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RESEARCH ARTICLE

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Damage of *Melanagromyza obtusa* (Malloch) and Management Potential of Newer Insecticides in Pigeon Pea

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ABSTRACT

Background: The pod fly, *Melanagromyza obtusa* (Malloch) is one of the major biotic constraints in increasing production and productivity of pigeon pea crop throughout the country and it causes up to 100 per cent losses in field condition. Injudicious use of pesticides against this destructive pest, further ignites the problem of resistance, resurgence and environmental and ecological imbalances.

Methods: Experiments were conducted at Banda University of Agricultural and Technology, Banda during *kharif*, 2020 and 2021. To estimate the bio-efficacy of insecticides for the management of *M. obtusa* in pigeon pea the experiment was laid out in randomized block design (RBD) with eight treatments and three replications. Pod and grain damage were assessed and C:B ratio was calculated.

Result: First appearance of pod fly was noticed in third standard week. Throughout cropping period highest pod damage was recorded in eighth standard week and lowest pod damage was recorded in twelfth standard week. Emamectin benzoate 5 SG @ 11 g a.i./ha + Dimethoate 30 EC @ 300 g a.i./ha was the best treatment as it exhibited minimum pod damage and highest yield.

Key words: Bio-efficacy, Grain damage, *Melanagromyza obtusa*, Pod damage, Pod fly.

INTRODUCTION

India is leading producer of pulses in the world. India shares 25% of global production, 27% of world consumption and importer 14% of pulses in the world (FAO, 2018). Major pulses *viz*., chickpea, pigeon pea, moong bean, urd, masur, peas and various kinds of beans are grown in India (APEDA, 2020). Pigeon pea and chickpea forms majority of share in total production of pulses. India ranks first in area and production of pigeon pea in the world contributing 80 per cent and 67 per cent in world's acreage and production, respectively (Directorate of Pulses Development, Bhopal, 2017). It is the second most important pulse crop after chickpea (Bhadani *et al*., 2019). It covered an area of around 42.29 lakh ha, producing 37.54 lakh tones with the average productivity of 806 kg/ha approximately during 2019-20 (*Kharif* Pulses Prospects-2020-21). Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, Gujarat, Jharkhand, Telangana and Andhra Pradesh are the major producers of pigeon pea with more than 90 per cent share in total pigeon pea production (Directorate of Pulses Development, Bhopal, 2017). Karnataka has the highest area under pigeon pea (13 lakh ha), but the highest production was recorded in Maharashtra (9.71 lakh tones) (*Kharif* Pulses Prospects-2020-21). Nearly 90% of the crops are cultivated in rainfed conditions with medium or long-term cultivars. The biotic factors comprise insect pests, weeds, pathogens, mites and nematodes, among which insect-pests pose a serious threat to the pigeon pea crop. Nearly, 250 species of insect pests have been reported on pigeon pea, among which 34 are key pests in world (Lal and Katti, 1997). Insects which have become serious include pod fly *Melanagromyza obtusa* (Malloch), pod bug *Calvigralla gibbosa* (Spinola) and *C. scutellarius* (Westwood), Leaf Webbers *Maruca vitrata* (Gayer), *Cydia critica* (Meyrick) and Glaerucid beetle. Polyphagous pests like Cutworms *Agrotis ipsilon* and *Ochropleura flammatra* and hairy caterpillars (*Amsacta moorei, A. albistriga* and *Spilosoma obliqua*) have also become serious threat as reported by (Upadhyay *et al*., 1998 and Sharma *et at*., 2010). Pigeon pea pod fly *M. obtusa* (Malloch) is a more detrimental pest and infests 12 to 100 per cent pods. The pod fly emerged as a key pest and causing10 to 80 per cent damage (Kumar *et al*., 2003) and estimated to cause a monitory annual loss of US$256 million (Arbind *et al*., 2013). It was observed that the damage of 22.5%, 21% and 13.2% in North India, Central India and South India, respectively, (Lateef *et al*., 1981). Female of Pod fly lay eggs in immature pods and feeds on

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developing seeds. The infested immature pods do not show external evidence of damage until the fully-grown larvae makes exit holes by chewing on the pod walls (Singh, 2014). It is noticeable from pod initiation till maturity stage of crop. The affected grains became shriveled, discolored with fungal infection rendering them unsuitable for sowing and consumption (Shanower *et al*., 1998). Hence, the present study was mainly focused on the effective management strategies of *M. obtusa* in pigeon pea in Bundelkhand region. Considering the importance of pigeon pea in context of India the damage caused by pod fly present study was formulated.

