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Management of Pod fly, *Melanagromyza obtusa* on Pigeonpea (*Cajanus cajan* L.)

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ABSTRACT

Background: Pod fly, *Melanagromyza obtusa* is one of the most obnoxious pest causing grain damage ranging from 10-80% with a monitory loss of US$ 256 million annually. Being an internal feeder, infested pods do not show any external symptoms of damage until the fully grown maggots chew the pod wall, leaving a thin papery membrane intact called as window, through which adults exit from the pod. Several field studies were conducted to determine the efficacy of insecticides for the control of pod fly. However, these findings did not find acceptability and led to partial success. Insecticides that should leave lesser residues and pose lesser environmental threat have become imperative. The present study aimed to evaluate the efficacy of certain new insecticide molecules against pod fly in pigeonpea ecosystem.

Methods: Two field experiments were conducted at Regional Agricultural Research Station, Lam, Guntur during *Kharif*, 2012 and 2013 in a randomized block design (RBD) using pigeonpea cv. ICPL 85063 (Lakshmi) with 17 treatments including untreated control and 3 replications. Two sprays were given at 10 days interval starting from pod initiation stage. At maturity, number of pods showing pod fly damage were recorded and expressed as percentage. Grain yield was recorded and cost–benefit ratio was worked out.

Result: 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). It was further suggested that effective insecticides may be alternated in order to avoid development of resistance to pod fly in pigeonpea.

Key words: Insecticides, *Melanagromyza obtusa*, Pigeonpea, Pod fly.

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is a tropical grain legume mainly grown in India which ranks second in area and production and contributes about 90% in the world's pulse production. In India during 2018-19, pigeonpea was grown in 4.42 million ha with a production of 3.68 million tonnes and productivity of 832 kg / ha, whereas, in Andhra Pradesh, the area, production and productivity of pigeonpea during 2017-18 was 2.76 lakh ha, 1.39 L tonnes and 504kg / ha, respectively (Anonymous, 2018). Though the area under redgram is increasing, the yields have remained stagnant (500 - 700 kg/ha) for the past 3-4 decades, largely due to insect pest damage (Sharma and Pampapathy, 2004). It is attacked by more than 300 species of insects of which pod fly, *Melanagromyza obtusa* is one of the most obnoxious pest causing the grain damage ranging from 10-80% damage (Shanower *et al.*, 1999, Kumar and Nath, 2003, Subharani and Singh, 2009) with a monitory loss of US$ 256 million annually (Anonymous, 1992). Pod fly being an internal feeder, lays eggs inside the immature pod. The eggs hatch and the developing maggots feed on the developing immature seeds by making tunnels and pupate. Thus making the seeds unfit for human consumption as well as seed purpose. The infested pods do not show any external symptoms of damage until the fully grown maggot chew the pod wall, leaving a thin papery membrane intact called as window, through which adults exit from the pod. Sahoo *et al.* (1991), Kumar and Nath (2003) and Yadav and Dahiya (2004) conducted several field studies to determine the efficacy of insecticides for the control of pod fly. However, these findings did not find acceptability and led to partial success. Insecticides that should leave lesser residues and pose lesser environmental threat have become imperative. Hence, the present study is aimed at evaluating the efficacy of certain new insecticide molecules against pod fly in pigeonpea ecosystem.

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MATERIALS AND METHODS

Two field experiments were conducted at Regional Agricultural Research Station, Lam, Guntur during *Kharif*, 2012 and 2013 in a randomized block design (RBD) with 3 replications using pigeonpea cv. ICPL 85063 (Lakshmi) with 17 treatments including untreated control. The treatments include sixteen insecticides *viz*., profenophos 50 EC @ 2.0 ml/l, cypermethrin 5% + ethion 40% @ 2.5 ml/l, novaluron 10 EC @ 1.0 ml/l, diafenthiuron 50 WP @ 1.5 g/l, acetamiprid

