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Development of bio-intensive pest management module in sunflower for the management of head borer and defoliators

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Abstract
Field experiments were carried out on the impact of different BIPM modules on the incidence insect pests, natural enemies and pollinators. Pooled data for three years revealed that, among the modules, Module-III 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 significantly superior over others in reducing the pest population and in recording higher number of natural enemies. The next best module was module-IV. Module-III recorded highest yield of 1233.79 Kg/ha followed by Module-IV which recorded yield of 1100.42 Kg/ha. The module III recorded a highest benefit cost ratio of 2.91 followed by module-IV which recorded a B:C ratio of 2.63. Incremental Benefit: Cost Ratio (IBCR) was maximum in module III (1.33) followed by module IV (1.05), module II (0.80) and module I (0.65).

Keywords: Sunflower insect pests, natural enemies, BIPM and IBCR

Introduction
Sunflower (*Helianthus annuus* L.) is one of the important oilseed crops in the world which ranks third in area after soybean and groundnut. Indian farmers started large scale cultivation of sunflower in 1972 with the introduction of high yielding Russian varieties. Sunflower yield levels of the country are the lowest in the world due to several biotic and abiotic factors and yet the potential of the crop is, far from being exploited. Sunflower insect pests are broadly categorised as seedling pests, sucking pests, soil insects, defoliators and inflorescence pests (Basappa and Prasad, 2005). Sucking pests like leafhoppers, thrips and whiteflies causes considerable extent of loss to the crop.

Sunflower is mainly cultivated by the farmers of the dry tracts, in poor and marginal soils. Therefore, dependency on expensive and hazardous insecticides will inflate the cost of sunflower production and also reduce the profit margin of the farmer. Widespread and indiscriminate use of synthetic chemical insecticides, has led to the development of resistance in insects, resurgence of sucking pests, destruction of beneficial fauna, in addition to the several toxic hazards due to large scale manufacture and handling of the chemical pesticides. These drawbacks are forcing the scientists working on sunflower to explore viable eco-friendly alternatives for pest management. In this context bio-pesticide based IPM strategies offer the most eco-friendly option to the sunflower farmer. Hence the present investigation was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Raichur Campus, during the Kharif seasons of three consecutive years i.e. 2011-12, 2012-13 and 2013-14.

Materials and Methods
Four different pest management modules were formulated and validated for their efficacy against major insect pests of sunflower during three consecutive kharif seasons of 2011, 2012 and 2013 at at the Main Agricultural Research Station, University of Agricultural Sciences, Raichur Campus, viz, M-I: Seed treatment with imidacloprid 70WS(5g/kg) + metalaxyl 35SD(5g/kg) + handpicking & destruction of gregarious early instar larvae of defoliators (*Spodpptera litura* Fab. and *Spilarctia oblique* Walker) + two sprays with neem kernel extract: M-II: Seed treatment with imidacloprid 70WS (5g/kg) + metalaxyl 35SD (5g/kg) handpicking & destruction of gregarious early instar larvae of defoliators (*S. litura* and *S. obiliqua*) + two

sprays with Helicoverpa armigera NPV (250LE). M-III: Seed treatment with imidacloprid 70 WS(5g/kg) + handpicking & destruction of gregarious early instar larvae of defoliators (*S. litura* and *S. obliqua*) + two sprays with spinosad 45SC (0.0045%). M-IV: Seed treatment with imidacloprid 70WS (5g./kg)+ metalaxyl 35SD (5g/kg) + two sprays with profenophos 50 EC @ 0.05%.

Population of headborer and natural enemies were recorded at one day before treatment and one, three and seven days after treatment whereas, cumulative per cent defoliation was recorded for defoliators. The mean population of pests and natural enemies were worked out and subjected to statistical analysis.

Results and Discussion

During first spray, Helicoverpa larval population ranged from 1.45 to 1.78 larvae per plant at one day before first spray and it was statistically non-significant among the modules. Post-spray observations on *H. armigera* revealed significant differences between the modules.

