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EVALUATION OF ECOFRIENDLY IPM MODULES AGAINST KEY INSECT PESTS IN BITTER GOURD

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ABSTRACT

Field experiment was conducted at Malayalthanpatti Village, Madurai District, Tamil Nadu during March to June 2018 to evaluate three IPM modules viz., Farmer's practice (M1), Recommended practice (TNAU)(M2), IPM suggested module (M3) for the management of key insect pests of bitter gourd viz., aphid, whitefly, leaf eating caterpillar, fruit fly, hadda beetle and pumpkin beetle. The suggested Module (M3) comprising basal application of neem cake @ 250 kg/ ha, foliar application of NSKE 5% at 20 DAP, installations of Barrix trap (25 traps/ ha) @ 30 DAP, foliar spray of Bt @ 2g/ l of water @ 40 DAP, foliar spray of chlorantraniliprole 150ml/ha at 60 DAP had recorded minimum population of aphids (2.08/ 3 leaves), whitefly (2.29/ 3 leaves), leaf eating caterpillar (0.65/ plant), hadda beetle (0.82/ plant) and pumpkin beetle (0.73/ plant). Fruit fly infestation was also minimum (6.80%) in the suggested module (M3) giving maximum yield (28.89 t/ha)

Key words: Bitter gourd, fruit fly, hadda and pumpkin beetle, aphid, whitefly, leaf eating caterpillar, IPM modules, Barrix trap, chlorantraniliprole,

Bitter gourd (*Momordica charantia* L) (Cucurbitaceae), is one of the important cucurbitaceous vegetables grown in India. Among the cucurbits, it is considered as high nutritive vegetable. Several insect pests infests bitter gourd during different growth stages, which include melon fruit fly, *Bactrocera cucurbitae* (Coquillett), hadda beetle, *Henosepilachna vigintioctopunctata* (F.), pumpkin caterpillar, *Diaphania indica* (Sounders), and pumpkin beetle, *Aulacophora foveicollis* (Lucas), The fruit fly alone can inflict yield loss ranging from 30-100% (Dhillon et al., 2005; Shooker et al., 2006). In case of severe infestation, the grub and adults cause 45-75% defoliation to this crop (Shukla and Upadhyay, 1987). Among different species of pumpkin beetles, incidence of adult stage of red pumpkin beetle (RPB), *A. foveicollis* on different cucurbits had been reported (Nath, 1964; Nath and Thakur, 1964; Bogawat and Pandey, 1967). Bitter gourd being a readily consumable produce, use of synthetic pesticides leaves toxic residues. For these limitations, the logical alternative is the ecofriendly IPM). Hence this field experiment to evaluate the efficacy of different IPM modules against key insect pests in bitter gourd.

MATERIALS AND METHODS

Field experiment was conducted at Malayalthanpatti, Madurai District, Tamil Nadu during March to June 2018 to evaluate three different modules *viz.,* Farmer's practice (M1), Recommended practice (TNAU)(M2), IPM suggested module (M3) in comparison with untreated check (control), for the management of key insect pests of bitter gourd. Each module was replicated five times in 0.20 ac. The plant protection measures were carried out in different IPM modules are as detailed below:

Module- I. Farmer's practice**:** Two foliar sprays with Imidacloprid 17.8 SL @ 0.5ml/l of water at 20 days after sowing (DAP) @10 days interval. Foliar spray of dimethoate 30 EC @ 2 ml/ l of water at 45 DAP and 60 DAP

Module- II. TNAU module**:** Collection and destruction of affected fruits. Exposing the pupae by ploughing. Setting up fish meal trap with 5g of wet fish meal and 1ml of dichlorvos in cotton swab @ 50/ ha. Foliar spray of malathion 50 EC @ 500 ml /ha on 30 DAP and 60 DAP

Module- III. IPM (Suggested Module)**:** Basal application of neem cake @ 250 kg/ha. Foliar application of NSKE 5% at 20 DAP. Installations of Barrix trap (25 traps/ ha) @30 DAP. Foliar spray of *B.t* @ 2g/l of water @ 40 DAP. Foliar spray of chlorantraniliprole 150 ml/ ha at 60 DAP

Module- IV. Control (Water spray)

In each module ten plants were selected at random. populations of pumpkin beetle, leaf eating caterpillar, epilachna beetle, aphids, and whitefly were recorded at an interval of 15 days. Observations on the damage by fruit fly were recorded on ten randomly selected plants from each plot at once in 15 days. At harvest bitter gourd yield/ plot was recorded module wise and converted to t/ ha. The incremental cost benefit ratio was worked out to assess the economic viability of various modules. The data on field population of insects were subjected to square root transformations while % damage were transformed into arcsine values and analyzed statistically. The treatment mean values were compared by Duncan's Multiple Range Test (DMRT, p=0.05).

