

Evaluation of different IPM modules against green semilooper (*Thysanoplusia orichalcea* Fab.) and capitulum borer (*Helicoverpa armigera* Hub.) of sunflower

ABSTRACT

During Khariff-2017 seven different IPM modules were evaluated against green semilooper, *Thysanoplusia orichalcea* Fab. and capitulum borer, *Helicoverpa armigera* Hub. infesting sunflower. of which spinosad based module (M₅) (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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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 spray and 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, Thysanoplusia orichalcea, Helicoverpa armigera 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, *Helicoverpa armigera* Hub, green semilooper, *Thysanoplusia orichalcea* Fab., bihar hairy caterpillar, *Spilarctia obliqua* (Walker), tobacco caterpillar, *Spodoptera litura* (Fab), cabbage semilooper, *Trichoplusia* sp., cutworm, *Agrotis* sp. and green leaf hopper, *Amrasca biguttula biguttula* 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.

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.*, *Cheilomenes sexmaculata* (Fab.), *Coccinella transversalis* (Fab.) and *Alesia discolor* (Fab.) (*Micraspis discolor*) and the spider species 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 detailed below

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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* Walker) + 2 sprays of *Bacillus thuringiensis* (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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* 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, *Chrysoperla zastrowi arabica* Henry, lady bird beetle, *Cheilomenes sexmaculata* Fab. and spiders.

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

Corrected (%)

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

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

RESULTS AND DISCUSSION

Effect on *T. orichalcea*

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 were found superior in suppressing larval population over other modules. At 3 days after second spray, IPM module 5 was 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 was followed 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~~were 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 were found superior over other modules. At 10 days after second spray, IPM module 5, IPM module 4 (Neem based) and IPM module 6 were 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 instars of *S. litura* and *S. obliqua* + two sprays with spinosad 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 resulted in the highest efficacy of 96.12 (%) which is on par 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 followed 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 *Nomuraea rileyi* (1kg/ha), *Bacillus thuringiensis* (1kg/ha) and *B. bassiana* (1kg/ha). The present findings are in 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, *Thysanoplusia orichalcea* Fab. and capitulum borer, *Helicoverpa armigera* Hub. are major defoliator pests of sunflower. Biointensive 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 (M₅) (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 (*Spodoptera litura* Fab. and *Spilarctia obliqua* Walker) + 2 sprays of spinosad (50 and 70 DAS) was found superior against these defoliators.

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Table 1. Effect of IPM modules on semilooper, *Thysanoplusia orichalcea*

IPM Module s	Number of larvae/plants							
	I st spray (50 DAS)				II nd spray (70 DAS)			
	P r e . T r e a t .	3 D A F S	5 D A F S	10 D A F S	P r e . T r e a t .	3 D A S S	5 D A S S	1 0 D A S S
M1 (Bt based)	1 . 1 0 (	0 . 1 9 0	0. 40 (0 .9 3)	0. 20 (0. 82) ^{ab}	0 . 1 2 (	0. 13 (0 .8 0) ab	0 . 1 3 (	0 . 1 0 (

	1 . 1 8)	(1 . 1 8) b	ab		0 . 7 9)		0 . 8 0)	0 . 7 7)
M2 (<i>Beauve</i> <i>ria</i> based)	0 . 8 0 (1 . 1 0)	0 . 8 0 (1 . 1 4) b	0. 43 (0 .9 5) ab	0. 40 (0. 94) ^b	0 . 2 0 (0 . 8 4)	0. 13 (0 .7 9) ab	0 . 1 0 (0 . 7 7)	0 . 1 3 (0 . 8 0)

<p>M3</p> <p>(NPV based)</p>	<p>1 · 0 7</p> <p>(1 · 2 5)</p>	<p>0 · 8 7</p> <p>(1 · 1 7) b</p>	<p>0. 70</p> <p>(1 .0 9) b</p>	<p>0. 30</p> <p>(0. 89)^{ab}</p>	<p>0 · 3 0</p> <p>(0 · 8 9)</p>	<p>0. 23</p> <p>(0 .8 6) ab</p>	<p>0 · 1 3</p> <p>(0 · 7 9)</p>	<p>0 · 1 3</p> <p>(0 · 7 9)</p>
<p>M4</p> <p>(Neem based)</p>	<p>0 · 9 0</p> <p>(1 · 1</p>	<p>0 · 4 3</p> <p>(0 · 9</p>	<p>0. 27</p> <p>(0 .8 7) a</p>	<p>0. 10</p> <p>(0. 77)^a</p>	<p>0 · 2 0</p> <p>(0 · 8</p>	<p>0. 17</p> <p>(0 .8 1) ab</p>	<p>0 · 1 7</p> <p>(0 · 8</p>	<p>0 · 1 3</p> <p>(0 · 8</p>

