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ASSESSMENT OF IPM MODULES AGAINST INSECT PESTS OF OKRA

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ABSTRACT

Field experiments at two locations were conducted for the validation of IPM modules against sucking and borer pests of okra. In both locations, the proposed IPM module led to the least incidence of sucking pests viz., leafhopper *Amrasca biguttula biguttula* (Ishida), whitefly *Bemisia tabaci* (Gennadius) and aphid *Aphis gossypii* Glover (1.63, 2.41 and 0.79/ leaf, respectively). The leastshoot and fruit damage caused by *Earias* spp. was in the IPM and BIPM modules (4.67-4.81; 7.65-8.01%, respectively). Thus, IPM module was found to be effective with maximum reduction of both sucking and borer pests, which led to the maximum cost-benefit ratio of 1:8.34.

Key words: Okra, *Amrasca biguttula biguttula, Bemisia tabaci, Aphis gossypii, Earias* spp., IPM, BIPM modules, cost-benefit ratio.

Okra (*Abelmoschus esculentus*) is an important vegetable and it is regarded as a vital nutritional component of the human diet (Anonymous 2019a). Major constraint in okra production are insect pests causing yield loss of 32.06 to 94.00%, mainly due to the sucking pests- leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly *Bemisia tabaci* (Gennadius) and aphid *Aphis gossypii* Glover; 17.46 to 48.00% loss due to two-spotted mite, *Tetranychus urticae* (Koch) and avoidable yield loss of 36.00- 90.00% by *Earias* spp. are estimated (Sastry and Singh, 1974; Chaudhary and Dadeech, 1989; Singh and Brar, 1994; Misra et al., 2002; Kumaran et al., 2007). To manage these, farmers resort to indiscriminate use of broad-spectrum pesticides resulting in many hazards like resistance to insecticides, secondary pest outbreaks, phytotoxicity, toxicity to beneficial organisms, intoxication of farm personnel and environmental pollution like contamination of groundwater (Birah et al., 2012; Halder et al., 2014); this is in addition to the residue problems in fruits (Anonymous, 2019b). Based on the survey conducted among major okra growing districts of Tamil Nadu, only 13.33% of okra farmers were practicing IPM (Meenambigai, 2017a). The use of newer generation pesticides, along with the economics of IPM is of paramount importance from the farmer's point of view. This study evaluates two IPM modules comprising seed treatment, botanicals, biocontrol agents such as microbial, parasitoids and predators, and novel insecticides along with their cost: benefits.

MATERIALS AND METHODS

The field experiment was carried out in farmer's field at two locations, Narasipuram (10°99'35"N,76°75'71"E, 488 masl- location I) and Thondamuthur (10°99'47"N, 76°83'28"E, 450 masl- location II), in Coimbatore district of Tamil Nadu, India. Okra seeds (CO 4 hybrid) were sown in a flat bed with a spacing of 45x 30 cm during kharif 2017. The crop was raised by following Tamil Nadu Agriculture University (TNAU) recommended agronomic practices except for plant protection measures. The experiment was laid out in a randomized complete block design (RCBD) with five replicates in a plot size of 100 m^2. Each replication was separated by a 2 m alley to serve as buffer zone. Three IPM modules were formulated and evaluated along with untreated control. Farmer's routine module (M_3) was formulated based on the preliminary survey on pesticide usage patterns in major okra growing districts of Tamil Nadu (Meenambigai et al., 2017b). Biocontrol agents used were procured from the Department of Agricultural Entomology, TNAU, and pesticides were procured from local shops. IPM module (M_1) comprised of seed treatment with imidacloprid 600FS (48% w/w) @ 5 mL kg^{-1} seed; sowing of maize as border crop; installation of yellow sticky trap 15 cm above the crop canopy @ 24 traps ha^{-1} at 30 DAS; release of *Chrysoperla zastrowi sillemi* (Esben-Peterson) eggs @ 5000 ha^{-1} at 30 DAS; release of *Trichogramma chilonis* Ishii (5 releases at weekly interval) @ 1,00,000 ha^{-1} from 30

