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Efficacy study of some module based management packages against major sucking pest complex [jassid (*Amrasca biguttula biguttula* (Ishida) and whitefly (*Bemisia tabaci* (Gennadius)] on okra under lower gangetic alluvial zone of west Bengal

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Abstract
A field investigation was carried out during *kharif* 2017 at Central Research Farm, Bidhan Chandra Krishi Viswasvidyalaya, West Bengal to conduct a module based management package of practices against jassid and whitefly of okra. Seven treatments including untreated one was laid out under randomized block design. It was observed that all modules have significantly contributed for reducing the pest population between the range 57.41- 74.14% and 44.44- 67.24% against whitefly and jassid respectively. The management module comprising seed treatment with imidacloprid 70 FS @5g/kg seed followed by spraying of clothianidin, acetamiprid and acephate was found to be superior over all the treatments including control and also having the highest yield advantage (84.21%) over control.

Keywords: Jassid, whitefly, module management

1. Introduction

Okra (*Abelmoschus esculentus* L.) is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus and the southern United States. India ranks first in the world with 3.5 million ton (70% of the total world production) of okra production from 0.35 million ha land (FAOSTAT 2008). In India, West Bengal ranks first in production of okra followed by Bihar, Orissa, Andhra Pradesh, Gujarat, Jharkhand and Karnataka. Okra is cultivated for its fibrous fruits or pods containing round, white seeds. The fruits are harvested at immature stage and used mainly as culinary purposes. The roots and stems of okra are used for cleaning the cane juice from which gur or brown sugar is prepared [2].Okra is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery [7]. Its medicinal value has also been reported in curing ulcers and relief from haemorrhoids [1]. The major constraint in accelerating yield potential of okra is its susceptibility to a number of diseases and insect pest attack. About 72 species of insects have been recorded on okra plant [11]. The important insect pests responsible for limiting okra production are tissue borers, viz, shoot and fruit borer (*Earias sp*.), fruit borer (*Helicoverpa armigera*) and sap feeders, viz, leaf hopper (*Amrasca biguttula*), aphids (*Aphis gossypii* and *Myzus persicae*), whitefly (*Bemisia tabaci*) and red spider mite (*Tetranychus cinnabarinus*). Among these pests the most important is whitefly because it acts as a vector for spread of important viral diseases like yellow vein mosaic (YVMV) and elation leaf curl virus (OELCV). Krishnaiah (1980) [5] reported that about 40-56 per cent losses in okra due to leafhopper. Infection rate may reach up to 100% but in field, yield loss ranges between 50% to 94% depending on the stage of crop growth. Sastry and Singh (1974) [10] reported that if infection occurs in first 20 days after germination, the growth of plant stop, few leaves and fruits are formed and yield loss reaches up to 94% and with the increase in age of plant the rate of yield loss decreases due to pathogen. To tackle the pest menace, a number of chemical insecticides are liberally sprayed on this vegetable crop which leads to several problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. Due to the presence of pesticidal residues in the commodity there is also a risk of rejection of whole consignments during export. To overcome these problems, effective alternative ways of pest management without harming the ecosystem is the need of the hour. The present investigation was therefore, oriented to find out an eco-friendly approach towards management of pest population.

2. Materials and Methods

2.1 Experimental site

The experiment was carried out at Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, and West Bengal.

2.2 Experimental Details

The okra crop was raised during the summer season of 2017 following normal agronomical practices. The seeds of okra var Samrat were sown in plots of 3m x 2.5 m with a row to row and plant to plant spacing of 50cm x 30cm. The experiment was laid out in randomized block design with eight treatments. Each treatment was replicated thrice.

2.3 Details of the Modules under investigation:

Table 1.

