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Effect of dates of sowing and intercropping on pod damage caused by *H. armigera* in chickpea

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Abstract
A field experiment was conducted during Rabi season of 2011-12 and 2012-13 at instructional farm, Junagadh Agricultural University, Junagadh to find effect of date of sowing and intercropping on pod damage caused by *Helicoverpa armigera* (Hubner) in chickpea. Results showed that the incidence of *H. armigera* on crop was found least per cent pod damage (17.47%) with the highest grain yield (793 kg ha^{-1}) sown on 15th November as compare to other date of sowing (1st November and 30th November). Coriander (2:1) was taken as intercrop with chickpea, it found lower per cent pod damage (13.73%), which also recorded the highest equivalent yield (831 kg ha^{-1}). Whereas, the chickpea sown on 15th of November and intercropped with coriander also registered the highest equivalent yield (947 kg ha^{-1}) with lower per cent pod damage (10.96%).

Keywords: Date of sowing, intercropping, pod damage, *H. armigera*, chickpea

1. Introduction
Chickpea (*Cicer arielinun* l Linn.) also known as bengal gram or gram. chana, garbanzo etc., is one of the most important pulse crops of India and is considered as "King of Pulses" [2]. India accounts for 68% of total global output of chickpea and incidentally it is one of the largest consumers. Chickpea is grown in about 8.68 million hectare in India with tentative production of 5.35 million tones [3]. In 2010-11, the estimated production was about 8.25 MT, a record in the last 50 year. Four states *viz*, Madhya- Pradesh, Uttar- Pradesh, Maharashtra and Rajasthan together contribute about 87% of production from area. In Gujarat, area under chickpea has been reported 2.39 lakh hectares with total production of 2.73 lakh tones and productivity of 1139 kg/ha during rabi 2011-12 [3].
The productivity of chickpea crop has not witnessed any significant jump as compared to the cereal crops, because of several biotic and abiotic constraints. Among the many biotic factors responsible for low yield, damage due to insect pests is the major limiting factor [1]. Chickpea crop is attacked by nearly 57 species of insect and other arthropods in India [4]. Among them, pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is most important and accounts for about 90 to 95% of the total damage caused by all the insect pests [7]. This pests is popularly known as "gram pod borer", while in the U.S.A., it is called "bollworm" or "American bollworm" or "Corn worm". Synonyms of gram pod borer *Heliothis armigera* (Hubner) reported by [8] are as *Heliothis obsoleta* Fabricius, *Helicoverpa armigera* (Hubner), *Chloridae armigera* (Hubner) and *Chloridae obsoleta* Fabricius. It has been reported 3.6 - 72.8 per cent pod damage in chickpea [6].
Chickpea is one of the major pulse crops in India and widely grown in Saurashtra region of Gujarat State [3]. This crop is attacked by *H. armigera*, which causes the economic damage. Due to the development of resistance toward the commonly used insecticides, this pest has created a serious threat to the agricultural industry [8]. To overcome such problem, it is necessary to develop IPM module, which helps to manage the population of *H. armigera* below ETL and conserve the bio-agent and helps in reducing the environmental pollution. Looking to the present scenario, hence effort was made in present study to know the role of cultural practices like sowing time; intercropping etc. in managing the population of *H. armigera* is useful as one of the important IPM components.

2. Materials and Methods
With a view to evaluate the effect of date of sowing and intercropping on pod damage caused by *H. armigera* in chickpea, crop was sown during *rabi* season of 2011-12 and 2012-13 with

following experimental details.