DAS; collection and destruction of affected shoots; installation of pheromone traps (Ervit® lure traps) @ 10 traps ha^{-1}; spraying of neem seed kernel extract (NSKE) 5% at 30 and 50 DAS; imidacloprid 200 SL (17.8% w/w) @ 0.2 ml l^{-1} at 25 and 35 DAS, dimethoate 30 EC @ 2 ml l^{-1} at 40 DAS and emamectin benzoate 5 SG @ 0.4 g l^{-1} at 45 and 55 DAS; Biointensive pest management (BIPM) module (M_2) comprised of all the components from IPM module except seed treatment with imidacloprid and spraying of imidacloprid and dimethoate. Instead, spraying of *Bacillus thuringiensis* var *kurstaki* (18000 IU mg^{-1}) @ 2 ml l^{-1} at 35 DAS was included. Farmer's routine module ($M_{3)}$ comprised of spraying of imidacloprid 200 SL (17.8 SL) @ 1 ml l^{-1} at 30 and 40 DAS, dimethoate 30 EC @ 2ml l^{-1} + acephate 75 SP @ 1 g l^{-1} at 35 and 45 DAS, flubendiamide 480 SC (39.95% w/w) @ 1 ml l^{-1} at 40 and 50 DAS. In unprotected control module (M_4) no IPM practices were followed.

Observations on *A. biguttula biguttula* (15 DAS), *A. gossypii* and *B. tabaci* (25 DAS) were recorded after the first appearance from the abaxial surface of the leaf at the top, middle and bottom of the canopy at 6 AM. These were monitored at ten days interval from ten randomly selected plants/ replication. The mean incidence of these was calculated/ leaf/ replication for each treatment and the overall mean computed for the entire crop duration. Shoot and fruit damages were recorded in ten randomly selected plants. Shoot damage was recorded from 35 DAS to the end of crop duration and expressed as the overall mean %. Fruit damage was recorded at the time of every harvest and the mean % damage was worked out on a weekly basis (three pickings/ week) and expressed as the overall mean %. The cumulative yield of all the pickings was computed and expressed in kg/ plot and finally computed as q/ ha. The economics in terms of cost-benefit (C: B) analysis was calculated. Data on incidence of pest from the two locations separately, as well as pooled ones, were subjected to ANOVA (Gomez and Gomez, 1984). Pair-wise comparisons were performed by using Least Significant Difference (LSD) test (p=0.05). Statistical analysis of data was carried out in STAR version 2.0.1 software (IRRI, Los Banos, Philippines)

