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COMPARISON OF VARIOUS PEST MANAGEMENT MODULES IN HYBRID MAIZE

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Abstract

Among the borers, *Chilo partellus* and *Sesamia inferens* were found high during *Kharif* and *Rabi* respectively. Though aphid infestation was observed in both the seasons, infestation was high during *Kharif* compared to *Rabi*. Insecticides based module (Module I) was effective in controlling maize stem borers, sucking pests, cob borers and leaf eating caterpillars than non-insecticides module (Module II). Maximum yield with less number of damaged cobs was recorded in Module I.

Key words: Hybrid Maize, Insect pest and Management modules.

1. Introduction

Maize (*Zea mays* L.) is one of the important cereal crops of the world and contributes to food security in most of the developing countries. Global production of maize has grown at a CAGR of 3.4 per cent over the last ten years, from 717 MnMT in 2004 - 05 to 1041.7 MnMT in 2017 - 18 (FICCI, 2018). The area under maize cultivation in India has increased from 7.5 Mn hectare in 2004 - 05 to 8.9 Mn hectare in 2016 - 17, with a production of 21.80 million tonnes and productivity of 2.5 mt/ha (AICRIP, 2016). Over 130 insect pests have been reported to infest maize but only few are serious. Amongst these, the spotted stem borer, *Chilo partellus* Swinhoe the key pest throughout India during rainy season and pink stem borer, *Sesamia inferens* Walker is serious in peninsular India in *rabi* and causes economic yield losses (Siddiqui and Marwaha, 1993). Mallapur *et al.* (2012), reported that the stem borer infestation varied enormously (2.33 to 32.60 %) among different cultivated maize hybrids. The modules evaluated by Anuradha *et al.* (2012) and Ali *et al.* (2014), explicit the effectiveness of insecticides, pheromones and intercropping. In the present study a non insecticidal module is tested along insecticidal module.

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2. Materials and Methods

Experiments were carried out in the farmers' field at Nagaram village, Parkalmandal, Warangal district to test the efficacy of few pest management modules during *Rabi* and *Kharif*. Randomized block design was followed to determine the efficient module. Hybrids P3501 and 30V92 were used in *Kharif* and *Rabi* seasons respectively. In total three modules were tested with an untreated check and each module was replicated five times. For a module 1000 sq. m. (25 m × 40 m) block was earmarked and the seeds sown in a spacing of 60 × 25 cm. Around each block five meter isolation distance was maintained. The details of the module tested as follows.

Module 1- Insecticidal management ● Spraying of Rynaxypr 20SC @ 60 ml/ac at 15-18 DAS (stem borers) ● Whorl application of carbofuran 3G@ 6kg/ac at 30-35 DAS (stem borers) ● Spraying of Acetamprid 20 SP @40 g/ac @ 40-45 DAS (aphids) ● Dusting of quinalphos 1.5 D @ 4 kg/acre @ 60- 70 DAS (cob borers)
Module 2 – Non- Insecticidal management ● Spraying of Bt formulation @ 100 g/ac at 15-18 DAS (stem borers) ● Whorl application of neem granules @ 10 kg/ac at 30-35 DAS (stem borers) ● Spraying of *Verticillium lecani* @1 kg/acre @ 40-45 DAS (aphids) ● Spraying of Bt formulation @100g/ac @ 60- 70 DAS (cob borers)
Module 3- Farmers practice ● Soil application of carbofuran 3G @ 4 kg/ac @ 25 DAS ● Spraying of monocrotophos 36SC @500 ml/ac @ 30-40 DAS
Module 4- Untreated check ● No plant protection methods were followed

Leaf Injury	Rating/Scale
Apparently healthy plant	1
Plant showing slight damage pinhole on 1 – 2 leaves	2
Plant showing slight damage pinhole on 3 – 4 leaves	3
Plant showing injury pinholes, shot holes slits in about 1/3 total leaves	4
Plant showing 50 % leaf damage	5
Plant showing 2/3 total leaf injuries	6
Plant with every type of injury almost all damaged	7
Entire plant with complete leaf injury likely to form dead heart	8
Complete dead heart	9

In the earmarked plots, observations were recorded at 25, 45, 55, 75 and 90 DAS and harvest on pinholes, leaf injury, dead heart, Larvae/plant or cob, infested plant by sucking pests. A scoring scale on leaf injury by stem borers given below was followed to rate the infestation.

