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Bioefficacy of promising insecticides against maggot population of pigeonpea pod fly, *Melanagromyza obtusa* (Malloch)

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Abstract
The present studies revealed the treatment with chlorantriniliprole 18.5 SC @ 30 g a.i. per ha was found best with minimum maggot population of *M. obtusa* at first and second spray *i.e.* 34.33, 16.33, 11.67, 10.67 and 18.00; and 30.33, 34.33, 12.00, 9.33 and 19.33 maggots per 100 pods on one, three, seven, ten and fourteen days after first and second spray and it was followed by neem oil @ 3%. The least effective treatment was *Eucalyptus* oil @ 5% with maximum population at first and second spray *i.e.* 44.67, 42.67, 38.67, 39.33 and 46.33; and 40.33, 44.67, 38.00, 35.00 and 46.00 pod fly maggots per 100 pods at one, three, seven, ten and fourteen days after first and second spray. The result revealed that chlorantriniliprole 18.5 SC @ 30 g a.i. per ha was found best treatment in respect of minimum maggot population after the both insecticidal spray.

Keywords: Bioefficacy, Insecticides, Maggots, *Melanagromyza obtusa*, Pigeonpea and Pod fly

Introduction
Pigeonpea [*Cajanus cajan* (L.) Millsp.] is the second important pulse crop grown in India and commonly known as red gram or tur or arhar [1, 2]. Pigeonpea is one of the most important pulse crop, widely grown by small farmers in the semi-arid tropics as a backyard subsistence crop being cultivated in more than 25 countries of the world [3]. More than 300 species of insect species have been reported infesting pigeonpea crop [4] of which pod fly, *Melanagromyza obtusa* (Malloch) is of regular occurrence, causing 10-80% damage [5, 6] and estimated to cause a loss of US$ 256 million annually [7]. The pod fly lays eggs in immature pods and feeds on developing seeds. The infested immature pods do not show external evidence of damage until the fully grown larvae chew exit holes in the pod walls [8]. Till date, chemicals are the only available efficient strategy against *M. obtusa* yet it involves several limitations like no promising management of the pest even after two or three applications of insecticides, the crop still undergo considerable losses and also the insecticides are mostly unsafe to natural enemies and also cause hazards to mankind. The insecticides which have ovicidal and translaminar action to create the lethal concentration in host at infestation points may be effectual. [6, 9, 10] conducted several field studies to determine the efficacy of several insecticides applied alone 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 [11]. Exploring new insecticides with lesser residues, lower environmental threat, novel mode of action and more remunerative has become imperative. Keeping this in view, therefore the present studies were carried out to evaluate the bioefficacy of promising insecticides against maggot population of pigeonpea pod fly, *Melanagromyza obtusa* (Malloch).

2. Materials and Methods
The field experiment was conducted at Research Farm, Agricultural Entomology Unit, Agricultural Research Station, Badnapur (VNMKV, Parbhani), Maharashtra, India during *Kharif* season of 2015-16 to determine the bioefficacy of promising insecticides against maggot population of pigeonpea pod fly, *Melanagromyza obtusa* (Malloch). The experiment was laid out in randomized block design (RBD) with three replications. Total 33 plots of 5.4 m X 4.8 m size were sown with 30 cm X 60 cm spacing by using Cv. BDN-711. Eleven treatments including untreated control were imposed in all three replication randomly.

The crop was raised as per the recommended package of practices. The crop was raised under rainfed conditions and only a protective irrigation was provided during flowering stage of the crop. Hand picking of pod borer, *Helicoverpa armigera* (Hubner) larvae and other lepidopteran pests on pods was done to avoid the losses caused by these pests. Pod fly, *M. obtusa* maggot population was counted from 100 randomly collected pods covering all the plants of each net plot [12]. In all plots two sprayings were given. Observations in respect of *M. obtusa* maggot population were recorded on one day before and one, three, seven, ten and fourteen days after each spraying [13]. Figures of population obtained in different insecticidal treatments were √x+0.5 transformed. Thus, the data obtained on population of *M. obtusa* maggots in different insecticidal treatments was analyzed statistically by using randomized block design as per the methods suggested by Panse and Sukhatme [14].

