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Positioning New Pesticide Chemistries in the Management of Pod Fly, *Melanagromyza obtusa* Malloch (Diptera: Agromyzidae) in Pigeonpea

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ABSTRACT

Background: Pigeonpea is an important pulse-cum-grain legume crop of India. Major constraint in its production is the insects damage. Pod fly, *Melanagromyza obtusa* is of regular occurrence in South and Central India causing yield loss to the tune of 60 to 80 per cent particularly in late maturing pigeonpea crop. Due to its feeding habit as an internal borer, cultural, biological and mechanical methods are ineffective in reducing the damage due to pod fly and insecticides play a paramount role in managing their population under field conditions. Hence, present study have been aimed to evaluate the efficacy of different new pesticide chemistries against pod fly in pigeon pea ecosystem.

Methods: Two field experiments were conducted during *Kharif* 2019 and 2020 in RCBD using pigeonpea cv. GRG 811 with 14 treatments replicated twice. Two sprays were imposed at 15 days interval initiating from pod initiation stage. At maturity, number of damaged pods were recorded and expressed as percentage. Grain yield was recorded and benefit cost ratio was also worked out.

Result: Among the screened insecticides, fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha followed by thiamethoxam 25 WG @ 50 g a.i./ha and fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha provided better control of pod fly in terms of reduction in pod damage (69.54, 62.13 and 62.57%) and seed damage (72.51, 71.35 and 70.39%) respectively over untreated check. The average grain yield of 1577 kg/ha was highest in fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha followed by fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha (1555.5 kg/ha) and thiamethoxam 25 WG @ 50 g a.i./ha (1536.5 kg/ha). Whereas, B: C was higher in fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha (2.84) and thiamethoxam 25 WG @ 50 g a.i./ha (2.83). Therefore these insecticides can be used for effective management of pod fly.

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

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the major pulse crops of the tropics and subtropics grown approximately in 50 countries of Asia, Africa and America. Among the *Kharif* pulses, pigeonpea has great significance in Indian agriculture because of its multiple use as food, feed, fodder and fuel and its role in sustaining agricultural productivity. India accounts for about 75 per cent of world's production. Economically it is the second most important pulse crop after chickpea accounting for about 20 per cent of total pulse production (Sharma *et al*., 2010). Major constraint in its production is the insects damage. About number of insect species belonging to 8 orders and 61 families have been found to infest pigeonpea from seedling to harvesting stage and virtually no plant part is free from insect infestation (Upadhyay *et al.,* 1998). Pod fly has emerged as a potential pest in key pulse growing areas and causing yield losses especially in long duration varieties (Gopali *et al*., 2010; 2013; Sharma *et al*., 2011).

Pod fly is an internal feeder whose maggots remain inside the pod and feed on the developing grains (Lal and Yadav, 1994) and infested pods do not show any external symptom of damage until the fully grown maggot chew the pod wall, leaving a thin papery membrane intact called as exit window, through which adults exit the pods. Several field studies were conducted by Sahoo *et al.* (1991), Kumar and Nath (2003) and Yadav and Dahiya (2004) to determine the efficacy of several insecticides applied for the control of pod fly. However, these findings did not find acceptability

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and led to partial success. Subharani and Singh (2007) found that the pod fly infestation is not influenced significantly by any of the environmental factors, except for relative humidity, which exerted significant negative effect with the pest infestation. Till date, insecticides are the only available means against *M. obtusa* yet it involves several limitations like no promising management of the pest even after two or three rounds of insecticides application, the crop still come across considerable losses (Sharma *et al*., 2016, Chiranjeevi and Sarnaik, 2017). This need to rule out some efficient molecules that should leave lesser residues and pose lesser environmental threat and best control of target pest have become imperative. Keeping this in view, the present investigation was attempted to rule out the best and efficient insecticide chemistry for the management of pod fly in pigeonpea.

