DOI : 10.5958/0974-0112.2020.00045.6

Indian J. Hort. 77(2), June 2020: 328-332

Evaluation of suitable IPM module for management of YVMV disease in okra under West Central Table Zone of Odisha

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ABSTRACT

Field experiment was conducted to evaluate eight integrated pest management (IPM) modules to control insect vector white fly which transmits the YVMV disease in okra. The IPM module i.e, seed treatment with Imidacloprid 600 FS @ 5ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of Acetamiprid 20 SP @ 0.3 gm / lit. of water was found most effective among all other modules to control YVMV disease, white fly population and okra leaf hopper. A maximum increase in yield and highest cost:benefit ratio were also achieved with the same module.

Key words: *Abelmoschus esculentus*, whitefly, okra leaf hopper, yellow sticky trap, cetamiprid.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.), one of the important vegetable crops of Malvaceae family is cultivated throughout the year in tropics and subtropics of India. In India total area under okra cultivation is 509 thousands ha with a total production of 6095 thousands MT during 2017-18 (Anon, 3). The plant is rich in minerals, carbohydrates fibre, protein, fat, vitamins and phenols. However, one of the major constraints for okra production is heavy infestations caused by various insect pests and diseases which not only exert quantitative loss but also qualitative loss to the crop. Among diseases, yellow vein mosaic virus (YVMV) disease of okra is the major limitation in the production. The disease is characterized by different degrees of chlorosis and yellowing of veins and veinlets, smaller leaves, fewer and smaller fruits, and stunting (Seikh *et al*., 11). The YVMV disease is transmitted through whitefly (*Bemisia tabaci* Gen.) in a persistent manner. Beside the vector of 'yellow vein mosaic' virus in the plants, whitefly damages the plant directly by sucking the cell sap from the leaves and excretes honeydew on which sooty mould develops, which affects the normal photosynthetic activity of the plant. Another important pest of okra is the leaf hopper; *Amrasca biguttula biguttula* (Ishida) which sucks the cell sap from lower surface of the leaves and injects toxic substance in it, resulting in yellowing and curling of leaf margins and stunted plant growth. In case of severe infestation, leaf hopper causes burning of leaves which fall down later and results 40-60% reduction in yield (Narke and Suryawanshi, 6). Due to these factors, the growth of plant is adversely affected. YVMV disease is very destructive which causes about 50 to 94% yield losses depending on the stage of the crop growth at which infection occurs (Ali *et al*., 1; Sastry and Singh, 10). As the YVMV disease is transmitted by insect vector so management of vector is important to check the YVMV disease. Therefore it is necessary to develop an IPM module which will minimise the losses caused by YVMV disease. For this, the present study is an attempt to evaluate different IPM modules for management of insect vector of YVMV disease of okra, their effect on leaf hopper and on natural enemies.

MATERIALS AND METHODS

The research trial was conducted at the Research Farm of Regional Research and Technology Transfer Station, Chiplima, Sambalpur, Odisha. Field experiments were carried out during *kharif* season of 2016 and 2017 to study the effect of different IPM modules on YVMV of okra. Nine treatments (modules) with untreated control replicated thrice and field trial was laid out in randomized complete block design with a spacing of 60 × 30 cm. Plot sizes were 15sq m. and Arka Anamika variety was planted during the month of July during both the years. Recommended agronomic practices were applied and manual weeding and irrigation was carried out when necessary. The modules are M_1= Seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed; M_2 = Installation of yellow sticky trap @ 50 / ha; M_3 = Seed treatment with imidacloprid 600 FS @ 5 ml/ kg of seed and installation of yellow sticky trap @ 50/ha ; M_4 = Seed treatment with imidacloprid 600 FS @ 5 ml/ kg of seed, installation of yellow sticky trap @ 50/ha

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and spraying of Neem Oil 0.15% @ 2 ml/l of water; M_5=Seed treatment with Imidacloprid 600 FS @ 5ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of Buprofezin 25 SC @ 1 ml/l of water; M_6 = Seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of Triazophos 40 EC @ 2 ml/l of water; M_7=Seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of acetamiprid 20 SP @ 0.3 gm/lit. of water; M_8 = Seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of diafenthiuron 50% WP @ 1 g/l of water; and M_9 = Untreated control.

