Evaluation of different IPM modules against green semilooper (*Thysanoplusiaorichalcea Fab.*)andcapitulum borer (*Helicoverpaarmigera Hab.*)of sunflower

ABSTRACT

During Khariff-2017 seven different IPM modules were evaluated against green semilooper, *Thysanoplusiaorichalcea* Fab. and capitulum borer, *Helicoverpaarmigera* Hub. infesting sunflower. of which spinosad based module (M_5) (Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + hand picking & destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of spinosad (50 and 70 DAS) found superior against major defoliator *T.orichalcea*Fab. at 3, 5 and 10 days after second sprayand capitulum borer, *H.armigera*Hub. at 3, 5 and 10 days after first spray, followed by IPM module (UAS-B) (Seed treatment with imidacloprid 70 WS (5 g/kg) + two sprays of 5 % NSKE and HaNPV (50 and 70 DAS).The present findings also revealed that spinosad based module and NSKE based modules were potential candidates for the suppression of green semilooper and capitulum borer among the different IPM modules that were evaluated.

Keywords: Sunflower, IPM modules, Thysanoplusiaorichalcea, Helicoverpaarmigera and Spinosad

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an annual oil seed plant native to the America. Insect pests and diseases are the major production constraints in sunflower. In India, the major insect pests include capitulum borer,*Helicoverpaarmigera* Hub, green semilooper, *Thysanoplusiaorichalcea* Fab., bihar hairy caterpillar, *Spilarctiaobliqua* (Walker), tobacco caterpillar, *Spodopteralitura* (Fab), cabbage semilooper, *Trichoplusia* sp., cutworm, *Agrotis* sp. and green leaf hopper, *Amrascabiguttulabiguttula* are of major economic importance (Basappa, 1995).

The wide spread and indiscriminate usage of synthetic chemical insecticides to manage these pests cause resistance to insecticides, besides pesticide residual effect, pest resurgence, outbreak of secondary pests, disturbance in ecological harmony *etc.*, forcing the farmers to explore viable eco-friendly alternatives like IPM modules along with insecticides for management of pests (Jagadish et al., 2014; Matti et al., 2015; Basappa, 2004).

Integrated Pest Management or Integrated Pest Control is an ecosystem-based approach that mainly focuses on the prevention of insect pests or their damage through different practices like biological control, habitat manipulation, modified cultural practices, use of resistant varieties. It mainly emphasizes on the efficient use of all other practices along with need-based application of insecticides as a component of IPM module can effectively reduce the pest population.

During the last two decades, people have realized the problems associated with synthetic chemical insecticides, therefore alternative forms of crop protection like botanical based IPM modules can effectively reduce the pest population and least disturbance to natural fauna in the field. Natural fauna includes, coccinillid species *viz.*, *Cheilomenessexmaculata*(Fab.), *Coccinella transversalis* (Fab.) and *Alesia discolor* (Fab.) (*Micraspis discolor*) and the spider spicies such as, *Oxyopes*sp., *Argiope* sp., *Araneus* sp., *Neoscona* sp. and *Plexippus* sp.

Hence, the present study was undertaken to evolve the different IPM modules against major insect pests *viz.*, green semilooper and capitulum borer in sunflower.

MATERIALS AND METHOD

The present study envisages to determine the bio-efficacy of selected Integrated Pest Management modules against major insect pests of sunflower and their effect on the activity of natural enemies and foraging pattern of major bee pollinator fauna. The investigation was carried out during *Kharif*-2017, at Zonal Agricultural Research Station (ZARS), University of Agricultural Sciences, GKVK, Bengaluru.

In order to formulate a viable IPM package for sunflower, with a focus to minimize the hazards caused by chemical pesticides to the environment and non-target species, six Integrated Pest Management (IPM) modules along with two checks were evaluated for their efficacy against major insect pests of sunflower.

The details of the materials used and the methodologies adopted for fulfilling different objectives of this investigation are described hereunder.

