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Field efficacy of bio-inputs and insecticides against melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) in bitter gourd (*Momordica charantia* L.)

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ABSTRACT: Field efficacy of different bio-inputs and insecticides against melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) in bitter gourd was carried out in farmer's field. The effect of different bio-inputs (ITK concoction) and insecticides were superior over control in reducing the fruit fly damage and increasing yield. The application of spinosad 45 SC and chlorantraniliprole 18.5 SC gave maximum fruit yield (12,200 and 14,540 kg/ha) and (11,780 and 13,950 kg/ha) followed by agniastram (10,950 and 13,600 kg/ha), karpurakaraisal (10,570 and 13,095 kg/ha) in *Kharif* and *Rabi*, respectively. The minimum fruit yield was recorded in ten leaf extract (9560 and 11,110 kg/ha) during *Kharif* and *Rabi.* The benefit cost ratio was maximum in spinosad 45 SC (1:2.33 and 1:2.81) and chlorantraniliprole 18.5 SC (1:2.18 and 1:2.61) followed by agniastram (1:2.14 and 1:2.56), karpurakaraisal (1:2.20 and 1: 2.40) in *Kharif* and *Rabi*.

KEY WORDS: ITK concoction, insecticides, melon fruit fly, management

INTRODUCTION

Bitter gourd (*Mormodica charantia* L.) is the most important vegetable among the cucurbitaceous crops which occupies a predominant place in Indian vegetables. The tender fruit is found to have medicinal and nutritional properties *viz.,* reducing blood glucose level, asthma and ulcer (Oishi *et al*., 2007) as it contains a steroidal compound saponins (charantin) and insulin like peptide (Altinterim, 2012). Bitter gourd is being cultivated in an area of 95.00 lakh ha, with 1087 MT/ha production and 10.87 MT/ha of productivity in India (Anon, 2018). Bitter gourd is attacked by various pests *viz.* aphids, melon fruit flies, hadda beetle, pumpkin caterpillar and gall fly during different growth stages. Among the pests of bitter gourd, melon fruit fly *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) is important as it causes yield loss of 30 to 100 per cent (Dhillon *et al*., 2005).

To meet this yield reduction, fruit fly management has to be taken in various methods. Mostly using insecticides such as spinosad 45 SC (4.67 eggs and 80.28 %) and chlorantraniliprole 18.5 SC (6.33 eggs and 73.23 %) had minimum number of eggs laid and high oviposition deterrence of melon fruit fly, respectively (Mawtham *et al*., 2019). However,

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Synthetic insecticides were found to be carcinogenic, teratogenicity to humans and pollutes the environment by upsetting the balance of nature (Jenkins *et al*., 2013) and involves huge insecticide cost (25%) (Nasiruddin *et al*., 2004). Therefore, desirable alternative methods of pest control using botanicals and traditional pest management practices has to be exploited (El-Wakeil, 2013). Botanical extracts from neem (*Azadiracta indica*), lantana (*Lantana camara*), garlic (*Allium sativam*), turmeric (*Curcuma longa*), acacia (*Acacia auriculiformis*) (Ignacimuthu, 2004: Thakur and Gupta, 2012) and bio-inputs like, cow urine, meenamilam, neem oil, ginger-garlic extracts, ten leaf extract, tobacco leaf extract, agniastram and neemastram (Priya *et al*., 2018) acted as oviposition deterrent, repellent and antifeedant against melon fruit fly (Singh and Singh, 1998). Karpurakaraisal with main compound of camphor has one of the monoterpenes; hence it is effective against pupation, adult emergence, deformation, oviposition, adult longevity and ovarian development of fruit fly (El-Minshawy *et al*., 2018). Efficacy of bio-inputs in comparison to insecticides for the management of fruit fly in bitter gourd was investigated and the results are presented.

