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Management of fruit flies infesting muskmelon through eco-friendly modules

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ABSTRACT: Three different fruit fly management modules were evaluated in muskmelon during the *kharif,* 2018 and *rabi,* 2018-19 at College of Horticulture, Anantharajupeta. The eco-friendly module II (IPM) which is the integration of different aspects *viz*., maintenance of field sanitation, poison baiting with rotten banana, bait spray of deltamethrin mixed with jaggery at flowering, installation of cue lure traps from fruit set onwards, spray of 5% NSKE and malathion at 40 and 60 DAS respectively is the most effective and economical method for the management of fruit flies in muskmelon crop with lower fruit fly infestation (18.58%) and higher returns (BC ratio 2.8). Further, quality analysis results indicated that, average fruit weight, TSS were highest (1.27 Kg, 11.39º) in module II. Finally from the above results it can be concluded that the effectiveness of the three fruit fly management modules lies in the order of IPM > Organic IPM > Farmers practice.

Keywords: muskmelon, fruit fly, *Zeugodacus cucurbitae*, management, eco-friendly module

INTRODUCTION

Muskmelon (*Cucumis melo* L.) is an important horticultural crop in India and worldwide, and plays an important role in international trade. In India, muskmelon is grown in 60,000 hectares with a production of 1312 thousand MT with a productivity of 21.9 tonnes/ha (Anonymous, 2020-21). In Andhra Pradesh muskmelon is grown in an area of 2466 ha with a production of 600 thousand MT (Anonymous, 2019-20). Melon fruit fly, *Zeugodacus cucurbitae* damages over 81 plant species, but plants belonging to the family cucurbitaceae are the most preferred hosts (Allwood *et al.*, 1999). Depending on the environmental conditions and susceptibility of the crop species, the extent of yield loss varies from 30 % to 100 % (Shooker *et al.*, 2006). The pest was reported to cause damage to an extent of 28.55% in watermelon, 77.03 % in bitter gourd, 75.65 % in ridge gourd, 73.83 % in cucumber and 63.31 % in pickling cucumber and 100% damage in cucumber (Krishna Kumar *et al.*, 2006 ; Vignesh and Shashidhar, 2015). This pest has been a major limiting factor in obtaining good quality fruits and high yield of cucurbitaceous vegetables. Female flies prefer to oviposit on soft tender, physiologically ripen fruit tissues puncturing with it's ovipositor, watery fluid oozes out from the punctures, which later transform into dry resinous deposit. The pseudopunctures (punctures without eggs) also reduce the market value. The maggots feed on mature fruits internally but sometimes also feed on young fruits and flowers. The affected fruits are softened, discolored and drop off prematurely, finally losing market value. The maggots of the pest remain inside the infested fruits and the adults are free living. They visit fruits only at the time of oviposition and left immediately after egg deposition. So the control of the pest can hardly be assured. Management of this pest using chemical insecticides is not possible and only integrated pest management is the best available alternative. The present study was aimed to evaluate various management modules against fruit flies in muskmelon.

MATERIALS AND METHODS

Field experiments were conducted during the two seasons; *kharif,* 2018 and *rabi,* 2018-19 at experimental farm, College of Horticulture, Anantharajupeta, Andhra Pradesh, India to evaluate the effectiveness of three different management modules against fruit flies in muskmelon. All the recommended agronomical practices were followed to raise good crop. Three different modules as given under

Module-I (Farmer's practices)

a. Spray of imidacloprid 17.8 SL @ 0.5 ml/l of water at 30 days after sowing (DAS).
b. Spray of dichlorvos 76 EC @ 1 ml/l of water at 45 DAS.
c. Spray of malathion 50 EC @ 2 ml/l of water at 60 DAS.
d. Installation of cuelure traps (4/acre) from fruit set onwards.