2.1 Experimental details

1. **Title of Experiment:** Effect of date of sowing and intercropping on pod damage caused by *H. armigera* in chickpea.
2. **Location:** Instructional Farm, JAU, Junagadh.
3. **Crop and Variety:** Gujarat Gram – 1 (GG-1)
4. **Seed Rate:** 60-65 kg/ha
5. **Fertilizers (NPK kg/ha):** 20 – 40- 0
6. **Season and Year:** r*abi*, 2011-12 and 2012-13
7. **Experimental Design:** Split plot Design
8. **Treatment Combination:** 12
9. **No. of replication:** Three
10. **Spacing:** 45 cm x 15 cm (row to row and plant to plant)
11. **Plot Size:** (a) Gross – 5.0 x 3.6 m

(1) Main plot: Date of sowing

D1 1st November
D2 15th November
D3 30th November

(2) Sub Plot: Intercrops

C1 Chickpea sole crop
C2 Chickpea + Mustard (4:1)
C3 Chickpea + Coriander (2:1)
C4 Chickpea + Wheat (2:1)

Table 1: Treatment combinations of dates of sowing and intercrops in chickpea.

S. No.	Treatment combination	Combination details
1	D1+C1	1st November + Chickpea sole crop
2	D1+C2	1st November + Chickpea + Mustard (4:1)
3	D1+C3	1st November + Chickpea + Coriander (2:1)
4	D1+C4	1st November + Chickpea + Wheat (2:1)
5	D2+C1	15th November + Chickpea sole crop
6	D2+C2	15th November + Chickpea + Mustard (4:1)
7	D2+C3	15th November + Chickpea + Coriander (2:1)
8	D2+C4	15th November + Chickpea + Wheat (2:1)
9	D3+C1	30th November + Chickpea sole crop
10	D3+C2	30th November + Chickpea + Mustard (4:1)
11	D3+C3	30th November + Chickpea + Coriander (2:1)
12	D3+C4	30th November + Chickpea + Wheat (2:1)

2.2 Method of observation

At the time of maturity, the pods from 10 plants were plucked and observations on number of healthy and damaged pods from each treatment were recorded separately and thus per cent pod damage was work out and then statistical analysis was done.

$$\text{Per cent pod damage} = \frac{\textbf{number of damage pods}}{\textbf{Total number of pods}} \boldsymbol{x\ 100}$$

2.3 Yield

The grain yield obtained from each treatment of sole as well as intercrop an equivalent yield was worked out and finally yield data was converted on hectare basis and subjected to statistical analysis. The percent increase in yield over check (sole crop) was calculated by using the following formula:

$$\text{Yield increase over control} = \frac{T - C}{C} \text{ X } 100$$

Where, T = Yield of respective treatment (kg/ha), C = Yield of check (sole crop) (kg/ha)

2.4 Statistical analysis

Data on aspect carried out in experiment was tabulated, analyzed statistically by standard procedure given by Steel and Torrie [18].

3. Results and Discussion

3.1 Per cent pod damage in chickpea

At harvest per cent pod damage was recorded by counting healthy and damaged pods from five randomly selected plants from each treatment. The data on per cent pod damage due to *H. armigera* are presented and discussed below.

The pooled result presented in Table 2 showed that all the dates of sowing and intercropping found statistically significant. The date of sowing *i.e.* 15th November (D_2) found significantly superior as it recorded the lowest per cent pod damage (17.47%). Whereas, the highest per cent pod damage *i.e.* 27.82 per cent was noted in the 30th November (D_3). The crop sown on 1st November (D_1) was found moderately effective as it was found comparatively higher per cent pod damage which recorded 22.31 per cent.

In case of intercropping, the lower per cent pod damage was found in the treatment of (I_3) chickpea + coriander as it proved to be most effective treatment with 13.73 per cent. Whereas, the higher per cent pod damage observed in the treatment of chickpea sole crop (I_1) (31.63%). The treatment chickpea + mustard (I_2) and chickpea + wheat (I_4) recorded moderately pod damage as they noted 18.01 and 25.08 per cent, respectively.