MATERIALS AND METHODS

Two field experiments were conducted during *Kharif* 2019-20 and 2020-21 to evaluate the efficacy of different insecticides against pod fly at Zonal Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, India. It is situated in the North-Eastern dry zone of Karnataka (Zone 2) located between 17.32°N and 76.54°E longitude at an elevation of 443 meter above MSL. The experiment was laid out in randomized block design with two replications using pigeonpea cv. GRG 811 sown in plots of 5.4 m × 4.8 m size. Each plot consisted of six rows with twenty four plants in each row. The treatments included both sole and premix insecticides (Table 1). The crop was raised following the standard agronomic practices as per the package of practices of UAS Raichur (Anonymous., 2017) except for insect pest management. *Helicoverpa armigera* was managed by spraying HaNPV @ 250 LE/ha at weekly interval starting from flower initiation stage of the crop. Against pod fly, two sprays were imposed at 15 days interval initiating from pod initiation stage with hand operated knapsack sprayer with a spray volume of 800 l / ha water with neutral pH. At maturity, number of pods and seeds with pod fly damage were recorded and expressed as percentage. Grain yield was recorded and cost benefit ratio was worked out The data were subjected to analysis using AGRES package (Gomez and Gomez, 1984).

$$\text{BC ratio} = \frac{\text{Gross returns per ha}}{\text{Total cost per ha}}$$

RESULTS AND DISCUSSION

Pod damage (%)

It was found that all tested insecticides were significant in reducing pod damage due to pod fly. The results during 2019-20 revealed that among different insecticides, the pod damage varied from 12.80 (thiamethoxam 25 WG @ 50 g a.i./ha) to 20 per cent (dinotefuran 20 SG @ 40 g a.i./ha) as against 30.60 per cent in untreated control (Table 2). Fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha was statistically on par with thiamethoxam 25 WG @ 50 g a.i./ ha with 13.20 per cent pod damage followed by buprofezin 20 + acephate 50 WP @ 200+500 g a.i./ha (15.20%), fipronil 40+ imidacloprid 40 WG @ 160+160 g a.i./ha (15.60%), beta cyfluthrin 8.49+imidacloprid 19.81 OD @ 14.9+34.67 g a.i./ha (15.60%) and acephate 50+imidacloprid 1.8 SP @ 500+18 g a.i./ha (16.40 %) which were on par with each other. Similarly during 2020-21, the pod damage due to pod fly ranged from 7.15 per cent in fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha to 19.20 per cent in acephate 75 SP

Table 1: Details of insecticides selected for their efficacy against pod fly.

Treatments(Chemical name)	Trade name	Dosage (g a.i./ha)	Manufacturers
Acetamiprid 20% SP	Pride	20	Syngenta India Pvt. Ltd., Pune, Maharastra
Lambda cyhalothrin 5% EC	Karate	25	Syngenta India Pvt. Ltd., Pune, Maharastra
Fipronil 5% SC	Regent	16	Bayer Crop Sciences, Mumbai, Maharastra
Dinotefuran 20% SG	Osheen	40	PI Industries Pvt Ltd., Kurnool, AP
Flonicamid 50% WG	Ulala	100	United Phosphorus Limited (UPL), Mumbai, Maharastra
Thiamethoxam 25% WG	Actara	50	Syngenta India Pvt. Ltd., Pune, Maharastra
Imidacloprid 17.8% SL	Confidor	50	Bayer Crop Sciences, Mumbai, Maharastra
Acephate 75% SP	Asataf	750	Tata Rallis Pvt. Ltd., Mumbai, Maharastra
Acephate 50%+Imidacloprid 1.8% SP	Lancer gold	500+18.0	United Phosphorus Limited (UPL), Mumbai, Maharastra
Beta cyfluthrin 8.49%+ OD midacloprid 19.81%	Solomon	14.9+34.67	Bayer Crop Sciences, Mumbai, Maharastra
Buprofezin 20%+Acephate 50% WP	Odis	200+500	Tata Rallis Pvt. Ltd., Mumbai, Maharastra
Fipronil 40%+Imidacloprid 40% WG	Lesenta	160+160	Bayer Crop Sciences, Mumbai, Maharastra
Fipronil 4%+Thiamethoxam 4% SC	Mojati	40+40	Parijat Industries Pvt. Ltd., Ambala, Haryana
Untreated control	-	-	-

Table 2: Efficacy of different treatment schedules of insecticides against pod fly on medium duration pigeonpea during 2019-20 and 2020-21.

