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Bio-Efficacy of Select Insecticides and Plant Products against the Pigeon pea Pod fly, *Melanagromyza obtusa* (Diptera: Agromyzidae) Malloch

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ABSTRACT

Pod fly, Melanagromyza obtusa Malloch is a serious pest of Pigeon pea. During the present investigation, ten insecticides were evaluated under field and laboratory conditions. Results of experiments showed that after 3 and 6 hr, Emamectin benzoate (0.001 %) and Dimethoate (0.03%), followed by Indoxacarb (0.004%), Dichlorvos (0.08%) and Fenvalerate (0.02%) recorded higher per cent of adult mortality and the NSKE (4 %) treated pods received the least number of eggs and was significantly superior over others. Significantly lower per cent seed damage was recorded for plots sprayed with Dimethoate 0.03%. The highest seed yield was obtained from plots treated with a combination of NSKE 5%-Emamectin benzoate 0.001%-Dichlorvos (1666.00 kg/ha) and Dichlorvos- Dimethoate 0.03%- cypermethrin 0.01% -Emamectin benzoate 0.001% (1583.00 kg/ha) over control. These results can substantially contribute to the development of IPM in Pigeon pea.

Key words: *Pod fly, Melanagromyza obtuse, Mortality, Ovipositional deterrence, Seed yield*

INTRODUCTION

Pigeon pea (*Cajanus cajan* Millsp.) is one of the most important pulse crops grown worldwide because it is endowed with several unique characteristics with diversified uses for human needs and is an important crop in semi-arid tropical and subtropical areas. Especially in Asia it is a major source of protein for humans[16]. As many as 250 insect species have been recorded to attack pigeon pea[23] among which the pod-borers and pod fly are the most damaging pests, inflicting considerable damage to the reproductive parts of the plant.

The pigeon pea pod fly *Melanagromyza obtusa* Malloch (Diptera: Agromyzidae) is found throughout south and south-east Asia[17]. The main country suffering from its pestilence is India because of widespread pigeonpea cultivation (>90% of the world production)[22, 1, 16]. Females deposit eggs on the pigeon pea green pods and the developing larva initially feeds just under the epidermis of the seed like a leaf miner.

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Generally, pod yield losses due to this vary between 5-30 per cent during winter and spring from several countries [21,22]. During the pest surveys conducted by International Crops Research Institute for Semi-Arid Tropics (ICRISAT,1976), *M. obtusa* was recorded causing losses from 2.4 to 29.4 percent in different districts of Karnataka. Hence, attempts were made to evaluate the efficacy of different insecticides and botanicals for the sustainable management of the pigeon pea pod fly.

MATERIALS AND METHODS

Experiments were conducted at the University of Agricultural Sciences, Gandhi Krishi Vignan Kendra (GKVK), Bangalore, during *kharif* and *summer* (2011 - 2013). Geographically, the experimental site was located at 12°58' N and 77°35' E and 930 MSL.

Evaluation of chemicals: Ten chemicals *viz.*, Dimethoate (0.03%), Indoxacarb (0.004%), Fenvalerate (0.02%), Dichlorvos (0.08%), Emamectin benzoate (0.001 %), Methomyl (0.05%), Monocrotophos (0.04%), NSKE (4 %), Neem oil (2 %) and Pongamia oil (2 %) were uniformly sprayed on to a thoroughly cleaned glass Petri dish using Potters Towers. Similarly, water spray was used as control. The Petri dish was dried in the shade. Five pairs of adults were released into the Petri dish. Observations on pod fly mortality were recorded at three and six hours after release and experiment was replicated five times.

Similarly, the chemicals were sprayed on 10-15 days old pods in the laboratory using Potters tower. These pods were then placed inside a thoroughly cleaned Petri dish after shade drying. Five pairs of adults were released. Observations on pod fly mortality were recorded at three and six hours after release and experiment was replicated five times.

