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Time of application of insecticide in the management of Podfly, *Melanagromyza obtusa* (Malloch) on Pigeonpea

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Abstract
A field experiment conducted during *kharif*, 2016 at Regional Agricultural Research Station, Lam, Guntur dist. Andhra Pradesh to know the time of application of insecticide and its economics for the management of podfly revealed that the insecticide dimethoate 30 EC @ 2 ml l^{-1} applied at 2, 3, 4 and 5 weeks after 50% flowering was found most effective in reducing pod and grain damage due to podfly with more yield. However, the same insecticide applied twice at 3 and 4 weeks after 50% flowering was most promising and can be recommended, as it registered more incremental cost benefit ratio (ICBR) of 17.77.

Keywords: Dimethoate, insecticides, *Melanagromyza obtusa*, Pigeonpea and Podfly

Introduction

Pigeonpea (*Cajanus cajan* L) is a tropical grain legume mainly grown in India and ranks second in area and production and contributes about 90% in the world's pulse production. In India, pigeonpea is grown in 3.96 million ha with an annual production of 2.56 million tonnes and productivity of 646 kg ha^{-1}. Whereas, in Andhra Pradesh, the area, production and productivity of pigeonpea is 2.2 lakh ha, 1.32 lakh tonnes and 600 kg ha^{-1}, respectively (AICRP Report, 2017) [1]. Though the area under redgram is increasing both in *Kharif* and *Rabi* seasons, the yields have remained stagnant (500-700 kg ha^{-1}) for the past 3-4 decades, largely due to insect pest damage (Sharma and Pampapathy, 2004) [8]. It is attacked by more than 250 species of insects of which podfly, *Melanagromyza obtusa* (Malloch) is one of the important pests causing 10-80% damage (Shanower *et al*., 1999, Kumar and Nath, 2003) [7, 5] and estimated to cause a monitory loss of US$ 256 million annually (Anonymous, 1992) [2].

Podfly being an internal feeder, both maggot and pupal stages are present inside the pods. The maggots feed on the developing seed and pupate inside the pod, thus making it unfit for human consumption as well as seed purpose. The podfly 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 window, through which adults exit from the pod. The podfly attack remains unnoticed by farmer owing to the concealed mode of life with in the pods and thus it becomes difficult to manage the pest in time. It is an emerging constraint to increase the production and productivity of this crop under subsistence farming conditions. Even though wide range of insecticides were tested against podfly, the information on the time of application of insecticide was very scanty. Thus, keeping this in view, the present study was conducted to know the time of application of insecticide for the management of podfly.

Materials and methods

The experiment was laid out at Regional Agricultural Research Station, Lam, Guntur in a Randomized Block Design (RBD) with eleven treatments replicated thrice including untreated control. The size of each plot was 36 m^2 with an inter row spacing of 1.8 m and an intra-row spacing of 0.2 m. The variety used was LRG 52 (Amaravathi). The crop is well protected with the recommended insecticides up to 50% flowering. Against podfly, the treatments were imposed with the recommended insecticide *viz*., dimethoate 30 EC @ 2.0 ml l^{-1} as follows.

T_1 – 2 weeks after 50% flowering
T_2 – 3 weeks after 50% flowering
T_3 – 4 weeks after 50% flowering
T_4 – 5 weeks after 50% flowering
T_5 – 2 and 3 weeks after 50% flowering
T_6 – 3 and 4 weeks after 50% flowering
T_7 – 4 and 5 weeks after 50% flowering
T_8 – 2, 3 and 4 weeks after 50% flowering
T_9 – 3, 4 and 5 weeks after 50% flowering
T_{10} – 2, 3, 4 and 5 weeks after 50% flowering
T_{11}– Control

Observations on pod damage (%), grain damage (%), number of maggots and pupae per pod, yield (kg/ha), percent increase in yield over control, incremental cost benefit ration (ICBR) were recorded as follows.

Pod damage (%)

To assess the degree of infestation caused by podfly, two hundred pods were picked out randomly from each replication at the time of harvest and the percent pod damage was calculated.

$$\text{Percent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Grain damage (%)

At the time of harvest two hundred pods per replication were collected at random and were split open to count the healthy and damaged grains and the percent grain damage was calculated. The grains damaged by podfly have a characteristic streak on seeds.

$$\text{Percent grain damage} = \frac{\text{Number of damaged grains}}{\text{Total number of grains}} \times 100$$

Number of maggots and pupae per pod

The number of maggots and pupae per pod was counted after completion of all sprays and the sampled pods (50 pods per plot) were split open to count the number of maggots and pupae and the average number per pod was calculated.