3. Results and Discussion

The data presented in Table 1 revealed that one day before spray the maggot population of *Melanagromyza obtusa* (Malloch) ranged from 50.00 to 58.67 maggots per 100 pods and non-significant difference was found among all the different treatments. The observations indicated that population of *M. obtusa* maggots was significantly reduced in treated plots as compared to untreated. Chorantriniliprole 18.5 SC @ 30 g a.i. per ha was found as best treatment with minimum maggot population of *M. obtusa* on one, three, seven, ten and fourteen days after first spray *i.e.* 34.33, 16.33, 11.67, 10.67 and 18.00 pod fly maggots per 100 pods on one, three, seven, ten and fourteen days after first spray, indicating that it is more effective against pod fly maggots due to its translaminar action; followed by all other remaining treatments *i.e.* neem oil @ 3 per cent, flubendiamide 480 SC @ 48 g a.i. per ha, emamectin benzoate 5 SG @ 11 g a.i. per ha and lambda-cyhalothrin 4.9 CS @ 25 g a.i. per ha having at par effect with each other, respectively indicating that the treatments were effective against pod fly. The treatment application of custard apple seed extract @ 5 per cent, *Pongamia* oil @ 3 per cent, triazophos 40 EC @ 500 g a.i. per ha, curry leaf extract @ 5 per cent and *Eucalyptus* oil @ 5 per cent resulted in moderately suppressing the maggot population of *M. obtusa* and all these treatments exhibited at par effect with each other, respectively. While, maximum maggot population of *M. obtusa* was observed in control *i.e.* 54.00, 66.67, 73.00, 87.33 and 100.67 pod fly maggots per 100 pods.

Table 1: Effect of different insecticide treatments on maggot population of *M. obtusa* after first spray.

S. No.	Treatments	Maggot Population of *M. obtusa* per 100 Pods					
		1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	14 DAS
1	Neem oil @ 3%	51.00 (7.18)	37.33 (6.15)	21.67 (4.71)	16.67 (4.14)	13.00 (3.67)	15.67 (4.02)
2	*Pongamia* oil @ 3%	53.00 (7.31)	45.00 (6.75)	38.33 (6.23)	33.33 (5.82)	29.00 (5.43)	33.33 (5.82)
3	*Eucalyptus* oil @ 5%	52.67 (7.29)	44.67 (6.72)	42.67 (6.57)	38.67 (6.26)	39.33 (6.31)	46.33 (6.84)
4	Curry Leaf Extract @ 5%	54.00 (7.38)	51.00 (7.18)	46.00 (6.82)	36.67 (6.10)	35.67 (6.01)	42.67 (6.57)
5	Custard Apple Seed Extract @ 5%	52.33 (7.27)	45.33 (6.77)	28.67 (5.40)	23.00 (4.85)	21.00 (4.64)	31.00 (5.61)
6	Chlorantriniliprole 18.5 SC @ 30 g a.i./ha	50.00 (7.11)	34.33 (5.90)	16.33 (4.10)	11.67 (3.49)	10.67 (3.34)	18.00 (4.30)
7	Flubendiamide 480 SC @ 48 g a.i./ha	56.67 (7.56)	40.33 (6.39)	24.33 (4.98)	20.33 (4.56)	19.00 (4.42)	25.67 (5.12)
8	Emamectin benzoate 5 SG @ 11 g a.i./ha	52.67 (7.29)	41.67 (6.49)	26.33 (5.18)	22.00 (4.74)	20.00 (4.53)	29.67 (5.49)
9	Triazophos 40 EC @ 500 g a.i./ha	58.67 (7.69)	45.33 (6.77)	36.33 (6.07)	32.00 (5.70)	28.67 (5.40)	41.33 (6.47)
10	Lambda-Cyhalothrin 4.9 CS @ 25 g a.i./ha	51.33 (7.20)	42.67 (6.57)	27.00 (5.24)	21.00 (4.64)	20.33 (4.56)	28.33 (5.37)
11	Untreated Control	56.00 (7.52)	54.00 (7.38)	66.67 (8.20)	73.00 (8.57)	87.33 (9.37)	100.67 (10.06)
	SE ± (m)	0.28	0.17	0.38	0.39	0.34	0.26
	CD at 5%	NS	0.48	1.10	1.14	0.97	0.75
	CV	6.72	4.36	11.46	12.82	11.16	7.52

Figures of population in parenthesis are √x+0.5 transformed values.
*DBS - Days Before Spray
*DAS - Days After Spray

The observations presented in Table 2 revealed that one day before spray the maggot population of *M. obtusa* ranged from 38.00 to 84.33 maggots per 100 pods and non-significant difference was found among all the different treatments. The data revealed that all the treatments were found statistically superior to the untreated control at one, three, seven, ten and fourteen days after second spray. The minimum population of 30.33, 34.33, 12.00, 9.33 and 19.33 pod fly maggots per 100 pods was observed in the treatment application of chorantriniliprole 18.5 SC @ 30 g a.i. per ha and it was found best among all the treatments. This was followed by neem oil @ 3 per cent, flubendiamide 480 SC @ 48 g a.i. per ha, emamectin benzoate 5 SG @ 11 g a.i. per ha and lambda-cyhalothrin 4.9 CS @ 25 g a.i. per ha having at par effect with each other, indicating that the treatments were effective against pod fly. The maximum maggot population of *M. obtusa* was observed in treatment application of *Eucalyptus* oil @ 5 per cent which recorded with number of 40.33, 44.67, 38.00, 35.00 and 46.00 pod fly maggots per 100 pods at one, three, seven, ten and fourteen days after second spray; followed by *Pongamia* oil @ 3 per cent, curry leaf extract @ 5 per cent, triazophos 40 EC @ 500 g a.i. per ha, custard apple seed extract @ 5 per cent and which recorded with moderate pod fly maggot population and were at effect with each other, respectively; and it was found statistically superior to the untreated control. The highest maggot population of *M. obtusa* was observed in untreated control *i.e.* 74.00, 54.00, 91.33, 88.00 and 118.00 pod fly maggots per 100 pods.