Two insecticidal sprays were given at 15 days interval starting from 40 days after sowing. In each plot one sq m area was fixed from which 5 plants were selected for taking observation excluding the border rows from each plot. Populations of whitefly and leaf hopper (jassid) were recorded on three leaves selected from top, middle and bottom canopy of the plant. However, the population of predator viz. spiders was recorded on per plant basis on five randomly selected plants. The population of the pest and their predators were recorded 1 day before the application of the insecticides. The post treatment population of whitefly, leaf hopper and spider were recorded at 5, 10, 15 days after each spray.

Reduction over control (ROC) was calculated by using the following formula:

$$\text{ROC (\%)} = \frac{\text{Population in control plots} - \text{Populations in treatment plot}}{\text{Populations in treatment plot}} \times 100$$

Data collected was transformed to the square root values and analyzed by ANOVA under randomized block design.

Disease severity was recorded before commencement of each spray and final data was recorded 15 days after 2nd spray. To assess the disease scoring for Yellow Vein Mosaic Virus was done on a 0-5 scale (Senevirathna *et al.*, 12) on the basis of visual observations. The description of scale is given as under:

Description of symptoms	Severity scale	Rating Scale	Severity Range
Absence of symptoms	0	Highly resistant (HR)	0%
Very mild symptoms, initial vein clearing	1	Resistant (R)	1-20%
Leaf veins completely yellow and inter-veinal regions remain green or normal	2	Moderately resistant (MR)	20-40%
Curly leaves and whole leaf get yellow colour	3	Moderately susceptible (MS)	40-60%
Whole leaf yellow coloured. Leaf margin start drying	4	Susceptible (S)	60-80%
Yellowish and deformed pods with whole leaf yellow coloured. All leaves of the plant get affected	5	Highly Susceptible (HS)	80-100%

Percent Disease Index (PDI) was calculated following standard formula given by Mckinny (5).

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{No. of observations} \times \text{Maxmimum rating}} \times 100$$

The yield of okra fruits was recorded from each plot on weight basis and computed to per ha. Cost: benefit ratio was calculated in all the modules.

RESULTS AND DISCUSSION

During *kharif*, 2016, significantly minimum percent disease severity was observed (Table 1) in M_7 (9.33%) i.e, seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of acetamiprid 20 SP @ 0.3 g/l of water which was found significantly superior to rest of the treatments. The next best module was M_6 (10.67%), i.e, seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of triazophos 40 EC @ 2 ml/l of water. Significantly maximum percent disease severity was observed in untreated control (24.0%).

During kharif 2017, significantly minimum percent disease severity was observed (Table 1) in M_7 (7.33%), i.e., seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of acetamiprid 20 SP @ 0.3 g/l of water followed by M_6 (9.33%), i.e., seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of triazophos 40 EC @ 2 ml/l of water. Significantly maximum percent disease severity was observed in untreated control (26.0%).

The pooled data (Table 1) revealed that the significantly minimum percent disease severity was found in M_7 module (8.33%), i.e., seed treatment with imidacloprid 600 FS @ 5 ml/ kg of seed, installation of yellow sticky trap @ 50/ha and spraying of acetamiprid 20 SP @ 0.3 gm/ lit. of water. The next best module was M_6 (10.0%), i.e., seed treatment with imidacloprid 600

Table 1. Effect of different module on yellow vein mosaic virus (YVMV) disease severity in okra during *kharif* 2016 and 2017.