Module		Insecticide with dose and time of application
M_1	i)	Seed treatment with Imidacloprid 70 FS @5g/kg seed
	ii)	Foliar spray with Difenthiauron 50% WP @500g a.i./ha at 20 days after sowing (DAS)
	iii)	Foliar spray with Propergite 57% EC @700g a.i./ha at 35 DAS.
	iv)	Foliar spray with Fipronil 5% SC @75-100g a.i./ha at 50 DAS.
M_2	i)	Seed treatment with Imidacloprid 70 FS @5g/kg seed.
	ii)	Foliar spray with Neem oil 0.03% @300 ppm /l of water at 20 DAS.
	iii)	Foliar spray with Karanjin 2% EC @2ml/l of water at 35 DAS.
	iv)	Foliar spray with Neemazal 10000ppm @ 3ml/l at 50 DAS.
M_3	i)	Seed treatment with Imidacloprid 70 FS @5g/kg seed.
	ii)	Foliar spray with Clothianidin 50% WDG @20-25g a.i./ha at 20 DAS.
	iii)	Foliar spray with Acetamiprid 20% SP @15g a.i./ha at 35 DAS.
	iv)	Foliar spray with Acephate 95% SG @300-400g a.i./ha at 50 DAS.
M_4	i)	Seed treatment with Thiomethoxam 70% WS @2.5g/kg seed.
	ii)	Foliar spray with Neemzyme @2.5ml/l of water 20 days after sowing (DAS)
	iii)	Foliar spray with Acephate 95% SG @300-400g a.i./ha at 35 DAS.
	iv)	Foliar spray with Profenophos 50% EC @500g a.i./ha at 50 DAS.
M_5	i)	Seed treatment with Thiomethoxam 70% WS @2.5g/kg seed.
	ii)	Foliar spray with Chlorfenapyr 10% EC @75-100g a.i./ha at 20 DAS.
	iii)	Foliar spray with Flonicamid 50% WG @75g a.i./ha at 35 DAS.
	iv)	Foliar spray with Difenthiauron 50% WP @500g a.i./ha at 50 DAS.
M_6	i)	Seed treatment with Thiomethoxam 70% WS @2.5g/kg seed.
	ii)	Foliar spray with NSKE 5% @5gm/l of water at 20 DAS.
	iii)	Foliar spray with Neemzyme @2.5ml/l of water 35 days after sowing (DAS).
	iv)	Foliar spray with Neemzyme @2.5ml/l of water 50 days after sowing (DAS)
M_7	i)	Seed treatment with neem oil 0.03% @300 ppm.
	ii)	Foliar spray with Karanjin 2% EC @2ml/l of water at 20 DAS.
	iii)	Foliar spray with Garlic bulb extracts @75g/l of water at 35 DAS.
	iv)	Foliar spray with Tobacco leaf extract 2% @20g/l of water at 50 DAS.
M_8		Untreated control.

2.4 Methodology

Seven modules with an untreated check were tested for effective management of whitefly and jassid population in okra. Seeds were treated with various chemicals according the modules. Other pre scheduled pesticidal spraying were done at 20, 35, 50 days after sowing. High volume knapsack sprayer was used for spraying insecticides.

2.5 Preparation of botanicals

Preparation of Garlic Bulb Extract

Two Garlic bulbs were taken and grounded by the grinder. The mixture was allowed to stand for 24 hours. Then four cups of water and few drops of soap as sticker were added to this mixture for spray.

Application methodology

One part of the emulsion was diluted with nine parts of water and shaken well before using. The emulsion was sprayed thoroughly on the infested plant, preferably early in the morning.

2.6 Observation

- Population of whitefly and jassid were recorded at one day before spraying, 1DAS, 3 DAS, 7DAS and 10 DAS (Days after spraying) from randomly selected five plants per plot for all consecutive three spraying including control.
- Pest population was recorded from one leaf at three different canopy i.e. (top, middle and bottom) level of such plants.