Yield (kg ha^{-1})

Harvesting was done when 80 percent of the pods in the plot had matured. After drying for 6-7 days the pods were threshed and grain yield was recorded plot wise and later converted to kg ha^{-1}.

Percent increase in yield over control

The percent increase in yield over control in various treatments was estimated by using the formula.

$$\text{Increase in yield over control (\%)} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

Incremental Cost Benefit Ratio (ICBR)

In order to evolve incremental cost benefit ratio, the net profit obtained by deducting the plant protection cost from the value of additional yield was divided with the plant protection cost.

Results and discussion

Data on pod and grain damage due to *M. obtusa*, number of *M. obtusa* maggots and pupae per pod and yield in different insecticidal treatments were presented in Table 1. The experimental results showed that all the insecticidal treatments proved their effectiveness in reducing the podfly damage with yield increase and were better than control.

Table 1: Studies on time of application of insecticide (dimethoate 30 EC @ 2 ml l^{-1}) for the management of podfly, *M. obtusa* on pigeonpea during *Kharif*, 2016-17

Treatment no.	Treatments	Pod damage* (%)	Grain damage* (%)	No. of maggots** per pod	No. of pupae** per pod	Yield (kg ha-1)	Yield gain over control (%)
T_1	2 weeks after 50% flowering	12.20 (20.44)^{ef}	5.60 (13.68)^{fg}	0.110 (0.330)^{d}	0.137 (0.369)^{fg}	1301^{f}	10.72
T_2	3 weeks after 50% flowering	7.00 (15.10)^{d}	4.40 (12.10)^{f}	0.060 (0.235)^{bc}	0.063 (0.251)^{cd}	1376^{ef}	17.11
T_3	4 weeks after 50% flowering	9.80 (18.24)^{e}	3.30 (10.35)^{e}	0.077 (0.269)^{cd}	0.107 (0.326)^{ef}	1412^{ef}	20.17
T_4	5 weeks after 50% flowering	14.20 (22.15)^{f}	6.50 (14.77)^{g}	0.097 (0.306)^{d}	0.160 (0.398)^{gh}	1233^{f}	4.94
T_5	2 and 3 weeks after 50% flowering	4.60 (12.39)^{bc}	2.30 (8.72)^{cd}	0.047 (0.215)^{abc}	0.043 (0.208)^{bc}	1586de	34.98
T_6	3 and 4 weeks after 50% flowering	3.90 (11.39)^{bc}	1.70 (7.44)^{bc}	0.030 (0.169)^{a}	0.037 (0.191)^{ab}	1833^{bc}	56.00
T_7	4 and 5 weeks after 50% flowering	5.40 (13.43)^{cd}	2.90 (9.81)^{de}	0.057 (0.235)^{bc}	0.077 (0.277)^{de}	1697^{cd}	44.43
T_8	2, 3 and 4 weeks after 50% flowering	2.30 (8.52)^{a}	1.40 (6.74)^{ab}	0.027 (0.155)^{a}	0.030 (0.172)^{ab}	1983^{ab}	68.77
T_9	3, 4 and 5 weeks after 50% flowering	3.00 (9.94)^{ab}	1.10 (5.77)^{a}	0.033 (0.179)^{ab}	0.020 (0.138)^{a}	2056^{ab}	74.98
T_{10}	2, 2, 3, 4 and 5 weeks after 50% flowering	2.10 (8.29)^{a}	0.90 (5.40)^{a}	0.023 (0.152)^{a}	0.020 (0.138)^{a}	2133^{a}	81.53
T_{11}	Control	19.37 (26.03)^{g}	10.10 (18.51)^{h}	0.203 (0.450)^{e}	0.207 (0.451)^{h}	1175^{f}	---
F-Test		Sig	Sig	Sig	Sig	Sig	---
SEm±		0.90	0.55	0.022	0.020	81.74	---
CD (P=0.05)		2.65	1.61	0.064	0.058	241.15	---
CV (%)		10.33	9.20	15.352	12.843	8.76	---

*Values in the parentheses are arc sine percentage transformed values, **Values in parentheses are square root transformed values
Numbers followed by same letter in each column are not significantly different, Sig. - Significant

Pod Damage (%)

