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Influence of plant density of marigold on larval population of gram pod borer *H. armigera* in chickpea (*Cicer arientinum* L.)

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Abstract
A field experiment on Influence of plant density of marigold on larval population of *H. armigera* in chickpea (*Cicer arientinum* L.) was conducted at Entomology Research Farm, PGI, MPKV, Rahuri during *Rabi* 2019-20 to evaluate the different planting combination of chickpea (Digvijay) with marigold in a Randomized block design (RBD) with 4 replication. All treatment combination record lowest larval population and pod damage as compare to sole chickpea crop. The lowest larval population was observed in T_2 Chickpea +Marigold 3 (6:2) i.e. 2.06 larvae per meter row length. In Trap cropping with marigold maximum yield (22.54 q/ha) of chickpea was obtained from Chickpea + Marigold, 6:2 ratio. The average pod damage recorded ranged between 11.18 to 17.03%.

Keywords: Chickpea, *H. armigera*, sole chickpea crop, trap cropping, marigold

Introduction
Pulses are the important group which occupies a unique position among the food crops in the world of agriculture by virtue of their high protein content. Gram (*Cicer arietinum* Linnaeus) commonly called as 'Chickpea' or 'Bengal gram' is the most important pulse crop of India grown in *Rabi* season. It is a self- pollinated crop and belongs to the sub family Papilionaceae of the family Leguminaceae (Bentham and Hooker, 1970) [3] with its probable origin in South West Asia i.e.in countries like Afghanistan and Persia. Pulses beside rich source of proteins, also enriched the soil by symbiotic nitrogen fixation. Due to their protein richness, pulses are the integral part of daily diet of the Indian people. In nutritional point of view, chickpea seeds contain protein (17.7%), lysine (0.49%) and methionine (0.11%) (Katiyar, 1982) [7]. In addition to this, it also carries 56.6% carbohydrates, ash, calcium, phosphorus, iron and vitamin B in considerable amount (Thakur, 1980) [13].
India is the largest producer of chickpea (*Cicer arietinum*) with 67 per cent of the global production and occupies nearly 31 percent of area in the country contributing over 37 per cent to the national pulse production (Reena *et al*., 2009) [10]. In 2017-18, chickpea was cultivated in about 106 lakh ha area in India. The country harvested a record production of > 111 lakh ton at the ever highest productivity level of 1056 kg/ha. As usual, Madhya Pradesh has contributed a significant 34% of the total gram area and 41% of total gram production in the country, thereby ranking first both in area and production. Maharashtra (18%) and Rajasthan (13%) were the next in terms of area. (Anonymous, 2018) [1]. Chickpea crop suffers a lot due to the attack of number of insect-pests. Among these Gram pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is the most important pest of chick pea. *Helicoverpa armigera* (Hubner) causes up to 75 percent reduction in yield (Begum *et al*., 1992) [2]. On average about 30 to 40% pods are found to be damaged by the pod borer resulting in the yield loss of 400 kg/ha (Rahman, 1990) [9]. It is a polyphagous insect also known as American bollworm has become a pest of national importance in India, causing economic losses to several crops like chickpea, pigeon pea, cotton, tomatoes etc. (Sachan 1994) [11].
The most commonly method for the control of this pest is to have a film of a persistent effective insecticide over the foliage. The indiscriminate use of insecticide has eroded sustainability and resulted in build up of pesticide residues, resistance to pesticides, resurgence, secondary outbreak of this pest and is becoming great problem for entomologists

(Fitt, 1989; Mehrotra, 1991) [5]. So the use of insecticides for the control of this pest is highly criticized for various reasons and therefore switching from insecticides to trap cropping. Trap crop provides protection by preventing the pest from reaching the main crop and the pests are diverted away from the main crop or concentrated in certain pockets of the field where they are easily arrested or controlled. Trap crops have an important attribute that it is distinctly more attractive to the pest than the main crop and have additional function for natural enemies (Pats *et al.*, 1997) [8]. Therefore, The main emphasize of the study is use of marigold as a trap crop against chickpea borer on gram was evaluated in different cropping combinations.

Materials and method

The field experiment on "Influence of plant density of marigold on oviposition/larval population of *H. armigera*." was conducted at Entomology Research Farm, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Rabi* 2019-20 to evaluate the different planting combination of chickpea (Digvijay) with marigold in a Randomized block design (RBD) with 4 replication. Thirty days old seedling were transplanted at the time of sowing of chickpea in the field. For chickpea was sown at a spacing of 30 cm x 10 cm. Crop was raised according to all agronomic package of practices under irrigated condition except the plant protection measures. Data on number of eggs and larvae were recorded from 5 plants of Marigold and per meter row length of chickpea at weekly interval from the first appearance of the pest and will continuing till then availability.