MATERIALS AND METHODS

The present investigation was conducted at Banda University of Agriculture and Technology, Banda during *kharif* season of 2020 and 2021. The crop was sown on 12th July with plot size of 10 × 10 m^2. Variety sown for the experimentation was IPA-203 (maturity duration 246 days). Hundred pods were plucked from five randomly selected plants. Selected pods were taken to laboratory and they were cut open for inspecting pod damage. This process was carried out every week starting from initiation of pod formation to crop maturity. The pod damage was estimated. At harvest of the crop both healthy and damaged pods were plucked from 5 randomly selected plants from each treatment of entire three replications to estimate the pod damage.

Per cent pod damage =

$$\frac{\text{Total number of damaged pods}}{\text{Total number of pods}} \times 100$$

The grain damage was also estimated. Out of the pods selected for estimating per cent pod damage, 100 grains were selected randomly and data was recorded the per cent grain damage.

Per cent grain damage =

$$\frac{\text{Total number of damaged grains}}{\text{Total number of grains}} \times 100$$

To study the impact of different weather parameters on pest incidence, a simple correlation between population of the pest and weather parameters was worked out. To estimate the bio-efficacy of insecticides for the management of *M. obtusa* in pigeon pea the experiment was laid out in randomized block design (RBD) with eight treatments and three replications. Total 24 plots of 4.0 × 4.5 m size were sown with a spacing of 30 × 60 cm. The first spray was applied at 50 per cent flowering stage and second spray was administered at after 15 days interval through high volume hand operated knapsack sprayer. The yield and cost benefit ratio (C: B) was also calculated.

RESULTS AND DISCUSSION

Population dynamics of *M. obtuse*

Damage caused by *M. obtusa* were recorded from the pod initiation stage to the maturity of crop. The first appearance of pod fly *M. obtusa* was noticed on 3rd Standard Meteorological Week (SMW) of 2021. The maximum pod damage (90%) was observed in 8th SMW followed by (85%) in 9th SMW and minimum pod damage (37.5%) was recorded in 12th SMW. Pod damage were increased continuously from 3rd, 4th and 5th SMW *i.e.* (53%), (68%) and (71.66%), respectively. thereafter damage suddenly went down in 6th SMW (58.33%) and 7th SMW (55%). Pod damage was demeaned from 10th SMW (61.45%) to 12th SMW (37.5%) (Table 1). Simple correlation between pod damage and weather parameters were non–significant.

Similarly, highest grain damage (83.33%) was observed in 8th SMW of the year 2022. followed by (73%) in 9th SMW and minimum grain damage (21.55%) was recorded in 12th SMW. Grain damage were increased continuously from 3rd, 4th and 5th SMW *i.e*., 38%, 45% and 49.3%, respectively. Thereafter, damage suddenly declined in 6th SMW (43.33%) and 7th SMW (30%). However, in 8th (83.33%) and 9th (73%) SMW grain damage was massively increased when temperature was increased. Grain damage declined from 10th SMW (39.9%) to 12th SMW (21.55 %). Simple correlation between grain damage and weather parameters was found to be non-significant (Table 2).

The maximum pod damage (74%) was observed in 8th SMW of 2022 followed by (69.3%) in 9th SMW and minimum pod damage (38.0%) was recorded in 12th SMW. Pod damage were increased continuously from 3rd, 4th and 5th SMW *i.e*., 48%, 62% and 64.3%, respectively, thereafter damage suddenly dropped down in 6th SMW (56.7%) and 7th SMW (49.3%). Pod damage was demeaned from 10th SMW (56.8%) to 12th SMW (38.0%) (Table 1). Simple correlation between pod damage and weather parameters were non–significant (Table 2).

