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Evaluation of different pest management modules in bitter gourd

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Abstract
Bitter gourd (*Momordica charantia*) is a popular and cosmopolitan cucurbit crop grown in all the districts of Telangana. Fruit fly (*Bactrocera cucurbitae*) is the major pest that attacks its fruits and causes a great loss to the bitter gourd farmers. An experiment was conducted for three years on bitter gourd var. Amansri, in randomized block design with four treatments and five replications including control to evaluate the efficacy of different pest management modules against pests of bitter gourd during 2016-19 at Vegetable Research Station, Rajendranagar, Sri Konda Laxman Telangana State Horticulture University. Red pumpkin beetle and fruit fly were the major pests. For the management of red pumpkin beetles all the modules were effective compared to control. Among the tested modules, lowest fruit fly damage was recorded in the Integrated module (Seed treatment with thiamethoxam 70 WS 5-10 g/kg seed, removal of damaged cotyledonary leaves, spraying emamectin benzoate 25 WG @ 0.4 g/l, spraying of neem oil 3000 ppm @ 5 ml/l, Installation of cuelure traps 15/acre, spraying spinosad 45 SC @ 0.3 ml/l.) with high yield (16.00 t/ha) and highest benefit cost ratio (2.61).

Keywords: Bitter gourd fruit fly, red pumpkin beetles, Bactrocera cucurbitae, integrated module

Introduction
Bitter gourd is popular and demanded cucurbit crop grown in all the districts of Telangana. Bitter gourd ranks first in all cucurbits as it is rich in Iron, Phosphorous, Ascorbic acid (Awasthi and Jaiswal 1986). It is considered to be a rich source of vitamins and minerals and rich in vitamin C (88 mm/100g) (Akter and Rahman 2010) [3]. Bitter gourd is attacked by several pests such as red pumpkin beetles in the vegetative stage, Jassids, whitefly, thrips both in vegetative and reproductive stages. Fruit fly is the major pest that attacks fruits and causes a great loss to the bitter gourd farmers. Fruit fly in cucurbits was first reported by Lefroy in 1907 which will reduce not only the quality of the fruits and vegetables but also a serious limiting factor in production of gourds. Depending on the environmental factors, the extent of losses in bitter gourd range between 30 to 100% (Gupta and Verma 1992, Dhillon *et al*. 2005, Shooker *et al*. 2006) [6, 5, 16].

Usage of excessive, unwanted and unnecessary chemical pesticides may lead to residue problems and also resurgence of target pests and also secondary pest outbreaks, finally leading to adverse effect on human health and killing of non-target organisms (Halder *et al*. 2010, 2013). There are several management options for fruit fly such as protein spray, para pheromone trap, spray of ailanthus and cashew leaf extract, neem products, bagging of fruits, field sanitization, food baits and spray of chemical insecticide (Pawar *et al*. 1991, Zaman *et al*. 1995, Neupane, 2000, Akhtaruzzaman *et al*. 2000, Satpathy and Rai 2002, Dhillon *et al*. 2005, Palaniappan and Annadurai 2006, Jacob *et al*, 2007) [13, 17, 11, 2, 15, 5] are used in the management of cucurbit fruit fly. However suitable Integrated Pest Management (IPM) package for eco-friendly pest management for good bitter gourd production is very much essential and hence the present studies were undertaken.

Material and Methods
Experiments were conducted for three years on bitter gourd cv. Amansri to evaluate the efficacy of different pest management modules against red pumpkin beetles and fruit fly during 2016-17, 2017-18, 2018-19 at Vegetable Research Station, Rajendranagar at Sri Konda

Laxman Telangana State Horticulture University. The trial was laid in randomized block design with four treatments including control and five replications. All the agronomic practices were followed for raising the crop as per the recommended package of practices except any plant protection measures. The treatments are mentioned below