MATERIALS AND METHODS

Two field experiments were conducted during *Kharif* and *Rabi* season, 2018-19 at Elamanam village, Tiruchirappalli district, Tamil Nadu, India under Randomised Block Design (RBD) with eight treatments and replicated thrice. The bitter gourd East west hybrid (F_1) seeds were raised in a plot size of 6m × 4m with spacing of 60cm × 200 cm. All the recommended packages of practices were followed according to TNAU crop production guide except plant protection measures. The treatments imposed for the study comprised of five bio-inputs and two insecticides *viz.,* 5% karpurakaraisal (camphor), 5% tobacco mixture (agniastram), 0.5% fish acid (mennamilam), 5% ten leaf extract (pathilaikasayam), 5% NSKE, 0.12 ml/l spinosad 45 SC and 0.4 ml/l chlorantraniliprole 18.5 SC. The melon fruit fly infestation was recorded in each plot on five randomly selected labelled plants for each observation. The foliar spray was given after 30 per cent incidence of fruit fly damage in each plot. Second spray was given after 15 days by using high volume hand operated compression knapsack sprayer. Totally two rounds of spray in *Kharif* and three rounds in *Rabi* of each treatment were given and the fruits were harvested thrice after each spraying. Observation on pre and post treatment counts was made on 1st, 5th, 10th and 15th day after each application. Mean damage percent was calculated using the formula given by Shivangi *et al*. (2017).

$$\text{Fruit damage (\%)} = \frac{\text{No of infested fruits}}{\text{Total no of harvested fruits}} \times 100$$

$$\text{Fruit Infestation over control (\%)} = \frac{\text{Yield in the treatment to be assessed} - \text{Yield in the untreated check}}{\text{Yield in untreated check}} \times 100$$

The benefit cost ratio was calculated by using the formula

$$\text{Benefit/Cost ratio} = \frac{\text{Gross returns (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

Preparation of bio-inputs

Meenamilam (Fish acid): The fish waste and jaggery were taken at the rate of one kg each and mixed well and kept in a plastic bucket. The content was stirred once in five days upto one month and then kept undisturbed for fermentation upto 40 days. After 45 days, the content was filtered using muslin cloth and kept in an airtight container for future use.

Agniastram (Tobacco extract): It is similar to the ZBNF (Zero Budget Natural Farming) agniastram, but without added to cow dung. The main constituents for 'agniastram' were green chilli, ginger, garlic and dry leaves of tobacco. 500g chilli, ginger and garlic were crushed and then 250 g of dry tobacco leaves were mixed in 10 l of country cow urine and boiled in a mud pot till one third of the total volume of the extract was obtained. The extract was kept for 24 h and then filtered and stored in an air tight plastic container under room temperature for future use.

Pathilaikasayam (Ten leaf extract): The ten leaf extract includes the leaves of Notchi (*Vitex negundo* L.), Aristolochia (*Aristolochia indica*

L.), Papaya (*Carica papaya* L.), Heartleaf moonseed (*Tinospora cordifolia* M.) and custard apple (*Annona squamosa* L.) as basic five ingredients in addition to leaves from other five plants *viz.,* Neem (*Azadirachta indica* A. juss), calotropis (*Calotropis gigantea* L.), waste land weed (*Tephrosia purpurea* L.), physic nut (*Jatropha curcas* L.), pungam (*Millettia pinnata* L.). The leaves from notchi, aristolochia, papaya, heartleaf moonseed and custard apple each of 5 kg and neem, calotropis, waste land weed, physic nut, pungam leaves each of 2 kg were taken in 200 l of water, 5 l of country cow urine and 3 kg of cow dung and stored in an airtight plastic container for three months and allowed to ferment. The plastic container was kept in a cool shaded place and stirred three times a day for efficient mixing and uniform fermentation.

NSKE (Neem seed kernel extract): The neem seed kernel (4 kg) was ground gently into powder using a blender. One kg of powdered neem seed kernel was tied in a filter cloth and soaked in one litre of water overnight. Then the extract was filtered twice or thrice and finally prepared 5 per cent of NSKE for used field experiments studies.

Karpurakaraisal (camphor mixture): The camphor mixture was prepared by mixing one litre of neem oil with 50 ml of country fresh cow urine and 5 g of camphor (pachaikarpuram), stirred gently and kept in closed containers. Prepared mixture (5%) was used for field and laboratory experiments. Since, camphor is insoluble in water, alcohol was used to dissolve the camphor and mixed with neem oil.

The collected data was statistically analysed in a Randomized Block Design of field experiments through AGRES programme. The treatment mean values were compared by Latin Square Design (LSD).

