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Evaluation of IPM modules against whiteflies, *Bemisia tabaci* Genn. in bitter gourd (*Memordica charantia* L.) ecosystem

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ABSTRACT: Field evaluation of eight IPM modules was done against whiteflies, *Bemisia tabaci* Genn. in bitter gourd during, *kharif* and *rabi* -summer 2016-17 and 2017-18 at ICAR- Indian Institute of Horticultural Research, Bengaluru, Karnataka. During kharif 2016-17, spraying diafenthiuron 50 WP @ 1g/L, triazophos 40 EC @1.5ml/l, buprofezin 25SC @ 0.25ml/l and imidacloprid 17.8 SL @ 0.5ml/lat 15days intervals proved effective with 78.09% control followed by module consisting of application of Neem oil @ 1%, Pongam oil @ 1%, *M. anisopliae* (2x10^9) @ 2ml/l and *B. bassiana* (2x10^8) @ 2ml/l at weekly intervals and spraying Neem oil @ 1%, Pongam oil @ 1% at weekly intervals. Spraying subsequently diafenthiuron 50 WP @ 1g/l and triazophos 40 EC @1.5ml/l both 15 days intervals, respectively. Sowing maize (barrier crop) + removal of infested leaves and residues from the field +erection of solar light traps @ 5 traps/ha for mass trapping +tying yellow sticky trap to attract whiteflies) were able to suppress 15.5% whiteflies. When the same IPM modules were evaluated during *rabi*– summer 2017 -18, same trend prevailed. The above mentioned first module alone had a control of 80.69% whiteflies followed by other modules. Application of *M. anisopliae* (2x10^9), *B. bassiana* (2x10^8), Neem oil 1% and Pongam oil 1% at 10 days intervals gave the highest yield of 10.50 and followed by 10.39, 10.24 and 10.09 t/ha in other modules. The above module recorded higher benefit cost ratio (2.82).

Keywords: Modules, bitter gourd, whiteflies, barrier crop, light trap

INTRODUCTION

Bitter gourd is an important vegetable in India and other countries. The crop is native to tropical Asia, particularly from Indo Burma region (Banerji *et al.*, 2016). It is widely grown in India, Indonesia, Malaysia, China and tropical Africa. The immature fruits are unique, bitter and a rich source of vitamins and minerals. Bitter gourd is popular due to its medicinal properties. Bitter gourd is attacked by many insect pests. Among them, whiteflies and aphids play a major role in causing severe yield losses by transmitting diseases (Cohen and Nitzany, 1960). Red pumpkin beetle, *Aulacophora foveicollis* and fruit flies *Dacus cucurbitae* and *Ducus dorsalis*, also attack it (Saljoqi and Khan, 2007).

Whitefly is one of the most intractable, highly polyphagous and serious pest on economically important food and fiber crops. It does direct damage to plants by sucking sap. Besides it is a potent means of virus transmission from plant- to -plant. It excretes honeydew and transmits over 100 plant viruses, especially of genus begomovirus. Whitefly transmits plant viruses of distinct groups like geminiviruses, closteroviruses, carlaviruses, potyviruses, nepoviruses, luteoviruses etc. Among the several problems involved in the cultivation of bitter gourd, virus diseases are important. Approximately more than 35 viruses have been recorded from family Cucurbitaceae (Ozaslan *et al.* 2006).

MATERIALS AND METHODS

Integrated pest management modules were evaluated against whiteflies in bitter gourd (*cv*. Arka harit) during *kharif* and *rabi* seasons of 2016-17and 2017-18 at ICAR-Indian Institute of Horticultural Research, Bengaluru (13.1348° N, 77.4960° E). The experiment was carried out with 9 treatments (modules) with 3 replications (Table1). The untreated control plot maintained without any insecticidal sprays during both the seasons. The crop was grown under drip irrigation conditions at 90 x 60 cm following all recommended agronomic practices with soil application of FYM @ 10 t/ha + Neem cake @ 500 kg/ha as basal application.