Module No.	Treatment	Percent disease Index (PDI)			**PEDC
		2016	2017	Pooled	
M_1	Seed Treatment with imidacloprid 600 FS @ 5 ml/kg of seed	15.33 *(4.01)	16.0 (4.09)	15.67 (4.08)	37.3
M_2	Installation of Yellow Sticky Trap @ 50/ha	18.0 (4.33)	19.33 (4.49)	18.67 (4.43)	25.3
M_3	Seed Treatment with imidacloprid 600 FS @ 5 ml/kg of seed + Installation of Yellow Sticky Trap @ 50/ha	14.0 (3.87)	14.67 (3.95)	14.33 (3.91)	42.7
M_4	Seed Treatment with imidacloprid 600 FS @ 5 ml/kg of seed + Installation of Yellow Sticky Trap @ 50/ha + spraying of Neem oil 0.15% @ 2 ml/l of water	13.33 (3.77)	12.67 (3.68)	13.0 (3.73)	48.0
M_5	Seed treatment with imidacloprid 600 FS @ 5ml/ kg of seed+ installation of Yellow Sticky trap @ 50/ha + spraying of buprofezin 25 SC @ 1 ml/l of water	12.0 (3.60)	10.67 (3.40)	11.33 (3.51)	54.7
M_6	Seed treatment with imidacloprid 600 FS @ 5 ml/kg of seed + Installation of Yellow Sticky Trap @ 50/ ha + spraying of triazophos 40 EC @ 2 ml / l of water	10.67 (3.40)	9.33 (3.19)	10.0 (3.32)	60.0
M_7	Seed treatment with imidacloprid 600 FS@ 5ml/ kg of seed + Installation of Yellow Sticky trap @ 50/ ha + spraying of acetamiprid 20 SP @ 0.3 g/lof water	9.33 (3.19)	7.33 (2.85)	8.33 (3.04)	66.7
M_8	Seed treatment with imidacloprid 600FS@ 5 ml/kg of seed + installation of Yellow sticky Trap @50/ha+ spraying of diafenthiuron 50% WP @ 1 gm/lit. of water	12.67 (3.68)	11.33 (3.48)	12.0 (3.60)	52.0
M_9	Untreated Control	24.0 (4.99)	26.0 (5.18)	25.0 (5.08)	-
CD at 5%		0.81	0.89	0.56	-

*Square root transformed value, **PEDC=Percent efficacy of disease control

FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of triazophos 40 EC @ 2 ml /l of water. Significantly maximum percent disease severity was observed in untreated control (25.0%). Gowdar *et al*. (4) reported that two sprays of acetamiprid 20 SP at 40 g a.i./ha was effective in reducing the incidence of YVMV in okra. Similarly, Yadav *et al*. (13) also reported that acetamiprid was effective in reducing the incidence of whitefly as well as YVMV disease.

The data presented in the Table 2 clearly depicts that all the IPM modules were effective in reducing the whitefly population. The results after first and second spray revealed that the highest reduction was observed to the module M_7 containing acetamiprid (62.9% reduction over control) followed by module M_6 containing triazophos (60.4% ROC), module M_8 containing diafenthiuron (55.7% ROC), module M_5 containing buprofezin (49.1% ROC) and module M_4 containing neem oil (42.8% ROC).

Beside the whitefly, we also tested the modules against leaf hopper which is another major sucking pest of okra. The mean populations of leafhopper of two sprays were calculated. The result represented in the Table 3 revealed that after 15 days, all the modules containing insecticide spray were significantly superior over control. Among all the treatments Acetamiprid (4.48 leafhopper/3 leaves, 81.7% ROC) recorded lowest population of leafhopper and was at par with Triazophos (5.88 leafhopper/3 leaves, 76.0% ROC) but statistically significant with other remaining treatments. Triazophos and Diafenthiuron (7.19 leafhopper/3 leaves, 70.6% ROC) were statistically at par with each other followed by Buprofezin (10.43 leafhopper/3 leaves, 57.3% ROC) and Neem oil (13.93 leafhopper/3 leaves, 43.02% ROC). Module M_1, M_2 and M_3 were statistically at par in case of hopper management after 15 days of two sprays.

The present findings are in accordance with the findings of Nikita *et al*. (7) who reported that, acetamiprid 20 SP (0.007 ppm) was the most toxic insecticide to okra leafhopper on the basis of LC_{50} values. Likewise, Anitha and Nandihalli (2) also

Table 2. Effect of different module on the population of whitefly in okra (pooled data).