Different IPM modules evaluated against major insect pests and non-target species in the study are as detailedbelow

Module 1: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of *Bacillus thuringenesis*(2 ml/l) (50 and 70 DAS) **(*Bt*based module)**

Module 2: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of *Beauveria bassiana*(2 g/l) (50 and 70 DAS) **(*Beauveria* based module)**

Module 3: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays with respective NPV formulations (1.25 ml/l) (50 and 70 DAS) **(NPV based module)**

Module 4: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of Azadirachtin (2 ml/l) (50 and 70 DAS) **(Neem based module)**

Module 5: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of Spinosad (0.1 ml/l) (50 and 70 DAS) **(IIOR BIPM module)**

Module 6: Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + handpicking and destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) 2 sprays of 5 % NSKE (50 DAS & 70 DAS) + two sprays of HaNPV (1.25 ml/l) (50 and 70 DAS) (**IPM module -UASB)**

T7: Water spray

T8: Untreated check

Observations were recorded before and after imposition of modules on the incidence of both the pests viz., *H. armigera* and *T. orichalcea* and also on the population of predators viz., green lace wing, *Chrysoperlazastrowi* arabica Henry, lady bird beetle, *Cheilomenessexmaculata* Fab. and spiders.

Corrected efficacy(%) of each IPM modules were calculated according to Henderson & Tilton formula.

$$Corrected\ (\%) = \left(1 - \frac{n\ in\ Co\ before\ treatment * n\ in\ T\ after\ treatment}{n\ in\ Co\ after\ treatment * n\ in\ T\ before\ treatment}\right) * 100$$

Where: n = Insect population, T = treated, Co = control

RESULTS AND DISCUSSION

Effect on *T. orichalsea*

There was no significant difference between the treatments with respect to the pre-spray observations on the larval population of green semilooper. However, 3, 5 and 10 days after first spray, IPM module 5 and IPM module 4 (Neem based) modules found superior in suppressing larval population over other modules. At 3 days after second spray, IPM module 5 found superior over other modules by registering the lowest larval population.

Corrected efficacy (%) at 10 days after first spray, IPM module 5 and IPM module 4 recorded highest efficacy 88.56 (%) each fallowed by IPM module 6 (88.08%) over other modules (Fig 1).

Similar findings have been reported earlier by Anitha (2008) who proved that IPM module are effective in reducing the population of semilooper, *T. orichalcea*.

Effect on *H. armigera*

When the treatments were imposed for the first time at 50 DAP, there was no significant difference in the no. of larvae per plant between the treatments. However, when the treatments were imposed for the second time at 70 DAP, significant differences were observed between the treatments at 3 days, 5 days and 10 days after second spray (Table 2).

At 3 days after second spray, IPM module 5, IPM module 6 (NSKE) and IPM module 3 (HaNPVbased) modules were recorded lowest larvae per plant 0.20 and 0.30 larvae respectively. At 5 days after second spray, same modules found superior over other modules. At 10 days after second spray, IPM module 5, IPM module 4 (Neem based) and IPM module 6 found superior over other modules.Similar findings have been reported earlier by Jagadish *et al*. (2016) who evaluated three BIPM modules among that, module M3 comprising of seed treatment with imidacloprid (5 g/kg) + metalaxyl (5g/kg) + handpicking and destruction of early instatrs of *S. litura* and *S. obliqua* + two sprays with spinosed 45SC @ 0.0045%, was the most superior module by virtue of recording significantly lower incidence of major pests. Similarly, by Srinivasan and Duyrairaj(2007) who observed least *Helicoverpa* larval population (2.0 / plant) with spinosad 45 SC (73 g a.i./ha) in pigeon pea and also by Basavaraj *et al*. (2014) in sunflower.

Corrected efficacy (%) at 10 days after second spray, IPM module 6 highest efficacy 96.12 (%) which is on for with IPM module 3 and IPM module 5 (94.83 %) over other modules (Fig 2).

Effect on predators

As far as the effect of biopesticides on predators was concerned, no significant differences were found between the predator population even after imposition of both the sprays, which could be due to the low population of some predators that is less than one per plant.

Effect on seed yield

Significant differences were found between the treatments as far as seed yield was concerned. However, IPM module 5 (2366 kg/ha) recorded highest yield fallowed by IPM module 1 (2184 kg/ha) and IPM module 6 (2181 kg/ ha) as compared with other treatments (Table 3). Similar finding was reported by Jagadish *et al*. (2016) module M3 (spinosad based) recorded highest seed yield of 2744 kg/ha.