Module-II (IPM)

a. Field sanitation (Removal of affected fruits, dried and damaged plant parts, regular soil raking, weed free maintenance etc.).
b. Poison bait consisting of rotten banana/pumpkin pulp 1000g + Yeast 10g + malathion 10ml + citric acid 3g

Table 1. Bio efficacy of different fruit fly modules against fruit fly, *Z. cucurbitae* infesting muskmelon during the two the seasons

Module	Fruit infestation (%)			No. of maggots/fruit			Yield (q/ha)			Economics	
	kharif 2018	*rabi* 2018-19	Pooled	*kharif* 2018	*rabi* 2018-19	Pooled	*kharif* 2018	*rabi* 2018-19	Pooled	Net Returns (Rs)	B:C ratio
Module I (Farmers practice)	38.21 (38.15)^{c}	33.53 (35.38)^{b}	35.87 (36.74)	13.93^{b}	15.25^{c}	14.59^{c}	112.80^{a}	127.68^{a}	120.2^{a}	109,179	1.8
Module II (IPM)	20.73 (27.06)^{a}	16.43 (23.56)^{a}	18.58 (25.42)	8.92^{a}	4.64^{a}	6.63^{a}	168.20^{c}	165.03^{c}	166.23^{c}	172,171	2.8
Module III (Organic IPM)	24.88 (29.88)^{b}	17.04 (24.05)^{a}	20.96 (27.22)	7.84^{a}	7.00^{b}	7.42^{b}	145.60^{b}	147.72^{b}	146.66^{b}	147,103	2.5
S Em ±	0.86	1.17	0.77	0.71	1.09	0.73	4.99	5.27	5.14		
CD (p=0.05)	2.64	3.60	2.36	2.18	3.34	2.26	15.34	16.28	15.81		

Figures in the parenthesis are arc sin transformed values

kept in an earthen pot to attract the adult flies from fruit set onwards.

c. Bait spray consisting of deltamethrin 2.8 EC @ 1ml/l mixed with jaggery 15g from flowering onwards.
d. Installation of cuelure traps (6/acre) from fruit set onwards.
e. Spray of NSKE 5% at 40 DAS.
f. Spray of malathion 50EC @ 2 ml per litre of water at 60 DAS

Module-III (Organic IPM)

a. Seed treatment with beejamrutham.
b. Growing of jowar as border crop (4 rows, sown 15 days before the main crop)
c. Field sanitation (Removal of affected fruits, dried and damaged plant parts, regular soil raking, weed free maintenance etc.).
d. Spray of NSKE 5% at 20 DAS.
e. Spray with jeevamrutham at 35 DAS.
f. Spraying with pongamia soap/neem soap @ 10g/l at 45 DAS.
g. Spray of spinosad 45 SC @ 0.375 ml/l at 60 DAS.

Method of observations recording

All the recommended agronomic practices (e.g. weeding, fertilization, hoeing, etc.) were performed equally in each experimental bed. Adequate distance between two plots was maintained. The muskmelon plot allotted to module-1and II was kept 100 m away from module III. Three harvestings of the fruits were done in each growing season of muskmelon. For recording data on fruit fly infestation, randomly 20 fruits were selected in each module. The infested fruits were sorted and the percent fruit infestation and number of maggots/ fruit were calculated. The total treatmental yield, total marketable yield of all the replications were calculated from different pickings and final cost benefit ratio for the three management modules was worked out. The retail price of each insecticide, labour wages were taken into consideration for computing total cost of cultivation in different management modules. Quality parameters like average fruit weight, total soluble solids and acidity were also worked out for comparison in different modules. The per cent fruit infestation and number of larvae/ fruit (Level of incidence/ larval density per fruit) were calculated using the following formulae.

Final fruit yield was calculated by adding the total harvest attained from all the harvests in individual plot and converted into per hectare yield. The benefit cost ratio was calculated on the basis of net returns from each module and the total cost incurred towards different components of each modules.

Benefit-Cost ratio

The cost of the individual components of the modules *viz*., field sanitation, pheromone traps setting, poison baiting, border crop, organic solutions preparation and pesticides spray and cost for their timely implementation were worked out separately and returns per hectare were worked for different modules. The data were computed

Table 2. Effect of fruit fly management modules in muskmelon on various quality parameters of the fruits