Ten out of fifty plants showing pin holes/ shot holes/dead heart symptoms were destructed and observed for the larvae to group the genus *Chilo* and *Sesamia*. Per cent infested plants due to sucking pests by thrips, aphids and mites were recorded.

3. Results and Discussion

Stem borers

The data on effect of different pest management modules on stem borers is presented in Table - 1 and 2. During *kharif*, the mean leaf injury rating caused by stem borer was minimum in chemical control module (0.11) followed by biological control module (1.11). The highest leaf injury was recorded in farmer practice (5.06) and untreated control (4.98). The peak leaf injury rating was observed during 25 days in farmer practice (5.49) and untreated control (7.29). Highest per cent of dead hearts caused by stem borers was recorded in untreated check (21.91 %) and farmer practice (21.59 %). Lowest dead heart of 2.61 per cent was recorded in chemical control

module followed by biological (5.15 %). The mean *C. partellus* larvae per plant was low in chemical control module (0.03 larvae) followed by biological control module (0.92 larvae). Peak larval incidence was recorded in farmer practice (3.87) and untreated control (3.75).

During *Rabi*, the mean leaf injury rating caused by stem borer was minimum in chemical control module (2.40) as against maximum in untreated control (5.29). The peak leaf injury rating was observed during 25 days in untreated check (7.28) and farmers practice (6.28). Highest per cent of dead hearts caused by stem borers was recorded in untreated check (21.67 %) and farmer practice (15.01 %). Lowest dead heart of 4.91 per cent was recorded in chemical control module followed by biological (8.68 %). Data pertaining to mean larvae plant of *S. inferens* indicated low incidence in chemical control module (0.74) followed by biological control module (1.30 larvae/plant). Peak larval incidence was recorded in farmer practice (2.53 larvae per plant) and untreated control (2.78 larvae per plant).

Among major pests of maize, stem borers *Chilo partellus* and *Sesamia inferens* are causing severe damage at early growth stages affecting plant population and early vigor. Most of the farmers due to lack of awareness regarding the pest control measures and considering maize as less input crop, adopt pest control measures like spraying of monocrotophos, endosulfan and soil application of 3G and 10G granules. However, the stem borers are not effectively controlled with practices followed by farmers in general. Module 1- chemical control with Rynaxypr 20 SC spray followed by Carbofuran 3G whorl application (instead of soil application) is highly effective in controlling leaf injury and dead hearts caused by stem borer. Early vigorous plants and maintaining optimum plant population at early stages ultimately results into higher yield.

Sucking pests

During *kharif*, aphid infestation was high at 55 and 75 DAS. Pooled mean data indicated that the per cent aphid infestation was the highest in untreated check (11.22 %) followed by farmer practice (7.62 %). Minimum incidence of aphids was recorded in chemical control module (2.89 %) followed by biological control (5.88 %). Thrips incidence was noticed during 45 and 55 DAS. Pooled mean data revealed that incidence was higher in untreated check (2.81 %) followed by 1.60 % in farmer practice. Minimum infestation of thrips was observed in chemical control (0.45 %) followed by biological control (0.75 %).

During *Rabi*, aphid infestation was highest during 55&75 DAS. Pooled mean data indicated that the per cent aphid infestation was the highest in untreated check (17.37 %) followed by farmer practice (15.66 %). Minimum incidence of aphids was recorded in chemical control module (4.52 %) followed by biological control (9.8 1%). Thrips incidence was noticed during 45, 55 and 75 DAS. Pooled mean data revealed that thrips incidence was higher in untreated check (2.26 %) followed by 1.89 % in farmers' practice. Minimum infestation of thrips was observed in chemical control (0.19 %) followed by biological control (0.71%). Infestation by mites was noticed during 45 and 90 DAS. Pooled mean data revealed that mites incidence was higher in untreated check (4.26 %) followed by 2.31 % in farmer practice. Minimum infestation of mites was observed in chemical control (0.74 %) followed by biological control (1.32 %).