2.7 Fruit yield estimation of okra

At each picking, the weight of fruits were recorded per plot and computed on hectare basis. The yield data were subjected to statistical analysis, for comparing efficacy of various treatments.

$$\%\text{Reduction over control} = \frac{(\text{Mean Population in control- Mean population in treatment}) \times 100}{(\text{Mean population in control})}$$

2.8 Statistical analysis
The data on the pest population were subjected to analysis of variance after making necessary transformation wherever required by using SPSS software.

3. Results and Discussion
Several chemicals and botanicals were evaluated against the whitefly and jassid of okra under field conditions. There were seven types of combination of chemicals including botanicals and these were applied against these sucking pests to know the efficacy of the best module with respect to yield attribute.

3.1 Effect of different modules on the population of Jassid (*Amrasca biguttulla biguttulla*)
The data were presented in the Table 2 and on the basis of the mean data of thirteen observations recorded at different dates after application. Population of jassid per three leaves in different treated plots ranged from 2.95 to 11.40. Among the modules, the third one (M_3) was found most effective against jassid population where the least mean population (2.95/3 leaves) was observed followed by 3.40 Jassid/three leaves against the fourth module (M_4). While solely dependent on bio control agents (M_7) in reducing the jassid population seemed to be the third best treatment with the mean jassid population of 3.70/ three leaves. The remaining all modules have significantly superior effect over control.

3.2 Effect of different treatments on the population of Whitefly (*Bemisia tabaci*)
The data presented in the Table3, revealed that all the treatments significantly contributed in reducing the whitefly population. Population of whitefly recorded among different treated plots ranged from 2.29 to 6.98 against control. Among them third module (M_3) was found superior against whitefly population with a mean of 2.29/three leaves followed by the fourth module (M_4) (2.64/three leaves). Here also the application of bio-control components (M_7) against the whitefly population seems to third best treatment with the mean population of 2.92 per three leaves.
The seed treatment chemical viz., Imidacloprid 70 WS provided excellent protection against Jassid upto 50 days after sowing, keeping jassid population below ETL. Whereas, Thiamethoxam 70 WS proved promising upto 45 DAS. These studies are in confirmation with the findings of Dey *et al.* (2005) [3] who reported that Imidacloprid 70 WS at 5, 7.5 and 10 g/kg seeds proved excellent protection against Jassid upto 45 days after sowing in okra. The efficacy of Acetamiprid and Imidacloprid reducing the whitefly population has been documented by Raghuraman and Gupta (2005) [8] and foliar application of Acetamiprid for effective control of whitefly upto 10 days after spraying was documented by Horowitz *et al.* (1998) [4]. Muhammad Anjum Ali *et al* (2005) [6] also reported Imidacloprid and Thiomethoxam to be effective in controlling the whitefly population.

3.3 Yield estimation
Statistically significant variation in yield was observed among different treatment modules in managing whitefly and jassid on okra (Table 4). The highest yield (96.25 q/ha) was recorded against third module which has 84.21% yield advantage over control followed by the fourth one (92.50 q/ha) while in module solely based one bio-control agents have a 59.80% yield advantage with the production of 83.50 q/ha. The control plot produced only 52.25q okra/ha.