Pod borer infestation per plant was recorded at weekly intervals from the randomly tagged 5 plants per meter row length in plot starting from flowering to pod maturity from all replications.

All the pods were counted from each plot and examined. The data on damaged (bored), healthy and total pods was recorded from each plot on number basis by examining the pods for *H. armigera* infestation. The percent pod damage was calculated using the following formula:

$$\% \text{ Pod damage} = \frac{\text{Damaged pod}}{\text{Total pod}} \times 100$$

Table 1: Treatment Details

Tr. No.	Treatments
T1	Chickpea +Marigold 4 (4:2)
T2	Chickpea + Marigold 3 (6:2)
T3	Chickpea + Marigold 2 (10:2)
T4	Chickpea + Marigold at border
T5	Chickpea sole crop

Result and discussion

Influence of plant density of marigold on *H. armigera* larval population

The effect of plant density of marigold on the incidence of *H. armigera* in various weeks were recorded. The different Chickpea + Marigold planting ratios were Chickpea + Marigold 4 (4:2), Chickpea + Marigold 3 (6:2), Chickpea + Marigold 2 (10:2) and Chickpea + Marigold at border. Significant effect was found on the *H. armigera* larval population at the various days after sowing. The effect of plant density of marigold on the incidence of *H. armigera* (Hub.) in chickpea at the various day after sowing is presented in Table 2.

35 Days after sowing (DAS)

The minimum population of *H. armigera* (1.77 larvae/mrl) was found in the treatment T_3 (Chickpea + Marigold, 10:2 ratio). The treatments T_2 (Chickpea + Marigold, 6:2 ratio, 1.91 larvae/mrl), T_1 (Chickpea + Marigold, 4:2 ratio, 2.45 larvae/mrl) and T_4 (Marigold at border, 2.61 larvae/mrl) were next better treatments which were at par with each other. The highest larval population (3.26 larvae/mrl) was found in the treatment T_5 (Sole Chickpea crop).

42 DAS

The minimum population of *H. armigera* (2.06 larvae/mrl) was recorded in the treatment T_2 (Chickpea + Marigold, 6:2 ratio), followed by the treatments T_3 (Chickpea + Marigold, 10:2 ratio, 2.26 larvae/mrl) and T_4 (Marigold at border, 2.58 larvae/mrl) which were at par with each other. The maximum larval population (4.03 larvae/mrl) was observed in treatment T_5 (Sole Chickpea crop).

49 DAS

The minimum larval population of *H. armigera* (2.11 larvae/mrl) was recorded in the treatment T_2 (Chickpea + Marigold, 6:2 ratio) followed by the treatments T_3 (Chickpea + Marigold, 10:2 ratio, 2.38 larvae/mrl) and T_4 (Marigold at border, 3.26 larvae/mrl) respectively, which were at par with each other. The maximum population was found (4.20 larvae/mrl) in the treatment T_5 (Sole Chickpea crop).

56 DAS

The minimum population of *H. armigera* (2.22 larvae/mrl) was recorded in the treatment T_2 (Chickpea + Marigold, 6:2 ratio) followed by the treatment T_3 (Chickpea + Marigold, 10:2 ratio, 2.50 larvae/mrl). The next better treatment was T_4 (Marigold at border, 4.15 larvae/mrl). The maximum population (5.52 larvae/mrl) was found in the treatment T_5 (Sole Chickpea crop).

63 DAS

The minimum pest population (2.46 larvae/mrl) was recorded in treatment T_2 (Chickpea + Marigold, 6:2 ratio), followed by the treatments T_2 (Chickpea + Marigold, 10:2 ratio, 2.70 larvae/mrl) and T_1 (Chickpea + Marigold, 4:2 ratio, 4.13 larvae/mrl) respectively. The maximum larval population (5.73 larvae/mrl) was found in the treatment T_5 (Sole chickpea crop).

70 DAS

It was observed that the population decreased from the previous weeks. The maximum population of *H. armigera* 5.42 larvae/mrl) was found in treatment T_5 (Sole Chickpea crop) and minimum population (2.28 larvae/mrl) was found in the treatment T_2 (Chickpea + Marigold, 6:2 ratio).

77 DAS

The pest population was minimum (2.00 larvae/mrl) in the treatment T_2 (Chickpea + Marigold, 6:2 ratio) followed by the treatment T_3 (Chickpea + Marigold, 10:2 ratio, 2.23 larvae/mrl). The maximum larval population (4.86 larvae/mrl) was observed in the treatment T_5 (Sole chickpea crop).

84 DAS

The minimum pest population (1.84 larvae/mrl) was found in treatment T_2 (Chickpea + Marigold, 6:2 ratio) followed by the treatment T_3 (Chickpea + Marigold, 10:2 ratio, 2.06

larvae/mrl). The maximum pest population (4.64 larvae/mrl) was found in the treatment T_5 (Sole chickpea crop).