20 SP @ 0.2 g/l, metaflumizone 22 SC @ 2.0 ml/l, spinosad 45 SC @ 0.3 ml/l, flubendiamide 480 SC @ 0.2 ml/l, quinalphos 25 EC @ 2.0 ml/l, monocrotophos 36 SL @ 1.6 ml/l, acephate 75 SP @ 1.5 g/l, neem formulation 10000 ppm @ 1.0 ml/l, fipronil 5 SC @ 2.0 ml/l, thiacloprid 21.7 SC @ 0.7 ml/l, chlorantraniliprole 18.5 SC @ 0.3 ml/l and dimethoate 30 EC @ 2.0 ml/l (Table 1). Seeds were sown at a depth of 5 cm below the soil surface in black cotton soils with the help "gorru" behind the cattle pair with 180 cm spacing between rows. Immediately after sowing "guntaka" was run over the seeds to cover the seeds with soil. Thinning was done 20 days after seedling emergence by retaining one seedling per hill at a spacing of 20 cm between the plants. Normal agronomic practices were followed for raising the crop (Basal fertilizer N: P: K: 20:50:0 kg/ha). Intercultural and weeding operations were carried out as needed. Crop protection against all other pests was done with recommended insecticides. Against pod fly, two sprays were given at 10 days interval starting from pod initiation stage with hand operated knapsack sprayer by using a spray volume of 500 l /ha. At maturity, number of pods showing pod fly damage were recorded and expressed as percentage. Grain yield was recorded and cost–benefit ratio was worked out. The data was subjected to RBD analysis using AGRES package (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

It was found that all the insecticides tested were significantly better in reducing pod damage. The results during 2012-13 revealed that among different insecticides, the pod damage due to pod fly ranged between 9.3 (thiacloprid 21.7 SC @ 0.7 ml/l) to 49.0% (fipronil 5 EC @ 2.0 ml/l) as against 56.0 per cent in untreated control. However, the insecticides *viz*., diafenthiuron 50 WP @ 1.5 g/l (11.8%), dimethoate 30 EC @ 2.0 ml/l (13.4%), cypermethrin 5% + ethion 40 % @ 2.5 ml/l (18.9%), chlorantraniliprole 18.5 SC @ 0.3 ml/l (20.1%), profenophos 50 EC @ 2.0 ml/l (21.9%) and spinosad 45 SC @ 0.3 ml/l (22.1%) were at par with thiacloprid 21.7 SC (Table 1). Similarly, during 2013-14, the pod damage due to pod fly ranged from 14.5% in thiacloprid 21.7 SC to 29.9% in quinalphos 25 EC @ 2.0 ml/l as against 40.8 per cent in control. However, the insecticides *viz*., diafenthiuron 50 WP @ 1.5 g/l (15.8%), profenophos 50 EC @ 2.0 ml/l (17.4%), dimethoate 30 EC @ 2.0 ml/l (17.5%), flubendiamide 480 SC @ 0.2 ml/l (19.2%), cypermethrin 5% + ethion 40% @ 2.5 ml/l (19.3%), spinosad 45 SC @ 0.3 ml/l (19.7%), metaflumizone 22 SC @ 2.0 ml/l (20.4%), chlorantraniliprole 18.5 SC @ 0.3 ml/l (20.5%), fipronil 5 SC @ 2.0 ml/l (20.8%), acetamiprid 20 SP @ 0.2 g/l (21.1%) and acephate 75 SP @ 1.5 g/l (22.1%) were at par with thiacloprid 21.7 SC (Table 1). The cumulative efficacy of insecticides against pod fly in both the years (2012-13 & 2013-14) revealed that pod damage due to pod fly in different treatments ranged from 11.9 to 48.4% (untreated control). The pod damage recorded was lowest in thiacloprid 21.7 SC @ 0.7 ml/l (11.9%), followed by diafenthiuron 50 WP @ 1.5 g/l (13.8%), flubendiamide 480 SC @ 0.2 ml/l (14.3%), dimethoate 30 EC @ 2.0 ml/l (15.5%), cypermethrin 5% + ethion 40% @ 2.5 ml/l (19.1%), profenophos 50 EC @ 2.0 ml/l (19.7%) and spinosad 45 SC @ 0.3 ml/l (20.9%) with 75.4, 71.5,

Table 1: Efficacy of different insecticides against pod fly on medium duration pigeonpea.