Similarly, highest grain damage (62.0%) was observed in 8th SMW of the year 2022 followed by (58.0%) 9th SMW and minimum grain damage (24.0%) was recorded in 12th SMW. Grain damage were increased continuously from 3rd, 4th and 5th SMW *i.e*., 33%, 39.0% and 45.0%, respectively. Thereafter, damage suddenly declined in 6th SMW (42.0%) and 7th SMW (35.0%). Grain damage declined from 10th SMW (45.6%) to 12th SMW (24.0%) (Table 1). Simple correlation between grain damage and weather parameters was found to be non-significant (Table 2). According to (Shanker *et al*., 2021) simple correlation between pod fly (larvae and pupae) with weather parameter revealed that maggot population showed non-significant positive correlation with minimum and maximum temperature (0.279 and 0.111). (Subharani *et al*., 2007) also reported that correlation studies showed that the infestation of the pest on the crop was non-significant with any of the environmental factors, except for relative humidity.

Bio-efficacy of insecticides

During *kharif* 2020, the pod damage was recorded 23.52% to 54.71%. The minimum pod damage (23.52%) was recorded in in Emamectin benzoate + Dimethoate followed by Chlorantraniliprole with 26.4% pod damage, Dimethoate with 26.95% pod damage and maximum pod damage 54.71% was recorded from untreated plots (Table 3). The Emamectin benzoate + Dimethoate was statistically at par with Chlorantraniliprole and Dimethoate, whereas, statistically superior over rest of the treatments. Azadirachtin, Emamectin + Acephate and Cyantraniliprole were at par with each other, whereas, these treatments were superior over spinosad. All the chemicals were significantly superior over control in reducing the pod damage (Table 3).

The grain damage was recorded 13% to 34.60%. The minimum grain damage was 13% recorded in treatment Emamectin benzoate + Dimethoate followed by treatment Chlorantraniliprole with 17.8% grain damage, Dimethoate with 18.5% grain damage and maximum grain damage 34.60% was recorded from untreated plots. Whereas, the Chlorantraniliprole, Dimethoate and Emamectin benzoate + Acephate were at par with each other. Azadirachtin and Cyantraniliprole were at par with each other. All the treatments were significantly superior over control in reducing the grain damage (Table 3).

Maximum per cent control in pod damage was recorded in treatment Emamectin benzoate + Dimethoat (31.19%) followed by Chlorantraniliprole (28.31%), Dimethoate (27.76%), Emamectin benzoate + Acephate (25.78%), Azadirachtin (22.85%), Cyantraniliprole (22.39%) and Spinosad (16.16%) as compared to control.

Similarly, the maximum per cent control in grain damage was recorded in Emamectin benzoate + Dimethoate (21.6%) followed by Chlorantraniliprole (16.8%), Dimethoate (16.1%), Emamectin benzoate + Acephate (13%), Azadirachtin (11.2%), Cyantraniliprole (11.1%) and Spinosad (4.5%) as compared to control (Table 3).

During *kharif* 2021, the pod damage was recorded 16.29% to 39.81%. The minimum pod damage 16.29% was recorded in Emamectin benzoate + Dimethoate followed by Chlorantraniliprole with 19.59% pod damage and maximum pod damage 39.81% was recorded from untreated plots (Table 3). The Emamectin benzoate + Dimethoate was statistically at par with Chlorantraniliprole and Dimethoate, whereas, statistically superior over rest of the treatments. Azadirachtin, Emamectin + Acephate and Cyantraniliprole were at par with each other, whereas, these treatments were superior over spinosad. All the chemicals were significantly superior over control in reducing the pod damage (Table 3).

The grain damage range was recorded 11.41% to 30.04%. The minimum grain damage was 11.41% recorded in treatment Emamectin benzoate + Dimethoate followed by treatment Chlorantraniliprole with 15.85% grain damage, Dimethoate with 16.84% grain damage and maximum grain damage 30.04% was recorded from untreated plots (Table 3). Whereas, the Chlorantraniliprole, Dimethoate and Emamectin benzoate + Acephate were at par with each other. Azadirachtin and Cyantraniliprole were at par with each other. All the treatments were significantly superior over control in reducing the grain damage (Table 3).

Table 1: Damage caused by *M. obtusa* in pigeon pea during 2020 and 2021.