The pigeonpea cultivar TTB-7 was used in the experiment with a randomized complete block design with 11 treatments [Dimethoate (0.03%), Indoxacarb (0.004%), Fenvalerate (0.02%), Dichlorvos (0.08%), Emamectin Benzoate (0.001 %), Methomyl (0.05%), Monocrotophos (0.04%), NSKE (4 %), Neem oil (2 %), Pongamia oil (2 %) and water (as control)] and replicated four times and thrice for efficacy of insecticides on different dates and ovipositional deterrence of pod fly, respectively. The plot size was 4 × 4.5 m and spacing between rows and plants was 90 cm and 20 cm, respectively. The spraying was done thrice with 700 liters per hectare spray fluid starting at 10 days after pod initiation and remaining two sprays at ten and seven day intervals after the first spray for efficacy of insecticides on different dates and ovipositional deterrence of pod fly, respectively. Observations were recorded on pod damage by pod fly on randomly selected 250 pods to identify the efficacy of insecticides. The number of eggs laid by pod flies on randomly selected 100 pods were recorded to know ovipositional deterrence of pod fly. Statistical interpretation of data was done following Fischer's Analysis of Variance technique and procedures outlined by Rangaswamy *et al.*[14].

Sequential application of insecticides: A field trial was conducted to evaluate the efficacy of sequential application of insecticides for the management of pigeon pea pod fly during *kharif* 2011 at the Farm of the University of Agricultural Sciences, GKVK, Bangalore. TTB-7 was used in the experiment with a randomized complete block design with 10 treatments [T1- A-B–C, T2- A-D-F, T3- E-B–C, T4- A-F-E, T5- G–C–B, T6- F-C-B, T7- C-C-G, T8- C-B–C, T9- D-H-C and T10- untreated control] and replicated thrice. The chemical consists *viz*., A = NSKE 5%, B = Emamectin Benzoate 0.001%, C = Dimethoate 0.03%, D = Pongamia oil 5%, E = Fenvalerate 0.02%, F = Dichlorvas, G = Indoxacarb and H = Neem oil. The plot size was 4 × 4.5 m and spacing between rows and plants was 90 cm and 20 cm, respectively. The spraying was done thrice with 700 liters per hectare spray fluid starting at 10 days after pod initiation and remaining two sprays at ten day intervals after the first spray. Observations were recorded on pod damage by pod fly on randomly selected

250 pods and seed yield per plot was also recorded. Statistical interpretation of data was done following the Fischer's Analysis of Variance technique and procedures outlined by Rangaswamy *et al.*[14].

RESULTS

Mortality of adult fly (in cages): Three hours after treatment, pod fly mortality was significantly higher in Dimethoate (88.67), Emamectin Benzoate (0.001 %) (89.67), Dimethoate (0.03%) followed by Indoxacarb (0.004%) (68.35), Dichlorvos (0.08%) (65.48) and Fenvalerate (0.02%) (60.69). Remaining treatments caused adult mortality less than 55.00 per cent. After 6 hr, 98.66 per cent mortality was recorded in Dimethoate and in Emamectin Benzoate (0.001 %) (96.79), and Fenvalerate (0.02%) recorded 97.77 per cent mortality. These insecticides were on par with Indoxacarb (0.004%) and Dichlorvos (0.08%) which caused more than 90.00 per cent mortality (Fig. 1).