T.No.	Treatment	Dose	Pod damage (%) due to pod fly			
			2012-13	2013-14	Mean	Reduction over control (%)
T_1	Profenophos 50 EC	2.0 ml/L	21.9 (27.8)	17.4 (24.6)	19.7 (26.4)	59.3
T_2	Cypermethrin 5% + Ethion 40%	2.5 ml/L	18.9 (25.4)	19.3 (25.8)	19.1 (25.9)	60.5
T_3	Novaluron 10 EC	1.0 ml/L	47.1 (44.8)	25.3 (29.7)	36.2 (37.0)	25.2
T_4	Diafenthiuron 50 WP	1.5 g/L	11.8 (19.9)	15.8 (23.3)	13.8 (21.8)	71.5
T_5	Acetamiprid 20 SP	0.2 g/L	31.0 (33.8)	21.1 (27.4)	26.1 (30.7)	46.1
T_6	Metaflumizone 22 SC	2.0 ml/L	36.3 (36.9)	20.4 (26.8)	28.4 (32.2)	41.3
T_7	Spinosad 45 SC	0.3 ml/L	22.1 (27.9)	19.7 (26.1)	20.9 (27.2)	56.8
T_8	Flubendiamide 480 SC	0.2 ml/L	27.4 (31.4)	19.2 (25.9)	14.3 (22.2)	70.5
T_9	Quinalphos25 EC	2.0 ml/lt	45.5 (42.4)	29.9 (32.8)	37.7 (37.9)	22.1
T_{10}	Monocrotophos 36% SL	1.6 ml/lt	37.5 (37.7)	27.5 (31.4)	32.5 (34.8)	32.9
T_{11}	Acephate 75 SP	1.5 g/lt	32.3 (34.6)	22.1 (28.0)	27.2 (31.4)	43.8
T_{12}	Neem formulation 10,000 ppm	1.0 ml/lt	32.5 (34.7)	26.5 (30.9)	29.5 (32.9)	39.1
T_{13}	Fipronil 5 SC	2.0 ml/l	49.0 (44.4)	20.8 (27.0)	34.9 (36.2)	27.9
T_{14}	Thiacloprid 21.7 SC	0.7 ml/lt	9.3 (17.7)	14.5 (22.1)	11.9 (20.2)	75.4
T_{15}	Chlorantraniliprole18.5 SC	0.3 ml/lt	20.1 (26.4)	20.5 (26.8)	20.3 (26.8)	58.1
T_{16}	Dimethoate 30 EC	2.0 ml/l	13.4 (21.4)	17.5 (24.6)	15.5 (23.2)	68.0
T_{17}	Untreated control	-	56.0 (48.6)	40.8 (39.7)	48.4 (44.1)	-
	C.D (P=0.05)		9.3	6.3	7.8	-
	C.V (%)		16.3	13.2	14.8	-

Figures in parenthesis are arc sine percentage transformed values.

Table 2: Economics of different insecticides applied against pod fly on medium duration pigeonpea.