SMW	2020		2021	
	Pod damage (%)	Grain damage (%)	Pod damage (%)	Grain damage (%)
3	53.00	38.00	48.00	33.00
4	68.00	45.00	62.00	39.00
5	71.66	49.30	64.30	45.00
6	58.33	43.33	56.70	42.00
7	55.00	30.00	49.30	35.00
8	90.00	83.33	74.40	62.00
9	85.00	73.00	69.30	58.00
10	61.45	39.90	56.80	45.60
11	56.66	33.33	49.90	36.00
12	37.50	21.55	38.00	24.00

Table 2: Correlation between weather factor and damage caused by *M. obtusa* in pigeon pea during 2020 and 2021.

Weather factors	2020		2021	
	Pod damage	Grain damage	Pod damage	Grain damage
Max temperature	-0.066^{NS}	0.024^{NS}	-0.269^{NS}	-0.082^{NS}
Min temperature	-0.206^{NS}	-0.158^{NS}	-0.351^{NS}	-0.179^{NS}
Relative humidity (RH)	-0.080^{NS}	-0.137^{NS}	0.322^{NS}	0.117^{NS}
Rainfall (RF)	-0.629^{NS}	-0.568^{NS}	-0.267^{NS}	-0.287^{NS}

NS- Non-significant.

Maximum per cent control in pod damage was recorded in treatment Emamectin benzoate + Dimethoate (59.08%) followed by Chlorantraniliprole (50.79%), Dimethoate (45.42%), Emamectin benzoate + Acephate (42.58%), Azadirachtin (38.99%), Cyantraniliprole (36.42%) and Spinosad (26.38%) as compared to control.

Similarly, the maximum per cent control in grain damage was recorded in Emamectin benzoate + Dimethoate (62.02%) followed by Chlorantraniliprole (47.24%), Dimethoate (43.94%), Emamectin benzoate + Acephate (33.95%), Azadirachtin (26.86%), Cyantraniliprole (24.43%) and Spinosad (21.94%) as compared to control (Table 3).

This result is corroborated by Sharma *et al*. (2011) Emamectin benzoate 5 SG in combination with Acetamiprid 20 SP or Dimethoate 30 EC gave higher grain yield of 1399 and 1392 kg/ha, respectively and minimum grain damage by virtue of pod fly. Sonune *et al*., (2018) also reported Emamectin benzoate was significantly superior to Chlorantraniliprole. However, Khinchi and Kumawat (2021) observed the use of Chlorantraniliprole @150 ml/ha was the most effective to control pod fly in pigeon pea crop.

Yield of pigeon pea

Among the treatments significantly the highest yield was recorded in Emamectin benzoate + Dimethoate (26.98 q/ha) and it was significantly at par with Chlorantraniliprole (25.65 q/ha) and Dimethoate (24.70 q/ha) during *kharif* 2020. The treatment Emamectin benzoate + Acephate (23.33 q/ha) were significantly at par with Cyantraniliprole (22.63 q/ha), Azadirachtin (22.37 q/ha) and Spinosad (20.67 q/ha). However, all the treatments are significantly over the control (Table 4). The per cent increase in yield was maximum in Emamectin benzoate + Dimethoate (76%) followed by Chlorantraniliprole (68.06%) as compared to control (Table 4).

During *kharif* 2021, the highest yield was recorded in Emamectin benzoate + Dimethoate (20.25 q/ha) followed by Chlorantraniliprole (18.92 q/ha) and lowest yield was recorded in the control (12.30 q/ha). The treatment Emamectin benzoate + Dimethoate was significantly at par with Chlorantraniliprole and Dimethoate. The per cent increase in yield was maximum increased in Emamectin benzoate + Dimethoate (64.63%) followed by Chlorantraniliprole (53.82%) as compared to control (Table 4).

Cost-benefit ratio

The highest cost-benefit ratio was recorded with Dimethoate (1:10.41) followed by Azadirachtin (1:9.61), Emamectin benzoate + Dimethoate (1:9.51), Chlorantraniliprole (1:9.27), Emamectin benzoate + Acephate (1:8.51), Cyantraniliprole (1.6.17) and the was recorded with Spinosad (1:3.13) in *kharif* 2020 (Table 4).

However, during 2022, the highest cost-benefit ratio was recorded with Emamectin benzoate + Dimethoate (1:6.56) followed by Chlorantraniliprole (1:6.01), Dimethoate (1:5.91), Emamectin benzoate + Acephate (1:4.64),

Table 3: Bio-efficacy of different insecticides for the management *M. obtusa* in field condition during 2020-21.