Chemical Module I

T_1: Seed treatment with imidacloprid 48 FS @ 5-10 g/kg seed, spraying of rynaxpyr 18.5 SC 0.3 ml/l followed by emamectin benzoate 25 WG 0.4g/l, spinosad 45 SC 0.3 ml/l, vertimec or abamectin 1.9 EC 0.3 ml/l

Chemical Module II

T_2: Seed treatment with imidacloprid 48 FS @ 5-10 g/kg seed Spraying dimethoate, 2 ml/l, Spraying indoxacarb 14.5 SC @ 0.5 ml/l Spraying Wettable Sulphur @ 3g/lt

Module III: Bio-Intensive Module

T_3: Seed treatment with cow dung and *Trichoderma viridae*, soil application of Neem cake 250 kg/ha, removal of infestsed cotyledon leaves Seven days after germination, spraying NSKE 5% or Neem oil 3,000 ppm @ 5 ml/l, installation of cue-lure traps 15 traps/acre,application of vermiwash 1:1 (Interval of treatment application)

Module IV: Integrated module

T_4: Seed treatment with thiamethoxam 70 WS 5-10 g/kg seed, removal of cotyledonary leaves 7 days after germination, spraying Emamectin benzoate 25 WG @ 0.4 g/l, spraying-/Neem oil 3000 ppm @ 5 ml/l, Installation of cuelure traps 15/acre, spraying spinosad 45 SC @ 0.3 ml/l

Untreated control

T_5- Control: Fruit fly incidence was calculated by the following formula Percent fruit fly incidence = (Number of damaged fruits / Total number of fruits) X 100 Red pumpkin beetle. Population per plant recorded percent reduction over control was recorded. Yield was recorded and data was subjected to statistical analysis

Results and Discussion

Comparative performance of the test modules

Red pumpkin beetle: It is evident that among the tested modules all the modules were effective in the management of red pumpkin beetles in comparison with control. Module I, II, bio intensive module and integrated module were effective in reducing the red pumpkin beetles to an extent of 59.64 to 63.15%. The red pumpkin beetles cause damage to the bitter gourd in 3-4 leaf stage and sometimes due to severe infestation the seedlings may die and hence the management of the beetles is very important. Module I, II, bio intensive module and Integrated module recorded 0.92, 0.84, 0.86 and 0.91 beetles per plant in comparison with control which recorded 2.28 beetles/plant.

Fruit fly: In case of fruit fly, infestation caused by *Bactrocera cucurbitae*, lowest fruit damage was recorded in the Integrated module (M_4) and corresponding number of fruits damaged was 8.10, 7.77 and 9.73 during 2017-18, 2018-19, 2019-20. However, in the pooled analysis, the tested modules were equally effective in reducing fruit damage over three years of experimentation and significantly superior over control. Maximum percent reduction of fruit fly was recorded in Integrated module (M_4) followed by Biointensive module (M_3). Integrated Pest Management (IPM) module comprising of installation of cue-lure baited traps @ 50 traps/ha for mass trapping, weekly clipping of infested fruits, foliar spray of aqueous leaf extracts of *Morinda citrifolia* @ 100g/l and foliar spray of spinosad 45SC or imidacloprid 17.8SL @ 0.3ml/l alternately at 15 days interval was found effective with respect to less fruit damage due to fruit fly (9%) and maximum fruit yield (10.75 t/ha) in bitter gourd (Ajanta Birah *et al* 2015).