T.No.	Treatment	Dose	Yield (kg/ha)			Increase in yield over control (%)	Increase in yield over control (kg)	Cost of increased yield (Rs.) [A]	Plant protection cost (Rs.) [B]	Net Profit (Rs.) [A-B]	ICBR [A-B/B]
			2012-13	2013-14	Mean						
T_1	Profenophos 50 EC	2.0 ml/lt	1574	1152	1363	91.4	651	27993	4960	23033	1: 4.64
T_2	Cypermethrin 5% + Ethion 40%	2.5 ml/lt	1593	1169	1381	94.0	669	28767	5296	23471	1: 4.43
T_3	Novaluron 10 EC	1.0 ml/lt	1083	1088	1086	52.5	374	16082	7370	8712	1: 1.18
T_4	Diafenthiuron 50 WP	1.50 g/lt	1759	1111	1435	101.6	723	31089	9520	21569	1: 2.27
T_5	Acetamiprid 20 SP	0.2 g/lt	1412	1030	1221	71.5	509	21887	3988	17899	1: 4.49
T_6	Metaflumizone 22 SC	2.0 ml/lt	1287	1094	1191	67.3	479	20597	6970	13627	1: 1.96
T_7	Spinosad 45 SC	0.3 ml/lt	1537	1215	1376	93.3	664	28552	8270	20282	1: 2.45
T_8	Flubendiamide 480 SC	0.2 ml/lt	1517	1227	1372	92.7	660	28380	6750	21630	1: 3.20
T_9	Quinalphos 25 EC	2.0 ml/lt	1092	949	1021	43.4	309	13287	4560	8727	1:1.91
T_{10}	Monocrotophos 36% SL	1.6 ml/lt	1296	961	1129	58.6	417	17931	4490	13441	1:2.99
T_{11}	Acephate 75 SP	1.5 g/lt	1454	1076	1265	77.7	553	23779	4442	19337	1:4.35
T_{12}	Neem formulation 10,000 ppm	1.0 ml/lt	1370	1019	1195	67.8	483	20769	4770	15999	1:3.35
T_{13}	Fipronil 5 SC	2.0 ml/l	1083	1001	1042	46.4	330	14190	7670	6520	1:0.85
T_{14}	Thiacloprid 21.7 SC	0.7 ml/lt	1806	1186	1496	110.1	784	33712	5490	28222	1:5.14
T_{15}	Chlorantraniliprole18.5 SC	0.3 ml/lt	1546	1238	1392	95.5	680	29240	7930	21310	1:2.69
T_{16}	Dimethoate 30 EC	2.0 ml/lt	1685	1146	1416	98.9	704	30272	4320	25952	1:6.00
T_{17}	Untreated control	-	833	590	712	-	-	-	-	-	-
	C.D (P=0.05)	-	304.2	124.4	-	-	-	-	-	-	-
	C.V (%)	-	12.5	6.5	-	-	-	-	-	-	-

ICBR: Incremental Cost Benefit Ratio; Sale price of the produce Rs. 4300/-per q; Spray fluid used: 500 l /ha.

70.5, 68.0, 60.5, 59.3 and 56.8 per cent reduction of pod damage over control (48.4%), respectively (Table 1). Further, the grain yield in different treatments ranged from 1083 to 1806 kg/ha (thiacloprid 21.7 SC) as against 833 kg/ha in control during 2012-13. Similarly, the grain yield ranged from 949 to 1238 kg/ha (chlorantraniliprole 18.5 SC) as against 590 kg/ha in control during 2013-14. The cumulative results on yield in both the years put together ranged from 1021 to 1496 kg/ha. Highest grain yield was recorded in thiacloprid 21.7 SC @ 0.7 ml/l (1496 kg/ha), followed by diafenthiuron 50 WP (1435 kg/ha), dimethoate 30 EC (1416 kg/ha), chlorantraniliprole 18.5 SC (1392 kg/ha), cypermethrin 5% + ethion 40% (1381 kg/ha), spinosad 45 SC (1376 kg/ha), flubendiamide 480 SC (1372 kg/ha) and profenophos 50 EC (1363 kg/ha) with 110.1, 101.6, 98.9, 95.5, 94.0, 93.3, 92.7 and 91.4 per cent increase in yield over control (712 kg/ha) However, the incremental cost benefit ratio (ICBR) when calculated it was found that highest ICBR was obtained with dimethoate 30 EC @ 2.0 ml/l (1:6.00), followed by thiacloprid 21.7 SC @ 0.7 ml/l (1:5.14),profenophos 50 EC @ 2.0 ml/l (1:4.64), acetamiprid 20 SP @ 0.2 g/l (1: 4.49), cypermethrin 5% + ethion 40% @ 2.5 ml/l (1: 4.43) and acephate 75 SP @ 1.5 g/l (1: 4.35). Lowest ICBR was recorded in fipronil 5 SC (1: 0.85)(Table 2).