Module	Average fruit weight (Kg)			Total soluble solids (°B)			Acidity (%)		
	kharif, 2018-19	*rabi*, 2018-19	Pooled	*kharif*, 2018-19	*rabi*, 2018-19	Pooled	*kharif*, 2018-19	*rabi*, 2018-19	Pooled
Module I (Farmers practice)	0.93	0.93	1.23	9.50	9.80	9.65	0.59	0.65	0.62
Module II (IPM)	1.35	1.20	1.27	10.56	12.21	11.39	0.65	0.60	0.63
Module III (Organic IPM)	1.20	0.84	1.00	11.14	11.27	11.20	0.66	0.61	0.64
SEm ±	**0.27**	**0.12**	**0.10**	**1.150**	**1.39**	**1.05**	**NS**	**NS**	**NS**
CD (p=0.05)	**0.09**	**0.06**	**0.03**	**0.37**	**0.45**	**0.33**	**0.05**	**0.03**	**0.04**

NS - Non significant

through one-way ANOVA using SPSS 16 software. The means of significant parameters among the tested modules were compared using critical difference (CD) for paired comparisons at 95% probability level.

RESULTS AND DISCUSSION

Fruit fly infestation

kharif, 2018

The fruit infestation showed significant difference among the three tested modules during the *kharif*, 2018. The module II (IPM) was found to be the best module with lowest per cent (20.73%) fruit fly damage followed by module III (Organic IPM) (24.88%). Significantly highest infestation was recorded module I (38.21%). Similarly larval density was found to be less in module III (7.84) and module II (8.92) compared to the module I (13.93) in the first season (Table 1).

The total treatment fruit yield was found highest (141.60 kg) in module II (IPM). Relatively higher treatment yield (126.40 kg) was recorded in module I (Farmers practice) than in Organic IPM module (121.88 kg). However, marketable fruit yield was highest (117.62 kg) in IPM module followed by Organic IPM module (101.83 kg). In farmers practice module, lowest marketable yield of 78.88 kg was obtained. Highest total yield of 168.20 q/ha was recorded in module II (IPM) and lowest of 112.80 q/ha in module I (Farmers practice).

Rabi, 2018-19

During the second season (*rabi,* 2018-19) of evaluation of different management modules, significant difference was noticed both in fruit infestation and maggot density among the three modules. The per cent fruit infestation was lowest in module II (16.43%) and was statistically at par with the module III (17.04%), while larval density was lowest in module II (4.64). Highest fruit infestation and maggot density were recorded in module I (33.53%, 15.25) (Table 1).

Pooled results of the two seasons

The pooled analysis (Table 1) of the two seasons indicated that, among the three tested modules, IPM module was significantly differed with the other two modules with lowest fruit infestation (18.58%). However, both in module II and III was the larval density (6.63 and 7.42) was found to be statistically at par with each other but differing significantly with the module I (14.59 larvae/fruit).

Yield

kharif, 2018

The fruit yield was found to be highest (168.20 Q/ha) in module II (IPM) followed module III (145.60 Q/ha), whereas, lowest yield was recorded in module I (112.80 Q/ha). Similarly, marketable fruit yield was highest (117.62 kg) in module II followed by module III (101.83 kg). In farmers practice module, lowest marketable yield of 78.88 kg was obtained during the first season (*kharif*, 2018 (Table 1).

Rabi, 2018-19

During the second season, highest fruit yield was recorded in module II (165.03 q/ha) followed by in module III (147.72 q/ha) and it was lowest in module III (127.68 Q/ha). The highest marketable fruit yield of 115.41 Kg was recorded in module II. The lowest

marketable yield was recorded in module I (89.27 Kg) (Table 1).

Pooled results of the two seasons

The pooled analysis (Table 3) of the two seasons indicated that, among the three tested modules, highest total and marketable yields (166.23 Q/ha, 113.83 Kg) were recorded in module II. And are in the order of II > III > I (IPM > Organic IPM > Farmers practice).

Assessment of quality parameters

The quality parameters *viz*., average fruit weight, total soluble solids and acidity of the fruits recorded in three different modules were analyzed statistically and the results were presented in the table- 2. The quality analysis results indicated that, all the three modules differed significantly from each other. Average fruit weight was found to be highest (1.27 Kg) in module II (IPM) and was lowest in module III (Farmers practice) (1.0 Kg). TSS was also found to be highest in module II (11.39º) and was at par with module III (11.20º). Lowest TSS was recorded in fruits of module I (9.65º). Significant difference was not found in case of acidity in both the seasons between the modules. The above results indicated that, different fruit fly management modules not only affect the fruit yield and returns but also influence their quality parameters.