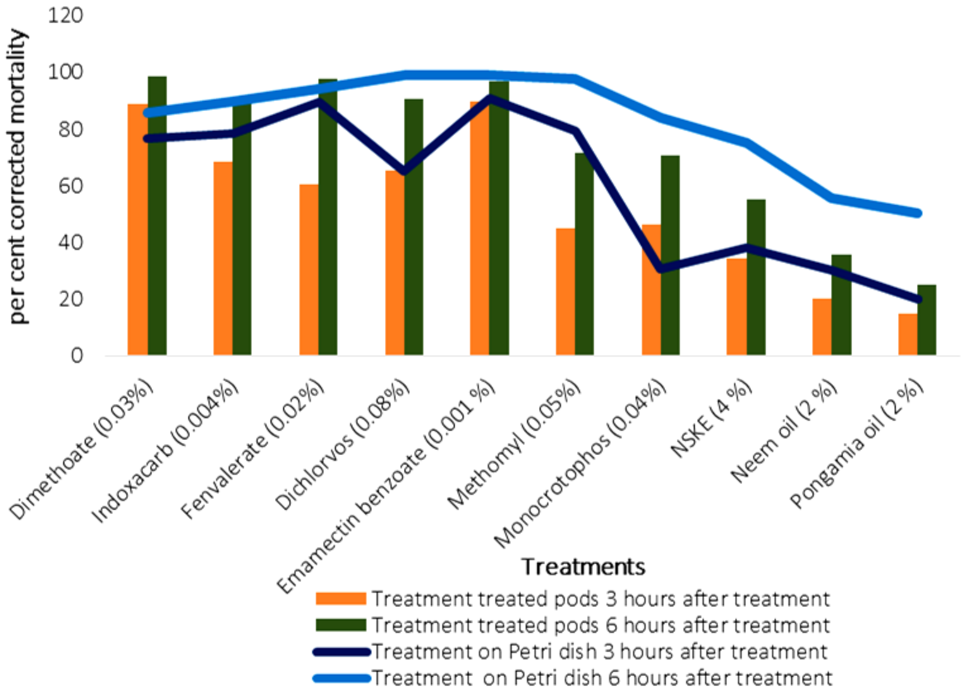

Fig. 1: Mortality of adult pod fly treated with insecticides on treated pods and Petri dish

Mortality of adult pod fly treated with insecticide on Petri dishes: To further elucidate on the effectiveness of insecticides, laboratory experiments were conducted in Petri dishes (Fig.1). Three hours after treatment, Emamectin benzoate (0.001%) (90.66) and Fenvalerate (0.02%) (89.68) caused maximum mortality of adult pod fly when treated with insecticide and treated pods enclosed in Petri dishes (Dia. 8 inches). These insecticides were followed by Methomyl (0.05%) (79.48), Indoxacarb (0.004%) (78.67) and Dimethoate (0.03%) (76.67). During 6 hr after treatment, Emamectin benzoate (0.001 %) (99.00), Dichlorvos (0.08%) (98.99) and Methomyl (0.05%) 97.66 showed maximum adult mortality. These were on par with Fenvalerate (0.02%) (94.28). These were followed by Indexacarb (0.004%), Dimethoate (0.03%) and Monocrotophos (0.04%).

Ovipositional deterrence of insecticides and plant products against pod fly: Data were also collected to determine ovipositional deterrence of insecticides and neem against adult pod fly (Table 1). The NSKE (4 %) (2.20, 1.20 and 0.87 eggs per 10 pods after 1st, 2nd and 3rd sprays, respectively) treated pods received the least number of eggs and was found significantly superior over others. This treatment was on par with Neem oil (2 %) (4.50, 2.46 and 0.89 eggs per 10 pods after 1st, 2nd and 3rd sprays, respectively) and Pongamia oil (2 %) (4.75, 3.60 and 1.20 eggs per 10 pods after 1st, 2nd and 3rd sprays, respectively). During the third spray after treatment the above mentioned treatments were also on par with Emamectin benzoate (0.001 %) (2.86 eggs), Fenvalerate (0.02%) (4.20), Indoxacarb (0.004%) (4.63) and Methomyl (0.05%) (4.63).

Efficacy of insecticides against pod fly damage: Efficacy of five insecticides and time of spray was evaluated for management of *M. obtusa*. Data on effect of insecticides on pod and seed damage and seed yield are presented in Tables 2, 3 and 4, respectively. Five insecticides provided significantly lower pod damage over control. There was statistically significant interaction between insecticide and pod age. Among the different insecticides, Dimethoate (0.03%) recorded the least per cent pod damage when sprayed at 5 (8.36 % pod damage), 10 (6.58 % damage), 15 (9.93 % pod damage) and 20 (8.86 % pod damage) days after pod formation stage. On an average, pod damage was 8.56 %, significantly less than all other treatments. This was followed by Indoxacarb 0.004% (12.91 % pod damage), Fenvalerate0.02%(14.38 % pod damage) and NSKE 4% 0.025 % (12.17 % pod damage). With respect to spraying at different days after pod formation, spraying at 10 days after pod formation recorded significantly lower pod damage across select insecticides tested. Spraying at all other days after pod formation caused significantly higher pod damage than spraying at 10 days after pod formation stage (Table 2).