Treatments	Dosage	% pod damage by pod fly			% Seed damage by pod fly		
	(g a.i./ha)	2019-20	2020-21	Mean	2019-20	2020-21	Mean
Acetamiprid 20% SP	20	17.20 (24.50)	15.25 (22.99)	16.23 (23.74)	11.33 (19.67)	9.20 (17.66)	10.27 (18.69)
Lambda cyhalothrin 5% EC	25	18.80 (25.70)	14.60 (22.46)	16.70 (24.08)	13.10 (21.22)	8.90 (17.36)	11.00 (19.37)
Fipronil 5% SC	16	18.40 (25.40)	12.78 (20.95)	15.59 (23.17)	11.65 (19.96)	7.10 (15.45)	9.38 (17.83)
Dinotefuran 20% SG	40	20.00 (26.57)	14.90 (22.71)	17.45 (24.64)	12.95 (21.09)	8.60 (17.05)	10.78 (19.16)
Flonicamid 50% WG	100	19.20 (25.99)	14.60 (22.46)	16.90 (24.23)	12.29 (20.52)	8.55 (17.00)	10.42 (18.83)
Thiamethoxam 25% WG	50	12.80 (20.96)	12.50 (20.70)	12.65 (20.83)	7.53 (15.93)	6.80 (15.12)	7.17 (15.53)
Imidacloprid 17.8% SL	50	17.20 (24.50)	17.90 (25.03)	17.55 (24.77)	11.17 (19.52)	10.15 (18.58)	10.66 (19.06)
Acephate 75% SP	750	16.80 (24.20)	19.20 (25.99)	18.00 (25.09)	10.44 (18.85)	11.20 (19.55)	10.82 (19.20)
Acephate 50%+Imidacloprid 1.8% SP	500+18	16.40 (23.89)	12.50 (20.70)	14.45 (22.30)	10.17 (18.60)	7.05 (15.40)	8.61 (17.06)
Beta cyfluthrin 8.49 %+ Imidacloprid 19.81 % OD	14.9+34.67	15.60 (23.26)	13.40 (21.47)	14.50 (22.37)	9.53 (17.98)	7.90 (16.32)	8.72 (17.17)
Buprofezin 20%+Acephate 50% WP	200+500	15.20 (22.95)	16.50 (23.97)	15.85 (23.46)	8.66 (17.11)	12.50 (20.70)	10.58 (18.98)
Fipronil 40%+Imidacloprid 40% WG	160+160	15.60 (23.26)	9.40 (17.85)	12.50 (20.56)	9.67 (18.12)	5.15 (13.12)	7.41 (15.80)
Fipronil 4%+Thiamethoxam 4% SC	40+40	13.20 (21.30)	7.15 (15.51)	10.18 (18.41)	9.16 (17.62)	4.60 (12.38)	6.88 (15.21)
Untreated control	-	30.60 (33.58)	36.20 (36.99)	33.40 (35.29)	21.55 (27.66)	28.50 (32.27)	25.03 (30.02)
S.Em±		0.47	0.35	0.28	0.29	0.24	0.21
CD @ 5%		1.45	1.03	0.88	0.89	0.74	0.64

Figures in parentheses are arc sin transformed values.

@ 750 g a.i./ha as against 36.20 per cent in untreated control. The pooled data of two years (2019-20 and 2020-21) on efficacy of insecticides against pod fly revealed that fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha was superior over the remaining treatments recording significantly lower pod damage (10.18%) with maximum pod damage reduction over untreated control (69.54 %) followed by fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha and thiamethoxam 25 WG @ 50 g a.i./ha with 12.50 and 12.65 per cent pod damage and 62.57 and 62.13 per cent reduction over untreated control, respectively which were on par with each other. Acephate 75 SP @ 750 g a.i./ha and imidacloprid 17.8 SL @ 50 g a.i./ha were less effective and recorded 18.00 and 17.55 per cent pod damage, respectively compared to maximum pod damage in control plot (33.40%).

Seed damage (%)