Marketable fruit yield: Significantly higher yields were obtained in T_4 treatment (16.06 t/ha) followed by T_1 and T_3 treatments (13.58 and 12.67 t/ha) than control (9.36 t/ha). Though the modules are effective, installation of cue lure is a major control measure for the management of fruit flies. (Table No:4)

Cost-benefit ratio: Among all the tested treatments, T4 -the integrated module recorded highest cost benefit ratio of 1:2.61 followed by T3-bio-intensive module (1:2.03), T1-module-1(1:1.87) respectively. (Table no.5)

Among all the tested treatments the integrated module (T_4: Seed treatment with thiamethoxam 70 WS 5-10 g/kg seed, removal of cotyledonary leaves seven days after germination, spraying Emamectin benzoate 25 WG @ 0.4 g/l, spraying Neem oil 3000 ppm @ 5 ml/l, Installation of cuelure traps 15/acre, spraying spinosad 45 SC @ 0.3 ml/l) was effective in the management of red pumpkin beetles and fruit flies in bitter gourd. Natural enemies: Predatory beetles, *chrysopa*, coccinellids and spiders (*Argeope, Thomesus*, crab spider population) was observed during the last 15 days of the crop. All the treatments were significantly superior over control. Similarly, Kumar *et al*. 2019 and Ranganath *et al*. 2015 also reported that minimum fruit fly incidence was observed in integrated pest management module than other treatments.

Conclusion

Among the tested modules, Integrated module (Seed treatment with thiamethoxam 70 WS 5-10 g/kg seed, removal of cotyledonary leaves seven days after germination, spraying Emamectin benzoate 25 WG @ 0.4 g/l, spraying of Neem oil 3000 ppm @ 5 ml/l, Installation of cuelure traps 15/acre, spraying spinosad 45 SC @ 0.3 ml/l.) with high yield and highest benefit cost ratio than other modules.

Table 1: Evaluation of different pest management modules (Red pumpkin beetles) in bitter gourd pooled data (2016-17,2017-18 and 2018-19)

Red Pumpkin beetles population per plant					**ROC(Avg) %**
Treatment	2016-17	2017-18	2018-19	Pooled	
T_1	1.50	0.43	0.82	0.92	59.64
T_2	1.00	0.23	1.29	0.84	63.15
T_3	1.62	0.22	0.75	0.86	62.28
T_4	1.70	0.29	0.74	0.91	60.08
T_5	3.63	1.33	1.88	2.28	
CD (5%)	0.49	0.31	0.25	0.74	
CV	13.89	32.52	11.95	33.96	
SEM±	0.15	0.09	0.08	0.23	

*ROC =Reduction over control

Table 2: Effect of different pest management modules (fruit fly) in bitter gourd pooled data (2016-17,2017-18 and 2018-19)

Treatment	Number of fruit fly affected fruits (Before IPM)				Number of fruit fly affected fruits (After IPM)				ROC (Avg) %
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled	
T_1 Module I	2.03	1.84	3.04	2.30	15.00	14.10	16.14	15.08	19.78
	(1.42)	(1.36)	(1.74)	(1.52)	(3.87)	(3.75)	(4.02)	(3.88)	
T_2 Module II	3.00	1.64	2.70	2.45	15.50	14.00	15.40	14.9	20.7
	(1.73)	(1.28)	(1.64)	(1.56)	(3.93)	(3.62)	(3.90)	(3.81)	
T_3 Bio-Intensive Module	3.10	1.75	2.75	2.53	13.00	13.56	12.56	13.04	30.63
	(1.76)	(1.32)	(1.66)	(1.59)	(3.00)	(3.68)	(2.94)	(3.01)	
T_4 Integrated module	3.10	1.92	2.76	2.59	8.10	7.77	9.73	8.53	54.62
	(1.76)	(1.39)	(1.66)	(1.61)	(2.85)	(2.79)	(3.12)	(2.92)	
T_5 Untreated control	3.00	1.86	3.06	2.64	17.44	18.44	20.53	18.80	
	(1.73)	(1.36)	(1.75)	(1.62)	(4.18)	(4.29)	(4.53)	(4.34)	
CD (5%)	NS	NS	NS	NS	2.17	2.18	2.16	1.37	
CV	12.31	11.11	13.50	12.61	10.61	11.36	9.85	4.78	
SEM±	0.09	0.21	0.17	0.18	0.36	0.72	0.72	0.42	

*Figures in parenthesis are square root transformed values, *ROC =Reduction over control

Table 3: Effect of different pest management modules (fruit fly) in bitter gourd pooled data (2016-17,2017-18 and 2018-19).

