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Impact of pest management modules in mitigating the pod borer (*Helicoverpa armigera* Hubner) population on chickpea

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Abstract
A field experiment was carried out at Chatha Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST- J) during 2020-21 to evaluate the impact of pest management modules against *H. armigera* (Hubner) on chickpeas. Five different modules *viz*., Bio-intensive module (Module-I), IPM module (Module-II), Chemical module (Module-III), Package of Practices (Module-IV) including control (Module-V) were tested against *H. armigera*. The results of the experimentation revealed that Module III (Chemical module) was found superior in reducing the larval population of *H. armigera.* In the case of yield attributes against *H. armigera*, all the modules showed significantly different results wherein Module III (2366.6kg/ha) accounted for maximum chickpea yield followed by Module-II (1944.4 kg/kg), Module-I (1511.1 kg/ha), Module-IV (911.1 kg/ha) and Module-V (466.6 kg/ha) after harvest, respectively.

Keywords: *Cicer arietinum, Helicoverpa armigera*, IPM modules, management, pod borer, yield

Introduction
Chickpea (*Cicer arietinum* L.), belonging to the family Papilionaceae, originated in southeastern Turkey. It has long been considered as 'poor man's meat' due to less expensive sources of protein (Mohanty and Satyasai, 2015) [3]. During 2017-18, chickpea was globally grown in 149.66 lakh ha area, with a total production of 162.25 lakh tonnes and average productivity of 1252 kg/ha (FAOSTAT, 2019) [1] wherein Asia and Africa contribute around 80 per cent of world production. A plethora of biotic and abiotic stresses play a crucial role in the successful cultivation of pulses. Among the biotic factors, insect pest is the major limiting factor responsible for damaging the pods and low yield (Sharma, 2005) [7]. On average, 30-80% of crop losses occur in pulses due to ravages caused by insect pests which are valued ₹ 4000-5000 crores. Among the diverse group of insect pests damaging chickpeas, Gram pod borer (*H. armigera*) is a highly polyphagous insect that feeds on at least 181 plant species (Manjunath *et al*., 1989) [2] in India alone. According to Srivastava *et al*. (2010) [9], a single larva of *H. armigera* destroys at least 30-40 pods before its maturity. In recent years, global warming and abrupt climatic variability have become the prominent reasons for the increased crop losses and early infestation by *H. armigera* in North India (Sharma, 2010) [6]. Patil *et al*. (2017) [5] observed the continuous infestation of *H. armigera* in chickpeas from vegetative to pod formation stages and estimated that this pest can damage the chickpea crop up to 90%. Therefore, they further advocated adopting the comprehensive method of the chickpea production system to mitigate the survival and damage of pod borer by using resistant varieties, good agronomic practices, such as early sowing including planting density, optimum use of fertilizer level, intercrops (coriander, mustard, linseed, sunflower, sorghum, and marigold), installing T-shaped bird perches at 2 m distance and monitoring pod borer through pheromone traps, respectively. Integrating all of these approaches with biological control has shown some encouraging results for sustainable pod borer management and has resulted in high chickpea yield. Keeping these facts in view, the present experiment was carried out to evaluate different pest management modules against *H. armigera* on chickpeas.

Materials and Methods
To evaluate the effectiveness of different pest management modules against *H. armigera* on chickpeas, a field experiment was carried out at Entomology experimental field, SKUAST-J, Chatha in Randomized Block Design (RBD) with three replications.

The plot size was 3×3 m and spacing was maintained at 45×15 cm. There were five different modules for managing the pod borer (*H. armigera*) *viz*., Module- I (Bio-intensive module), Module- II (IPM module), Module- III (Chemical module), Module- IV (Package of practice), and Module- V (Control). Each module contained a set of different treatments which were validated under field conditions (Table 1).

Table 1: Different IPM modules for managing pod borer (*H. armigera*)

Modules	Treatments
Module- 1 Bio- intensive module	▪ Soil application of neem cake @ 500kg/ha ▪ Installation of Pheromone traps Helilure @ 12-15/ha ▪ Bird perches @ 15/ha ▪ Spraying of NSKE@ 1500 ml/ha as a blanket spray ▪ Spraying of Ha NPV @ 250 LE/ha ▪ Spraying of Bacillus thuringiensis@ 500 g/ha
Module- 2 IPM module	▪ Soil application of cartap hydrochloride 4G @ 20kg/ha ▪ Installation of Pheromone traps @ 15/ha ▪ Bird perches @ 15/ha ▪ Spraying of Neem oil@ 0.5% /ha blanket spray ▪ Spraying of Ha NPV @ 250 LE/ha ▪ Spraying of Emamectin bezoate @ 150 g/ha
Module- 3 Chemical module	▪ Soil application of carbofuron 3G @ 20 kg/ha ▪ Spraying of Chlorantriniliprole @ 150 ml/ha
Module- 4 Package of practice	▪ Intercropping with Mustard, linseed, coriander (6:2 ration) ▪ Spraying of Novaluron 10 EC, ▪ Profenophos 50 EC, ▪ NSKE 5% 2g /lit at pod setting stage ▪ Bird perches@ 20/ha
Module- 5 Control	▪ water spray

Preparation of insecticidal solution

The spray solution for field application was put together by the following methods. In case of liquid formulations, the required quantity of insecticides was added to little quantity of water and stirred thoroughly. The remaining quantity of water was then put on slowly with constant stirring, to get the desired concentration of spray fluid. The amount of insecticide needed (ml or g per liter of water) was calculated by the following formula:

$$\text{Amount of insecticide (ml or g per liter of water)} = \frac{\text{Concentration required (\%)}}{\text{Percent active ingredient}} x1000$$

Pod yield

The data on pod yield was recorded from the net plot of each treatment separately and converted into quintal per hectare basis for final presentation.

