The Pharma Innovation Journal 2022; 11(4): 479-483

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(4): 479-468

www.thepharmajournal.com
Received: 17-01-2022
Accepted: 29-03-2022

Hari Prakash Namdev
Ph.D., Scholar, Department of Entomology, Brahmanand Post Graduate College, Rath, Hamirpur, Uttar Pradesh, India

Ram Subhag Singh
Associate Professor, Department of Entomology, Brahmanand Post Graduate College, Rath, Hamirpur, Uttar Pradesh, India

Corresponding Author:
Hari Prakash Namdev
Ph.D., Scholar, Department of Entomology, Brahmanand Post Graduate College, Rath, Hamirpur, Uttar Pradesh, India

Influence of intercropping on crop losses by chickpea pod borer, *Helicoverpa armigera* (Hub.) in chickpea

Hari Prakash Namdev and Ram Subhag Singh

Abstract
An experiment was conducted at Agricultural Research Farm of Brahmanand Post Graduate College, Rath, Hamirpur (U.P.) on influence of intercropping on crop losses by chickpea pod borer, *Helicoverpa armigera* (Hub.) in chickpea during 2016-17 and 2019-20 cropping season. Intercropping had significant influence on the reduction of pod damage and grain damage (in number and by weight) inflicted by grain pod borer (*H. armigera*) during 2016-17 and 2019-20 cropping seasons. The chickpea intercropped with marigold was found most effective in reducing the pod damage (5.33%),grain damage (4.49%) and grain weight loss (3.5%) during both the cropping seasons, While pod damage reduction over control were 57.15%, 61.35%, and 63.41%, respectively. The second most important intercropping system was chickpea + mustard followed by chickpea + linseed and chickpea + barley. The chickpea + safflower intercropping system were found least effective in reducing the crop losses (pod damage, and grain damage) by *H. armigera* larvae. The chickpea sole crop had maximum pod damage (12.33%) grain damage (11.48%), grain weight loss (9.75%) and produced minimum grain yield (15.68 q/ha). Chickpea intercropped with marigold was most effective for the management of crop losses in chickpea by chickpea pod borer which produced 19.53q/ha and over chickpea sole crop this intercrop increases 24.55% grain yield. The chickpea intercropped with safflower was observed to produced minimum yield (16.20 q/ha) followed by chickpea + barley (16.66 q/ha) and over chickpea sole crop it increases 3.35% and 6.29% grain yield, respectively.

Keywords: Chickpea, intercropping, *Helicoverpa armigera* (Hub.), crop losses

Introduction
Chickpea pod borer (*Helicoverpa armigera* Hub.) is one of the major pests of chickpea. The pest starts its activity from vegetative stage of the crop and become severe at pod formation and maturity stage of the crop. A single larva of gram pod borer can damage up to 40 pods of gram in its life span. It feeds on tenders shoots, buds and pods. It makes holes on pods and inserts its half body in to pod and eat the developing grains. In India, the extent of crop losses due to *Helicoverpa armigera* Hub. in chickpea is up to 27.9% in North West plan zone, 13.2% in north east plane, 24.3% in central zone and 36.4% in south zone. In Uttar Pradesh alone 15.3% of chickpea crop worth rupees 462.5 million is last annually due to infestation of chickpea pod borer, 17.2% in Karnataka and 28.5% in Delhi (Chaturvedi *et al*., 2019) [2]. Chickpea pod borer (*H. armigera* Hub.) is considered as widespread and cosmopolitan insect responsible for drastic declined in chickpea productivity across the world. The management *H. armigera* is of prime importance to achieve sustainable chickpea yield. Gram Pod borer can cause yield loss up to 90% depending upon the insect density and susceptibility of cultivars. There management through use of resistant cultivar, adopting recommended cultural practices, biological control measure and ecofriendly selective insecticides have been found more effective, economical, and sustainable, ecofriendly (Mahmood *et al*. 2021) [7]. Intercropping with several other crops provides insurance in the farming ecosystem against the insect pests. Intercropping with common host crops has also contributed to lift up the population of polyphagous insect pest like *H. armigera*; therefore intercropping with non host crop resulted in reduced larval population. Intercropping of chickpea with certain crops does not offer same kind of stimuli and companionship for the pod borer therefore, less extent of damages were recorded. Pimbert (1990) [12] Ahamad (2003) reported that chickpea intercropped with mustard, wheat, linseed and non host crops had loss pod damage (38.3%) in comparison to the sole chickpea crop. However, Pattar *et al*. (2012) reported highest chickpea grain yield and reduced larval population in chickpea + mustard, followed by chickpea + barley and chickpea + safflower intercropping system.

