~~T4:~~ Flubendiamide 480 Sc @ 30 g a.i. ha$^{-1}$ proved to be the most effective in reducing the podfly population (3.67 ~~No~~flies/25 pods).~~The other treatments tested were found to be on par except T1: Buprofezin 25 Sc @ 200 g a.i. ha-1 treated plots (6.33 Nos), whereas untreated check reported with 14.67Nos at 14 DAS. At the same time, pod damage was also calculated and~~ The lowest pod damage was recorded in ~~T4:~~ Flubendiamide 480 SC @ 30 g a.i. ha$^{-1}$ and ~~T5:~~ Lufenuron 5.4 EC @ 30 g a.i. ha$^{-1}$ treated plotsand were significantly superior over other treatments and found to be on par with each other with 10.00 and 11.33 per cent, respectively. After two applications of ~~T4:~~ Flubendiamide 480 SC @ 30 g a.i. ha$^{-1}$ the pod fly damage reduction was upto80.1 per cent ~~and other treatments reported the damage between 42.2 72.5 per cent~~ over untreated check. The highest yield was reported in plots treated with ~~T4:~~ 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 the untreated check. ~~The other treated plots reported between 402.3 - 615.3 kg of grain yield ha-1 with 12.54 - 34.62 per cent increase over untreated check.~~ The highest Benefit:Cost ratio was obtained in the plots treated with ~~T4:~~ 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.


**Comment [mj1]:** Describe when. E.g., Interval between two applications, First application when and second when

**Comment [mj2]:** Change "No" to "flies" throughout the manuscript


***Key words***: Insect growth regulators, insecticides, efficacy, Podfly, pod damage, pigeonpea


## INTRODUCTION

~~Redgram or Tur or~~ Pigeonpea,~~or~~*Cajanus cajan* L. is a significant pulse crop that is grown on an area of 4.65 million hectares worldwide. It produces 3.43 million tonnes annually and has an average productivity of 780 kg per hectare. Due in significant part to damage from insect pests, pigeonpea productivity has stagnated over the past forty years. 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~~ animportant pest of Pigeonpea[1]. Pod fly, *Melanagromyzaobtusa* (Malloch) is a hidden pest occurring at pod formation stage without external ~~symptom~~ symptomsof damage and causes yield loss ~~upto~~ up to60 to 80 per cent [2].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 the complexity of their management [3]. 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~~. It thus posesa challenge for management, since the oviposition occurs at the inner surface of the podwall involving anatomical, morphological, and biochemical basis of preference. ~~In spite of~~Despite application of three to four rounds of application of insecticides against other podborers, it also resulted in the failure of control of*M. obtusa*which requires a 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 podfly in the pigeonpea ecosystem.

**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 atthe 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, and eight 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 control, and increased yield over 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 [4].

= Number of damaged pods / ______________________ X100

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**Comment [mj3]:** Add the details of treatments along with doses

$$\text{Pod damage (\%)} \qquad \frac{\qquad\qquad}{\text{Total number of pods}}$$

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

$$\text{Pod damage reduction over untreated check (\%)} = \frac{\text{Mean pod damage in untreated check - Mean pod damage in treatment}}{\text{Mean pod damage in the untreated check}} \text{X100}$$

$$\text{Seed damage reduction over untreated check (\%)} = \frac{\text{Mean seed damage in untreated check - Mean seed damage in treatment}}{\text{Mean seed damage in the untreated check}} \text{X100}$$

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

## RESULTS AND DISCUSSION

The data on the population of *M. obtusa*~~podfly~~ maggots and pupae, pod, and seed damage ~~we~~are presented in Table 1. The pre-count population of maggots and pupae ranged from 12.00 to~~-~~12.67 ~~Nos per~~flies/ 25 pods and was found to be non-significant. After the first application of treatments, at the pod initiation stage, at 14 DAS, there existed significant ~~difference~~ differences among the various treated plots. Among the seven treatments tested,~~T4:~~Flubendiamide 480 SC @ 30 g a.i. ha-1 was found to be superior over ~~other~~ others and recorded 3.67~~Nos per~~flies/ 25 pods followed by other treatments *viz*., ~~T5:~~ Lufenuron 5.4 EC @ 30 g a.i. ha-1 , ~~T3:~~ Dinetofuran 20 SG @ 40 g a.i.ha-1 , ~~T2:~~Diafenthiuron @ 350 g a.i. ha-1 ~~T6:~~Thiamethoxam @ 50 g a.i. ha-1 were found to be on par with each other and recorded with 4.33-5.33Nos per 25 pods, respectively. The highest population of podfly was recorded in T1:Buprofezin 25 SC @ 200 g a.i.ha-1 (6.33Nos./25 pods) treated plots, whereas the untreated plots recorded 14.67 Nos per 25 pods at 14