Table 1: Ovipositional deterrence of insecticides and plant products against adult pod fly

Treatments	No. of eggs after spray / plant*		
	1st spray	2nd spray	3rd spray
Dimethoate (0.03%)	12.50 (3.53)c	10.40 (3.22)c	6.30 (2.50)c
Indexacarb (0.004%)	12.36 (3.51)c	8.80 (2.96)c	4.63 (2.15)ab
Fenvalerate (0.02%)	10.67 (3.26)c	5.80 (2.40)c	4.20 (2.04)ab
Dichlorvos (0.08%)	10.18 (3.19)c	7.00 (2.64)c	3.00 (1.73)ab
Emamectin benzoate (0.001 %)	12.63 (3.55)c	7.46 (2.73)c	2.86 (1.69)a
Methomyl (0.05%)	12.36 (3.51)c	8.80 (2.96)c	4.63 (2.15)ab
Monocrotophos (0.04%)	10.18 (3.19)c	12.63 (3.55)c	6.38 (2.52)c
NSKE (4 %)	02.20 (1.48)a	1.20 (1.09)a	0.87 (0.93)a
Neem oil (2 %)	4.50 (2.12)ab	2.46 (1.56)ab	0.89 (0.94)a
Pongamia oil (2 %)	4.75 (2.17)ab	3.60 (1.89)ab	1.20 (1.09)a
Control (Water spray)	15.00 (3.87)d	17.00 (4.12)d	25.00 (5.00)d
SEm±	1.38	1.38	2.22
CD at 5%	425	3.84	6.51

Figures in parentheses are SQRT (X) transformed values; * mean of 20 plants

Table 2: Effect of insecticides on pod damage (%) by pod fly at different days after pod formation

Treatment	Pod damage (%)				Mean*
	Days after pod formation				
	5	10	15	20	
Emamectin benzoate (0.001%)	17.16	10.13	15.89	16.17	14.84 (22.64)b
Indoxacarb (0.004%)	15.18	10.69	13.13	12.64	12.91 (21.04)ab
Fenvalerate (0.02%)	15.00	11.16	16.17	15.18	14.38 (22.97)b
Dimethoate (0.03%)	8.36	6.58	9.93	8.86	08.56 (17.00)a
NSKE (4%)	13.14	11.19	11.15	13.19	12.17 (20.40)ab
Control	27.38	28.83	30.64	31.00	29.46 (32.85)d
SEm±					1.06
CD at 5%					3.58

*Figures in parentheses are angular transformed values

Seed damage by pod fly was significantly lower over control in all the plots sprayed with insecticides. Significantly lower per cent seed damage was recorded for plots sprayed with Dimethoate 0.03% (8.58 % seed damage). All the others were on par with each other in terms of per cent seed damage but significantly higher than Dimethoate 0.03%. Per cent seed damage varied significantly with spraying on different days after pod formation. Least seed damage was recorded from plots sprayed on 5 and 20 days after pod formation (6.00 and 6.87 per cent seed damages, respectively) which were on par with each other and significantly lower than the seed damage in plots sprayed on 10 and 15 days after pod formation (9.63 and 11.81per cent seed damage, respectively). The interaction between insecticides and pod age at the time of spray with respect to per cent seed damage was non-significant ($P<0.05$) (Table 3).

Table 3: Effect of insecticides on seed damage (%) by pod fly at different days after pod formation

Treatment	Seed damage (%)				Mean
	Days after pod formation				
	5	10	15	20	
Emamectin benzoate (0.001%)	10.18	16.79	13.19	14.60	13.69 (3.70)[b]
Indoxacarb (0.004%)	11.67	15.67	16.51	10.18	13.51 (3.67)[b]
Fenvalerate (0.02%)	16.79	18.00	17.40	12.63	16.21 (4.02)[b]
Dimethoate (0.03%)	6.00	9.63	11.81	6.87	08.58 (3.04)[a]
NSKE (4%)	15.67	12.91	16.45	14.15	14.80 (3.84)[b]
Control	26.63	34.40	32.68	31.67	31.35 (5.60)[c]
SEm±					0.85
CD at 5%					7.01

Figures in parentheses are SQRT (X) transformed values

Seed yield showed significantly ($P<0.05$) higher yields from the plots treated with insecticides over control (Table 4). The highest average yield was obtained from the plots treated with Dimethoate 0.03% (1516 kg seeds/ha). The lowest average yield was obtained from the plots treated with Indexacarb 0.004%(1198 kg seeds/ha) on par with Emamectin benzoate 0.001%(1237 kg/ha) and NSKE 4% (1204 seeds/ha). Yields from plots sprayed at different days after pod formation also varied significantly. Lower yields were obtained from plots sprayed at 20 days after pod formation.