Effect on other growth parameters

There was no significant difference in the growth parameters viz., volume weight (seeds/100 ml), 100 seed weight (g), oil content (%) and germination (%)(Table 3).

The present finding revealed that for the suppression of *T. orichalcea*, IPM module 5 (Spinosad based) and IPM module 4 (neem based) were significantly superior over other module 3. For *H. armigera,* IPM module 5 (spinosad based), IPM module 6 (NSKE) and IPM module 4 were found superior in suppressing larval population. Similar results were obtained by Sireesha (2000), wherein, Ha NPV @ 250 LE per ha was found to be significantly more effective and on par with NSKE (5%) followed by *Nomuraearileyi* (1kg/ha), *Bacillus thuringiensis* (1kg/ha) and *B. bassiana* (1kg/ha). The present findings are agreement with Jagadish *et al.* (2006) who reported the IPM module (seed treatment with imidacloprid (5g/kg) + two sprays of NSKE 5 % + two sprays of HaNPV at 250LE/ ha.) gave a significant highest grain yield and cost: benefit ratio (1:2.32) and it was also superior to chemical control in sunflower.Jagadish *et al.* (2016) who reported that module M3 (Spinosad based) recorded highest seed yield of 2744 kg/ha with highest incremental benefit cost ratio (IBCR) of 9.27.

CONCLUSION

Green semilooper, *Thysanoplusiaorichalcea* Fab. and capitulum borer, *Helicoverpaarmigera*(Hub.)are the major defoliator pests of sunflower. Bio intensive IPM modules are an effective and environmentally sensitive approaches to pest management and impart least impact on non-target organisms like predators in sunflower ecosystem. Among the different IPM modules evaluated, spinosad based module (M_5) (Seed treatment with imidacloprid 70 WS (5 g/kg) + metalaxyl 35 SD (5 g/kg) + hand picking & destruction of gregarious early instar larvae of defoliators (*Spodopteralitura*Fab. and *Spilarctiaobliqua*Walker) + 2 sprays of spinosad (50 and 70 DAS) found superior against these defoliators.

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1.

2.

3.

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Table 1. Effect of IPM modules on semilooper, *Thysanoplusiaorichalcea*

IPM Modules	Number of larvae/plants							
	Ist spray (50 DAS)				IInd spray (70 DAS)			
	Pre. Treat.	3 DAFS	5 DAFS	10 DAFS	Pre. Treat.	3 DASS	5 DASS	10 DASS
M1 (Bt based)	1.10 (	0.90	0.40 (0.93)	0.20 (0.82)ab	0.12 (	0.13 (0.80)ab	0.13 (	0.10 (

	1.18)	(1.18)b	ab		0.79)		0.80)	0.77)
M2 ***(Beauveria*** **based)**	**0.80 (1.10)**	**0.80 (1.14)b**	**0.43 (0.95)ab**	**0.40 (0.94)b**	**0.20 (0.84)**	**0.13 (0.79)ab**	**0.10 (0.77)**	**0.13 (0.80)**

M3 (NPV based)	1.07 (1.25)	0.87 (1.17)^{b}	0.70 (1.09)^{b}	0.30 (0.89)^{ab}	0.30 (0.89)	0.23 (0.86)^{ab}	0.13 (0.79)	0.13 (0.79)
M4 (Neem based)	0.90 (1.1	0.43 (0.9	0.27 (0.87)^{a}	0.10 (0.77)^{a}	0.20 (0.8	0.17 (0.81)^{ab}	0.17 (0.8	0.13 (0.8

	4)	5)^{a}			3)		1)	0)
M5 (Spinosad based)	**1.17 (1.29)**	**0.23 (0.86)^{a}**	**0.20 (0.84)^{a}**	**0.13 (0.79)^{a}**	**0.20 (0.83)**	**0.10 (0.77)^{a}**	**0.07 (0.75)**	**0.07 (0.75)**
M6 (NSKE based)	**1.10 (**	**0.37 (**	**0.33 (0.91)^{ab}**	**0.17 (0.82)^{ab}**	**0.20 (**	**0.13 (0.79)^{ab}**	**0.07 (**	**0.07 (**