All the insecticidal treatments showed significantly less pod damage over untreated control (19.37%). The pod damage recorded was only 2.10 percent in T_{10} (2, 3, 4 and 5 weeks after 50% flowering) and it was on par with T_8 (2, 3 and 4 weeks after 50% flowering) and T_9 (3, 4 and 5 weeks after 50% flowering) with 2.30 and 3.00 percent pod damage, respectively. The other promising treatments in the order of pod damage were T_6 (3 and 4 weeks after 50% flowering), T_5 (2 and 3 weeks after 50% flowering), T_7 (4 and 5 weeks after 50% flowering), T_2 (3 weeks after 50% flowering) and T_3 (4 weeks after 50% flowering) with 3.90, 4.60, 5.40, 7.00 and 9.80 percent pod damage, respectively. The treatments T_1 (2 weeks after 50% flowering) and T_4 (5 weeks after 50% flowering) recorded highest pod damage (12.20% and 14.20%, respectively) among all treatments.

Grain Damage (%)

All the insecticidal treatments showed significantly less grain damage over untreated control (10.10%). The grain damage recorded was only 0.90 percent in T_{10} (2, 3, 4 and 5 weeks after 50% flowering) and it was on par with T_9 (3, 4 and 5 weeks after 50% flowering) and T_8 (2, 3 and 4 weeks after 50% flowering) with 1.10 and 1.40 percent grain damage, respectively. The next best treatments in the order of percent grain damage were T_6 (3 and 4 weeks after 50% flowering), T_5 (2 and 3 weeks after 50% flowering), T_7 (4 and 5 weeks after 50% flowering), T_3 (4 weeks after 50% flowering) and T_2 (3 weeks after 50% flowering) with 1.70, 2.30, 2.90, 3.30 and 4.40 percent grain damage, respectively. The treatments T_1 (2 weeks after 50% flowering) and T_4 (5 weeks after 50% flowering) recorded highest grain damage (5.60% and6.50%) among all treatments.

Number of Maggots per Pod

All the treatments were significantly different from each other in reducing number of maggots per pod and superior over untreated control (0.203 maggots / pod). Among the treatments, T_{10} (2, 3, 4 and 5 weeks after 50% flowering) was found to be most effective as it recorded lowest number of maggots per pod (0.023 maggots / pod), followed by T_8 (2, 3 and 4 weeks after 50% flowering), T_6 (3 and 4 weeks after 50% flowering) and T_9 (3, 4 and 5 weeks after 50% flowering) with 0.027, 0.030 and 0.033 maggots per pod, respectively, but were on par with each other. The least significant treatments were T_1 (2 weeks after 50% flowering), T_4 (5 weeks after 50% flowering) and T_3 (4 weeks after 50% flowering) with 0.110, 0.097 and 0.077 maggots per pod, respectively.

Number of Pupae per Pod

All the treatments were significantly different from each other in reducing number of pupae per pod and superior over untreated control (0.207 pupae / pod). Among the treatments, T_{10} (2, 3, 4 and 5 weeks after 50% flowering) and T_9 (3, 4 and 5 weeks after 50% flowering) were found to be most effective as they recorded lowest number of pupae per pod (0.020 pupae / pod), followed by T_8 (2, 3 and 4 weeks after 50% flowering) and T_6 (3 and 4 weeks after 50% flowering) with 0.030 and 0.037 pupae per pod, respectively, but were on par with each other. The least significant treatments were T_4 (5 weeks after 50% flowering) and T_1 (2 weeks after 50% flowering) with 0.160 and 0.137 pupae per pod, respectively.

Yield (kg ha^{-1})

The data revealed that all the insecticidal treatments recorded significantly higher yields than the untreated control (1175 kg ha^{-1}). Among the treatments, T_{10} (2, 3, 4 and 5 weeks after 50% flowering), T_9 (3, 4 and 5 weeks after 50% flowering) and T_8 (2, 3 and 4 weeks after 50% flowering) respectively recorded highest yields of 2133, 2056 and 1983 kg ha^{-1} with an increase of 81.53, 74.98 and 68.77 percent yield over control. The treatments that were moderately better in recording higher yields were T_6 *i.e.*, 3 and 4 weeks after 50% flowering (1833 kg ha^{-1}), T_7 *i.e.*, 4 and 5 weeks after 50% flowering (1697 kg ha^{-1}) and T_5 *i.e.*, 2 and 3 weeks after 50% flowering (1586 kg ha^{-1}) with 56.00, 44.43 and 34.98 percent increase in yield over untreated control respectively. The treatments, T_3 (4 weeks after 50% flowering), T_2 (3 weeks after 50% flowering), T_1 (2 weeks after 50% flowering) and T_4 (5 weeks after 50% flowering) respectively recorded lowest yields of 1412, 1376, 1301, 1233 kg ha^{-1} with an increase of 20.17, 17.11, 10.72 and 4.94 percent yield over control.