Table 2: Effects of various treatment modules over Jassid population on okra

Modules	Population of Jassid per three leaves														Percent Reduction Over control
		1st Spray				2nd Spray				3rd Spray				Mean	
	1DBS	1DAS	3DAS	7DAS	10DAS	1DAS	3DAS	7DAS	10DAS	1DAS	3DAS	7DAS	10DAS		
M_1	12.22	5.89	3.89	6.23	8.07	3.67	3.22	4.56	5.89	3.89	2.89	4.89	4.22	4.86	57.41%
	(3.75)	(2.53)	(2.10)	(2.59)	(2.93)	(2.04)	(1.93)	(2.25)	(2.53)	(2.09)	(1.84)	(2.32)	(2.17)	(2.31)	
M_2	13.00	4.78	2.63	5.67	6.99	2.91	2.36	4.00	4.71	2.89	2.11	3.89	3.45	3.98	65.12%
	(3.81)	(2.30)	(1.77)	(2.48)	(2.74)	(1.85)	(1.69)	(2.12)	(2.28)	(1.84)	(1.62)	(2.09)	(1.96)	(2.12)	
M_3	13.11	3.78	1.89	4.22	5.29	2.21	1.33	3.00	3.66	1.82	1.22	2.78	3.33	2.95	74.14%
	(3.78)	(2.07)	(1.54)	(2.17)	(2.41)	(1.58)	(1.35)	(1.87)	(2.04)	(1.52)	(1.31)	(1.79)	(1.95)	(1.86)	
M_4	11.78	4.33	2.22	5.00	6.00	2.54	1.67	3.78	3.89	2.11	1.44	3.00	3.67	3.40	70.16%
	(3.55)	(2.20)	(1.65)	(2.35)	(2.55)	(1.74)	(1.47)	(2.07)	(2.10)	(1.61)	(1.39)	(1.39)	(2.10)	(1.98)	
M_5	11.90	5.22	3.30	5.78	7.11	3.22	3.19	3.89	5.22	3.22	2.44	4.11	3.89	4.30	62.28%
	(3.75)	(2.39)	(1.95)	(2.51)	(2.76)	(1.93)	(1.92)	(2.10)	(2.39)	(1.93)	(1.72)	(2.14)	(2.12)	(2.19)	
M_6	12.67	5.67	3.44	5.89	7.56	3.33	2.67	4.33	5.11	3.56	2.67	4.59	4.00	4.49	60.63%
	(3.94)	(2.48)	(1.99)	(2.53)	(2.84)	(1.96)	(1.78)	(2.20)	(2.37)	(2.01)	(1.78)	(2.18)	(2.09)	(2.23)	
M_7	10.45	4.67	2.33	5.30	6.77	2.68	2.21	3.89	4.11	2.23	1.67	3.33	3.89	3.70	67.51%
	(3.65)	(2.27)	(1.68)	(2.41)	(2.70)	(1.78)	(1.65)	(2.09)	(2.15)	(1.65)	(1.47)	(1.47)	(2.06)	(2.05)	
M_8	11.78	13.63	14.44	13.89	12.67	12.33	10.89	11.67	11.44	10.33	9.67	10.00	8.89	11.40	
(control)	(3.63)	(3.76)	(3.87)	(3.79)	(3.63)	(3.58)	(3.37)	(3.49)	(3.46)	(3.29)	(3.19)	(3.19)	(3.71)	(3.45)	
SEM	0.11	0.08	0.10	0.07	0.14	0.11	0.9	0.06	0.07	0.09	0.10	0.09	0.10		
CD	NS	0.25	0.28	0.20	0.41	0.33	0.28	0.18	0.19	0.25	0.29	0.27	0.30		

NB: DBS- Days before sowing, DAS- Days after sowing
Figures in the parentheses are square root transformed value