Statistical analysis

The data from the experimental location was collected for the spotted insect pest population. Critical difference for treatments was computed at 5% level of significance using one-way analysis of variance (ANOVA) and post hoc data analysis Tukey HSD test statistical analysis was done by using SPSS 16.0 software.

Results and Discussion

The perusal of the recorded data revealed that Module-III (0.13 larvae/m row length of plants) was superior over other treatment modules in reducing the larval population of *H. armigera* during the vegetative stage of crop followed by Module-II (0.86 larvae/m), Module-I (1.44 larvae/m), Module-IV (2.17 larvae/m) and Module-V (3.18 larvae/m), respectively. Again, at 50% flowering and 50% pod setting stage, Module-III (0.43 and 0.54 larvae/m row length of plants) was found to be superior in reducing the larval population of *H. armigera* on flowers followed by Module II (1.26 and 1.70 larvae/m row length of plants), Module I (2.40 and 2.60 larvae/m row length of plants), Module IV (3.34 larvae/m row length of plants) and Module V (4.30 and 5.16 larvae/m row length of plants), respectively. Overall, the impact of treatment combinations in Module-III were found to be superior followed by Module- II, Module-I and Module-IV, respectively whereas Module-V was the least effective of all the treatments in suppressing the larval population of *H. armigera* (Table 2). The descending orders of performance of four different modules were as follows: Module III> Module II> Module I> Module IV> Module V. In case of yield attributes against *H. armigera,* all the modules showed significantly different results i.e., Module-III (23.67 q/ha) accounted maximum chickpea yield as compared to other treatment modules. Module-II (19.44 q/ha), Module-I (15.11 q/ha), Module-IV (9.11 q/ha) and Module-V (4.67 q/ha) were in succession, respectively, in terms of chickpea yield after harvest (Table 2). The descending orders of performance of five different modules were as follows: Module III> Module II> Module I> Module IV> Module V. Moreover, the data recorded on installed pheromone trap catches in different IPM modules revealed that Module-III was superior in catching the adult moth traps and was statistically significant over module-I and module-IV (Table 3). The present findings are in agreement with Nayak and Gupta (2012) [4] who found chemical module to be superior in comparison to other modules in controlling the incidence of pod borer in chickpea. Moreover, Singh and Kumar (2012) [8] reported that module M5 (pheromone traps @20 per ha, bird perch @40 per ha, chlorantraniliprole @0.15 liter per ha and water spray) was found effective to reduce the population of *H. armigera* and obtain the maximum yield, which is in conformation with our present findings.

Table 2: Evaluation of different types of IPM modules on larval infestation of pod borer, *Helicoverpa armigera* and yield of chickpea

Different types of IPM Modules	*H. armigera* larval mean population at Vegetative Stage	*H. armigera* larval mean population at 50% Flowering Stage	*H. armigera* larva mean population at 50% Pod Setting Stage	Yield (kg/plot)	Yield (q/ha)
Module-1 (Neem cake @ 500kg/ha+ Pheromone traps @ 15/ha+ Bird perches @ 15/ha+ NSKE@ 1500ml/ha+ Ha NPV @250LE/ha+ Bacillus thuringiensis @500g/ha)	1.4420^{c}	2.4000^{c}	2.6000^{c}	1.3662^{c}	15.1^{a}
Module-2 (Cartap hydrochloride 4G @ 20kg/ha+ Pheromone traps @15/ha+ Bird perches @15/ha+ Neem oil @0.5%/ha+ Ha NPV @250 LE/ha+ Emamectine benzoate @150g/ha)	0.8640^{b}	1.2600^{b}	1.7000 ^{b}	1.7588^{b}	19.4^{b}
Module-3 (Carbofuron 3G@ 20kg/ha+ Chlorantriniiprole@ 150ml/ha)	0.1300^{a}	0.4380^{a}	0.5460^{a}	2.1304^{a}	23.6^{a}
Module-4 (Intercropping with Mustard, linseed, coriander(6:2 ratio)+ Novaluron 10EC+ Profenophos50EC+ NSKE 5%2g/lit+ Bird perches@20/ha+ Pheromone traps @15/ha)	2.1720^{d}	3.4400^{d}	3.3400^{d}	0.8218^{d}	9.1^{d}
Modue-5 Control (untreated)	3.1820^{e}	4.3000^{e}	5.1600^{e}	0.4232^{e}	4.6^{e}

-Tukey HSD test; Means within the column followed by different letters are significantly different $P<0.05$

Table 3: Evaluation of Trap catches in different IPM modules

Different types of IPM Modules	Trap catch at Vegetative Stage	Trap catch at 50% Flowering Stage	Trap catch at 50% Pod Setting Stage
Module-I	0.9000 $_{b}$	1.9000$_{b}$	3.8200$_{b}$
Module-II	0.0200a	1.2000a	2.2200a
Module-IV	1.6000c	2.8800c	4.8000c

-Tukey HSD test; Means within the column followed by different letters are significantly different $P<0.05$

Conclusion
Among various modules tested, Module-III (Chemical module) was found to be more effective in controlling the larval population of *H. armigera* and also fetching the maximum yield of chickpeas. The installation of pheromone traps was found to be promising in monitoring the adult population. As such, it is advised to install pheromone traps in chickpea fields to effectively trap adults of *H. armigera* to hinder further population build-up of this pest. A combination of different treatments in place of a single chemical treatment should also be followed from the vegetative stage of this crop to hamper the crop damage at an early stage for successful pod development and enhanced yield.

Conflict of interest
All the authors have revised and approved the manuscript and there exists no conflict of interest between them.

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