In case of interaction between dates of sowing and intercropping, all the combinations of dates of sowing with intercropping was found significantly superior in reducing pod damage caused by *H. armigera*. The treatment combinations (D_2+I_3) *i.e.* 15th November and chickpea + coriander recorded the lowest pod damage *i.e.* 10.96 per cent found the most effective against larval population of *H. armigera*. However, it was found statistically at par with (D_2+ I_2) 15th November and chickpea + mustard (13.23%) and (D_1+ I_3) 1st November and chickpea + coriander (13.93%). However, the treatment combinations (D_3 + I_1) 30th November and chickpea sole crop (42.18%) recorded the highest per cent pod damage. The treatment combination of (D_3+ I_3) 30th November and chickpea + coriander, (D_2 + I_4) 15th November and chickpea + Wheat, (D_3 + I_2) 30th November and chickpea + mustard, (D_1 + I_2) 1st November and chickpea + mustard, (D_1 + I_4) 1st November and chickpea + wheat, (D_2 + I_1) 15th November and chickpea sole crop, (D_1 + I_1) 1st November and chickpea sole crop, (D_3 + I_4) 30th November and chickpea + wheat and (D_3 + I_1) 30th November and chickpea sole crop were found moderately effective against *H. armigera* which registered 16.54, 20.14, 20.38, 20.85, 21.32, 27.30, 34.55 and 34.83 per cent, respectively.

Thus, looking to the incidence noticed pertaining to per cent pod damage in various treatments it clearly indicated that significantly the lowest per cent pod damage was notice in the crop sown during 15th November while crop sown slightly early during 1st November recorded moderate incidence on *H. armigera* and found next in order the crop sown late during 30th November recorded the highest per cent pod damage due to *H. armigera.* So far as the intercrop concern the chickpea intercrop with coriander found most effective in reducing the incidence of *H. armigera* that may be due to conservation of bio control agents in the presence of coriander.

Prasad and Kumar [15] observed that intercropping of chickpea with coriander found to reducing the pod damage ranging from 18.0 to 28.1 per cent over sole crop of chickpea. Pandey and Ujagir [9] observed the highest pod borer damage (90.6%) in chickpea sole crop, which was significantly suppressed with the introduction of intercrops. Reena *et al*. [16] recorded the lower pod damage by *H. armigera* in chickpea + coriander.

Ambulkar *et al.* [14] found that crop sown in the October 28 and November 20 gave least pod damage 7.17 per cent and 7.5 per cent, respectively. Islam *et al*. [17] reported that crops sown in November 16 had the lowest level of pod damage as compared to early and late season sown crops. Thus, the results obtained through present investigation are more or less in accordance with earlier worker.

3.2 Grain Yield

The yield of chickpea and intercrops was recorded on net plot basis from each treatment plot. The yield of sole crop as well as intercrops was calculated and converted to equivalent yield of chickpea.

Pooled Equivalent grain yield harvested during both year are presented in Table 2 showed that difference in yield was found significant. The highest equivalent grain yield of chickpea was noticed in the treatment of 15th November (D_2) which registered 793 kg/ha. While, the lowest equivalent grain yield was recorded in the 30th November (D_3) which noted 663 kg/ha. The moderate effective equivalent grain yield was found in the treatment of 1st November (D_1) (739 kg/ha).

In case of intercropping, The higher equivalent grain yield was found in the treatment of chickpea + coriander (I_3) as it proved to be most effective intercrop which recorded 830 kg/ha. Whereas, the lower equivalent grain yield was observed in the treatment of chickpea + wheat (I_4) and chickpea sole crop (I_1) as they noted 679 and 638 kg/ha, respectively. The moderate effective equivalent grain yield observed in chickpea + mustard (I_2) (766 kg/ha).