RESULTS AND DISCUSSION

Field efficacy of bio-inputs and insecticides (*Kharif* and *Rabi*, 2018-19)

After first spray, all the treatments were significantly superior to untreated control. The pre count fruit damage ranged from 37.30 to 39.01 per cent. Among the treatments, spinosad 45 SC (14.83 and 17.44 %) and chlorantraniliprole 18.5 SC (19.43 and 20.21 %) showed minimum fruit damage in *Kharif* and *Rabi*, respectively followed by agniastram (28.48 and 25.83 %). The fruit fly damage recorded maximum in ten leaf extract was 45.65 and 42.74 %. Spinosad 45 SC (73.28 and 64.94 %) and chlorantraniliprole 18.5 SC (64.99 and 59.38 %) reduced the fruit damage in *Kharif* and *Rabi,* followed by agniastram (48.69 and 48.08 %), karpurakaraisal (41.75 and 39.25 %), NSKE (34.97 and 34.71 %), fish acid (26.03 and 25.51) and ten leaf extract (17.76 and 14.09 %). Waseem *et al*. (2009) who results concordance with spinosad 45 SC (54.00 ml/I) had minimum percentage of melon fruit fly damage (6.0 %) on foliar applications in cucumber (Table 1 and 2).

Comparative analysis of bio-inputs and insecticides (*Kharif* and *Rabi*, 2018-19)

In melon fruit fly management, spinosad 45 SC and chlorantraniliprole 18.5 SC recorded minimum fruit damage (14.83, 17.44 and 19.43, 20.21 %) in *Kharif* (2018) and *Rabi* (2019), respectively. Shivangi and Swami (2017) reported similar findings that repeated application of spinosad 45 SC had significant reduction in fruit oviposition mark (1.5/five plants) and 49.02 per cent avoidable losses of cucumber against melon fruit fly. Among the bio-inputs, agniastram (25.83 %) > karpurakaraisal (30.22 %) > NSKE (32.48 %) > fish acid (37.00 %) > ten leaf extract (42.74 %) were most effective in the order of fruit damage. According to El-Minshawy *et al*. (2018) results showed camphor was completely inhibited egg deposition (0.00 No.) and female longevity (40.33 days) compared with 68.33 days in control treatment ($P < 0.05$). In addition, significantly decreased pupation and adult emergence percentages at 20 mg/kg of camphor for pupae ($P < 0.05$). Therefore, karpurakaraisal were more effective against management of fruit flies than other formulations.

In *Kharif* and *Rabi*, spinosad 45 SC and chlorantraniliprole 18.5 SC treatment gave maximum fruit yield (12,200 and 14,540 kg/ha) and (11,780 and 13,950 kg/ha) followed by agniastram

Table 1. Field efficacy of bio-inputs and insecticides against melon fruit fly in bitter gourd (*Kharif*, 2018)

Treatments	Dose (ml/l)	Fruit damage 15 DAS (%)			Fruit damage (%)*	Reduction over control (%)
		Pre count (%)	Ist spray	IInd spray		
T_1- Karpura karaisal (Camphor mixture)	30.0	39.01 (38.65)	34.07 (35.71)^{c}	30.59 (33.58)^{bc}	32.33 (34.64)	41.75
T_2- NSKE (Neem Seed Kernel Extract)	50.0	35.71 (36.70)	37.40 (37.70)^{d}	34.81 (36.16)^{cd}	36.10 (36.93)	34.97
T_3- Ten leaf extract (Pathilaikasayam)	50.0	39.01 (38.65)	46.49 (42.99)^{e}	44.82 (42.03)^{e}	45.65 (42.51)	17.76
T_4- Fish acid (Meenamilam)	5.0	37.30 (37.64)	42.27 (40.55)^{d}	39.86 (39.15)^{d}	41.06 (39.85)	26.03
T_5- Agniastram (Tobacco mixture)	50.0	39.01 (38.65)	31.24 (33.98)^{b}	25.73 (30.48)^{b}	28.48 (32.23)	48.69
T_6- Spinosad 45 SC	0.12	37.30 (37.64)	15.67 (23.32)^{a}	14.00 (21.97)^{a}	14.83 (22.64)	73.28
T_7- Chlorantraniliprole 18.5 SC	0.4	38.06 (38.09)	21.07 (27.32)^{a}	17.79 (24.95)^{a}	19.43 (26.13)	64.99
T_8- Untreated control		37.30 (37.64)	57.37 (49.24)^{f}	53.66 (47.10)^{f}	55.51 (48.17)	
SEd			1.09	1.66		
CD (p=0.05)			2.35	3.55		