Among the sucking pests observed in maize aphids cause severe damage at flowering and post flowering. Peak incidences of aphids are observed at 50 - 60 DAS in top nodes and suck the sap near male flower tassel. As the crop reaches 150 - 250 cm at flowering stage, it is difficult to spray the top portion to control aphids; hence farmers do not spray to control aphids. Infestation of aphids is more in *Rabi* compared to *Kharif*. In chemical control module, spray of Acetamaprid at pre flowering stage 40 - 45 DAS gave effective control in controlling the pests.

Cob borers

Among the cob borers *H. armigera* and *M. separata*are the major pest at 55, 75 and 90 DAS.

Mean larval population of *H. armigera* per plant ranged between 0.78 in chemical control module and 2.05 in untreated check. About larval population of *M. separata* maximum larvae was observed in farmer practice (1.81 larvae per plant) as against the minimum population observed in chemical control (0.58 larvae per plant). During Rabi, cob borers *H. armigera* and *M. separata* are observed at 55 and 75 DAS. Mean larval population of *H. armigera* per plant ranged between 1.11 in chemical control module and 2.12 in untreated check. Larval population of *M. separata* maximum larvae was observed in farmer practice (0.17 larvae per plant).

H. armigera is considered as major pest among the cob borers. It feeds on silk & cobs at milky stage affecting yield and marketable quality of maize. Initially more larvae feeds on female flower (Silk) and later at milky stage only one larvae is observed in each cob feeding mainly on top portion of cobs. due to robust and dense growth of the crop, farmers will not spray at this stage chemical control of dusting quinolphos 1.5 % dust or spray of *B.t* formulation as non chemical control gives effective control against *H. armigera* and reducing damage in cobs.

Leaf eating caterpillars

The leaf eating caterpillars such as *S. litura* and hairy caterpillar are observed at 45 and 55 DAS. Maximum incidence of *S. litura* was observed in untreated control (2.23 larvae per plant) and nil incidences in Chemical control module. The hairy caterpillar was observed to be the highest in untreated control (3.02 larvae per plant) followed by farmers practice (2.44 larvae per plant) and nil incidences were observed in Chemical control module

During *Rabi* leaf eating caterpillars such as *S. litura* and hairy caterpillar are observed at 45, 55 and 75 DAS. Maximum incidence of *S. litura* was observed in untreated control (0.75 larvae per plant) and 0.15 larvae per plant in Chemical control module. The hairy caterpillar was observed to be the highest in untreated control (0.85 larvae per plant) followed by farmers practice (0.59 larvae per plant) and 0.19 larvae per plant in Chemical control module. Among leaf feeders *S.litura* and *Mythmna separata* are considering major losses to the crop. Incidence of leaf feeders is isolated and sporadic in nature. Hence need based chemical spray or non chemical *B.t* sprays can be followed.

Influence of Pest management modules on cob parameters and yield of Maize

The yield data revealed variation due to pest control modules (Table - 3). Highest yield of 8017 kg/ha and 8860 kg/ha was recorded in chemical control module plots during *Kharif* and *Rabi* respectively. In biological control module yield recorded was 7905 kg/ha in *Kharif* and 8017 kg/ha in *Rabi*. Yield recorded in farmer practice plot during *kharif* was 6023 kg/ha and 6245 kg/ha in *Rabi*. The lowest yield was recorded in untreated control during *Kharif* (5174 kg/ha) and *Rabi* (5406 kg/ha). Highest percent of damaged cobs was observed in untreated module during *Kharif* (23.2 %) and Rabi (31.1 %) followed by farmer practice with 18.8 % in *Kharif* and 22.4 % in *Rabi.*