Pooled data on equivalent grain yield revealed that difference in equivalent yield in various combinations of dates of sowing and intercropping was found statistically significant. The highest equivalent grain yield was recorded in the treatment combinations (D_2+I_3) *i.e.* 15thNovember and chickpea + coriander which registered 947 kg/ha. However, it was found statistically at par with (D_2+ I_2) 15th November and chickpea + mustard (878 kg/ha). The next treatment combination of (D_1+ I_3) 1st November and chickpea + coriander, (D_1 + I_2) 1st November and chickpea + mustard found moderate effective on production of equivalent grain yield which recorded 851 and 770 kg/ha, respectively. The remaining all combination of treatment *i.e.* (D_2 + I_4) 15th November and chickpea + Wheat, (D_3+ I_3) 30th November and chickpea + coriander, (D_1 + I_4) 1st November and chickpea + wheat, (D_3 + I_2) 30th November and chickpea + mustard, (D_3 + I_4) 30th November and chickpea + wheat, (D_2 + I_1) 15th November and chickpea sole crop, (D_1 + I_1) 1st November and chickpea sole crop and (D_3 + I_1) 30th November and chickpea sole crop produce lower equivalent grain yields which registered 694, 693, 687, 681, 657, 652, 645 and 619 kg/ha, respectively.

Pandey and Ujagir [9] reported that when chickpea intercrop with coriander (4:2) reported highest equivalent grain yield 887 kg/ha they further noted that lower equivalent yield *i.e.* 189 kg/ha in chickpea sole crop. Tripathi *et al*. [10] reported the highest yield increase was recorded in chickpea + mustard followed by chickpea + barley and chickpea + wheat. Gupta *et al.* [11] reported comparatively higher seed equivalent yield in gram + coriander (2999 kg/ha) as compared to 2326 kg/ha in sole gram.

Hossain *et al.* [12] reported that for ensuring higher yield with less pod borer damage, chickpea should be sown within the range of November 08 to 30 and the best date of sowing seems to be November 15. Hossain *et al.* [13] observed that for best protection against pod borer, the most effective IPM module was chickpea sown on 15th November ensuring higher yield and net return. Ambulkar *et al.* [14] found that crop sown in the October 28 and November 20 gave highest grain yield (25.13 and 26.098 q/ha, respectively).Thus, the results obtained through present investigation are more or less in accordance with earlier worker**.**

Table 2: Effect of date of sowing and intercropping on per cent pod damage in chickpea.

Treat. No.	Treatments	Per cent pod damage at harvest by *H. armigera*		
	Date of sowing	**2011-12**	**2012-13**	**Pooled**
D_1	1st November	27.92 (21.92)	28.46 (22.71)	28.19 (22.31)
D_2	15th November	25.00 (17.86)	24.42 (17.09)	24.71 (17.47)
D_3	30th November	32.17 (28.34)	31.50 (27.30)	31.83 (27.82)
	S.Em.±	1.21	1.01	0.79
	C.D. at 5%	4.73	3.95	2.56
	C.V.%	14.73	12.40	13.62
	Intercropping			
I_1	chickpea sole crop	37.89 (37.72)	34.22 (31.63)	36.06 (34.65)
I_2	chickpea + mustard (4:1)	24.56 (17.27)	25.67 (18.76)	25.11 (18.01)
I_3	chickpea + coriander (2:1)	21.33 (13.23)	22.17 (14.24)	21.75 (13.73)
I_4	chickpea + wheat (2:1)	29.67 (24.50)	30.44 (25.67)	30.06 (25.08)
	S.Em.±	0.78	0.76	0.54
	C.D. at 5%	2.32	2.25	1.56
	C.V.%	8.25	8.09	8.17
	Interaction:			
D x I	S.Em.±	1.35	1.31	0.94
	C.D. at 5%	3.41	3.40	2.70