RESULTS AND DISCUSSION

The results revealed that in both the locations, significant differences were observed in the incidence of *A. biguttula biguttula* (F=98.12, df= 3, 12, $p <$ 0.0001; F=83.45, df=3,12, $p < 0.0001$), *A. gossypii* (F=171.78, df= 3, 12, $p < 0.0001$; F=42.05, df=3,12, $p < 0.0001$), and *B. tabaci* (F=12.94, df= 3, 12, $p <$ 0.0005; F=53.68, df=3, 12, $p < 0.0001$). With pooled data also similar results were obtained. IPM module (M_1) registered the lowest incidence of *A. biguttula biguttula*, *A. gossypii,* and *B. tabaci* (1.63, 2.41 and 0.79/ leaf, respectively. A similar trend of shoot and fruit damage were noticed in both locations (Table 1). Reduction of sucking pests over control was highest (64.57 to 76.68%) in the IPM module, followed by chemical control (51.63 to 68.39%) and BIPM (36.68 to 52.06%). Thus, IPM module (M_1) was significantly superior. Seed dressing with imidacloprid controlled *A. biguttula biguttula*, *A. gossypii,* and *B. tabaci* for up to 40 - 50 days after germination (early growth period) in okra crop (Venkataravanappa et al., 2011; Singh et al., 2014; Verma et al., 2014). Dipankar et al. (2020) reported that the IPM module comprising seed treatment with imidacloprid 600 FS @ 5 ml kg^{-1} per seed, installation of yellow sticky trap @ 50 ha^{-1} and spraying of acetamiprid 20 SP @ 0.3 g l^{-1} was most effective against, *A. biguttula biguttula* and *B. tabaci* in okra. The release of *C. carnea* and the usage of neem products resulted in an effective reduction of sucking pests in okra (Praveen and Dhandapani 2001). Preetha and Nadarajan (2007) observed maximum suppression of sucking pests of okra in the IPM module consisting of seed treatment with imidacloprid, release of *T. chilonis* and *Chrysoperla* eggs, installation of pheromone traps and spraying of *Bacillus thuringiensis.* Patel et al. (2009) and Birah et al. (2010) observed reduced incidence of *A. biguttula biguttula* and *B. tabaci* with a module consisting of maize border crop, seed treatment with imidacloprid and foliar application of neem oil/ NSKE. Highly significant differences in mean shoot damage (F = 111.98, df = 3, 12, $p < 0.0001$; F = 95.09, df = 3,12, $p < 0.0001$) and fruit damage (F = 283.86, df = 3, 12, $p < 0.0001$; F = 275.28, df =3,12, $p < 0.0001$) were observed among the treatment modules. With pooled data also similar results were obtained. Both IPM (M_1) and BIPM (M_2) modules were found to be superior with mean % shoot damage being 4.67 and 4.81, respectively, while it was 7.65 and 8.01, respectively with fruit damage. Maximum reduction of shoot and fruit damage was recorded from both IPM (65.07% and 72.59%) and BIPM (64.01% and 71.29%) modules (Table 1). Preetha and Nadarajan (2006) obtained maximum suppression of shoot and fruit borer in the module consisting of release of *T. chilonis* and *Chrysoperla*, installation of pheromone trap and spraying of *B. thuringiensis.* Birah et al. (2012) reported that the biointensive IPM module comprising imidacloprid, maize as barrier crop, clipping off deadhearts and foliar sprays of NSKE was the most

Table 1. Efficacy and cost benefit of IPM modules against major insect pests of okra

Treatment	*Mean *A. biguttula biguttula*/ leaf			*Mean *A. gossypii*/ leaf			*Mean *B. tabaci*/ leaf			*Mean shoot damage (%)			*Mean fruit damage (%)		
	L I	L II	Pooled	L I	L II	Pooled	L I	L II	Pooled	L I	L II	Pooled	L I	L II	Pooled
M_1-IPM	1.56^d	1.70^d	1.63^d	2.24^d	2.57^c	2.41^d	0.79^c	0.79^d	0.79^c	3.74^c	5.60^c	4.67^c	7.00^c	8.29^c	7.65^c
	(1.24)	(1.29)	(1.27)	(1.57)	(1.70)	(1.64)	(0.87)	(0.89)	(0.88)	(1.93)	(2.37)	(2.16)	(2.65)	(2.88)	(2.77)
M_2-BIPM	3.37^b	3.34^b	3.35^b	4.28^b	4.87^b	4.58^b	1.40^b	1.40^b	1.40^b	3.86^c	5.77^c	4.81^c	7.37^c	8.65^c	8.01^c
	(1.84)	(1.84)	(1.84)	(2.05)	(2.18)	(2.12)	(1.17)	(1.18)	(1.18)	(1.96)	(2.40)	(2.19)	(2.65)	(2.88)	(2.83)
M_3- Farmer's routine	2.16^c	2.27^c	2.21^c	2.92^c	3.23^c	3.07^c	1.06^b	1.08^c	1.08^b	6.40^b	9.61^b	8.01^b	13.93^b	16.61^b	15.27^b
	(1.43)	(1.52)	(1.48)	(1.71)	(1.84)	(1.77)	(1.10)	(1.04)	(1.07)	(2.53)	(3.10)	(2.83)	(3.73)	(4.08)	(3.91)
M_4-Control	6.95^a	7.05^a	7.00^a	6.83^a	7.63^a	7.23^a	2.27^a	2.23^a	2.23^a	9.88^a	14.81^a	13.37^a	26.04^a	29.77^a	27.90^a
	(2.63)	(2.65)	(2.64)	(2.54)	(2.69)	(2.62)	(1.49)	(1.49)	(1.49)	(3.14)	(3.85)	(3.66)	(5.10)	(5.46)	(5.28)
SEd	0.0948	0.1016	0.0695	0.0962	0.1029	0.0704	0.0948	0.1016	0.0695	0.0962	0.1029	0.0704	0.0948	0.1016	0.0695
CD (p=0.05)	0.2067	0.2214	0.1434	0.1594	0.2243	0.1454	0.2067	0.2214	0.1434	0.1594	0.2243	0.1454	0.2067	0.2214	0.1434