Among the borers, *Chilo partellus* and *Sesamia inferens* were found high during *Kharif* and *Rabi* respectively. Though aphid infestation was observed in both the seasons, infestation was high during *Kharif* compared to *Rabi*. Chemical control module was effective in controlling maize stem borers, sucking pests, cob borers and leaf eating caterpillars. Maximum yield with less number of damaged cobs was recorded in insecticidal module. Anuradha *et al.* (2012) found that the module comprised of soil application of Carbofuran 3G @ 8 kg/ac, spraying of Chlorantriniliprole 20 SC @ 60 ml/ac and pheromone traps with Helilure @ 6/ac and with Litlure @ 6/ac at silking stage was effective than two other modules tested along. They recorded 74.39 % undamaged cobs in the above said module. Ali *et al.* (2014) recorded the minimum number of dead hearts in a module comprising inter crop with cowpea, imidacloprid 17.8 SL @ 7 ml/kg as seed treatment, indoxacarb 14.5 SC @ 500 ml/ha spray at 40DAS.

Table – 1: Comparison of pest management modules in maize hybrid - *Kharif*

DAS	Module	Stem borer rating		Mean larvae/plant		percent of infested plants (sucking pests)			Cob damage (Number of larvae /plant)				Leaf eating caterpillars (larvae /plant)	
		Mean LIR (1-9)	% Dead hearts	*Chilo*	*Sesamia*	Aphids	Thrips	Mites	*Helicoverpa*	*Spodoptera*	*Mythimna*	*Chilo*	*Spodoptera*	Hairy Caterpillar
25	M1	0.01	0.03	0.01	0	0	0	0	0	0	0	0	0	0
	M2	0.31	0.87	0.21	0.01	0	0	0	0	0	0	0	0	0
	M3	6.1	17.45	4.26	0.25	0	0	0	0	0	0	0	0	0
	M4	7.84	23.58	5.24	0.75	0	0	0	0	0	0	0	1.35	1.26
45	M1	0.01	0.03	0.01	0	0	0.57	1.02	0	0	0	0	0	0
	M2	0.28	0.98	0.17	0.01	0	1.02	2.64	0	0	0	0	1.24	3.36
	M3	5.49	20.59	4.6	0.19	0	2.18	2.78	0	0	0	0	2.35	4.2
	M4	7.29	30.65	5.66	0.6	0	3.82	4.74	0	0	0	0	2.57	4.26
55	M1	0.01	0.03	0.01	0	2.05	0.27	0.73	0.67	0	0	0	0	
	M2	0.21	0.98	0.15	0.01	5.84	0.48	1.88	0.89	0	0	0	0	2.28
	M3	4.23	21	4.23	0.18	7.68	1.02	2.13	1.87	0	0	1.12	2.45	3.12
	M4	5.4	31.88	4.81	0.57	11.45	1.8	3.27	1.94	0	0	0.76	2.78	3.53
75	M1	0.25	3.39	0.14	0.01	4.35	0	0.23	0.7035	0	0.87	0.21	0	0
	M2	4.78	8.24	3.96	0.19	7.67	0	1.21	1.12	0	1.21	0.67	0	0
	M3	6.56	30.96	3.68	0	8.98	0	1.34	1.98	0	4.32	1.27	0	0
	M4	0.01	0.04	0	0	14.32	0	1.67	2.11	0	4.21	0.98	0	0
90	M1	0.28	9.57	0	0.01	2.27	0	0.23	1.96	0	0.87	0.15	0	0
	M2	0.12	14.68	0.12	0.01	4.12	0	1.21	1.12	0	0.76	0.54	0	0
	M3	2.93	17.97	2.59	0.38	6.19	0	1.34	1.98	0	1.12	0.67	0	0
	M4	4.39	23.42	3.04	0.54	7.89	0	1.67	2.11	0	1.09	0.59	0	0
Pooled mean	**M1**	**0.11**	**2.61**	**0.03**	**0**	**2.89**	**0.42**	**0.55**	**0.78**	**0**	**0.58**	**0.12**	**0**	**0**
	M2	**1.14**	**5.15**	**0.92**	**0.05**	**5.88**	**0.75**	**1.74**	**1.04**	**0**	**0.66**	**0.4**	**0.41**	**1.88**
	M3	**5.06**	**21.59**	**3.87**	**0.2**	**7.62**	**1.6**	**1.9**	**1.94**	**0**	**1.81**	**1.02**	**1.6**	**2.44**
	M4	**4.98**	**21.91**	**3.75**	**0.49**	**11.22**	**2.81**	**2.84**	**2.05**	**0**	**1.77**	**0.78**	**2.23**	**3.02**