*Mean of three replications, DAS-Days after spray. Figures in parentheses are arc sine transformed values.
In a column, means followed by different letters are significantly different (p=0.05) as per LSD

Table 2. Field efficacy of bio-inputs and insecticides against melon fruit fly in bitter gourd (*Rabi*, 2019)

Treatments	Dose (ml/l)	Fruit damage 15 DAS (%)				Fruit damage (%)*	Reduction over control (%)
		Pre count (%)	Ist spray	IInd spray	IIIrd spray		
T_1- Karpura karaisal (Camphor mixture)	30.0	34.07 (35.71)	34.25 (35.82)^{d}	29.51 (32.91)^{d}	26.90 (31.24)^{d}	30.22 (33.32)	39.25
T_2- NSKE (Neem Seed Kernel Extract)	50.0	33.33 (35.26)	36.86 (37.38)^{e}	32.27 (34.61)^{e}	28.33 (32.16)^{d}	32.48 (34.71)	34.71
T_3- Ten leaf extract (Pathilaikasayam)	50.0	34.25 (35.82)	46.42 (42.95)^{g}	41.95 (40.37)^{g}	39.85 (39.14)^{f}	42.74 (40.82)	14.09
T_4- Fish acid (Meenamilam)	5.0	32.54 (34.78)	40.71 (39.64)^{f}	36.87 (37.39)^{f}	33.61 (35.43)^{e}	37.06 (37.48)	25.51
T_5- Agniastram (Tobacco mixture)	50.0	34.25 (35.82)	28.56 (32.30)^{c}	25.41 (30.27)^{c}	23.53 (29.01)^{c}	25.83 (32.23)	48.08
T_6- Spinosad 45 SC	0.12	30.16 (33.31)	19.28 (26.05)^{a}	16.94 (24.30)^{a}	16.11 (23.65)^{a}	17.44 (24.67)	64.94
T_7- Chlorantraniliprole 18.5 SC	0.4	31.23 (33.98)	21.94 (27.93)^{b}	19.52 (26.22)^{b}	19.17 (25.95)^{b}	20.21 (26.70)	59.38
T_8- Untreated control		32.54 (34.78)	52.61 (46.50)^{g}	48.76 (44.29)^{h}	47.88 (43.79)^{g}	49.75 (44.86)	
SEd			0.63	0.73	0.90		
CD (p=0.05)			1.36	1.55	1.93		

*Mean of three replication. DAS-Days after spray. Figures in parentheses are arc sine transformed values
In a column, means followed by different letters are significantly different (p=0.05) as per LSD

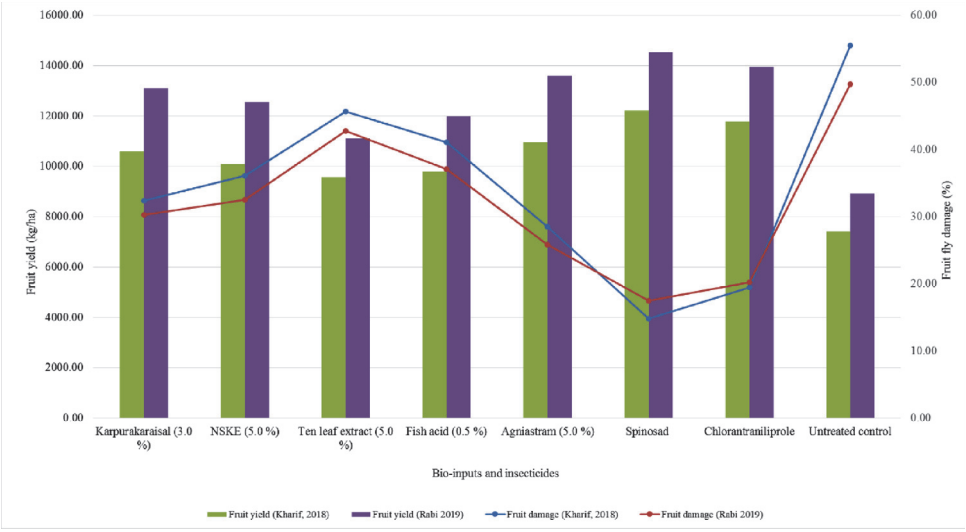

Fig. 1. Comparative analysis on the effect of bio-inputs and insecticides on melon fruit fly damage and fruit yield