91 DAS

The pest population was minimum in (1.64 larvae/mrl) in T_2 (Chickpea + Marigold, 6:2 ratio) followed by the treatment T_3 (Chickpea + Marigold, 7:2 ratio, 1.86 larvae/mrl). The maximum population of *H. armigera* (4.41 larvae/mrl) was found in the treatment T_5 (Sole Chickpea crop).

The trap crop (Marigold) grown with chickpea had significant effect on the larval population of *H. armigera* is presented in Table 2. The statistical analysis of the data revealed that the overall mean minimum population of *H. armigera* (2.06 larvae/mrl) was observed in the treatment T_2 (Chickpea + Marigold, 6:2 ratio), followed by T_3 (Chickpea + Marigold, 10:2 ratio, 2.26 larvae/mrl) which were at par with each other. The treatments T_1 (Chickpea + Marigold, 4:2 ratio, 3.60 larvae/mrl) and T_4 (Marigold at border, 3.61 larvae/mrl) were also at par with each other. The maximum larval population (4.67 larvae/mrl) was observed in T_5 (Sole Chickpea crop).

In the present investigation the minimum population of *H. armigera* (2.72 larvae/mrl) was observed in the treatment T_2 (Chickpea + Marigold, 6:2 ratio). The maximum population (4.67 larvae/mrl) was observed in T_5 (sole chickpea crop) at different observation. Sandhu and Arora (2014) [12] conducted dual choice test to study the ovipositional and larval preference of *H. armigera* on the test plants of marigold and coriander while the tomato plants acted as control. The maximum number of eggs were laid on the two varieties of marigold plants (83.6, 80.8) which were significantly higher than the number of eggs laid on coriander plants (67.6, 60.0) and less in tomato plants (25.6, 21.6). The order of preference for oviposition by females of *H. armigera* was: marigold > coriander > tomato which support our findings.

Table 2: Effect of Trap Crop (Marigold) on the larval population of *H. armigera* Hub. In chickpea.

Treatment Chickpea + Marigold	Number of Larvae/Meter row length (Days after sowing)									
	35	**42**	**49**	**56**	**63**	**70**	**77**	**84**	**91**	**Mean**
T_1 Chickpea + Marigold 4(4:2)	2.45 (1.86)	3.40 (2.10)	3.59 (2.14)	4.34 (2.31)	4.13 (2.26)	3.85 (2.23)	3.56 (2.14)	3.57 (2.14)	3.53 (2.13)	3.60 (2.15)
T_2 Chickpea +Marigold 3 (6:2)	1.91 (1.71)	2.06 (1.75)	2.11 (1.76)	2.22 (1.79)	2.46 (1.86)	2.28 (1.81)	2.00 (1.73)	1.84 (1.69)	1.64 (1.63)	2.06 (1.75)
T_3 Chickpea + Marigold 2(10:2)	1.77 (1.66)	2.26 (1.81)	2.38 (1.84)	2.50 (1.87)	2.70 (1.92)	2.58 (1.89)	2.23 (1.80)	2.06 (1.75)	1.86 (1.69)	2.26 (1.80)
T_4 Marigold at border	2.61 (1.90)	2.58 (1.89)	3.26 (2.06)	4.15 (2.27)	4.75 (2.40)	4.30 (2.30)	3.79 (2.19)	3.56 (2.14)	3.47 (2.11)	3.61 (2.15)
T_5 Sole Chickpea Crop	3.26 (2.06)	4.03 (2.24)	4.20 (2.28)	5.52 (2.55)	5.73 (2.59)	5.42 (2.53)	4.86 (2.42)	4.64 (2.37)	4.41 (2.33)	4.67 (2.38)
SEm ±	0.08	0.09	0.12	0.14	0.10	0.10	0.13	0.13	0.13	0.11
C.D. at 5%	0.26	0.28	0.36	0.42	0.31	0.31	0.39	0.40	0.39	0.35

Parenthesis are transformed values based on $\sqrt{x+1}$

Effect on pod damage and grain yield

Trap cropping of marigold with chickpea crop also affect the larval population of *H. armigera* which affect the pod damage and yield. The effect of plant density of marigold on the per cent pod damage and the grain yield of chickpea under various treatments is presented in Table 3. Significant effect was found in different treatments.

The minimum pod damage (11.18%) was observed in the treatment T_2 (Chickpea + Marigold, 6:2 ratio) with 22.54 q/ha chickpea yield. The treatment T_3 (Chickpea + Marigold, 10:2 ratio) and treatment T_4 (Marigold at border) were next better treatment with 11.35% and 11.84% pod damage and 22.12 q/ha and 19.85 q/ha chickpea yield respectively, which were at par with each other. In treatment T_1 (Chickpea + Marigold, 4:2) there was 13.70% pod damage and 18.79 q/ha chickpea yield. The maximum pod damage (17.03%) was observed in the sole chickpea crop giving 16.85 q/ha yield.