Table – 2: Comparison of pest management modules in maize hybrid - *Rabi*

DAS	Module	Stem borer rating		Mean larvae/plant		percent of infested plants (sucking pests)			Cob damage (Number of larvae /plant)				Leaf eating caterpillars (larvae /plant)	
		Mean LIR (1-9)	% Dead hearts	*Chilo*	*Sesamia*	Aphids			Mean LIR (1-9)	% Dead hearts	*Chilo*	*Sesamia*	Aphids	
25	M1	4.22	7.6	0.96	2.33	0	0	0	0	0	0	0	0	0
	M2	5.43	9.37	0.95	2.67	0	0	0	0	0	0	0	0	0
	M3	6.35	14.87	0.9	3.96	0	0	0	0	0	0	0	0	0
	M4	7.12	17.96	1.17	4.67	0	0	0	0	0	0	0	1.35	1.26
45	M1	3.12	7.6	1.02	1.12	0	0.57	1.02	0	0	0	0	0	0.67
	M2	5.65	9.45	1.11	1.76	0	1.02	2.64	0	0	0	0	0	0.54
	M3	6.92	16.45	0.98	4.01	0	2.18	2.78	0	0	0	0	0	0.59
	M4	7.28	26.7	1.08	4.67	0	3.82	4.74	0	0	0	0	0	0.69
55	M1	2.28	3.14	0	0	5.24	0	0	0.67	0	0	0	0	0.15
	M2	4.46	9.52	0	0.67	9.67	1.12	0	1.23	0	0	0	0.54	0.42
	M3	5.61	17.11	0.52	2.33	14.63	2.3	0	1.97	0.17	0	0	0.32	0.65
	M4	5.75	27.8	0.59	2.16	19.55	1.67	0	1.89	0	0.21	0	0.41	0.58
75	M1	1.18	1.98	0	0	5.87	0	0	1.54	0	0	0	0.45	0.13
	M2	2.41	6.76	0	0.54	14.02	0	0	1.53	0	0.24	0	0.52	0.36
	M3	3.14	12.01	0.65	1.21	22.43	1.19	1.75	2.44	0	0.31	0	0.53	0.56
	M4	3.16	16.34	0.78	1.17	22.89	1.28	3.45	2.34	0	0.34	0	0.49	0.5
90	M1	1.18	4.23	0	0.23	2.46	0	1.21	0	0	0	0	0	0
	M2	2.41	8.29	0	0.87	5.73	0	1.33	0	0	0	0	0	1.42
	M3	3.14	14.63	0	1.15	9.91	0	2.41	0	0	0	0	0	1.17
	M4	3.16	19.54	0	1.23	9.66	0	4.58	0	0	0	0	0	1.23
Pooled mean	**M1**	2.4	4.91	0.4	0.74	4.52	0.19	0.74	1.11	0	0	0	0.15	0.19
	M2	4.07	8.68	0.41	1.3	9.81	0.71	1.32	1.38	0	0.12	0	0.35	0.55
	M3	5.03	15.01	0.61	2.53	15.66	1.89	2.31	2.21	0.17	0.16	0	0.28	0.59
	M4	5.29	21.67	0.72	2.78	17.37	2.26	4.26	2.12	0	0.28	0	0.75	0.85

Table - 3: Comparison of Pest management modules on cob damage & yield

Module	*Kharif*		*Rabi*	
	Per cent damaged cobs	Yield (Kg/ha)	Per cent damaged cobs	Yield (Kg/ha)
Insecticides	7.3	8217	6.2	8860
Non-insecticides	11.2	7905	14.9	8017
Farmers Practice	18.8	6023	22.4	6245
Un treated Check	23.2	4962	31.1	4587

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