**Comment [mj4]:** Use only the scientific name M. obtusa throughout as there are also other species of pod fly

**Comment [mj5]:** Change No. to flies throughout

**Comment [mj6]:** Remove these symbols throughout the manuscript days after the 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 plotsand were significantly superior over other treatments and found to be on par with each other with 10.00 and 11.33 per cent, respectively. Almost, a 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 a significant difference in the pre-count population of podfly maggots and pupae and ranged between 6.77 – 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~~weresignificantly superior over other treatments and found to be on par with each other 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 6.90and~~–~~34.6 with its lowest value 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 podfly damage reduction was~~upto~~ up to80.1 per cent and other treatments reported the damage between 42.2and~~–~~ 72.5 per cent over the 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 43.1 per cent increase over the untreated check. The other treated plots reported between 431.6 - 680 kg of grain yield per ha with 17.52 -36.53per cent increase over the 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 (Table 2).

The current results corroborate with those of Chranjeevi and Sarnaik [5]who found that the novel pesticide Chloranraniliprole 18.5 SC @ 30 g a.i. ha-1 reduced pod flies more effectively due to the similar diamide group. ~~The results of [6]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 [7] also reported the efficacy of newer insecticides proved to be very effective against podfly 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 [8].The pod age was 13 to 25 days, and ovipositionwhich produced the most eggs, was facilitated by 10 to 15 days, according to Das and Odak [9] and Durairaj [10].Therefore, it can be said that using Flubendiamide480 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.

**CONCLUSION**

In recent days, pod fly acts as the primary cause ~~for~~of decline in pigeon pea production, which has resulted in significant losses for farmers across India. The pod fly is a quiet pod killer that kills juvenile pods without causing visible harm until the fully grown larvae create an escape hole in the pod walls, making maintenance more difficult. Therefore, constant observation and extra care are always needed for the efficient control of this pest in order to prevent significant losses and insecticides should be used in rotation with different modes of action so as to prevent or delay the development of resistance towards insecticides and also to conserve natural enemies in pigeonpea ecosystem.

**Comment [mj7]:** Read some paper about the conclusion. The conclusion means only important results and recommendations. These are not conclusions

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**Table 1. Evaluation of growth regulators and insecticides against podfly, *Melanagromyzaobtusa* in pigeonpea**

| Treatments | Dose /L | No. of maggots&pupae (No./flies/25 pods) | | | | | | | | 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 | 200 | 11.67 | 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 |
| $T_2$:Diafenthiuran | 350 | 12.67 | 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 |
| $T_3$:Dinetofuran | 40 | 11.67 | 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 | 30 | 11.67 | 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 | 30 | 12.00 | 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 | 50 | 12.33 | 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 | 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 | |

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**Table 2. Cost Economics studies for insecticides on ~~podfly,~~ *Melanagromyza~~.~~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 | 9.8 | 1:1.1 |
| $T_2$:Diafenthiuran 50 WP | 350 | 12.7 | 21.3 | 63.3 | 47.3 | 581.7 | 25.8 | 1:1.3 |
| $T_3$:Dinetofuran 20 SG | 40 | 10.9 | 16.1 | 68.5 | 60.1 | 576.7 | 25.2 | 1:1.3 |
| $T_4$:Flubendiamide 480 SC | 30 | 6.9 | 12.2 | 80.1 | 69.8 | 757.7 | 43.0 | 1:1.6 |
| $T_5$:Lufenuron 5.4 EC | 30 | 7.6 | 14.8 | 78.0 | 63.4 | 680.0 | 36.5 | 1:1.4 |
| $T_7$:Thiamethoxam 25 WG | 50 | 9.5 | 14.9 | 72.5 | 63.1 | 523.3 | 17.5 | 1:1.2 |
| $T_9$:Untreated Check | - | 34.6 | 40.4 | - | - | 431.6 | - | 1:0.9 |
| **SEd** | | | | | | 12.2 | - | |
| **CD<0.5 %** | | | | | | 24.6 | | |