The crop was grown in *kharif* season during 2016-17 and *rabi*-summer 2017-18. All the modules including farmers practice and control were evaluated in field trials. Bitter gourd seeds treated with imidacloprid before sowing to protect the seedlings from early sucking pests and sprayed imidacloprid 17.8SL @ 0.5ml/L on the seedlings three hours before transplanting. The pest management interventions were carried out only when the pests crossed economic threshold level. The observations were recorded at 10 days interval on top three leaves avoiding border rows from 5 randomly selected plants in each replication. Similarly, natural enemy population per plant was also recorded on 5 randomly selected plants in each replication.

RESULTS AND DISCUSSION

IPM Modules

Researchers across the world found IPM modules useful against different pests across crops than the farmers trials (Khajuria *et al*., 2015; Rao and Reddy, 2003; Bhosle *et al*., 2007; Balakrishnan *et al*., 2010; Sridhar *et al*., 2017). Eight IPM modules were evaluated against whiteflies and virus disease during *kharif* 2016-17and *rabi* -summer 2017-18. During kharif 2017,module 8 consisting spraying of diafenthiuron 50 WP @ 1g/L, triazophos 40 EC @1.5ml/l, buprofezin 25SC @ 0.25ml/l and Imidacloprid 17.8 SL @ 0.5ml/lat 15days intervals gave a promising result of 78.09% control followed by Module 6 and 5, which comprised Spraying of Neem oil @ 1%, Pongam oil @ 1%, *M. anisopliae* ($2x10^9$) @ 2ml/l and *B. bassiana* ($2x10^8$) @ 2ml/l at weekly intervals and spraying of Neem oil @ 1%, Pongam oil @ 1% both at weekly intervals. Diafenthiuron 50 WP @ 1g/l and triazophos 40 EC @1.5ml/l both 15 days intervals, respectively. Module 1 (sowing of maize as a barrier crop + removal of infested leaves and residues from the appearance of pests +erection of solar light traps @ 5 traps/ha for mass trapping +tying yellow sticky trap to attract whiteflies) were able to control only 15.5% damage by whiteflies. When the same IPM modules were evaluated on crop during *rabi*– summer 2017-18 seasons (Table 2), a similar trend was recorded. Module 8 alone was able to reduce 80.69% of whiteflies in bitter gourd followed by module 5 and 6. These two modules were at-par with each other in controlling the whitefly populations (Table 3). Many researchers found *Encarsia guadeloupae* (Viggiani) was successful in managing whiteflies population on subsequent crops (Mani *et al*., 2002, 2014; Mani and Krishnamoorthy, 2016; Taravati *et al*., 2013).

Table 1: **Details of IPM modules evaluated against whiteflies in bitter gourd**

No.	Module Treatment Details
M_1	Sowing of Maize as a Barrier Crop. Removal of infested leaves and residues from the appearance of pests. Erection of solar light traps @ 5 traps/ha for mass trapping. Tying Yellow Sticky Trap to attract whiteflies.
M_2	Sowing of Maize as a Barrier Crop. Removal of infested leaves and residues from the appearance of pests. Erection of solar light traps @ 5 traps/ha for mass trapping. Tying Yellow Sticky Trap to attract whiteflies. Releasing of *Encarsia guadeloupae* (Viggiani) 75,000/ha @ weekly intervals.
M_3	Sowing of Maize as a Barrier Crop. Removal of infested leaves and residues from the appearance of pests. Erection of solar light traps @ 5 traps/ha for mass trapping. Tying Yellow Sticky Trap to attract whiteflies. Spraying of *Metarhizium anisopliae* (Biomet)($2x10^9$/ml) @ 3 L/ha and *Beauveria bassiana* (Biorin)($2x10^9$/ml) @ 3 L/ha (sprayed in the evening hours)
M_4	Sowing of Maize as a Barrier Crop. Removal of infested leaves and residues from the appearance of pests. Erection of solar light traps @ 5 traps/ha for mass trapping. Tying Yellow Sticky Trap to attract whiteflies. Spraying of Neem oil @ 1% and Pongam oil @1%
M_5	Spraying of 1. Neem oil 1% 2. Pongam oil 1% 3.Diafenthiuron 50 WP @ 1g/l & 4. Triazophos 40 EC @1.5ml/l
M_6	Spraying of 1. *M. anisopliae* ($2x10^9$) 2. *B. bassiana* ($2x10^8$) 3.Neem oil 1% & 4. Pongam oil 1%
M_7	1. *M. anisopliae* ($2x10^9$/ml) 2. *B. bassiana* ($2x10^9$/ml) 3. Diafenthiuron 50 WP @ 1g/l & 4. Triazophos 40 EC @1.5ml/l
M_8	Spraying of 1. Diafenthiuron 50 WP @ 1g/L 2. Triazophos 40 EC @1.5ml/l 3. Buprofezin 25SC @ 0.25ml/l & 4. Imidacloprid 17.8SL @ 0.5ml/l
M_9	Untreated Control