One day after first spray, Module M-III recorded 0.31 headborer/plant and it was significantly superior over rest of the treatments. Module M-IV recorded 0.47 headborer/plant and was found to be superior over Module M-I (1.50 headborer/plant), Module-II (1.36 headborer/plant) and control (1.54 headborer/plant). Three days after first spray, Module M-III recorded 0.24 headborer/plant and it was significantly superior over rest of the treatments. Module M-IV recorded 0.63 headborer/plant and was found to be superior over Module M-I (1.32 headborer/plant), Module-II (1.23 headborer/plant) and control (1.63 headborer/plant).Seven days after first spray, Module M-III recorded 0.23 headborer/plant and it was significantly superior over rest of the treatments. Module M-IV recorded 0.44 headborer/plant and was found to be superior over Module M-I (0.92 headborer/plant), Module-II (0.82 headborer/plant) and control (1.73 headborer/plant). Similar trend was noticed at one, three and seven days after spray during the second spray (Table1).

Pre-spray observations on defoliator larvae revealed that there was no significant difference between the modules. Post-spray observation on per cent cumulative defoliation at harvest revealed that all four modules were significantly superior over untreated check (29.75%), however, module M-III recorded the lowest defoliation (10.49%) followed by M-IV (12.52%), M-I (22.60) and M-II (24.18%) (Table1).

During both first and second spray, Natural enemies population ranged from 0.62 to 0.72 per plant at one day before first spray and it was statistically non-significant among the modules. Post-spray observations on natural enemies revealed non-significant differences between the modules (Table2).

Module M-III recorded highest yield of 1233.79 Kg/ha followed by Module M-IV which recorded yield of 1100.42 Kg/ha. The module M-III recorded a highest benefit cost ratio of 2.91 followed by module M-IV which recorded a B:C ratio of 2.63. Incremental Benefit: Cost Ratio (IBCR) was maximum in module M-III (1.33) followed by module M-IV (1.05), module M-II (0.80) and module M-I (0.65) (Table1).

The results revealed that spinosad based module M3 was the most superior BIPM module by virtue of its highest incremental benefit cost ratio, for the third year in succession. Similar findings have been reported earlier by Jagadish *et al*. (2006) [3], who found that the IPM module (seed treatment with imidacloprid (5g/kg) + two sprays of NSKE 5% + two sprays of *Ha*NPV at 250 LE/ha) gave a significant decrease in population of all sucking pests and defoliators, besides higher incidence of predators, lower incidence of *H. armigera*, highest grain yield and cost: benefit ratio (1 : 2.32) and it was also superior than chemical control of insect pests in sunflower.

The pooled mean of the three years data revealed that, among the four modules that were evaluated, Module-III 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 significantly superior over others in reducing the pest population and in recording higher number of natural enemies. The second highest IBCR ratio was recorded incase of M-II comprising of seed treatment with Imidacloprid (5g/kg) + metalaxyl (5g/kg) +handpicking and destruction of early isstars of *S. litura* and *S. obliqua* + two sprays with *Ha* NPV (1.75). The spinosad treatments results were in accordance with the results of Sreekanth and Sehamahalakshmi (2012) [5] and Sreekanth *et al*. (2014) [6] concluded that new generation insecticide spinosad 45% SC @ 73 g a.i/ha for effective management of pod borers in pigeonpea ecosystem. Similarly by Srinivasan and Duyrairaj (2007) observed least *Helicoverpa* larval population (2.0 / plant) with spinosad 45 SC (73 g a.i./ha) followed by indoxacarb 14.8 SC treatment (2.4 / plant) in pigeonpea and also by Basavaraj *et al*. (2014) [2] in sunflower.