(10,950 and 13,600 kg/ha), karpurakaraisal (10,570 and 13,095 kg/ha), NSKE (10,080 and 12,570 kg/ha) and fish acid (9,790 and 11,990 kg/ha) (Table 3, 4 and Fig 1). The minimum fruit yield and per cent increase in yield were recorded in ten leaf extract (9560 and 11,110 kg/ha). Abhilash (2018) reported that azadirachtin (1%) with maximum yield (91.85 q/ha) followed by 5% NSKE (84.82 q/ha), 5 % *A. calamus* (61.91 q/ha) and untreated control (39.92 q/ha) in ridge gourd. Shivangi and Swami (2017) reported similarly that repeated application of spinosad 45 SC had significantly higher fruit yield (555.56 q/ha) followed by NSKE (402.78 q/ha) and untreated control (241.26 q/ha) in cucumber.

The bio-inputs *viz.,* agniastram, fish acid and ten leaf extracts consisted of gram-positive bacteria, *Bacillus subtilis* and *Bacillus vallismortis* and absence of fungus and actinomycetes (Priya *et al*., 2018) and produce biomolecules such as kanosamines and lipopeptides are effective against insect pests (Mazid *et al*., 2011). Vivekanandan (1994) reported various indigenous plant products for traditional pest management practices. Spraying

Table 3. Comparative efficacy of bio-inputs and insecticides in enhancing fruit yield of bitter gourd (*Kharif*, 2018)

S. No.	Treatment	Dose (ml/l)	Cumulative yield (kg / ha)	Yield Increase (%)	Gross return (Rs.)	Net return (Rs.)	Cost-Benefit ratio
1	Karpura karaisal (Camphor mixture)	30.0	10570	42.45	243110	162795	1 : 2.02
2	NSKE (Neem Seed Kernel Extract)	50.0	10080	35.85	231840	150940	1 : 1.86
3	Ten leaf extract (Pathilaikasayam)	50.0	9560	28.84	219880	139230	1 : 1.72
4	Fish acid (Meenamilam)	5.0	9790	31.94	225170	144770	1 : 1.80
5	Agniastram (Tobacco mixture)	50.0	10950	47.57	251850	171550	1 : 2.14
6	Spinosad 45 SC	0.12	12200	64.42	280600	196350	1 : 2.33
7	Chlorantraniliprole 18.5 SC	0.4	11780	58.76	270940	185740	1: 2.18
8	Untreated control		7420		170660	92330	1 : 1.28

Table 4. Comparative efficacy of bio-inputs and insecticides in enhancing fruit yield of bitter gourd (*Rabi*, 2019)

S. No.	Treatment	Dose (ml/l)	Cumulative yield (kg / ha)	Yield Increase (%)	Gross return (Rs.)	Net return (Rs.)	Cost-Benefit ratio
1	Karpura karaisal (Camphor mixture)	30.0	13095	46.80	327575	231260	1 : 2.40
2	NSKE (Neem Seed Kernel Extract)	50.0	12570	40.91	314250	219125	1 : 2.30
3	Ten leaf extract (Pathilaikasayam)	50.0	11110	24.55	277750	182850	1 : 1.92
4	Fish acid (Meenamilam)	5.0	11990	34.42	299750	202850	1 : 2.09
5	Agniastram (Tobacco mixture)	50.0	13600	49.66	340000	237485	1 : 2.56
6	Spinosad 45 SC	0.12	14540	63.06	363500	266685	1 : 2.81
7	Chlorantraniliprole 18.5 SC	0.4	13950	56.39	348750	250530	1 : 2.61
8	Untreated control		8920		223000	131550	1 : 1.44

insecticides recorded lower fruit damage and higher marketable yield. Similarly, bio-inputs *viz.,* agniastram (tobacco mixture) reduced the fruit damage and increased the marketable yield followed by karpurakaraisal (camphor mixture), NSKE, fish acid (Mennamilam) and ten leaf extract.

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