	4)	5) a			3)		1)	0)
M5 (Spinosa based)	1 . 1 7 (1 . 2 9)	0 . 2 3 (0 . 8 6) a	0. 20 (0 . 8 4) a	0. 13 (0. 79) a	0 . 2 0 (0 . 8 3)	0. 10 (0 . 7 7) a	0 . 0 7 (0 . 7 5)	0 . 0 7 (0 . 7 5)
M6 (NSKE based)	1 . 1 0 (	0 . 3 7 (	0. 33 (0 . 9 1) ab	0. 17 (0. 82) ab	0 . 2 0 (	0. 13 (0 . 7 9) ab	0 . 0 7 (	0 . 0 7 (

	1 . 2 6)	0 . 9 3) a			0 . 8 4)		0 . 7 5)	0 . 7 5)
M7 (Water spray)	1 . 0 0 (1 . 2 2)	0 . 9 0 (1 . 1 8) b	0. 93 (1 .2 0) c	1. 00 (1. 21) ^c	0 . 2 3 (0 . 8 6)	0. 23 (0 .8 6) ab	0 . 2 0 (0 . 8 4)	0 . 2 3 (0 . 8 6)
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 . 2 4)	7 (1 . 2 1) b	.2 0) c	22) ^c	7 (0 . 8 9)	.8 9) b	3 (0 . 8 6)	3 (0 . 8 6)
F-test	N S	*	*	*	N S	*	N S	N S
SEM±	-	0 . 0 6	0. 07	0. 05	-	0. 03	-	-
CD @ 5 %	-	0 . 1 7	0. 21	0. 14	-	0. 10	-	-
CV (%)	1	8	12	8.	7	7.	7	6

	6	.	.2	77	.	05	.	.
	.	8	6		6		2	7
	2	8			3		9	6
	8							

Numbers in the parenthesis are square root transformed value of $\sqrt{x+0.5}$

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

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

IPM Modules	Number of larvae/plants							
	I spray (50 DAS)				II spray (70 DAS)			
	P r e . T r e a t	3 D A F S	5 D A F S	1 0 D A F S	P r e. T r e a t.	3D AS S	5D AS S	10D ASS

	.							
M1 (Bt based)	0. 20 (0.083)	0. 17 (0.081)	0. 13 (0.079)	0. 10 (0.077)	0. 70 (1.09)	0.37 (0.93) ab	0.33 (0.91) ab	0.27 (0.88)) ^b
M2 (<i>Beauveria</i> based)	0. 30 (0.083)	0. 30 (0.081)	0. 30 (0.088)	0. 27 (0.088)	0. 70 (1.09)	0.63 (1.06) bc	0.47 (0.98) b	0.33 (0.91)) ^b

	8 9)	9 0)						
M3 (NPV based)	0 . 3 3 (0 . 9 0)	0 . 3 3 (0 . 9 0)	0. 2 3 (0. 8 5)	0. 1 3 (0. 7 9)	0. 6 0 (0. 7 0)	0.3 0 (0. 89) a	0.2 7 (0. 87) ab	0.03 (0.73) ^a
M4 (Neem based)	0 . 3 0 (0	0 . 3 0 (0	0. 2 7 (0. 8 7	0. 2 7 (0. 8 7	0. 7 0 (1. 0 5	0.5 0 (0. 99) abc	0.3 3 (0. 91) ab	0.33 (0.89) ^b

	<p>· 8 9)</p>	<p>· 8 9)</p>	<p>)</p>	<p>)</p>	<p>)</p>			
<p>M5 (Spinosa d based)</p>	<p>0 · 3 7 (0 · 9 3)</p>	<p>0 · 1 0 (0 · 7 7)</p>	<p>0. 1 0 (0. 7 7)</p>	<p>0. 1 0 (0. 7 7)</p>	<p>0. 6 0 (1. 0 5)</p>	<p>0.2 0 (0. 84) a</p>	<p>0.1 3 (0. 80) a</p>	<p>0.03 (0.73)^a</p>
<p>M6 (NSKE based)</p>	<p>0 · 3 3 (</p>	<p>0 · 2 0 (</p>	<p>0. 2 0 (0. 8</p>	<p>0. 1 7 (0. 8</p>	<p>0. 8 0 (1. 1</p>	<p>0.3 0 (0. 89) a</p>	<p>0.1 7 (0. 82) a</p>	<p>0.03 (0.73)^a</p>

	0 . 9 1)	0 . 8 4)	4)	2)	4)			
M7 (Water spray)	0 . 3 7 (0 . 9 3)	0 . 3 3 (0 . 9 1)	0. 3 7 (0. 9 3)	0. 4 0 (0. 9 5)	0. 8 0 (1. 1 3)	0.8 0 (1. 14) cd	0.7 7 (1. 22) c	0.90 (1.17) ^c
M8 (Untreat ed control)	0 . 3 3	0 . 3 7	0. 3 3 (0.	0. 3 0 (0.	0. 9 0 (1.	0.9 3 (1. 20) d	0.9 0 (1. 18) c	0.87 (1.17) ^c