	1.26)	0.93)^{a}			0.84)		0.75)	0.75)
M7 (Water spray)	**1.00 (1.22)**	**0.90 (1.18)^{b}**	**0.93 (1.20)^{c}**	**1.00 (1.21)^{c}**	**0.23 (0.86)**	**0.23 (0.86)^{ab}**	**0.20 (0.84)**	**0.23 (0.86)**
M8 (Untrea	**1.0**	**0.9**	**0.93 (1**	**1.00 (1.**	**0.2**	**0.30 (0**	**0.2**	**0.2**

ted control)	3 (1.24)	7 (1.21)^{b}	.20)^{c}	22)^{c}	7 (0.89)	.89)^{b}	3 (0.86)	3 (0.86)
F-test	NS	*	*	*	NS	*	NS	NS
SEM±	-	0.06	0.07	0.05	-	0.03	-	-
CD @ 5 %	-	0.17	0.21	0.14	-	0.10	-	-
CV (%)	1	8	12	8.	7	7.	7	6

	6.28	.88	.26	77	.63	05	.29	.76

Numbers in the parenthesis are square root transformed value of √x+0.5

*** Significant at (P≤0.05); DAS: Days after spray; DAFS: Days after first spray; DASS: Days after second spray;**

Table 2. Effect of IPM modules on capitulum borer, *Helicoverpaarmigera*

IPM Modules	Number of larvae/plants							
	I spray (50 DAS)				II spray (70 DAS)			
	Pre. Treat.	3 DAFS	5 DAFS	10 DAFS	Pre. Treat.	3DASS	5DASS	10DASS
M1 (Bt based)	0.20 (	0.17 (	0.13 (0.7	0.10 (0.7	0.70 (1.0	0.37 (0.93)^{ab}	0.33 (0.91)^{ab}	0.27 (0.88)^{b}

	0.83)	0.81)	9)	7)	9)			
M2 *(Beauveria* based)	0.30 (0.89)	0.30 (0.90)	0.30 (0.89)	0.27 (0.88)	0.70 (1.09)	0.63 (1.06)^{bc}	0.47 (0.98)^{b}	0.33 (0.91)^{b}
M3 (NPV based)	0.33 (0.90)	0.33 (0.90)	0.23 (0.85)	0.13 (0.79)	0.60 (0.70)	0.30 (0.89)^{a}	0.27 (0.87)^{ab}	0.03 (0.73)^{a}
M4 (Neem based)	0.30	0.30	0.27 (0.	0.27 (0.	0.70 (1.	0.50 (0.99)	0.33 (0.91)^{ab}	0.33 (0.89)^{b}

	(0.89)	(0.89)	87)	87)	05)	^{abc}		
M5 (Spinosad based)	0.37 (0.93)	0.10 (0.77)	0.10 (0.77)	0.10 (0.77)	0.60 (1.05)	0.20 (0.84)^{a}	0.13 (0.80)^{a}	0.03 (0.73)^{a}
M6 (NSKE based)	0.33 (0.91)	0.20 (0.84)	0.20 (0.84)	0.17 (0.82)	0.80 (1.14)	0.30 (0.89)^{a}	0.17 (0.82)^{a}	0.03 (0.73)^{a}
M7 (Water spray)	0.37	0.33	0.37 (	0.40 (	0.80 (	0.80 (1.14)	0.77 (1.22)	0.90 (1.17)^{c}

	(0.93)	(0.91)	0.93)	0.95)	1.13)	^{cd}	^{c}	
M8 (Untreated control)	**0.33 (0.91)**	**0.37 (0.93)**	**0.33 (0.91)**	**0.30 (0.89)**	**0.90 (1.18)**	**0.93 (1.20)^{d}**	**0.90 (1.18)^{c}**	**0.87 (1.17)^{c}**
F-test	**NS**	**NS**	**NS**	**NS**	**NS**	*****	*****	*****
SEM±	-	-	-	-	-	**0.05**	**0.04**	**0.03**
CD @ 5 %	-	-	-	-	-	**0.16**	**0.12**	**0.11**
CV (%)	**11.33**	**11.23**	**9.64**	**8.16**	**7.83**	**9.40**	**7.36**	**6.80**