Table 2. Efficacy of IPM modules on bitter gourd against whiteflies and virus disease (*kharif* 2017)

Module No.	Percent whiteflies mortality over control							
	30 DAP	**40 DAP**	**50 DAP**	**60 DAP**	**70 DAP**	**80 DAP**	**90 DAP**	**Mean**
1	15.60c (23.25)	25.76f (30.49)	13.16e (21.27)	18.86e (25.71)	11.76g (20.05)	18.62e (25.56)	19.09g (25.90)	17.44d (24.52)
2	21.88c (27.88)	35.04e (36.28)	22.47d (28.29)	34.55d (36.19)	46.70f (42.52)	35.65d (36.65)	32.68 (34.85)f	32.74c (34.73)
3	25.59c (30.38)	38.13d (38.12)	36.36c (37.07)	46.56c (43.00)	53.84e (47.19)	50.00c (44.98)	45.54e (42.43)	42.40c (40.52)
4	38.00b (38.04)	59.79c (50.62)	49.36b (44.62)	57.58 (49.34)b	60.63d (51.12)	60.46 (51.02)b	60.32d (50.93)	55.27b (48.02)
5	57.08a (49.05)	72.16b (58.13)	79.06a (62.74)	85.86 (67.89)a	87.78c (69.51)	88.76a (70.38)	72.13c (58.11)	77.60a (62.31)
6	66.62a (54.68)	78.35a (62.24)	83.72a (66.17)	87.95 (69.69)a	89.14b (70.73)	90.31a (71.83)	81.06b (64.17)	82.50a (65.70)
7	57.08a (49.05)	72.16b (58.13)	79.06a (62.74)	86.92 (68.82)a	87.78c (69.51)	88.37a (70.03)	88.62a (70.26)	80.39a (64.44)
8	61.92a (51.87)	78.35a (62.24)	83.72a (66.17)	87.95a (69.69)	90.50a (72.02)	89.15a (70.74)	83.04b (65.66)	82.09a (65.48)
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm±	**6.18**	**0.69**	**5.45**	**2.95**	**0.35**	**1.67**	**2.10**	**8.67**
CV	**1.27**	**11.55**	**1.44**	**2.66**	**22.31**	**4.72**	**3.78**	**0.22**
CD	**18.51**	**2.05**	**16.34**	**8.84**	**1.05**	**5.00**	**6.22**	**18.96**

Note: Modules (Treatments) values in the column with different alphabets are statistically significant (p=0.05) Figures in parenthesis are arc sine transformed values. DAP= Days after planting

Table 3. Efficacy of IPM modules on bitter gourd against whiteflies and virus disease (*rabi – summer* 2017-18)