	(0 . 9 1)	(0 . 9 3)	9 1)	8 9)	1 8)			
F-test	N S	N S	N S	N S	N S	*	*	*
SEM±	-	-	-	-	-	0.0 5	0.0 4	0.03
CD @ 5 %	-	-	-	-	-	0.1 6	0.1 2	0.11
CV (%)	1 1 . 3 3	1 1 . 2 3	9. 6 4	8. 1 6	7. 8 3	9.4 0	7.3 6	6.80

Numbers in the parenthesis are square root transformed value of $\sqrt{x+0.5}$

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

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

IPM Modules	Seed Yield (Kg/ha)	Cost-benefit ratio
M1 (Bt based)	2184^{ab}	5.54
M2 (<i>Beauveria</i> 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)	1477^c	-

control)		
F test	(*)	
SEm±	149.07	
CD @ 5 %	452.17	
CV (%)	13.21	

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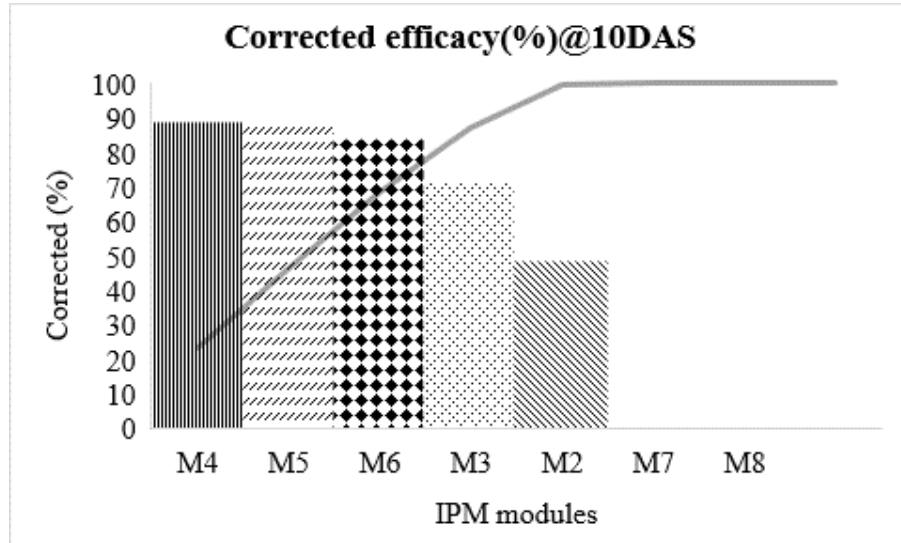


Fig. 1. Corrected efficacy of IPM modules against *Thysanoplosia orichalcea*

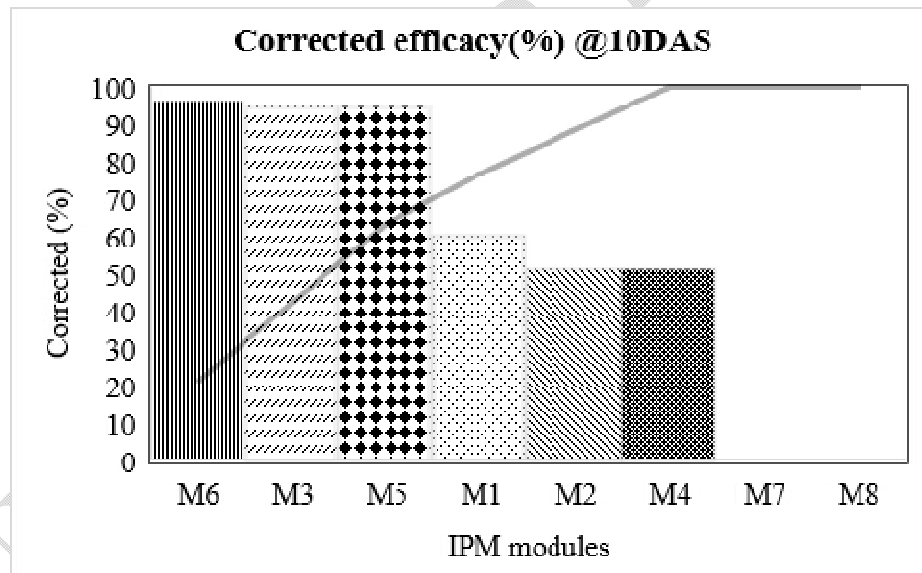


Fig. 2. Corrected efficacy of IPM modules against *Helicoverpa armigera*