RESULTS AND DISCUSSION

The results revealed that the suggested module (M3) found to be superior over other two modules. In Suggested module, the% reduction of aphid population was 82.92% with a mean population of 2.08/ 3 leaves, as against control (12.18/ 3 leaves). The nymphal and adult population of *B.tabaci* differed significantly due to different modules practiced in the field experiment. The results in the table depict that among different modules, the module (M3) was most effective in reducing the whitefly population over control (82.87%). This was found to be superior over the other two modules like recommended practice (M2) and farmer's practice (M1) which gave population reduction of (59.61%) and (52.95%) over the control (Table 1).

With regard to *D.indica,* the suggested module (M3) has recorded the lowest larval population (0.65/plant) as compared to control (4.15/ plant) which resulted in 84.33% reduction in larval population. This was followed by recommended module (M2) and farmer's practice (M1) which resulted in 65.78 and 52.77% reduction in larval population over control, respectively. The population of *A. foveicollis* differed significantly due to different modules. The results revealed that suggested module (M3) recorded the highest population reduction of 82.06 over the control. This was followed by the recommended practice (M2) and farmer's practice (M1) which gave 60.68 and 51.35% reduction over control (Table 2).

Among three different modules, suggested module (M3) was found to be effective against control than other two modules with the reduction of 82.84% over control as compared to Farmer' practice (M1) and recommended practice (M2) which gave 44.76 and 57.11% reduction of beetle population over control. The results on the effectiveness of various modules are presented in table. Among modules the suggested module (M3) has recorded the lowest damage (6.80), which resulted in 82.86% reduction in fruit damage over control. The next in the order was recommended module (M2) (15.79) and farmer's practice (M1) (21.67%) (Table 3).

The data on the yield and economics of various modules are presented in (Table 4). The suggested IPM module comprising of basal application of neem cake @ 100 kg/acre, foliar application of NSKE 5% at 20 DAP, Barrix trap (25 traps/ ha) @ 30 DAP, foliar spray of *B.t* @ 2g/ l of water @ 40 DAP, foliar spray of Chlorantraniliprole 150ml/ ha at 60 DAP, recorded the highest mean yield (28.89 t/ ha) followed by recommended practice (M2) 24.62 t/ ha. Based on the incremental cost benefit ratio, the various modules were ranked. Among modules, suggested IPM module registered the highest mean benefit cost ratio of 4.71 as compared to 2.37 in farmer's practice (M1). While considering both effectiveness and economics, the suggested module- M3 stood first indicating its superiority over other modules.

The present finding is in accordance with the earlier reports of the following workers. The neem oil cakes are invariably used as soil amendments and further they play a multirole as organic fertilizer, antifeedant, sterility inducer, wormicide and insecticide. Reddy and Reddy (2000) also observed that fields incorporated with neem cake were free from the rhizome fly of turmeric. Rao et al. (2001) reported the efficiency of neem cake in reducing the incidence of groundnut leafminer, *Aproaerema modicella* while Rao (2002) observed the low incidence of groundnut sucking pests i.e. jassid, *Empoasca kerri* and aphid, *Aphis craccivora* in neem cake treated plots than straight fertilized treatments.