Module No.	Per cent whiteflies mortality over control							
	30 DAP	**40 DAP**	**50 DAP**	**60 DAP**	**70 DAP**	**80 DAP**	**90 DAP**	**Mean**
1	8.39d (16.83)	30.08 (33.25)f	15.80 (23.41)d	14.91 (22.70)e	24.02 (29.34)e	24.71 (29.80)f	19.32g (26.07)	19.08d (25.56)
2	18.30 (25.31)c	38.82 (38.53)e	26.58 (31.02)d	39.79 (39.10)d	51.52 (45.85)d	33.80 (35.53)e	32.68f (34.85)	35.74c (36.47)
3	30.98 (33.81)b	41.74 (40.23)d	43.12 (41.03)c	48.43 (44.08)c	58.89 (50.10)c	51.28 (45.71)d	45.54e (42.43)	47.13 (43.31)b
4	37.80 (37.92)b	62.13 (52.00)c	58.11 (49.65)b	58.15 (49.67)b	64.71 (53.53)b	63.27 (52.68)c	60.32d (50.93)	58.29b (49.80)
5	61.96 (51.90)a	74.76 (59.82)b	80.57 (63.82)a	87.01 (68.85)a	89.53 (71.10)a	92.00 (73.54)ab	72.13c (58.11)	79.30a (63.58)
6	67.51 (55.23)a	79.61 (63.13)a	86.32 (68.27)a	87.95 (69.66)a	90.30 (71.83)a	92.00 (73.54)ab	80.06b (64.17)	83.67a (66.63)
7	64.79 (53.58)a	73.78 (59.18)b	81.28 (64.34)a	88.96 (70.56)a	89.53 (71.10)a	89.09 (70.68)b	88.62a (70.26)	82.25a (65.63)
8	70.35 (56.99)a	79.61 (63.13)a	84.18 (66.54)a	88.43 (70.08)a	91.47 (72.99)a	93.45 (75.15)a	83.04b (65.66)	83.56a (66.61)
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm (±)	**0.52**	**0.76**	**6.54**	**4.12**	**1.75**	**3.21**	**2.12**	**9.42**
CV	**9.56**	**10.48**	**1.20**	**1.90**	**4.49**	**2.44**	**3.71**	**0.21**
CD@5%	**2.21**	**2.26**	**19.62**	**12.38**	**5.24**	**9.65**	**6.35**	**20.36**

Note: Modules (Treatments) values in the column with different alphabets are statistically significant (p=0.05) Figures in parenthesis are arc sine transformed values DAP= Days after planting

Table 4. Effect of IPM modules on bitter gourd yield

Module No.	Kharif 2017	*Rabi*-summer 2017-18	Mean	Kharif 2017	*Rabi*-summer 2017-18	Mean BCR
	Yield (in tons) / ha	Yield (in tons) / ha	(in tons) / ha	BCR	BCR	
1	8.08	7.96e	8.02c	2.34	2.30	2.32
2	9.06	8.78d	8.92c	2.55	2.47	2.51
3	9.78	9.60c	9.69b	2.55	2.50	2.53
4	9.86	9.38c	9.62b	2.76	2.62	2.69
5	10.24	9.97b	10.10ab	2.52	2.45	2.49
6	10.50	10.06a	10.28a	2.82	2.70	2.76
7	10.09	9.64c	9.86ab	2.67	2.56	2.61
8	10.39	10.27a	10.33a	2.61	2.58	2.60
9	5.97	5.77f	5.87e	1.83	1.77	1.80
SEm (±)	**0.15**	**0.12**	**0.14**	-	-	-
CV	**0.42**	**0.38**	**0.39**	-	-	-
CD@5%	**2.85**	**2.37**	**2.52**	-	-	-

# Modules (Treatments) values in the column with different alphabets are statistically significant (p=0.05)
BCR= Benefit -Cost Ratio

Yield and Benefit-Cost Ratio (BCR)

The IPM modules were also evaluated for yields in two seasons, i.e. *kharif*- 2016-17 and *rabi*-summer 2017-18. During *kharif* 2016-17, all the modules gave significantly higher yield than the control (5.77 t/ha). Module 10 and 6 gave the highest yield of 10. 27 and 10.06 t/ha, followed by Module 5 (9.97 t/ha) and Module 7 & 4 (9.64 and 9.38t/ha). Module 6 recorded a higher BCR (2.70) and ranked first among all the IPM trials, followed by Module 4 (2.62). The Control gave BCR of 1.77 only. The BCR among all the modules, except control, gave promising results and were at-par each other (Table. 4).