Table 4: Effect of insecticides on seed yield (kg/ha) by pod fly at different days after pod formation

Treatment	Seed yield (kg/ha)				Mean
	Days after pod formation				
	5	10	15	20	
Emamectin benzoate (0.001%)	1267.00	1165.00	1300.00	1218.00	1237.00 [b]
Indoxacarb (0.004%)	1370.00	1300.00	1086.00	1036.00	1198.00 [b]
Fenvalerate (0.02%)	1364.00	1200.00	1285.00	1167.00	1254.00 [a]
Dimethoate (0.03%)	1631.00	1606.00	1463.00	1367.00	1516.00
NSKE (4%)	1267.00	1300.00	1050.00	1200.00	1204.00 [b]
Control	846.00	899.00	926.00	1095.00	941.00 [c]
SEm±					0.85
CD at 5%					7.01

Efficacy of sequential application of insecticides: Efficacy of A = NSKE 5%, B = Emamectin benzoate 0.001%, C = Dimethoate 0.03%, D = Pongamia oil 5%, E = Fenvalerate 0.02%, F=Dichlorvas, G=Indoxacarb, H=Neem oil applied in different sequences was tested for the supression of M. obtusa. Data on the pod and seed damage and seed yields are presented in Tables 5, 6 and 7.

Pod damage: All the treatment combinations were effective (P<0.05) over control. The combinations of BA-B–C, A-D-F, E-B–C, A-F-E, G–C–B, F-C-B, C-C-G, C-B–C and D-H-C gave significantly lower pod damage than the other treatments (Table 5). The pod damage due to pod fly varied from 5.28 to 18.79 per cent under natural conditions. The per cent decrease in pod damage varied from 44.86 to 81.32 per cent. The highest decrease in pod damage was realized in C-C-G treatment combination.

Seed damage: Seed damage varied from 4.58 to 21.71 % in control (Table 6). The maximum seed damage reduction of 78.90 per cent was realized in A-B-F treatment combination and this combination also resulted in the maximum seed yields of 1666.00 kg/ha (Table 7). Subsequently this eventually further resulted in the maximum increase in seed yields (51.00 %) over control, where no pest suppression measures were adopted. The treatment combinations resulted in statistical significant differences in the pod fly damage. These results suggest that seed damage is directly related to seed yield than pod damage.

All the treatment combinations were effective in reducing the seed damage by M. obtuse significantly (p>0.05) compared to control. Among the various combinations, A-B–C, A-D-F, F-C-B, C-C-G, C-B–C (7.65, 4.58, 7.42, 7.80 and 7.97 % seed damage, respectively) were on par with each other and were most effective in reducing the seed damage. The highest decrease in seed damage over control (78.90 %) was obtained in the A-B-F treatment combination (Table 6).

Seed yield: All the treatment combinations gave significantly higher seed yields over control. The highest seed yield was obtained from plots treated with A-B-C (1457.00 kg/ha), A-B-F (1666.00 kg/ha) and F-C-B (1583.00 kg/ha). The same combination of A-B-F, F-C- Band A-B-C gave 51.00, 48.51 and 44.06 % higher yield over control, respectively (Table 7).

Table 5: Efficacy of sequential application of insecticides on pod damage caused by pod fly

Sl. No.	Treatment (15 days interval)	Pod damage (%)	% decrease in pod damage over control
1	A-B-C	5.28 (13.28)^{b}	71.90
2	A-B-F	10.36 (18.77)^{d}	44.86
3	E- B–C	6.25 (14.47)^{bc}	66.74
4	A-F-E	10.27 (18.68)^{d}	45.34
5	G–C– B	5.86 (14.00)^{b}	68.81
6	F-C- B	9.57 (18.01)^{cd}	49.07
7	C-C- G	3.51 (10.79)^{a}	81.32
8	C- B–C	4.96 (12.86)^{b}	73.60
9	D-H-C	8.62 (17.07)^{c}	54.12
10	Control	18.79 (25.68)	-
	SEm±	1.50	
	CD at 5%	5.02	