The results were in agreement with the findings of Vamsi Chandrasekhar Reddy *et al.* (2018) who reported that dimethoate applied twice at 3 and 4 weeks after 50% flowering was most promising with high incremental cost benefit ratio (1: 17.77). Similarly, Revathi *et al*. (2015) found that grain damage due to pod fly was lowest in dimethoate (6.8%) with 59.0% reduction over control with highest ICBR (1: 5.48). Mahesh *et al*. (2015) reported that deltamethrin 1 EC + triazophos 35 EC was found to be most effective treatment in minimizing the damage to green and dry pods as well as grains. Further, thiacloprid 21.7 SC and profenophos 50 EC were found significantly effective in minimizing the cumulative mean per cent infestation of pod fly on pigeonpea. Das *et al.* (2015) reported that mixed formulation of novaluron 5.25 + fipronil 4 SC @ 80 g a.i/ha and fipronil 2 50 g a.i/ha were the best with 72.5% reduction of pod fly population for each treatment. Sambathkumar *et al*. (2015) recorded low per cent pod fly grain damage (11.7%) in chlorantraniliprole 18.5 SC @ 30 g a.i/ha with the highest yield of 892.2 kg/ha in indoxacarb 15.8 EC @ 75 g a.i/ha. The results were also in agreement with the findings of Sreekanth *et al*. (2014) who reported that pod damage due to pod fly was lowest in spinosad 45% SC (10.2%), flubendiamide 480 SC (10.4%) and profenophos 50 EC (10.9%) respectively with 76.7, 76.3 and 75.1% reduction over control (43.8%) with favorable benefit cost ratio. Further, Sreekanth *et al.* (2013) opined that grain damage due to pod fly was low in dimethoate (14.0%), followed by acetamiprid 20 SP (22.6%) with ICBR of 1: 6.16 and 1: 4.11, respectively. Whereas, Sharma *et al.* (2011) reported that Emmamectin benzoate 5 SG in combination with acetamiprid 20 SP gave higher grain yield (1399 kg/ha) and lower grain damage (13.3%) in pigeonpea due to pod fly. Dar *et al.* (2009a) revealed that dimethoate (0.03%) was second best chemical after profenophos (0.21%) against pod fly and was also relatively safe to parasitoids in pigeonpea. Dar *et al*. (2009b) found that two sprays of dimethoate, profenophos and quinalphos were superior by recording maximum yield (1660 to 2046 kg ha^{-1}) and minimum grain damage (13.5 to 21.6%) due to redgram pod fly. Dar *et al.* (2005) revealed that maggot population and pod damage due to pod fly was low in dimethoate (0.03%) treatment, followed by neem seed kernel extract (NSKE) and was relatively safe to parasitoids. Srivastava and Mohapatra (2003) reported that least per cent pod damage (3.0%) was observed in plots sprayed with dimethoate and gave higher grain yield with highest cost: benefit ratio (1: 7.45). Baruah and Chauhan Ramesh (2002) reported that cypermethrin treated plots registered lower damage and weight loss. High efficacy of dimethoate against agromyzid, *Melanagromyza obtusa* was also reported by Singh *et al.* (2001) and Ganapathy and Durairaj (1994).

CONCLUSION

From the present findings, it could be concluded that insecticides like thiacloprid 21.7 SC @ 0.7 ml/l, followed by diafenthiuron 50 WP @ 1.5 g/l, flubendiamide 480 SC @ 0.2 ml/l and dimethoate 30 EC @ 2.0 ml/l were very effective against pod fly with more grain yield and high incremental cost benefit ratio (ICBR). Hence, suggested that effective insecticides may be alternated in order to avoid development of resistance to pod fly in pigeonpea.

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