Ranganath et al. (1997) who reported that neem oil, NSKE were the most effective treatment against fruit fly. They reported that NSKE treatment showed 85.62% reduction in fruitfly infestation over control. Chlorantraniliprole 18.5 SC @ 150 ml/ha recorded higher reduction of fruit infestation which was corroborated by (Teixeira et al., 2009). (Kodandaram et al., 2014), who have reported that chlorantranilirpole 18.5 SC gave the best results which exhibited with lowest egg hatching of hadda beetle. Based on the

Table 1. Insect pests in bitter gourd as influenced by various IPM Modules

Module	Number of aphids / 3 leaves*							Number of whiteflies/ 3 leaves*						
	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)
Module 1- Foliar spray of Imidacloprid 17.8 SL @ 0.5ml per litre of water at 20 days after sowing (DAP) and Dimethoate 30 EC @ 2 ml per litre of water at 45 DAP and 60 DAP	11.25 (3.35)^{c}	8.42 (2.90)^{c}	6.34 (2.52)^{c}	3.42 (1.85)^{c}	2.00 (1.41)^{c}	6.28 (2.56)^{c}	48.44	13.26 (3.64)^{d}	8.74 (2.96)^{c}	5.29 (2.30)^{c}	2.23 (1.49)^{c}	1.94 (1.39)^{c}	6.29 (2.51)^{c}	52.95
Module 2- Collection and destruction of affected fruits, Exposing the pupae by ploughing, fish meal trap with 5g of wet fish meal and 1ml of dichlorovos in cotton swab @ 50 nos./ha, Foliar spray of malathion 50 EC @ 500 ml /ha on 30 DAP and 60 DAP	11.63 (3.41)^{b}	6.13 (2.48)^{b}	4.29 (2.07)^{b}	1.73 (1.32)^{b}	1.06 (1.03)^{b}	4.97 (2.23)^{b}	59.19	12.28 (3.50)^{b}	7.26 (2.69)^{b}	4.37 (2.09)^{b}	2.00 (1.41)^{b}	1.07 (1.03)^{b}	5.40 (2.32)^{b}	59.61
Module 3 - Basal application of neem cake @ 100 kg/acre, Foliar application of NSKE 5% at 20 DAP, Barrix trap (25 traps/ha) @ 30 DAP, Foliar spray of *B.t* @ 2g/ litre of water @ 40 DAP, Foliar spray of Chlorantraniliprole 150ml/ha at 60 DAP	6.42 (2.53)^{a}	1.96 (1.40)^{a}	1.00 (1.00)^{a}	0.76 (0.87)^{a}	0.25 (0.50)^{a}	2.08 (1.44)^{a}	82.92	6.76 (2.60)^{a}	2.34 (1.53)^{a}	1.28 (1.13)^{a}	0.79 (0.89)^{a}	0.28 (0.53)^{a}	2.29 (1.51)^{a}	82.87
Control	12.63 (3.55)^{d}	11.58 (3.40)^{d}	11.94 (3.46)^{d}	12.26 (3.50)^{d}	12.52 (3.54)^{d}	12.18 (3.45)^{d}		12.74 (3.57)^{c}	12.97 (3.60)^{d}	13.36 (3.66)^{d}	13.64 (3.69)^{d}	14.12 (3.76)^{d}	13.37 (3.66)^{d}	
	0.016	0.010	0.012	0.008	0.004	0.013		0.020	0.014	0.013	0.005	0.008	0.008	
	0.035	0.023	0.026	0.018	0.009	0.030		0.045	0.031	0.028	0.012	0.017	0.018	

PTC=Pre Treatment Count, DAS= Day(s) after spraying, NS – Non significant; *Each value mean of three replications, Figures in parentheses square root transformed values ,In a column, means followed by same letter(s) not significantly different by LSD (p= 0.05)