F* Test significant at 5% level,; A = NSKE 5%, B = Emamectin benzoate 0.001%, C = Dimethoate 0.03%, D = Pongamia oil 5%, E = Fenvalerate 0.02%, F=Dichlorvos, G=Indoxacarb, H=Neem oil; Figures in parentheses are angular transformed values

Table 6: Efficacy of sequential application of insecticides on seed damage caused by pod fly

Sl. No.	Treatment (15 days interval)	Seed damage (%)	% decrease in seed damage over control
1	A-B–C	7.65 (16.05)[ab]	64.76
2	A-B-F	4.58 (12.35)[a]	78.90
3	E- B–C	12.15 (20.39)[c]	44.04
4	A-F-E	11.84 (20.12)[c]	45.46
5	G–C– B	8.81 (17.26)[b]	59.42
6	F-C- B	7.42 (15.80)[ab]	65.82
7	C-C- G	7.80 (16.21)[ab]	65.55
8	C- B–C	7.97 (16.39)[ab]	63.29
9	D-H-C	9.52 (17.96)[b]	56.15
10	Control	21.71 (27.76)[d]	-
	SEm±	1.25	
	CD at 5%	3.59	

A = NSKE 5%, B = Emamectin benzoate 0.001%, C = Dimethoate 0.03%, D = Pongamia oil 5%, E = Fenvalerate 0.02%, F=Dichlorvos, G=Indoxacarb, H=Neem oil; Figures in parentheses are angular transformed values

Table 7: Efficacy of sequential application of insecticides on seed yield caused by pod fly

Sl. No.	Treatment (15 days interval)	Seed yield (kg/ha)*	% increase in seed yield over control**
1	A-B–C	1457.00 [b]	44.06
2	A-B-F	1666.00[a]	51.0
3	E- B–C	1106.00 [f]	26.31
4	A-F-E	1206.00[e]	32.42
5	G–C– B	1349.00[cd]	39.58
6	F-C- B	1583.00 [b]	48.51
7	C-C- G	1300.00 [c]	37.30
8	C- B–C	1287.00 [d]	36.67
9	D-H-C	1218.00 [e]	33.08
10	Control	815.00 [g]	-
	SEm±	100.66	
	CD at 5%	350.00	

A = NSKE 5%, B = Emamectin benzoate 0.001%, C = Dimethoate 0.03%, D = Pongamia oil 5%, E = Fenvalerate 0.02%, F=Dichlorvos, G=Indoxacarb, H=Neem oil; ; Figures in parentheses are angular transformed values

DISCUSSION

After 3 and 6 hr, Emamectin benzoate (0.001 %) and Dimethoate (0.03%), followed by Indoxacarb (0.004%) (68.35), Dichlorvos (0.08%) (65.48) and Fenvalerate (0.02%) recorded higher per cent mortality of pod fly.

Emamectin Benzoate (0.001 %) (90.66) and Fenvalerate (0.02%) (89.68) were effective in causing mortality of adult pod fly. The NSKE (4 %) treated pods received the least number of eggs and was significantly superior over others. This treatment was on par with Neem oil (2 %) and Pongamia oil (2 %). Insecticides like Chlorpyriphos, Quinalphos and Cypermethrin were in between and recorded more than 4 eggs per 10 pods. Akhauri *et al*. (1994) found that Endosulfan at 0.07% was better than Neem seed kernel extract. Currently the insecticides Endosulfan has been banned as the insecticide. Two round spraying of Dimethoate and Monocrotophos at 0.05 per cent each were effective in pod infestation[10]. Recommended three sprays of Monocrotophos (0.04 %) or two sprays of Endosulfan (0.07 %) for the management of pod borer complex on pigeon pea[20].

Endosulfan 2 per cent dust at 25 kg / ha proved most effective and methyl parathion dust at 20 kg/ha was the least effective[12, 13].