Treatment	% fruit fly damage before IPM				% fruit fly damage After IPM				ROC
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled	
T_1 Module I	28.3	27.33	29.38	28.34	19	19.88	21.99	20.29	35.32
	(28.35)	(31.45)	(32.77)	(32.16)	(27.22)	(26.43)	(27.93)	(26.76)	
T_2 Module II	24.94	24.9	26.97	25.6	24	21.3	23.41	22.9	
	(25.93)	(29.92)	(31.28)	(30.39)	(28.21)	(27.47)	(28.93)	(28.58)	27.00
T_3 Bio-Intensive Module	28.15	26.13	28.14	27.47	16	12.66	14.79	14.48	53.84
	(27.13)	(30.66)	(31.96)	(31.60)	(21.73)	(20.68)	(22.49)	(22.34)	
T_4 Integrated module	22.14	24.3	26.4	24.28	14	9.94	12.01	11.98	61.82
	(25.35)	(29.46)	(30.86)	(29.50)	(19.32)	(18.34)	(20.25)	(20.20)	
T_5 Untreated control	28.36	25.52	27.7	27.19	33	29.52	31.58	31.37	
	(26.61)	(30.29)	(31.71)	(31.42)	(33.55)	(32.89)	(34.17)	(34.05)	
CD (5%)	NS	NS	NS	2.1	3.22	3.23	3.21	2.15	
CV	14.46	14.95	13.97	4.2	12.2	12.9	11.5	5.65	
SEM±	0.87	0.71	1.73	0.64	0.54	1.07	1.07	0.66	

*Figures in parenthesis are angular transformed values, *ROC =Reduction over control

Table 4: Effect of different pest management modules on yield in bitter gourd pooled data (2016-17, 2017-18 and 2018-19).

Treatments	Marketable yield (t/ha)				Unmarketable yield (t/ha)				Total yield (t/ha)			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
T1 Module I:	10.36	12.66	9.66	10.89	2.1	3.36	1.96	2.47	13.1	16.02	11.62	13.58
T2 Module II	9.25	11.98	9.02	10.08	2.22	3.06	1.46	2.25	11.22	15.04	10.48	12.17
T3 Bio-Intensive Module	12.12	14.02	11.2	12.45	1.36	1.9	0.9	1.39	10.36	15.92	12.1	12.67
T4 Integrated module	14.35	17.72	14.73	15.6	0.72	1.24	0.5	0.82	14.36	18.96	15.2	16.06
T5 Untreated control	5.10	4.54	2.44	4.03	5.10	4.54	2.44	4.03	9.64	8.48	9.98	9.36
CD (5%)	2.74	2.86	2.62	0.95	0.78	0.88	0.67	0.56	2.24	1.08	2.67	1.48
CV	17.3	15.86	18.74	4.31	28.75	23.31	34.18	14.4	14.88	12.98	16.77	5.86
SEM±	0.91	0.95	0.87	0.29	0.26	0.29	0.22	0.17	0.73	0.56	0.89	0.45

*Figures in parenthesis are angular transformed values, *ROC =Reduction over control

Table 5: Cost Economics

S. No.	Treatment	Yield of healthy fruits (q ha-1)	Increase in yield over control (q ha-1)	Increase in yield over control%	Cost of cultivation	Total income	Net profit (Rs ha-1)	Cost: benefit ratio
1	T_1	13.58	4.22	45.1	118100	339500	221400	1.87
2	T_2	12.17	2.81	30.0	113100	304250	191150	1.69
3	T_3	12.67	3.31	35.4	104600	316750	212150	2.03
4	T_4	16.06	6.7	71.6	111100	401500	290400	2.61
5	T_5	9.36	0	0	98950	234000	135050	1.36

Average cost of Bitter gourd Rs. 2500 q-1

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