Table 2. Insect pests in bitter gourd as influenced by various IPM Modules

Module	Number of *D.indica* larvae/ plant*							Number of *A. foveicollis* adults / plant*						
	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)
Module 1- Foliar spray of Imidacloprid 17.8 SL @ 0.5ml per litre of water at 20 days after sowing (DAP) and Dimethoate 30 EC @ 2 ml per litre of water at 45 DAP and 60 DAP	3.59 (1.89)^{c}	2.68 (1.64)^{c}	1.54 (1.24)^{c}	1.23 (1.11)^{c}	0.75 (0.87)^{c}	1.96 (1.40)^{c}	52.77	3.15 (1.77)^{c}	2.68 (1.64)^{c}	1.89 (1.37)^{c}	1.26 (1.12)^{c}	0.94 (0.97)^{c}	1.98 (1.41)^{c}	51.35
Module 2- Collection and destruction of affected fruits, Exposing the pupae by ploughing, fish meal trap with 5g of wet fish meal and 1ml of dichlorovos in cotton swab @ 50 nos./ha, Foliar spray of malathion 50 EC @ 500 ml /ha on 30 DAP and 60 DAP	2.83 (1.68)^{b}	1.62 (1.27)^{b}	1.25 (1.12)^{b}	0.86 (0.93)^{b}	0.52 (0.72)^{b}	1.42 (1.19)^{b}	65.78	2.57 (1.60)^{b}	2.01 (1.42)^{b}	1.54 (1.24)^{b}	1.00 (1.00)^{b}	0.86 (0.93)^{b}	1.60 (1.26)^{b}	60.68
Module 3 - Basal application of neem cake @ 100 kg/acre, Foliar application of NSKE 5% at 20 DAP, Barrix trap (25 traps/ha) @ 30 DAP, Foliar spray of *B.t* @ 2g/ litre of water @ 40 DAP, Foliar spray of Chlorantraniliprole 150ml/ha at 60 DAP	1.26 (1.12)^{a}	0.85 (0.92)^{a}	0.72 (0.85)^{a}	0.28 (0.53)^{a}	0.12 (0.35)^{a}	0.65 (0.80)^{a}	84.33	1.29 (1.14)^{a}	0.96 (0.98)^{a}	0.72 (0.85)^{a}	0.45 (0.67)^{a}	0.21 (0.46)^{a}	0.73 (0.85)^{a}	82.06
Control	3.94 (1.98)^{d}	4.05 (2.01)^{d}	4.18 (2.04)^{d}	4.23 (2.06)^{d}	4.36 (2.09)^{d}	4.15 (2.04)^{d}		3.69 (1.92)^{d}	3.88 (1.97)^{d}	4.09 (2.02)^{d}	4.26 (2.06)^{d}	4.45 (2.11)^{d}	4.07 (2.02)^{d}	
	0.010	0.006	0.004	0.003	0.003	0.008		0.007	0.003	0.006	0.005	0.003	0.009	
	0.022	0.013	0.010	0.007	0.007	0.018		0.015	0.006	0.013	0.011	0.006	0.020	

PTC=Pre Treatment Count, DAS= Day(s) after spraying, NS- Non significant; *Each value mean of three replications, Figures in parentheses square root transformed values ,In a column, means followed by same letter(s) not significantly different by LSD (p= 0.05)

Table 3. Insect pests in bitter gourd as influenced by various IPM Modules

Module	Number of *H. vigintioctopunctata* adults /plant*							Mean% infestation of fruits due to *B. cucurbitae* (%)						
	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)	30 DAS	45DAS	60 DAS	75 DAS	90 DAS	Mean	Reduction over control (%)
Module 1- Foliar spray of Imidacloprid 17.8 SL @ 0.5ml per litre of water at 20 days after sowing (DAP) and Dimethoate 30 EC @ 2 ml per litre of water at 45 DAP and 60 DAP	4.00 (2.00)^{c}	3.52 (1.88)^{c}	2.63 (1.62)^{c}	1.84 (1.36)^{c}	1.23 (1.11)^{c}	2.64 (1.63)^{c}	44.76	31.29 (34.01)^{c}	27.25 (31.47)^{c}	22.83 (28.54)^{c}	16.67 (24.10)^{c}	10.33 (18.75)^{c}	21.67 (27.75)^{c}	45.40
Module 2- Collection and destruction of affected fruits, Exposing the pupae by ploughing, fish meal trap with 5g of wet fish meal and 1ml of dichlorovos in cotton swab @ 50 nos./ha, Foliar spray of malathion 50 EC @ 500 ml /ha on 30 DAP and 60 DAP	3.86 (1.96)^{b}	2.53 (1.59)^{b}	2.00 (1.41)^{b}	1.26 (1.12)^{b}	0.62 (0.79)^{b}	2.05 (1.43)^{b}	57.11	25.64 (30.42)^{b}	20.37 (26.83)^{b}	15.85 (23.46)^{b}	10.35 (18.77)^{b}	6.75 (15.06)^{b}	15.79 (23.42)^{b}	60.21
Module 3 - Basal application of neem cake @ 100 kg/acre, Foliar application of NSKE 5% at 20 DAP, Barrix trap (25 traps/ha) @ 30 DAP, Foliar spray of *B.t* @ 2g/litre of water @ 40 DAP, Foliar spray of Chlorantraniliprole 150ml/ha at 60 DAP	1.75 (1.32)^{a}	1.00 (1.00)^{a}	0.64 (0.80)^{a}	0.42 (0.65)^{a}	0.28 (0.53)^{a}	0.82 (0.90)^{a}	82.84	16.26 (23.78)^{a}	9.35 (17.80)^{a}	4.12 (11.71)^{a}	2.62 (9.32)^{a}	1.67 (7.43)^{a}	6.80 (15.12)^{a}	82.86
Control	4.28 (2.07)^{d}	4.65 (2.16)^{d}	4.82 (2.20)^{d}	4.96 (2.23)^{d}	5.18 (2.28)^{d}	4.78 (2.19) d		35.86 (36.79)^{d}	37.53 (37.78)^{d}	39.54 (38.96)^{d}	41.69 (40.22)^{d}	43.82 (41.45)^{d}	39.69 (39.05)^{d}	
	0.005	0.006	0.009	0.005	0.003	0.009		0.121	0.138	0.195	0.068	0.177	0.254	
	0.011	0.013	0.019	0.011	0.007	0.020		0.267	0.305	0.430	0.150	0.389	0.560	