The pooled results were agreement with the results of Katti *et al* (2003) [4] reported that a bio-intensive IPM module in sunflower based cropping system viz, deep summer ploughing + FYM (10 tonness/ha) + seed treatment with *Trichoderma virdae* (4g/kg) + foliar spray spray with NSKE (5%) and sorghum leaf extract 20 and 30 DAS + *H. armigera* NPV and/ or *S. litura* NPV (250 LE) + use of pheromone traps (10/ha) bird perches (60/ha) proved to be most effective for pest suppression in sunflower, besides registering the highest B : C ratio of 1.21, as compared 1.21. as compared with chemical insecticide based IPM module or farmers practice.

The present investigation is an important step towards the ecological ways of pest management. The study concludes that use of Module-III 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%, could effectively be used in the successful management of head borer and defoliator in sunflower.

Table 1: Evaluation of Biointensive Integrated Pest management (BIPM) Modules in Sunflower (Pooled data of 2011-2014)

Treatments	Pre count	Population of Head borer (No/Plant)						% Defoliation	Yield (Kg/ha)	B:C ratio	IBCR
		I Spray			II Spray						
		1 DAS	3 DAS	7 DAS	1 DAS	3 DAS	7 DAS				
1. Module-I	1.78	1.50 (1.41)	1.32 (1.35)	0.92 (1.19)	1.57 (1.44)	1.12 (1.27)	1.21 (1.31)	22.60	905.14	2.23	0.65
2. Module-II	1.63	1.36 (1.36)	1.23 (1.32)	0.82 (1.15)	1.30 (1.34)	0.77 (1.13)	0.66 (1.08)	24.18	1010.45	2.38	0.80
3. Module-III	1.56	0.31 (0.90)	0.24 (0.86)	0.23 (0.85)	0.32 (0.91)	0.25 (0.87)	0.24 (0.86)	10.49	1233.79	2.91	1.33
4. Module-IV	1.73	0.47 (0.98)	0.63 (1.06)	0.44 (0.97)	0.93 (1.20)	0.57 (1.03)	0.46 (0.98)	12.52	1100.42	2.63	1.05
5. control	1.45	1.54 (1.43)	1.63 (1.46)	1.73 (1.49)	1.40 (1.38)	1.54 (1.43)	1.62 (1.46)	29.75	631.10	1.58	0.00
SEM +	0.13	0.02	0.05	0.04	0.03	0.04	0.03	0.35	28.00	-	-
CD @ 0.05%	NS	0.07	0.16	0.10	0.08	0.12	0.10	1.05	85.00	-	-

*DAS: Days after spray

Table 2: Effect of BIPM modules on natural enemies in sunflower (Pooled data of 2011-2014)

Treatments	Pre count	Natural Enemies (No/Plant)						
		I Spray			II Spray			
		1 DAS	3 DAS	7 DAS	Pre count	1 DAS	3 DAS	7 DAS
1. Module-I	0.62	0.66 (1.08)	0.72 (1.10)	0.76 (1.12)	0.45	0.47 (0.98)	0.53 (1.01)	0.57 (1.03)
2. Module-II	0.71	0.75 (1.12)	0.79 (1.14)	0.82 (1.15)	0.43	0.44 (0.97)	0.49 (0.99)	0.52 (1.01)
3. Module-III	0.66	0.63 (1.06)	0.70 (1.10)	0.76 (1.12)	0.51	0.54 (1.02)	0.56 (1.03)	0.61 (1.05)
4. Module-IV	0.72	0.51 (1.00)	0.53 (1.01)	0.57 (1.03)	0.48	0.32 (0.91)	0.35 (0.92)	0.38 (0.94)
5. control	0.64	0.72 (1.10)	0.84 (1.16)	0.89 (1.18)	0.52	0.55 (1.02)	0.61 (1.05)	0.66 (1.08)
SEM +	0.09	0.02	0.05	0.04	0.07	0.03	0.05	0.03
CD @ 0.05%	NS	0.05	0.14	0.13	NS	0.09	0.16	0.10

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