Economics of different eco-friendly modules

The data on economics of the different eco-friendly modules applied against the melon fruit fly, *B. cucurbitae* in muskmelon was calculated with net cost benefit ratio (NCBR) are present in Table 1.

The gross returns and net returns worked out on the basis of average fruit yield per hectare. Highest per hectare gross and net returns (Rs.232,722, Rs. 172,171) were obtained in the module II (IPM module). In module III (organic module) Rs.205,324, Rs.147,103 were the gross and net returns recorded. In module I (Farmers practice) lowest net and gross returns of Rs.168,280, Rs.109,179 were obtained. Highest benefit cost ratio (2.8) was recorded in IPM module followed by Organic IPM module (2.5). In Farmers practice module, lowest benefit cost ratio (1.8) was obtained. The present results clearly indicated that, module II (IPM) which is the integration of different aspects *viz*., maintenance of field sanitation, poison baiting with rotten banana, bait spray of deltamethrin mixed with jaggery at flowering, installation of cue lure traps from fruit set onwards, spray of 5% NSKE and malathion at 40 and 60 DAS respectively is the most effective and economical method for the management of fruit flies in muskmelon crop with lower fruit fly infestation (18.58%) and higher returns (BC ratio 2.8). The results obtained are in coordination with the findings of Mandal (2012) who reported that mean per cent fruit damage was lowest in an IPM package consisting of installation of sex pheromone traps and spinosad spray along with discarding of infested/damaged fruits at each harvesting. This was also supported by Shravan *et al.* (2014) who have reported that, an organic IPM module comprising of growing resistant genotype (RM-50), spray of neem oil at 20 DAS, installation of pheromone trap (10/ hectare) at 42 DAS, spray of tumba fruit extract (TFE 5%) at 50 DAS and spray of spinosad 46 SC at 60 DAS was most effective with BC ratio of 8.84. Ajanta *et al.* (2015) developed a successful for the management of cucurbit fruit fly The 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 and was found effective with respect to less fruit damage due to fruit fly (9 %, 5.9%), maximum fruit yield (10.75,7.59 t/ ha) and higher cost benefit ratio (1:3.35, 1:1.99) in bitter gourd and ridge gourd respectively. Sunil *et al.* (2016) revealed that deltamethrin 2.8 EC + jaggery bait (0.0028 + 0.015 %) was the most effective treatment resulting in minimum fruit infestation (13.15%,8.61%) of melon fruit fly, *Bactrocera cucurbitae* in bitter gourd, as well as lowest number of maggots per fruit (12.58, 9.58) in both *kharif* and *rabi* seasons. Similarly, the present findings are in consent with the findings of Bharadiya *et al.* (2018), who have reported module-3 [destruction of infested fruits during each picking + poison bait @ 50 l/ha (jaggery 50 g/l + abamectin 1.9% EC 0.0025%) + application of *Azadirechtin* 0.003% at 15 days interval starting from flower initiation stage] as effective treatment against fruit flies in sponge gourd. The reason is that the fruit flies being internal feeders, very difficult to manage with the external spraying of pesticides. Unless the different management aspects combined together in a strategic way starting from the beginning of crop cultivation itself, pest infestation cannot be maintained to below economic damage level.

CONCLUSIONS

From the experimental results, it can be concluded that fruit fly infestation in muskmelon affects both quantity and quality parameters of the fruits. An integrated approach including cultural practices such as collection and deep burying of infested and fallen fruits, tillage around the trees/in the fields along with the timely bait sprays, poison baiting and adult trapping methods are effective and eco-friendly fruit fly management strategies

need to be adopted in order to manage the pest below economic threshold level and to reduce adverse effects on pollinators and natural enemies. In the present study, among the three tested fruit fly management modules, module II (IPM), an integration of different aspects *viz*., maintenance of field sanitation, poison baiting with rotten banana, bait spray of deltamethrin mixed with jaggery at flowering, installation of cue lure traps from fruit set onwards, spray of 5% NSKE and malathion at 40 and 60 DAS respectively is the most effective and economical method for the management of fruit flies in muskmelon crop with lower fruit fly infestation (18.58%) and higher returns (BC ratio 2.8). Further, it was again proved that, fruit fly management is possible only when various management aspects are integrated in a strategic manner.

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