Hence, an effort was made to ascertain the influence of intercropping on crop losses in chickpea by *Helicoverpa armigera* in Bundelkhand agro-climatic region of Uttar Pradesh.

Materials and Methods

The experiment was conducted was at Agricultural Research Farm of Brahmanand Post Graduate College, Rath, Hamirpur, U.P. during 2016-17 and 2019-20 cropping season. The field trail was laid out in Randomized Complete Block Design with three replications and five treatments including chickpea sole crop. The chickpea cultivar Radhey was intercropped with safflower (2:1), mustard (2:1), linseed (2:1), barley (2:1), and marigold (2:1).

At the time of harvesting 500 pods were collected randomly from each plot and pooled together and mixed thoroughly. A representative sample of 200 pods /plot was examined in the laboratory. On the basis of the nature of damage by chickpea pod borer, *Helicoverpa armigera* the damage was marked by the presence of big irregular circular holes on the pods and with all/few grains fed except some testa intact with placenta. All the 200 pods were opened to record number of the healthy pods/grains and damaged pods/grains by the chickpea pod borer, *Helicoverpa armigera*. The weight of the healthy grains and damaged grains was recorded. The data thus collected were subjected to the following formula to calculate per cent pod damage, grain damage and grain weight loss.

$$\text{Pod damage (\%)} = \frac{\text{NPD}}{\text{TNPE}} \times 100$$

Where,

NPD = Number of pods damaged by *H. armigera* in each sample TNPE = Total number of pods examined

$$\text{Grain damage (\%)} = \frac{\text{NSD}}{\text{TNSE}} \times 100$$

Where,

NSD = Number of seeds damaged by *H. armigera* in each sample TNSE = Total number of seeds examined

$$\text{Grain weight loss (\%)} = \frac{\text{CWDG}-\text{AWDG}}{\text{CWTPG}} \times 100$$

Where,

CWDG = Calculated weight (g) of damaged grain (equivalent to healthy grain) AWDG = Actual weight (g) of damage grain by *H. armigera*

CWTPG = Calculated weight (g) of total potential grains (healthy and damage)

The percentage data were used for analysis of variance after transformation by using arc sin transformation as suggested by Gomez and Gomez (1976) [5]. The analysis of variance table was prepared by following the methods of Randomized Complete Block Design (RCBD). The critical differences were calculated to know the significant differences among different intercrops.

Result and Discussion

1. Pod damage (%) by *H. armigera*

The chickpea pod borer was observed as major insect pest of chickpea in Bundelkhand agro climatic zone during 2016-17 and 2019-20 cropping seasons. The chickpea intercropped with marigold was found most effective in reducing the pod damage (6.33% and 4.33%) during both the cropping season and varied significantly with other intercropping systems. However, the pod damage was observed maximum (13.33 and 11.33%) in chickpea sole crop during both the cropping seasons. The second most important intercrop was chickpea + mustard which had 8.67% and 6.67% pod damage by *H. armigera*, respectively during 2016-17 and 2019-20. The average pod damage among various intercropping systems varied from 5.33 to 9.33% and varied significantly with chickpea sole crop (12.33%) (Table-1). The chickpea intercropped with mustard, linseed and barley and linseed, barley and safflower was found statistically at par in reducing the pod damage by chickpea pod borer with each other in their respective groups. The earlier findings made by Pandey and Ujagir (2008) who reported that chickpea intercropped with barley, linseed and coriander were found most effective in reducing the pod damage as compared to chickpea sole crop which had highest pod borer damage (90.6%). Significantly lower pod damage was recorded in chickpea + sunflower (19.50%) as compared to chickpea sole crop (24.28%).