Economics/ cost benefits

Treatment module	Yield of healthy fruits (q ha^{-1})	Increase in yield over control (q ha^{-1})	Increase in yield over control (%)	Cost of increased yield (Rs ha^{-1})	Cost of treatment (Rs ha^{-1})	Net profit (Rs ha^{-1})	Cost: benefit ratio (BCR)
M_1-IPM	193.51	102.79	110	123349	13200	110149	1:8.34
M_2-BIPM	167.83	77.11	85	92533	12000	80533	1:6.71
M_3- Farmer's routine	168.37	77.65	86	93176	10403	82773	1:7.96
M4-Control	90.72						

*Overall mean incidence during entire crop duration; L I= location I (N=5); L II = location II (N=5); Values in parentheses are square root transformed values; Means with the same letter in the same column are not significantly different ($p \leq 0.05$, LSD test). Spray volume = 500 l ha^{-1}; Cost of okra was Rs. 1200 q^{-1}

effective module. Similarly release of *T. chilonis* and *C. carnea* registered with 70.30% reduction in boll damage in cotton than modules containing insecticides alone (Brar et al., 2001). Gautam et al. (2013) observed the efficacy of damage (18.8%) in okra treated with NSKE 5%. Neem preparations were found relatively safe against predators and parasitoids such as *C. carnea* and *T. chilonis* compared with pesticides. Conservation of natural enemies could have in turn led to reduction of pests (Rao and Raguraman, 2005). The pest *E. vitella* was effectively suppressed giving highest yield with emamectin benzoate 5 SG (Laichattiwar and Meena, 2014; Dhaker et al., 2017). Javed et al. (2019) observed that IPM and BIPM modules were effective and contributed for least shoot and fruit damage.

The IPM module registered a highest marketable fruit yield (193.51 q ha^{-1}) giving maximum cost-benefit ratio of 1:8.26 followed by the farmer's routine module (1:7.59). Though a nearly similar yield was recorded from the BIPM and the farmer's routine module, the use of a few relatively low-cost conventional pesticides in the farmer's routine module led to a higher C: B ratio as compared to the BIPM module (1:6.71) (Table 1). Mohankumar et al. (2016) observed that IPM approach was effective against insect pests giving maximum cost: benefit ratio of 1: 2.53 to 1: 3.23 in okra. Borkakati et al. (2020) observed maximum yield and cost: benefit ratio (1: 8.46) in the IPM plot, although the population of *A. biguttula biguttula* and *B. tabaci* were recorded minimum in the chemical module (1: 7.98). Thus, in both locations, the proposed IPM module (M_1) was found superior with highest yield and cost-benefit ratio.

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AUTHOR CONTRIBUTION STATEMENT

K Bhuvaneswari conceptualized the research work, designed the experiments, read and approved the manuscript; C Meenambigai executed field experiments, collected, analyzed and interpreted the data, and prepared the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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