Numbers in the parenthesis are square root transformed value of √x+0.5

*** Significant at (P≤0.05); DAS: Days after spray; DAFS: Days after first spray; DASS: Days after second spray;**

Table 3. Influence of IPM modules on yield and yield attributing characters

IPMModules	Seed Yield (Kg/ha)	Cost-benefit ratio
M1(Bt based)	2184[ab]	5.54
M2(*Beauveria* based)	1839[bc]	4.66
M3(NPV based)	2034[ab]	4.49
M4(Neem based)	2041[ab]	5.88
M5(Spinosad based)	2366[a]	8.71
M6(NSKE based)	2181[ab]	4.02
M7(Water spray)	1511[c]	0.49
M8(Untreated control)	1477[c]	-
F test	(*)	
SEm±	149.07	
CD @ 5 %	452.17	
CV (%)	13.21	

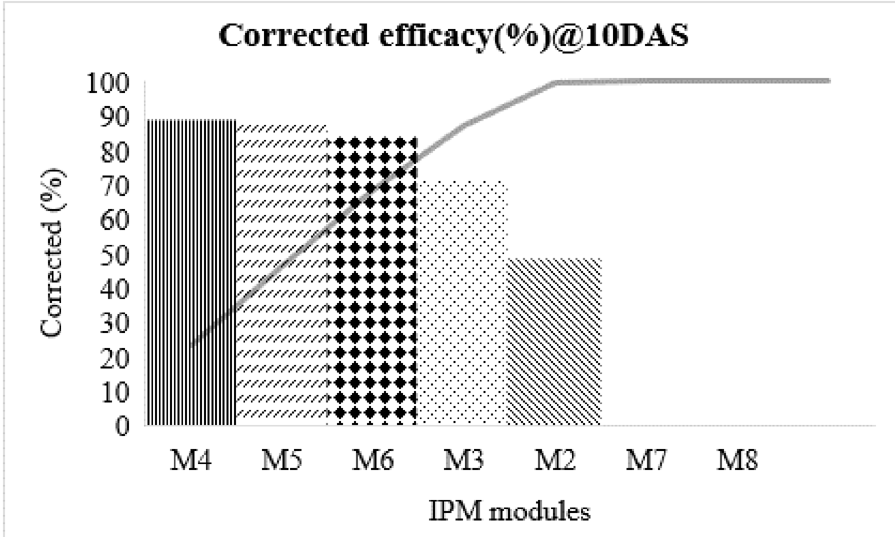

Fig. 1. Corrected efficacy of IPM modules against *Thysanoplusiaorichalcea*

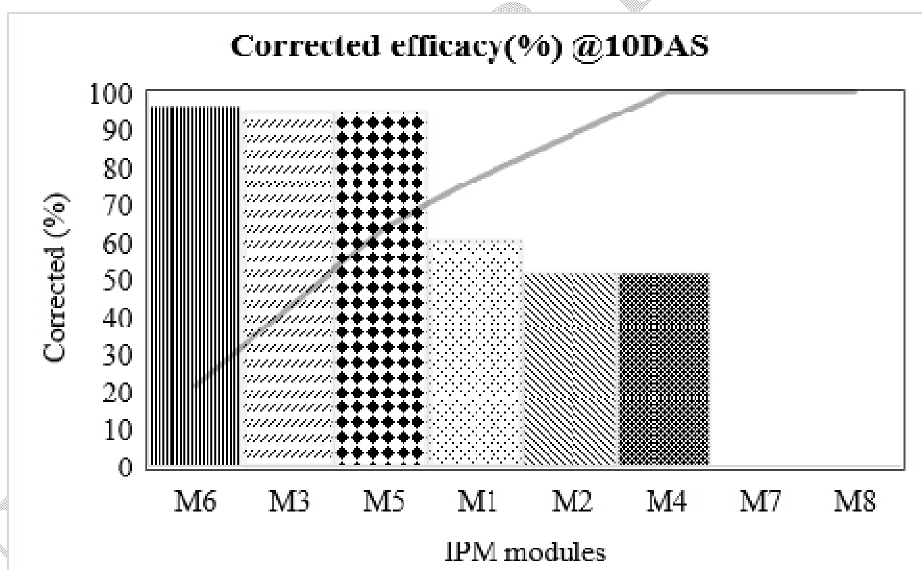

Fig. 2. Corrected efficacy of IPM modules against *Helicoverpaarmigera*