The seed damage during 2019-20 was to the tune of 7.53 per cent in thiamethoxam 25 WG @ 50 g a.i./ha to 13.10 per cent in lambda cyhalothrin 5 EC @ 25 g a.i./ha as against 21.55 per cent in untreated control. Plots treated with buprofezin 20+acephate 50 WP @ 200+500 g a.i./ha, fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha and beta cyfluthrin 8.49+imidacloprid 19.81 OD @ 14.9+34.67 g a.i./ha were on par with each other recording 8.66, 9.16 and 9.53 per cent seed damage, respectively. Similarly during 2020-21, seed damage ranged from 4.60 (fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha) to 12.50 per cent (buprofezin 20+ acephate 50 WP @ 200+500 g a.i./ha). Whereas, highest pod damage of 28.50 per cent was noticed in control plot (Table 2). It can be inferred from the cumulative data of both the years (2019-20 and 2020-21) that the seed damage due to pod fly in different treatments was ranging from 6.88 to 25.03 per cent (untreated control). Seed damage recorded was lowest in fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha (6.88%) with 72.51 per cent reduction over control which was statistically on par with thiamethoxam 25 WG @ 50 g a.i./ha (7.17%) and fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha (7.41%) with 71.35 and 70.39 per cent reduction over control, respectively. The descending order of toxicity of insecticides with respect to seed damage was acephate 50+imidacloprid 1.8 SP @ 500+18 g a.i./ha (8.61%) > beta cyfluthrin 8.49+imidacloprid 19.81 OD @ 14.9+34.67 g a.i./ha (8.72%) > fipronil 5 SC @ 16 g a.i./ha (9.38%) > acetamiprid 20 SP @ 20 g a.i./ha (10.27 %) > flonicamid 50 WG @ 100 g a.i./ha (10.42%) > buprofezin 20+acephate 50 WP @ 200+500 g a.i./ha (10.58%) > imidacloprid 17.8 SL @ 50 g a.i./ha (10.66%) > dinotefuran 20 SG @ 40 g a.i./ha (10.78 %) > acephate 75 SP @ 750 g a.i./ha (10.82%) > lambda cyhalothrin 5 EC @ 25 g a.i./ha (11.00%) (Table 2) with 65.60, 65.16, 62.52, 58.96, 58.37, 57.73, 57.41, 56.93, 56.77 and 56.05 per cent reduction over untreated, respectively.

Grain yield

The data on grain yield (Table 3) revealed that all insecticidal treatments were significantly superior over untreated control. During 2019-20, the grain yield was to the tune of

Table 3: Relative effectiveness of different treatment schedules in relation to grain yield and ICBR due to Pod fly in pigeonpea.

Treatments	Dosage (g a.i./ha)	Yield(kg/ha)			Gross returns /ha (Rs)	Total cost/) ha(Rs	Net returns/ ha(Rs)	Benefit: cost ratio
		2019-20	2020-21	Mean				
Acetamiprid 20% SP	20	1596	1290	1443.00	88023	32200	55823	1:2.73
Lambda cyhalothrin 5% EC	25	1561	1265	1413.00	86193	32600	53593	1:2.64
Fipronil 5% SC	16	1593	1305	1449.00	88389	32900	55489	1:2.69
Dinotefuran 20% SG	40	1563	1270	1416.50	86407	33900	52507	1:2.55
Flonicamid 50% WG	100	1571	1295	1433.00	87413	34900	52513	1:2.50
Thiamethoxam 25% WG	50	1664	1409	1536.50	93727	33100	60627	1:2.83
Imidacloprid 17.8% SL	50	1595	1290	1442.50	87993	33400	54593	1:2.63
Acephate 75% SP	750	1621	1270	1445.50	88176	33700	54476	1:2.62
Acephate 50%+Imidacloprid 1.8% SP	500+18	1634	1365	1499.50	91470	33790	57680	1:2.71
Beta cyfluthrin 8.49%+ Imidacloprid 19.81% OD	14.9+34.67	1639	1355	1497.00	91317	32980	58337	1:2.77
Buprofezin 20%+Acephate% WP	200+500	1624	1285	1454.50	88725	34300	54425	1:2.59
Fipronil 40%+Imidacloprid 40% WG	160+160	1633	1478	1555.50	94886	35500	59386	1:2.67
Fipronil 4%+Thiamethoxam 4% SC	40+40	1659	1495	1577.00	96197	33900	62297	1:2.84
Untreated control	-	1220	956	1088.00	66368	28900	37468	1:2.30
S.Em±		6.68	10.55	-	-	-	-	-
CD @ 5%		20.33	32.59	-	-	-	-	-

Sale price of the produce Rs. 61/kg.