Module No.	No./3 leaves				Mean	*ROC (%)
	1DBS	5DAS	10DAS	15DAS		
M_1	1.65 **(1.63)	1.85 (1.69)	2.30 (1.81)	2.58 (1.88)	2.10 (1.76)	34.0
M_2	2.03 (1.74)	2.10 (1.76)	2.60 (1.89)	2.95 (1.98)	2.42 (1.85)	23.9
M_3	1.75 (1.66)	1.82 (1.68)	2.20 (1.79)	2.53 (1.88)	2.08 (1.75)	34.6
M_4	1.87 (1.69)	1.55 (1.59)	1.75 (1.65)	2.10 (1.75)	1.82 (1.68)	42.8
M_5	1.85 (1.69)	1.52 (1.58)	1.40 (1.54)	1.70 (1.64)	1.62 (1.62)	49.1
M_6	1.75 (1.66)	0.92 (1.38)	1.05 (1.43)	1.30 (1.51)	1.26 (1.50)	60.4
M_7	1.77 (1.66)	0.83 (1.35)	0.98 (1.41)	1.15 (1.46)	1.18 (1.47)	62.9
M_8	1.77 (1.66)	1.15 (1.46)	1.23 (1.49)	1.48 (1.57)	1.41 (1.55)	55.7
M_9	2.52 (1.88)	2.80 (1.95)	3.45 (2.11)	3.93 (2.22)	3.18 (2.04)	-
CD at 5%	N.S	0.18	0.26	0.32	0.14	

Note: DBS = Days before spraying, DAS = Days after spraying; *ROC=Reduction over control; **Square root transformed value.

Table 3. Effect of different module on the population of leaf hopper during in okra (pooled data).

Module No.	No./3 leaves				Mean	ROC (%)
	1DBS	5DAS	10DAS	15DAS		
M_1	19.22 (4.44)*	21.48 (4.68)	22.42 (4.79)	24.42 (4.99)	22.77 (4.82)	6.9
M_2	20.11 (4.54)	21.93 (4.73)	23.15 (4.86)	25.26 (5.07)	23.44 (4.89)	4.1
M_3	18.96 (4.41)	21.29 (4.67)	22.80 (4.83)	24.01 (4.95)	22.70 (4.82)	7.2
M_4	17.84 (4.28)	12.65 (3.62)	13.92 (3.80)	15.22 (3.96)	13.93 (3.80)	43.0
M_5	17.55 (4.25)	13.41 (3.73)	9.44 (3.15)	8.44 (2.99)	10.43 (3.29)	57.3
M_6	18.29 (4.33)	6.11 (2.57)	5.88 (2.52)	5.64 (2.48)	5.88 (2.52)	76.0
M_7	17.89 (4.29)	4.97 (2.33)	4.08 (2.13)	4.37 (2.21)	4.48 (2.23)	81.7
M_8	17.15 (4.20)	7.31 (2.79)	6.94 (2.72)	7.31 (2.79)	7.19 (2.77)	70.6
M_9	20.86 (4.62)	23.26 (4.87)	23.78 (4.93)	26.31 (5.18)	24.45 (4.99)	-
CD at 5%	NS	0.35	0.23	0.21	0.32	-

*Square root transformed value

reported the effectiveness of acetamiprid 20 SP in reducing the leafhopper population in okra. Sangle *et al*. (9) observed that the chilli plots which received the spraying of acetamiprid 20 SP showed significantly minimum whitefly (0.58/leaf) population in comparison with other insecticidal treatments. From the experiment, it is also found that Neem oil treated plot was quite effective in leaf hopper (43.0% ROC) and whitefly reduction (42.8% ROC). The present findings are in agreement with the findings of Rosaiah (8) who reported that, the higher efficacy of neem oil @ 2% against the leaf hoppers found significantly superior by recording least leaf hopper population.