Economics

The economics of different insecticidal schedules with dimethoate 30 EC @ 2.0 ml l^{-1} were presented in table 2. The Incremental Cost Benefit Ratio (ICBR) ranged between 2.31 to 17.77 among different insecticidal schedules. The ICBR was in the decreasing order of T_6 (3 and 4 weeks after 50% flowering), T_9 (3, 4 and 5 weeks after 50% flowering), T_8 (2, 3 and 4 weeks after 50% flowering), T_7 (4 and 5 weeks after 50% flowering), T_{10} (2, 3, 4 and 5 weeks after 50% flowering), T_3 (4 weeks after 50% flowering), T_5 (2 and 3 weeks after 50% flowering), T_2 (3 weeks after 50% flowering), T_1 (2 weeks after 50% flowering) and T_4 (5 weeks after 50% flowering) with 17.77, 15.76, 14.37, 13.89, 12.67, 12.52, 10.73, 10.47, 6.19 and 2.31, respectively. Though, highest grain yield (2133 kg ha^{-1}) was recorded in T_{10} (2, 3, 4 and 5 weeks after 50% flowering), the ICBR (17.77) was more in T_6 (3 and 4 weeks after 50% flowering). This may be due to the fact that the increase in yield was not in proportionate to the increase in plant protection cost.

The literature pertaining to the time of application of insecticide for the management of podfly in pigeonpea is scanty. Hence, the available literature is utilized during discussion. The present results were in agreement with the findings of Sreekanth *et al*. (2013) [9] who revealed that highest ICBR was recorded when crop was sprayed twice (pod initiation and 50% podding stage) with dimethoate 30 EC @ 2.0 ml l^{-1}, whereas, Revathi *et al*. (2015) [6] reported that three sprays (first at pod initiation stage, followed 2nd and 3rd at 10 days interval) of dimethoate 30 EC @ 2.0 ml l^{-1} was found to be superior based on percent pod damage and grain damage with highest grain yield and ICBR, when compared to rest of the insecticides. Das and Odak (1991) [3] and Durairaj (2000) [4] under laboratory conditions, respectively found that pod age of 13 to 25 days and 10 to 15 days was conducive for oviposition, where maximum eggs were laid.

Thus, it can be concluded that dimethoate 30 EC @ 2 ml l^{-1} applied twice at 3 and 4 weeks after 50% flowering was most promising and can be recommended, as it registered more ICBR.

Table 2: Economics of insecticidal schedule with dimethoate 30 EC@ 2 ml l^{-1} in the management of podfly, *M. obtusa* on pigeonpea during *Kharif*, 2016-17

Treatment no.	Treatments	Yield (kg ha-1)	Additional yield over control (kg ha-1)	Value of additional yield per ha (Rs.) [A]	*Plant protection cost per ha (Rs.) [B]	Net profit (Rs.) [A-B]	ICBR (A-B) / B
T_1	2 weeks after 50% flowering	1301	126	6363	885	5478	6.19
T_2	3 weeks after 50% flowering	1376	201	10151	885	9266	10.47
T_3	4 weeks after 50% flowering	1412	237	11969	885	11084	12.52
T_4	5 weeks after 50% flowering	1233	58	2929	885	2044	2.31
T_5	2 and 3 weeks after 50% flowering	1586	411	20756	1770	18986	10.73
T_6	3 and 4 weeks after 50% flowering	1833	658	33229	1770	31459	17.77
T_7	4 and 5 weeks after 50% flowering	1697	522	26361	1770	24591	13.89
T_8	2, 3 and 4 weeks after 50% flowering	1983	808	40804	2655	38149	14.37
T_9	3, 4 and 5 weeks after 50% flowering	2056	881	44491	2655	41836	15.76
T_{10}	2, 2, 3, 4 and 5 weeks after 50% flowering	2133	958	48379	3540	44839	12.67
T_{11}	Control	1175	---	---	---	---	---

Cost of redgram seed – Rs. 50.50/- per kg, *Plant protection cost includes both chemical and spray boy charges
Cost of the chemical: Rs. 385/- per L, Spray boy charges: Rs. 500/- per ha.

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