1561 kg/ha in lambda cyhalothrin 5 EC @ 25 g a.i./ha to 1664 kg/ha in thiamethoxam 25 WG @ 50 g a.i./ha as against 1220 kg/ha in untreated control. Whereas, during 2020-21, fipronil 4 + thiamethoxam 4 SC @ 40+40 g a.i./ha recorded highest grain yield of 1495 kg/ha followed by fipronil 40+ imidacloprid 40 WG @ 160+160 g a.i./ha (1478 kg/ha), thiamethoxam 25 WG @ 50 g a.i./ha (1409 kg/ha). The cumulative results on yield in both the years put together varied from 1413 to 1577 kg/ha. Highest grain yield was recorded in fipronil 4+ thiamethoxam 4 SC @ 40+40 g a.i./ha (1577 kg/ha) with 44.94 per cent yield gain over control (Table 3) followed by fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha (1555.50 kg/ha), thiamethoxam 25 WG @ 50 g a.i./ha (1536.50 kg/ha), acephate 50+imidacloprid 1.8 SP @ 500+18 g a.i./ha (1499.50 kg/ha), beta cyfluthrin 8.49+ imidacloprid 19.81 OD @ 14.9+34.67 g a.i./ha (1497 kg/ha) and buprofezin 20+acephate 50 WP @ 200+500 g a.i./ha (1454.50 kg/ha) with 42.97, 41.22, 37.82, 37.59 and 33.69 per cent yield gain over control, respectively. Highest benefit cost ratio was obtained with fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha (2.84) followed by thiamethoxam 25 WG @ 50 g a.i./ha (2.83), beta cyfluthrin 8.49+ imidacloprid 19.81 OD @ 14.9+34.67 g a.i./ha (2.77), acetamiprid 20 SP @ 20 g a.i./ha (2.73) and acephate 50+ imidacloprid 1.8 SP @ 500+18 g a.i./ha (2.71). Whereas, benefit cost ratio was lowest in flonicamid 50 WG @ 100 g a.i./ha (2.50) (Table 3).

It is evident from present investigation that, the pod fly was effectively managed by using neonicotinoid group of insecticides either sole or in combination, as the lowest pod damage, seed damage and highest grain yield was noticed in fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha followed by thiamethoxam 25 WG @ 50 g a.i./ha and fipronil 40+ imidacloprid 40 WG @ 160+160 g a.i./ha. Similar findings were done by Kumar *et al*. (2016) who recorded lowest pod (4.60%) and seed damage (2.22%) in thiamethoxam 25 WG @ 0.25 g/l treated plot with highest benefit: cost ratio (3.20) and 1752 kg/ha grain yield. Das *et al*. (2015) reported that mixed formulation of novaluron 5.25+fipronil 4 SC @ 80 g a.i/ha and fipronil 5 SC @ 50 g a.i/ha were the best with 72.5 per cent reduction of pod fly population for each treatment. With respect to the performance of thiamethoxam 25 WG, results are also in line with the findings of Srujana and Keval (2013) who found thiamethoxam 25 WG @ 75 g a.i./ha as highly effective against pod fly with minimum pod (17.33%) and grain damage (6.77%) compared to other insecticides tested and maximum grain yield in plots treated with thiacloprid 24 SC (13.88 q/ha) followed by thiamethoxam 25 WG (12.93 q/ha). Further, Patel *et al*. (2014) from Gujarat opined that the pod (5.11%) and grain damage (3.27%) due to pod fly at harvest was lower in plots treated with thiamethoxam 25 WG 0.01 per cent. Whereas, Gogi (2003) recorded grain yield of 727.46 kg/ha in thiamethoxam 25 WG treated plots which was next best treatment after dimethoate 30 EC (872.36 kg/ha), thiochloprid 24 SC (861.21 kg/ha) and imidacloprid 17.8 SL (845.07 kg/ha) which were on par with each other.

Grain damage due to pod fly was the lowest in fipronil 20 SC (13.3%) and dimethoate (14.0%) followed by thiamethoxam 25 WG (16.6%) with 69.7, 68.1 and 62.1 per cent reduction over control, respectively (Sreekanth *et al*., 2013). However, Nithish and Rana (2019) noticed minimum per cent pod damage (13.47%) and grain damage (9.66%) due to pod fly in acetamiprid 20 SP which was at par with thiamethoxam 25 WG (14.40% pod damage and 9.79% grain damage).

CONCLUSION

Pigeonpea pod fly, *Melanagromyza obtusa* is predominant particularly on medium and long duration pigeonpea. Present study shows that fipronil 4+thiamethoxam 4 SC @ 40+40 g a.i./ha, thiamethoxam 25 WG @ 50 g a.i./ha and fipronil 40+imidacloprid 40 WG @ 160+160 g a.i./ha provided better control of pod fly infesting pigeonpea. Higher grain yield and benefit cost ratio was also obtained from these treatments as compared to other insecticides and untreated control. Thus, the results of these studies may be used as a basis for recommendation of insecticides for successful control of pod fly.

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Conflict of interest

All authors declared that there is no conflict of interest.

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