The influence of intercropping on pod damage reduction over chickpea sole crop inflicted by *H. armigera* larvae was observed maximum (52.51 and 61.78%) during both cropping seasons in chickpea + marigold intercrop. It was followed by chickpea intercrop with mustard, linseed, barley and safflower. The average efficacy of intercropping on pod damage reduction over chickpea sole crop varied from 57.15% to 24.50%. The chickpea + safflower cropping system were found least effective in pod damage reduction over sole crop during both the cropping season. The results are in conformity with the findings of Singh (2014) [13] that reported chickpea intercropped with coriander and marigold had significantly reduced pod damage 83.05 and 64.96% respectively over chickpea as sole crop.

Table 1: Influence of intercropping system on pod damage (%) by chickpea pod borer (*Helicoverpa armigera*) in chickpea.

S. No.	Intercrops	Pod damage (%)			Pod damage reduction over chickpea sole crop (%)		
		2016-17	2019-20	Average	2016-17	2019-20	Average
1	Chickpea+Safflower (T_1)	10.33 (18.72)	8.33 (16.74)	9.33 (17.73)	22.51	26.48	24.50
2	Chickpea+Mustard (T_2)	8.67 (17.16)	6.67 (15.00)	7.67 (16.08)	34.96	41.13	38.05
3	Chickpea+Linseed (T_3)	9.00 (17.46)	7.00 (15.34)	8.00 (16.40)	32.48	38.22	35.35
4	Chickpea+Barley (T_4)	9.67 (18.15)	7.67 (16.11)	8.67 (17.13)	27.46	32.30	29.88
5	Chickpea+Marigold (T_5)	6.33 (14.54)	4.33 (11.97)	5.33 (13.26)	52.51	61.78	57.15

6	Chickpea sole crop (T_6)	13.33 (21.39)	11.33 (19.65)	12.33 (20.52)	-	-	-
CD (P=0.05)		2.30	2.38	1.47			

The figures in parentheses are arc sin transformed values

2. Grain damage (%) by *H. armigera*

The chickpea intercropped with marigold (5.49 and 3.49%) and mustard (7.25 and 5.25%) were found most effective reducing the grain damage by *H. armigera* during 2016-17 and 2019-20, there average grain damage was 4.49% and 6.25% during both cropping seasons. The intercropping had significant influence in reducing grain damage as compared to chickpea sole crop which received maximum grain damage 12.48, 10.48 and 11.48% respectively during 2016-17, 2019-20 and their average (Table-2). Similar report made earlier by Patil *et al.* (2018) [10] who reported that the chickpea intercropped with mustard, safflower and linseed had lowest pod infestation as compared to chickpea sole crop. Wasu *et al.* (2020) [16] observed minimum pod infestation and maximum grain yield from chickpea intercropped with marigold. Another report made by Kumar *et al.* (2017) [6] who recorded lowest incidence of *H. armigera* in chickpea, intercropped with linseed followed by mustard. The percent average grain damage in chickpea + linseed (8.63%), chickpea + barley (8.66%) and chickpea + safflower (9.62%) were found to be at par with each other but varied significantly from chickpea sole crop (11.48%). Earlier report made by Nath and Chakravorty (2005) [8], Pandey and Ujagir (2008), Ghugal *et al.* (2013) [3], Singh (2014) [13], Singh *et al.* (2015) [14], Waseem *et al.* (2017) [15] and Girhpunje *et al.* (2020) who reported maximum infestation and minimum yield in chickpea sole crop as compared to chickpea intercrops are in conformity with the present findings. The chickpea intercropped with marigold, mustard, linseed, barley and safflower had maximum grain damage reduction over chickpea sole crop *i.e.* 61.35%, 45.91%, 25.20%, 24.76% and 16.33%, respectively.