During *rabi*-summer 2017-18, same set of IPM modules were evaluated. The same trend was recorded in all the modules which gave significantly higher yields than control (5.97 t/ha). Module 6 gave the highest yield of 10.50 and followed by 10.39, 10.24 and 10.09 t/ha in modules 8, 5 and 7, respectively. As per the economics, the module 6 recorded higher BCR (2.82), followed by module 4 (2.76), module 7 (2.67). The control gave BCR of 1.83 only. Overall results showed that, the BCR among the modules had significantly superior yields and were at-par with each other except control (Table. 4).

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REFERENCES:

Balakrishnan, N., Baskaran, R. M. and Mahadevan, N. R. (2010). Influence of intercrops/trap crops on the preference of major pests of cotton in different IPM modules under rainfed condition. *Journal of Biopesticides*, **3**(Special Issue), 373.

Banerji, R., Sahoo, S. K., Jha, S. and Banerjee, H. (2016). Persistence and dissipation of triazophos in bitter gourd. *Journal of Horticultural Science*, **3**(1), 82-83.

Bhosle, B. B., More, D. G., Bambawale, O. M., Sharma, O. P. and Patange, N. R. (2007). Effectiveness of cotton IPM module in rainfed Marathwada Region. *Annals of plant protection Sciences*, **15**(1), 21-25.

Cohen, S. and Nitzany, F. E. (1960). A whitefly transmitted virus of cucurbits in Israel. *Phytopathologia Mediterranea*, 44-46.

Khajuria, S., Rai, A. K., Rajkumar, K. L. and Jadhav, J. K. (2015).Evaluation of integrated pest management

(IPM) module against sucking pests of black gram under semi-arid conditions. *Insect Environ*, **20**, 126-132.

Mani, M. and Krishnamoorthy, A. (2002). Classical Biological Control of the Spiralling whitefly, *Aleurodicus dispersus* Russell -An Appraisal. *International Journal of Tropical Insect Science*, **22**(4), 263-273.

Mani, M. and Krishnamoorthy, A. (2016).Colonization of introduced parasitoid, *Encarsia guadeloupae* Viggiani, on the exotic spiralling whitefly, *Aleurodicus dispersus* Russell, infesting ornamentals. *Journal of Horticultural Science*, **1**(2), 148-151.

Mani, M., Krishnamoorthy, A., Venugopalan, R. and Pattar, G. L. (2004).Biological control of exotic spiralling whitefly, *Aleurodicus disperses* Russell on guava by *Encarsia haitiensis* dozier and *Encarsia guadeloupae* Viggiani in India. *Pest Management in horticultural ecosystems*, **10**(1).

Ozaslan, M., Aytekin, T., Bas, B., Kilic, I.H., African I.D and Dag, D.S 2006.Virus disease of cucurbits in Gaziantep Turkey. *Plant Pathology*, **5:** 24-27.

Rao, M. S. and Reddy, K. D. (2003). IPM of pod borers in long duration pigeonpea. *Annals of plant protection Sciences*, **11**(1), 26-30.

Saljoqi, A. U. R. and Khan, S. (2007). Relative abundance of the red pumpkin beetle, *Aulacophora foveicollis*, on different cucurbitaceous vegetables. *Sarhad Journal of Agriculture*, **23**(1), 135.

Sridhar, V., Onkara Naik, S., Achala Paripurna, K., Rao, V. K., Pillai, K. G. and Lakshmana ReddyD. C. (2017). Efficacy of neem, pongamia and fish oils alone and as synergists with insecticides for the management of whitefly, *Bemisiatabaci* (Gennadius) on tomato. *Pest management in Horticultural Ecosystem*. **23** (2):119-123.

Taravati, S., Mannion, C. and Osborne, L. S. (2013). Management of rugose spiraling whitefly (*Aleurodicus rugioperculatus*) in the south Florida landscape. In *Proceedings of the Florida State Horticultural Society* (Vol. **126**, pp. 276-278).

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