PTC=Pre Treatment Count, DAS= Day(s) after spraying, NS- Non significant; *Each value mean of three replications, Figures in parentheses square root transformed values ,In a column, means followed by same letter(s) not significantly different by LSD (p= 0.05)

Table 4. Yield and economics of various modules against major pests of bitter gourd

Module	Mean yield (t/ha)	Yield increase over control (t/ha)	Price of increase yield (Rs.)	Additional cost incurred towards each module (Rs.)	Benefit due to module (Rs.)	ICBR
Module 1- Foliar spray of Imidacloprid 17.8 SL @ 0.5ml per litre of water at 20 days after sowing (DAP) and Dimethoate 30 EC @ 2 ml per litre of water at 45 DAP and 60 DAP	23.25 (4.82)[c]	4.01	40,100	11,895	28,205	2.37
Module 2- Collection and destruction of affected fruits, Exposing the pupae by ploughing, fish meal trap with 5g of wet fish meal and 1ml of dichlorovos in cotton swab @ 50 nos./ha, Foliar spray of malathion 50 EC @ 500 ml /ha on 30 DAP and 60 DAP	24.62 (4.96)[b]	5.38	53,800	13,000	40,800	3.13
Module 3 - Basal application of neem cake @ 100 kg/acre, Foliar application of NSKE 5% at 20 DAP, Barrix trap (25 traps/ha) @ 30 DAP, Foliar spray of *B.t* @ 2g/litre of water @ 40 DAP, Foliar spray of Chlorantraniliprole 150ml/ha at 60 DAP	28.89 (5.37)[a]	9.65	96,500	16,890	79,610	4.71
Control	19.24 (4.39)[d]	-	-	-	-	-

Market price of fruit Rs. 10/ kg

results of earlier workers in the suggested module chlorantranilirpole 18.5 SC included in the suggested module. *Bt* is most effective on melon worm. These results are also in accordance with the findings of (Kalavathi et al., 1991).

Velvizhi, (2015) also noted that organic IPM module consists of soil application of *Azospirillum* and Phosphobacteria 2 kg/ ha and *Pseudomonas* 2.5 kg/ ha along with FYM 50 kg before ploughing, neem oil @ 15 ml/ l at 20 DAP, installations of Barrix trap @ 10 nos./ha at 30 DAP, NSKE 5 % spray at 40 DAP, spray application of Tumba Fruit extract @ 5% at 50 DAP and Spinosad 45 SC @ 0.4 ml/lit at 60 DAP, played a effective role in controlling the major insect pests of cucurbits.

The present findings revealed that the organic IPM (Suggested module- M3) exhibited effective control which is in accordance with the earlier reports by (Praveen and Dhandapani, 2001), (Singh et al., 2003) in okra

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