Table 2: Influence of intercropping system on grain damage (%) by chickpea pod borer (*Helicoverpa armigera*)

S. No.	Intercrops	Grain damage (%)			Grain damage reduction over chickpea sole crop (%)		
		2016-17	2019-20	Average	2016-17	2019-20	Average
1	Chickpea+Safflower (T_1)	10.62 (19.00)	8.62 (17.05)	9.62 (18.03)	14.90	17.75	16.33
2	Chickpea+Mustard (T_2)	7.25 (15.68)	5.25 (13.31)	6.25 (14.50)	41.91	49.90	45.91
3	Chickpea+Linseed (T_3)	9.63 (18.05)	7.63 (16.00)	8.63 (17.03)	22.84	27.19	25.20
4	Chickpea+Barley (T_4)	9.66 (18.15)	7.66 (16.11)	8.66 (17.13)	22.60	26.91	24.76
5	Chickpea+Marigold (T_5)	5.49 (13.56)	3.49 (10.78)	4.49 (12.17)	56.00	66.70	61.35
6	Chickpea sole crop (T_6)	12.48 (20.70)	10.48 (18.91)	11.48 (19.81)	-	-	-
CD (P=0.05)		1.45	1.63	1.31			

The figures in parentheses are arc sin transformed values

3. Grain weight loss (%) by *H. armigera*

Among all the intercrops minimum percent grain damage in weight was observed in chickpea + marigold (3.57%) and it was followed by chickpea + mustard, chickpea + linseed, chickpea + barley, chickpea + safflower with 4.53, 5.67, 5.85 and 6.83% grain weight loss, respectively (Table-3). The intercropping system significantly influenced the grain weight loss by *H. armigera* except chickpea intercropped with linseed, barley and safflower which had no significant differences with each other. The chickpea + marigold and chickpea + mustard were observed to be most effective in reducing grain weight loss during both the cropping season. The observations made by Ghugal *et al.* (2013) [3] who reported chickpea + marigold, chickpea + mustard and chickpea + coriander were the most effective in suppressing the crop losses by *H. armigera* in chickpea. Singh (2014) [13] and Singh *et al.* (2015) [14] observed that chickpea + African marigold was found most effective in reducing infestation and crop losses from *H. armigera* larvae and varied significantly from chickpea as sole crop. The percent grain weight loss in various intercropping system over chickpea sole crop revealed that chickpea intercropped with marigold had maximum influence (63.41%) in reduction of grain weight loss by *H. armigera*. It was followed by chickpea intercropped with mustard (54.11%), linseed (42.35%), barley (40.43%) and safflo,wer (30.27%). These findings are supported by various entomologist *i. e.* Pattar *et al.* (2012), Singh *et al.* (2015) [14], Waseem *et al.* (2017) [15], Patil *et al.* (2018) [10], Wasu *et al.* (2020) [16] and Girhpunje *et al.* (2020) who reported that intercropping had significant influence in reduction of chickpea crop losses as compared to chickpea sole crop.

Table 3: Influence of intercropping system on grain weight loss (%) by chickpea pod borer (*Helicoverpa armigera*)

S. No.	Intercrops	Grain weight loss (%)			Grain weight loss reduction over chickpea sole crop (%)		
		2016-17	2019-20	Average	2016-17	2019-20	Average
1	Chickpea+Safflower (T_1)	7.83 (16.22)	5.83 (13.94)	6.83 (15.08)	27.16	33.37	30.27
2	Chickpea+Mustard (T_2)	5.53 (13.56)	3.53 (10.78)	4.53 (12.17)	48.56	59.66	54.11