In Maharashtra compared the efficacy of synthetic Pyrethroids with commonly used compounds and found that Fenvalerate (0.01%) was the most effective followed by Cypermethrin (0.01%), permethrin(0.01%), Endosulfan (0.05%) and Methamidophos (0.05%) in reducing pod infestation by borer complex of pigeon pea[6]. Fenvalerate (0.01%) was effective against *M. obtusa* [13, 8.] Found that out of seven insecticides tested in reducing infestation of pods and seeds of pigeon pea by *M. obtusa,* Fenvalerate (0.02%) was found most effective and also reported that Fenvalerate gave the greatest profit per hectare, followed by Fenvalerate (0.02%)[19].

Triazophos (0.07%) and monocrotophos (0.04%) were found to be effective and recommended at 30 per cent flowering, followed by 2nd and 3rd sprays at 15 days intervals. Efficacy of five insecticides and time of spray was evaluated for the management of *M. obtusa* [11]. There was statistically significant interaction between insecticide and the pod age. Among the different insecticides, Dimethoate 0.03% recorded the least per cent pod damage. On an average, pod damage was 8.56 %, significantly less than all other treatments. This was followed by Monocrotophos @ 0.04% Indoxacarb 0.004% (12.91 % pod damage), Fenvalerate 0.02% (14.38 % pod damage) and NSKE 4% (12.17 % pod damage). Seed damage by pod fly was significantly lower over control in all the plots sprayed. Seed yield showed significantly higher yields from plots treated with insecticides over control. The highest average yield was obtained from the plots treated with Endosulfan @ 0.07 % (1516 kg seeds/ha).

Cypermethrin treated plots registered the lowest damage, weight loss and the highest average yield compared to Deltamethrin, Fenvalerate and Endosulfan treated plots in pigeon pea against pod fly[2]. Fenvalerate 20 EC (0.02%) on ICPL-85063 was effective in reducing pod fly infestation[15]. The efficacy of synthetic insecticides evaluated against pod bug and pod fly infesting pigeon pea cv. UPAS-120[9]. The order of efficacy was Cypermethrin (0.006%) >Fenvalerate (0.02%) >Deltamethrin (0.004%) > Control. Efficacy of Emamectin Benzoate 0.001%, Indoxacarb 0.004% and Dimethoate @ 0.03% applied in different sequences was tested for the supression of *M. obtusa.* All the treatment combinations were effective in reducing the seed damage by *M. obtusa* and were statistically significant compared to control.

The highest decrease in seed damage over control (78.90 %) was obtained in the A-D-F treatment combination which involved NSKE 5%, Emamectin Benzoate 0.001% and Dichlorvas as 3rd spray. The highest seed yield was obtained from plots treated with A-B–C (1457.00 kg/ha), A-B–F (1666.00 kg/ha) and F-C- B (1583.00 kg/ha). Based on field experiments Emamectin Benzoate 5 SG in combination with Acetamiprid 20 SP or Dimethoate 30 EC gave higher grain yield and lower pod fly grain damage[18].

Similarly, all the three biopesticide preparations (crude neem kernel seed extract (5%), neem oil (3000 ppm) and *Pongamia* oil gave higher grain yield in comparison to the control. four synthetic pyrethroids and two conventional insecticides in two schedules each (3 sprays and 2 sprays) were tested against pod borer complex of pigeon pea. Cypertmehrin in three sprays schedule was the most effective against the pod borer and pod fly, followed by Decamethrin and Fenvalerate[5].

Monocrotophos, Carbaryl, Fenvalerate and Thiodicarb recorded 9.4 to 12.69 per cent pod fly damage and were found significantly superior over Phosphomidon (25.54%) but in turn were at par with each other in pigeonpea[3]. Larval population were significantly reduced by Endosulfan (4 %), Carbaryl (10%) and HCH (10%) plus Carbaryl (10%)[7]. Cypermethrin and Fenvalrate were the most effective chemicals against pod fly infestation[18]. Similarly four sprays of Monocrotophos (0.04%) at 20 days interval was the most effective and most economical[4].

CONCLUSION

The kind and schedule of insecticides for pod borers management would depend on the plant phenology, composition and occurrence of different pod borer species in the pigeon pea ecosystem. Due cognizance should also be given to the pollinators and natural enemies in relation to the crop productivity. Hence, Modules with varying combination can be tried to manage pod borers at different locations.

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