In the present investigation, the minimum pod damage (11.18%) was observed in the treatment T_2 (Chickpea + Marigold, 6:2 ratio) with 22.54 q/ha chickpea yield whereas the maximum pod damage (17.03%) was observed in the sole chickpea crop giving 16.85 q/ha yield.

Jakhar and Suman (2015) [6] reported that, among six modules tested against *H. armigera* on tomato IPM-IV module (growing of african marigold after every 8 rows of tomato as well as on the periphery of the plot and two spray of *Ha*NPV @ 350 LE/ha on appearance of first instar larvae followed by spray of Decidan 32.8% EC @ 15ml/10 litre) was found highly effective and economical for management of tomato fruit borer, *H. armigera* and it exhibited least tomato fruit borer damage (3.44%) and maximum tomato yield (257.25q/ha) which supported our results. Chhangani *et al.*, (2018) [4] revealed that, the marketable yield of gram among different farms caped treatment ranged from 1.26 to 1.89 kg/ plot. The maximum marketable yield of 1.89 kg/ plot was recorded in gram bordered with marigold with bio pesticide application. The highest cost benefit ratio of 1:1.92, was recorded for gram bordered with marigold with biopesticide treatment; while, lowest cost benefit ratio of 1:1.33 was recorded for gram without farms caped treatment, which coincide with our results.

Table 3: Damaged pods (%) by *H. armigera* and grain yield (q/ha) in chickpea.

Treatment Chickpea+Marigold	Pod damage (%)	Grain yield (q/ha)
T_1 Chickpea+Marigold 4 (4:2)	13.70 (21.72)	18.79
T_2 Chickpea+Marigold 3 (6:2)	11.18 (19.53)	22.54
T_3 Chickpea+Marigold 2(10:2)	11.35 (19.69)	21.12
T_4 Marigold at border	11.84 (20.13)	19.85
T_5 Sole chickpea	17.03 (24.37)	16.85
SEm ±	0.51	0.25
C.D. at 5%	1.56	1.61

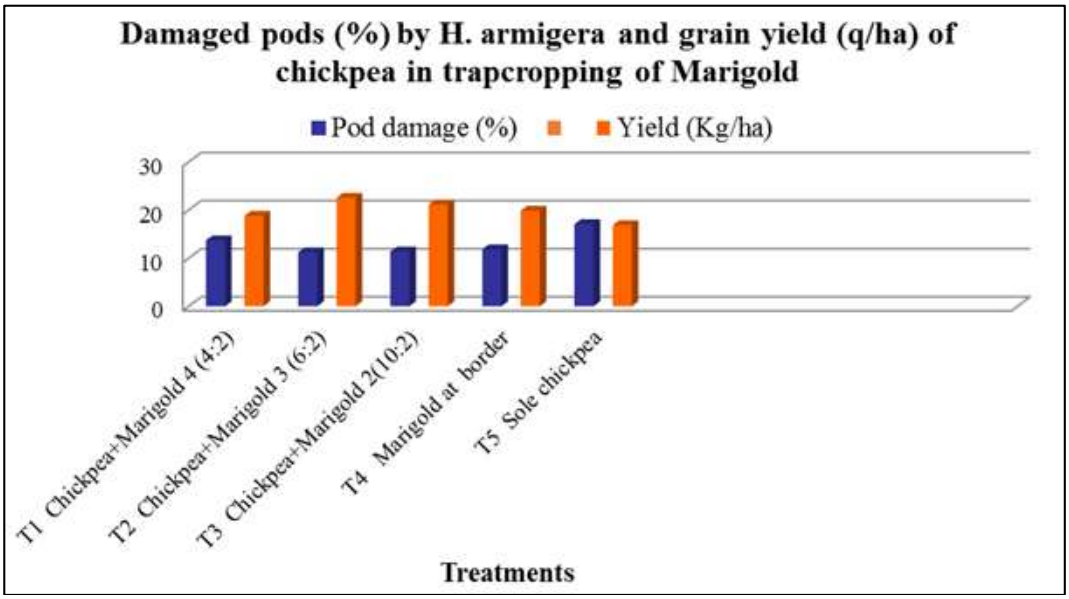

Fig 1: Damaged pods (%) by *H. armigera* and grain yield (q/ha) of chickpea in trap cropping of Marigold.

Conclusion

In Trap cropping with marigold lowest larval population (2.06 larvae per meter row length), lowest pod damage (11.18%) and maximum yield (22.54 q/ha) of chickpea was obtained from Chickpea + Marigold, 6:2 ratio. The average pod damage recorded ranged between 11.18 to 17.03%.

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