3	Chickpea+Linseed (T_3)	6.67 (15.00)	4.66 (12.52)	5.67 (14.01)	37.95	46.74	42.35
4	Chickpea+Barley (T_4)	6.85 (15.23)	4.85 (12.79)	5.85 (14.01)	36.28	44.57	40.43
5	Chickpea+Marigold (T_5)	3.90 (11.39)	3.23 (10.31)	3.57 (10.85)	63.72	63.09	63.41
6	Chickpea sole crop (T_6)	10.75 (19.19)	8.75 (17.26)	9.75 (18.23)	-	-	-
CD (P=0.05)		2.41	2.38	1.51			

The figures in parentheses are arc sin transformed values

4. Grain Yield of chickpea

The chickpea intercrop exhibited considerable changes in the grain yield of chickpea and varied significantly with chickpea sole crop. The chickpea + marigold intercrop was found most effective and had maximum grain yield during both the cropping seasons, while the minimum grain yield (q/hec) of both the cropping season was recorded in chickpea sole crop. The average grain yield of both the cropping seasons was observed maximum in chickpea intercropped with marigold (19.53 q/hec) and it was followed by mustard (17.64 q/hec), linseed (17.33 q/hec), barley (16.66 q/hec) and safflower (16.20 q/hec). The minimum grain yield (15.68 q/hec) was observed from chickpea sole crop (Table-4). The intercropping systems have significant influence on grain yield of chickpea and varied significantly with chickpea sole crop. The findings made by Pandey and Ujagir (2008), Kumar *et al.* (2017) [6] and Waseem *et al.* (2017) [15] are in agreement with the present findings they have found that the chickpea intercropping system produced maximum yield as compared to chickpea sole crop. Waseem *et al.* (2017) [15] observed highest grain yield in chickpea intercrop with marigold, mustard, coriander and linseed produced 19.13, 16.55, 16.43 and 15.52 q/hec, respectively. The chickpea sole crop was recorded with minimum (14.28 q/hec) grain yield. The percent grain yield increase over chickpea sole crop varied from 3.28% to 24.26% and 3.42% to 24.84% during 2016-17 and 2019-20 cropping seasons. The maximum average grain yield increase over chickpea sole crop was observed from chickpea + marigold (24.55%). It was followed by 12.54%, 10.56%, 6.29% and 3.35%, respectively from chickpea intercropped with mustard, linseed, barley and safflower.

Table 4: Influence of intercropping system on grain yield of chickpea.

S. No.	Intercrops	Grain yield (q/ha)			Grain yield increase over chickpea sole crop		
		2016-17	2019-20	Average	2016-17	2019-20	Average
1	Chickpea+Safflower (T_1)	15.75	16.65	16.20	3.28	3.42	3.35
2	Chickpea+Mustard (T_2)	17.15	18.13	17.64	12.46	12.61	12.54
3	Chickpea+Linseed (T_3)	16.85	17.81	17.33	10.49	10.62	10.56
4	Chickpea+Barley (T_4)	16.20	17.12	16.66	6.23	6.34	6.29
5	Chickpea+Marigold (T_5)	18.95	20.10	19.53	24.26	24.84	24.55
6	Chickpea sole crop (T_6)	15.25	16.10	15.68	-	-	-
CD (P=0.05)		1.04	1.34	1.38			

Conclusion

Chickpea pod borer is considered as wide spread and cosmopolitan insect pest responsible for drastic declined in chickpea productivity across the world. There management through intercropping with non-host crop or replant crops resulted in reduced larval population. The chickpea intercrop with mustard, linseed and barley were found most effective in reducing the pod and grain damage by chickpea pod borer and produced maximum grain yield in Bundelkhand agro climatic zone of Uttar Pradesh. The changes in crop canopy through intercropping system causes considerable impact on succession and population buildup of insect pest and flavoured the activity of natural enemies. Usually temperature and humidity of intercrops will differed from those of sole crop; thereby pest colonization will be affected.

Acknowledgement

The research paper is part of Ph.D., thesis of Hari Prakash Namdev. The author is Greatful to Principal B.N.P.G. college, Rath, Hamirpur (U.P.) for providing of Laboratory, Library and research field facilities. The author also oblige to Ph.D. research cell of Bundelkhand University, Jhansi for their valuable support and guidance.

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