Y x D	S.Em.±			1.11
	C.D. at 5%			NS
Y x I	S.Em.±			0.77
	C.D. at 5%			2.21
Y x D x I	S.Em.±			1.33
	C.D. at 5%			3.82
Interaction between dates of sowing and intercropping				
Treat. No.	**Treatment combinations**	**2011-12**	**2012-13**	**Pooled**
1	D_1+I_1	37.00 (36.62)	35.33 (33.45)	36.17 (34.83)
2	D_1+I_2	26.67 (20.14)	27.67 (21.56)	27.17 (20.85)
3	D_1+I_3	20.67 (12.46)	23.17 (15.48)	21.92 (13.93)
4	D_1+I_4	27.33 (21.08)	27.67 (21.56)	27.50 (21.32)
5	D_2+I_1	34.33 (31.81)	28.67 (23.01)	31.50 (27.30)
6	D_2+I_2	20.67 (12.46)	22.00 (14.03)	21.33 (13.23)
7	D_2+I_3	19.67 (11.33)	19.00 (10.60)	19.33 (10.96)
8	D_2+I_4	25.33 (18.31)	28.00 (22.04)	26.67 (20.14)
9	D_3+I_1	42.33 (45.35)	38.67 (39.04)	40.50 (42.18)
10	D_3+I_2	26.33 (19.68)	27.33 (21.08)	26.83 (20.38)
11	D_3+I_3	23.67 (16.11)	24.33 (16.98)	24.00 (16.54)
12	D_3+I_4	36.33 (35.10)	35.67 (34.00)	36.00 (34.55)

Outside parentheses are arcsine transformed value, Figure in parentheses are retransformed values

Table 3: Effect of dates of sowing and intercropping on grain yield of chickpea.

Treat. No.	**Treatments**	**Equivalent grain yield (Kg/ha)**		
	Date of sowing	**2011-12**	**2012-13**	**Pooled**
D_1	1st November	741.67	735.87	738.77
D_2	15th November	798.15	787.70	792.92
D_3	30th November	667.13	658.80	662.96
	S.Em.±	22.17	23.31	16.08
	C.D. at 5%	87.04	91.53	52.45
	C.V.%	10.44	11.10	10.77
	Intercropping			
I_1	chickpea sole crop	633.33	644.12	638.73
I_2	chickpea + mustard (4:1)	786.42	766.93	776.67
I_3	chickpea + coriander (2:1)	843.83	817.90	830.86
I_4	chickpea + wheat (2:1)	679.01	680.86	679.94
	S.Em.±	20.69	20.13	14.43
	C.D. at 5%	61.47	59.80	41.39
	C.V.%	8.44	8.30	8.37
	Interaction:			
D x I	S.Em.±	35.83	34.86	25.00
	C.D. at 5%	106.46	103.58	71.69
Y x D	S.Em.±			22.75
	C.D. at 5%			NS
Y x I	S.Em.±			20.41
	C.D. at 5%			58.54
Y x D x I	S.Em.±			35.35
	C.D. at 5%			101.39
Interaction between date of sowing and intercropping				
Treat. No.	**Treatment combinations**	**2011-12**	**2012-13**	**Pooled**
1	D_1+I_1	629.63	660.14	644.88
2	D_1+I_2	762.96	777.78	770.37
3	D_1+I_3	870.37	833.33	851.85
4	D_1+I_4	703.70	672.22	687.96
5	D_2+I_1	655.56	648.15	651.85
6	D_2+I_2	894.44	861.89	878.17
7	D_2+I_3	957.41	937.04	947.22
8	D_2+I_4	685.19	703.70	694.44
9	D_3+I_1	614.81	624.07	619.44
10	D_3+I_2	701.85	661.11	681.48
11	D_3+I_3	703.70	683.33	693.52
12	D_3+I_4	648.15	666.67	657.41

4. Conclusion

Based on the present study results, it can be concluded that 15th November is the most appropriate date of sowing in chickpea for minimizing incidence of *H. armigera* in chickpea. Interaction of dates of sowing and intercropping clearly indicated that crop sown on 15th of November and intercropped with coriander found most effective in reducing the incidence of *H. armigera* and obtained higher grain yield.

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