Spiders have a wide insect host range and act as biological control agents of different insect pests in okra agro-ecosystem. They are present throughout crop growth period. The mean populations of predator (spiders) after the insecticidal spray were presented in Table 4. Highest population of predators was found in the untreated plot (1.61/ plant) followed by the plots treated with module M_2 (1.60/plant and 1% ROC), module M_1 (1.48/ plant, 8.1% ROC), module M_3 (1.45/ plant, 9.9% ROC), module M_4 containing Neem oil (1.39/plant, 13.7% ROC), module M_5 containing buprofezin (1.28/plant, 20.5% ROC), module M_8 containing diafenthiuron (1.15/ plant, 28.6% ROC), module M_7 containing acetamiprid (0.93/plant, 42.2% ROC) and module M_6 containing triazophos 40 EC (0.64/plant, 60.2% ROC).

The pooled yield data over two years (Kharif, 2016 & 2017)) revealed that (Table 5) maximum yield was recorded in M_7 module i.e, seed treatment with Imidacloprid 600 FS @ 5 ml/kg of seed, installation of yellow sticky trap @ 50/ha and spraying of Acetamiprid 20 SP @ 0.3 gm/lit. of water whereas the lowest yield was recorded in untreated control. The highest benefit cost ratio (1.93) was found from the same module i.e from M_7 module. Gowdar *et al*., (4) also reported that two sprays of Acetamiprid 20 SP @ 40g a.i/ha. was effective in increased the yield of okra.

Hence, the integrated pest management module, which include seed treatment, use of insect trap and safer need based insecticide application in module M_7, *i.e.*, Seed treatment with imidacloprid 600 FS @ 5 ml/ kg of seed, installation of yellow sticky trap @ 50/ ha and spraying of acetamiprid 20 SP @ 0.3 g/l of water can be adopted for the better management of YVMV disease in west central table zone of Odisha.

Table 4. Effect of different module on the population of spiders in okra (Pooled data).

Module No.	No. /plant				Mean	ROC (%)
	1DBS	5DAS	10DAS	15DAS		
M_1	1.41 (1.55)*	1.46 (1.57)	1.51 (1.58)	1.54 (1.59)	1.48 (1.58)	8.1
M_2	1.53 (1.59)	1.55 (1.59)	1.62 (1.62)	1.71 (1.65)	1.60 (1.61)	0.60
M_3	1.37 (1.54)	1.42 (1.55)	1.48 (1.57)	1.52 (1.59)	1.45 (1.56)	9.9
M_4	1.39 (1.55)	1.34 (1.53)	1.38 (1.54)	1.45 (1.56)	1.39 (1.55)	13.7
M_5	1.41 (1.54)	1.30 (1.52)	1.16 (1.47)	1.23 (1.49)	1.28 (1.51)	20.5
M_6	1.36 (1.54)	0.33 (1.15)	0.40 (1.18)	0.45 (1.20)	0.64 (1.27)	60.2
M_7	1.33 (1.53)	0.62 (1.27)	0.68 (1.30)	1.08 (1.44)	0.93 (1.38)	42.2
M_8	1.42 (1.56)	0.98 (1.40)	1.05 (1.43)	1.14 (1.46)	1.15 (1.46)	28.6
M_9	1.49 (1.58)	1.58 (1.60)	1.60 (1.61)	1.77 (1.66)	1.61 (1.62)	-
CD at 5%	NS	0.19	0.11	0.13	0.11	

*Square root transformed value

Table 5. Effect of different module on yield in okra during kharif 2016 and 2017.

Module No.	Yield (q/ha)			Percent increase in yield over control	B:C ratio
	2016	2017	Pooled		
M_1	53.80	50.45	52.12	16.4	1.28
M_2	49.20	47.78	48.49	8.3	1.19
M_3	59.50	54.89	57.20	27.7	1.40
M_4	60.80	59.34	60.07	34.1	1.45
M_5	62.50	64.45	63.47	41.7	1.52
M_6	65.30	72.89	69.10	54.3	1.67
M_7	77.0	80.67	78.84	76.0	1.93
M_8	61.70	68.0	64.85	44.8	1.49
M_9	45.80	43.78	44.79	-	1.16
CD at 5%	12.98	7.63	17.90	-	-

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Received : July, 2019; Revised : May, 2020;
Accepted : June, 2020