Table 3: Effects of various treatment modules over Whitefly population on okra

Modules	Population of Whitefly per three leaves														Percent Reduction Over control
	1DBS	1st Spray				2nd Spray				3rd Spray				Mean	
		1DAS	3DAS	7DAS	10DAS	1DAS	3DAS	7DAS	10DAS	1DAS	3DAS	7DAS	10DAS		
M_1	6.78 (2.70)	4.55 (2.25)	4.00 (2.12)	4.45 (2.22)	5.00 (2.35)	3.78 (2.07)	3.22 (1.93)	4.11 (2.15)	4.67 (2.27)	3.11 (1.90)	3.33 (1.96)	2.44 (1.72)	2.56 (1.75)	3.88 (2.14)	44.44%
M_2	6.78 (2.70)	3.78 (2.07)	3.11 (1.90)	3.89 (2.10)	4.55 (2.25)	3.11 (1.90)	2.33 (1.68)	3.18 (1.92)	4.00 (2.12)	2.60 (1.76)	2.11 (1.62)	2.63 (1.77)	2.33 (1.68)	3.14 (1.98)	55.08%
M_3	7.22 (2.78)	2.89 (1.84)	2.11 (1.62)	3.00 (1.87)	3.56 (2.01)	2.33 (1.68)	1.33 (1.35)	2.44 (1.72)	3.78 (2.07)	1.67 (1.47)	1.00 (1.22)	1.56 (1.43)	1.78 (1.51)	2.29 (1.88)	67.24%
M_4	6.44 (2.63)	3.44 (1.99)	2.33 (1.68)	3.55 (2.01)	4.00 (2.12)	2.44 (1.72)	1.89 (1.55)	2.78 (1.81)	3.87 (2.09)	2.00 (1.58)	1.22 (1.31)	2.00 (1.58)	2.16 (1.63)	2.64 (1.87)	62.18%
M_5	6.67 (2.68)	4.33 (2.20)	3.44 (1.99)	4.00 (2.12)	4.78 (2.30)	3.45 (1.99)	2.67 (1.78)	3.33 (1.96)	4.22 (2.17)	2.78 (1.81)	3.00 (1.87)	2.41 (1.70)	2.45 (1.72)	3.41 (2.08)	51.23%
M_6	6.78 (2.70)	4.44 (2.22)	3.89 (2.10)	4.22 (2.17)	4.89 (2.32)	3.56 (2.01)	2.78 (1.81)	3.89 (2.10)	4.33 (2.20)	3.00 (1.87)	3.00 (1.87)	2.78 (1.81)	2.63 (1.77)	3.62 (2.12)	48.19%
M_7	6.55 (2.66)	3.78 (2.07)	3.00 (1.87)	3.67 (2.04)	4.33 (2.20)	2.67 (1.78)	2.19 (1.64)	3.00 (1.87)	4.00 (2.12)	2.33 (1.68)	1.33 (1.35)	2.33 (1.68)	2.44 (1.72)	2.92 (1.99)	58.12%
M_8 (control)	6.67 (2.68)	7.67 (2.86)	7.78 (2.88)	7.33 (2.80)	7.00 (2.74)	7.22 (2.78)	7.00 (2.74)	7.11 (2.76)	7.67 (2.86)	7.33 (2.80)	6.89 (2.72)	5.56 (2.46)	5.22 (2.39)	6.98 (2.73)	
SE(m)	0.17	0.11	0.05	0.13	0.10	0.10	0.17	0.10	0.07	0.12	0.10	0.06	0.07		
CD	NS	0.31	0.15	0.39	0.29	0.29	0.49	0.31	0.19	0.36	0.29	0.18	0.22		

NB: DBS- Days before sowing, DAS- Days after sowing
Figures in the parentheses are square root transformed values

Table 4: Yield over various treatment modules

Modules	Yield (q/ha)	Yield increase over Control (%)
M_1	64.50	23.44
M_2	78.50	50.23
M_3	96.25	84.21
M_4	92.50	77.03
M_5	72.50	38.75
M_6	68.00	30.14
M_7	83.50	59.80
M_8(control)	52.25	-
SE (m)	2.18	-
C.D.	6.68	-

4. Conclusion
From the present findings it can be concluded that the third module (comprising of seed treatment with Imidacloprid 70 FS @ 5g/kg seed followed by spraying of Clothianidin 50% WDG @20-25g a.i./ha, Acetamiprid 20% SP @15g a.i./ha and Acephate 95% SG @300-400g a.i./ha at 20, 35 and 50 days after sowing respectively) contributes the maximum reduction in jassid and whitefly population by 74.14% and 67.24% respectively and also having 84.21% yield advantage over control followed by fourth module while the module consists solely on bio organism contributes third best treatment.

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