Treatments	2020				2021			
	Pod damage (%)	% Control in pod damage	Grain damage (%)	% Control in grain damage	Pod damage (%)	% Control in pod damage	Grain damage (%)	% Control in grain damage
Spinosad 45 SC @ 73 g a.i./ha	38.55	16.16	30.1	4.5	29.31	26.38	23.45	21.94
Chlorantraniliprole 18.5 SC @ 30 g a.i./ha	26.4	28.31	17.8	16.8	19.59	50.79	15.85	47.24
Azadirachtin 3000 ppm @ 3 ml/l	31.86	22.85	23.4	11.2	24.29	38.99	21.97	26.86
Emamectin benzoate 5 SG @ 11 g a.i./ha + Acephate 75 SP @ 375 g a.i./ha	28.93	25.78	21.6	13	22.86	42.58	19.84	33.95
Emamectin benzoate 5 SG @ 11g a.i./ha + Dimethoate 30 EC @ 300 g a.i./ha	23.52	31.19	13	21.6	16.29	59.08	11.41	62.02
Dimethoate 30 EC @ 600 g a.i./ha	26.95	27.76	18.5	16.1	21.73	45.42	16.84	43.94
Cyantraniliprole10.26 OD @ 30 g a.i./ha	32.32	22.39	23.5	11.1	25.31	36.42	22.7	24.43
Control (Untreated plot)	54.71	-	34.6	-	39.81	-	30.04	-
C.D.	3.46	-	3.242	-	5.46	-	2.572	-
SEm(m)	1.13	-	1.059	-	1.78	-	0.840	-

Table 4: Yield, percent increase in yield and C: B ratio of pigeon pea (q/ha) in different treatments during 2020 and 2021.

Treatments	2020			2021		
	Yield q/ha	Per cent increase in yield over control	C: B ratio	Yield q/ha	Per cent increase in yield over control	C: B ratio
Spinosad 45 SC @ 73 g a.i./ha	20.67	34.86	1:3.1	14.50	17.89	1:1.3
Chlorantraniliprole 18.5 SC @ 30 g a.i./ha	25.65	68.06	1:9.3	18.92	53.82	1:6.0
Azadirachtin 3000 ppm @ 3 m/l	22.37	46.2	1:9.6	15.10	22.76	1:3.9
Emamectin benzoate 5 SG @ 11 g a.i./ha + Acephate 75 SP @ 375 g a.i./ha	23.33	52.26	1:8.5	16.60	34.96	1:4.6
Emamectin benzoate 5 SG @ 11g a.i./ha + Dimethoate 30 EC @ 300 g a.i./ha	26.98	76.93	1:9.5	20.25	64.63	1:6.6
Dimethoate 30 EC @ 600 g a.i./ha	24.7	61.73	1:10.4	17.55	42.68	1:5.9
Cyantraniliprole10.26 OD @ 30 g a.i./ha	22.63	47.93	1:6.2	15.95	29.67	1:3.1
Control (Untreated plot)	15.44	-	-	12.3	-	-
C.D.	2.679	-	-	4.067	-	-
SE(m)	0.875	-	-	1.328	-	-

Azadirachtin (1:3.88), Cyantraniliprole (1.3.13) and the was recorded with Spinosad (1:1.32) (Table 4).

CONCLUSION

It may be concluded that first appearance of pod fly *M. obtusa* was noticed on third standard week during both the year 2021 and 22. Maximum pod damage was observed in 8th SMW followed by 9th SMW and minimum pod damage was recorded in 12th SMW during both the year 2021 and 22. Emamectin benzoate + Dimethoate was found the best treatment as it exhibited minimum pod damage and highest yield. The highest cost-benefit ratio was recorded from Dimethoate 30 EC @ 300 g a.i./ha during 2020 and from Emamectin benzoate 5SG @ 11 g a.i./ha + Dimethoate 30 EC @ 300 g a.i./ha during 2021. Emamectin benzoate + Dimethoate may be applied before the 8th SMW in order to reduce the *M. obtusa* in pigeon pea.

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Conflict of interest

All authors declared that they have no conflicts of interest.

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