Table 2: Effect of different insecticide treatments on maggot population of *M. obtusa* after second spray.

S. No.	Treatments	Maggot Population of *M. obtusa* per 100 Pods					
		1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	14 DAS
1	Neem oil @ 3%	38.00 (6.20)	32.00 (5.70)	37.33 (6.15)	15.67 (4.02)	11.67 (3.49)	21.67 (4.71)
2	*Pongamia* oil @ 3%	39.00 (6.28)	38.67 (6.26)	45.00 (6.75)	27.67 (5.31)	31.00 (5.61)	40.33 (6.39)
3	*Eucalyptus* oil @ 5%	39.67 (6.34)	40.33 (6.39)	44.67 (6.72)	38.00 (6.20)	35.00 (5.96)	46.00 (6.82)
4	Curry Leaf Extract @ 5%	38.33 (6.23)	36.33 (6.07)	51.00 (7.18)	27.67 (5.31)	22.67 (4.81)	31.67 (5.67)
5	Custard Apple Seed Extract @ 5%	38.00 (6.20)	36.67 (6.10)	45.33 (6.77)	24.33 (4.98)	20.33 (4.56)	34.33 (5.90)
6	Chlorantriniliprole 18.5 SC @ 30 g a.i./ha	40.00 (6.36)	30.33 (5.55)	34.33 (5.90)	12.00 (3.54)	9.33 (3.14)	19.33 (4.45)
7	Flubendiamide 480 SC @ 48 g a.i./ha	37.67 (6.18)	33.33 (5.82)	40.33 (6.39)	19.00 (4.42)	16.33 (4.10)	31.33 (5.64)
8	Emamectin benzoate 5 SG @ 11 g a.i./ha	42.67 (6.57)	34.00 (5.87)	41.67 (6.49)	21.67 (4.71)	18.00 (4.30)	32.33 (5.73)
9	Triazophos 40 EC @ 500 g a.i./ha	40.67 (6.42)	40.00 (6.36)	45.33 (6.77)	24.00 (4.95)	24.00 (4.95)	34.67 (5.93)
10	Lambda-Cyhalothrin 4.9 CS @ 25 g a.i./ha	40.67 (6.42)	34.33 (5.90)	42.67 (6.57)	22.33 (4.78)	19.00 (4.42)	31.33 (5.64)
11	Untreated Control	84.33 (9.21)	74.00 (8.63)	54.00 (7.38)	91.33 (9.58)	88.00 (9.41)	118.00 (10.89)
	SE ± (m)	0.40	0.34	0.16	0.27	0.36	0.34
	CD at 5%	NS	0.99	0.45	0.78	1.05	0.98
	CV	10.50	9.50	4.05	8.89	12.71	9.53

Figures of population in parenthesis are √x+0.5 transformed values.
*DBS - Days Before Spray
*DAS - Days After Spray

All the treatments were effective in controlling *M. obtusa* maggot population. Among all treatments, chlorantriniliprole 18.5 SC @ 30 g a.i./ha and neem oil @ 3% was found best to control the maggots of *M. obtusa*. The present findings are in accordance with earlier reports of [15] who reported 10 per cent neem oil to be significantly reducing pod fly incidence. Whereas, Triazophos 0.07 per cent can effectively reduce pod fly population [16]. Similarly, application of rynaxypyr 18.5 SP @ 30 g a.i. per ha was found as best treatment for reducing the *M. obtusa* population to minimum on one, three, seven and fifteen days after spray (0.47, 0.13, 0.13 and 0.20 larvae per plant, respectively); and while maximum was observed in control [17]. Use of *Pongamia* oil can give an option for organically grown pulse crop in reducing pod fly infestation [7]. Eucalyptus oil is ineffective against pod fly [18]. The treatment application of deltamethrin 1 EC + triazophos 35 EC @ 0.07% was found to be superior and recorded 72.36 and 68.48 per cent larval reduction on seven and fourteen days after spraying and the next effective treatment was profenophos 50 EC @ 0.12% with 60.81 and 54.05 per cent larval reduction on seven and fourteen days after spraying, respectively [19]. Thiaclopride 21.7 SC and Profenophos 50 EC were found significantly effective in minimizing the cumulative mean per cent infestation of pod fly of pigeonpea [20]. With the literature reviewed so far, it is clear that no such specific studies were conducted earlier and so this is first work carried out on the aspect.

4. Conclusion

From the present study, it can be concluded that the insecticides *viz*., chlorantriniliprole 18.5 SC @ 30 g a.i./ha and neem oil @ 3% were most effective against *M. obtusa* by recording minimum maggot population after the both insecticidal spray and these may be utilized for *M. obtusa* management in farmers fields due to their novel mode of action.

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