J. Exp. Zool. India Vol. 20, No. 2, pp. 835-843, 2017	www.connectjournals.com/jez	*ISSN 0972-0030*

SCREENING OF CHICKPEA CULTIVARS AGAINST POD BORER *HELICOVERPA ARMIGERA* (HUBNER) UNDER UN PROTECTED CONDTIONS

Jaba Jagdish*[1'2], Ashish Devrani[2], Meena Agnihotri[2] and Snehel Chakravarty[3]

[1]Department of Entomology, College of Agriculture, G.B.Pant University of Agriculture & Technology, Pantnagar, India.
[2]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru - 502 324, Telangna, India.
[3]Department of Entomology and Zoology, Institute of Agriculture Science, B.H.U., Varanasi, India.
*e-mail : jaba.jagdish@gmail.com

(Accepted 6 June 2017)

ABSTRACT : Screening of elite twenty chickpea cultivars of along with two desi checks PG 186 and L 550 was carried out to evaluate for resistance to major pest *Helicoverpa armigera*. During the course of present investigation *H. armigera* was found to be major significance pest, which was mainly associated with leaves, flower and pod of chickpea. Present study revealed that, maximum mean egg and larval population were registered during 13th & 15th standard week respectively. The maximal and minimal number of mean egg population recorded of 12.86, 8.33 on ICC3137, D059 and 5.43, 3.60 on ICCV92944, respectively for 2012-13, 2013-14 seasons from selected five plants. The lowest larval population recorded of 23.33, 12.50 in ICCV07306, ICCV92944 and highest of 32.52, 22.39 in ICC3137, ICCV08107 in respective years. Per cent mean pod damage were ranged from 53.56 to 85.32 and 68.49 to 100 in respective years. The minimum grain yield of chickpea was recorded of 86.11, 158.33 kg/ha in ICCV07306, ICCV3137 and maximum grain yield of 1491.67, 972.42 kg/ha was found in ICCV 097105, ICCV92944 for respective years. Based on damaged rating scale of *H. armigera*, the moderately susceptible and consistent yield observed in PG-186, ICCV92944, ICCV10 and ICCV97105. This accession can be used for future in IPM programme against *H. armigera* in large farm level.

Key words : Chickpea, *Helicoverpa armigera*, host plant resistance.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an edible legume and the only cultivated species within the genus *Cicer*. It is one of the important pulse crops and being rich in protein content, in addition to maintain the soil fertility by biological nitrogen fixation by bacteria. India is the largest producer of chickpea with 67% of the global production. It covers nearly 31% of total pulse area in the country and contributes about 37% to the national pulse production (Jeewesh *et al*, 2013). The chickpea for the year 2013-14 marked a significant increase in area under chickpea (9.96 million ha) with production of (9.92 million tonnes) (Anonymous, 2014).

Gram Pod borer (*Helicoverpa armigera* Hubner) constitutes a worldwide pest of great economic importance for this crop. This pest is the major constraint in chickpea production causing severe losses upto 100% inspite of several rounds of insecticidal applications. Sometimes in serious cases, there may be a complete crop failure. It is a highly polyphagous pest, feeding on a wide range of food, oil and fiber crops. Due to its wider host range, multiple generations, migratory behaviour, high fecundity and existing insecticidal resistance; it has become a difficult pest to tackle (Sarwar, 2013).

Host plant resistance (HPR) assumes a pivotal role in controlling *H. armigera* damage either alone or in combination with other methods of control. It has been documented that for each $ 1 invested in plant resistance, farmers have realized a sum of $ 300 in return (Sharma, 2005). Since pod borer is highly polyphagous and well adapted to many crops and wild hosts in India (Narayanamma, 2005). Host plant resistance to *H. armigera* in legumes was first reported by Leuck *el al* (1967). Since then the literature on *H. armigera* resistance in legumes has expanded rapidly. Studies on host plant resistance in chickpea crop to pod borer have identified sources with lower susceptibility rating or those which can tolerate the pest incidence. The complex nature of resistance makes it very difficult to predict a definite IPM strategy. Keeping in this view the present studies has been carried out for screening of elite cultivars against pod borer *H. armigera* under natural condition, which influence in the indentifying suitable cultivar for sustainable production.

MATERIALS AND METHODS

Site of experiment

The screening experiments were conducted at the Crop Research Center (CRC), G. B. Pant University of

Agriculture & Technology, Pantnagar, situated between (29^0N, $79^{0.}$ 29' E at an elevation of 243.8 m.) above mean sea level in the district U. S. Nagar (Uttarakhand) during *rabi* season of 2012 and 2013. The soil of experimental field having slightly clay loam.

Screening of *Helicoverpa armigera* in different cultivars of chickpea

The studies on screening of different cultivars of chickpea against *Helicoverpa armigera* were carried at CRC, Pantnagar.To evaluate the relative resistance or susceptibility of different cultivars of chick pea to *H. armigera*, cultivars were planted in the field during the 2012 and 2013 *Rabi* season. Each entry was sown in 2 row plot, 2 m long, with spacing 10 x 45cm. There were three replications in a randomized complete block design. Normal agronomic practices were followed for raising the crop (basal fertilizer N: P: K: 50:60:40 $kgha^{-1}$). Intercultural and weeding operations were carried out as needed. The chickpea crop was raised without any insecticidal treatments so that population of the pest and its natural enemies could buildup freely.

Observation recorded

Observation on eggs and larval population of *H. armigera*

Five plants were selected at randomly from each plot. The plants were tagged and the numbers of eggs and larvae count were recorded at weekly interval from pest appearance to maturity of crop.

Observation on extent of pod damage and assessment of loss due to *H. armigera*

The per cent pod damage by gram pod borer, *H. armigera* was estimated from tagged plants at the time of harvest to assess, the extent of damage. Every pod was critically examined for the damage of pod borer, *H. armigera*. The criteria adopted were healthy or clear pods without any external damage symptoms. Pods attacked by *H. armigera* having big circular holes without larval exuviae on the pods. Number of healthy and damaged pods due to pod borer were recorded separately for each sample and converted into percentage pod damage with the help of following formula:

$$\text{Percent pod damage} = \frac{\text{Number of damaged pod}}{\text{Total number of pods}} \times 100$$

Observation on grain yield

The total yield per plant including the yield of plants sampled earlier was taken and compared as kg/ha basis. After harvesting the grains were sun dried to establish the moisture content. The weight of the seed was taken after this period.

Insect pest susceptibility rating of different cultivars

The susceptibility of different cultivars to insect pests was calculated on the basis of percent pod damage at the time of the crop maturity. The following formula was used as suggested by Lateef and sachan (1990).

$$\text{Insect pest susceptibility} = \frac{\text{Percent PD in check cultivar} - \text{Percent PD in test cultivar}}{\text{Percent PD in check cultivar}} \times 100$$

Where, PD = Pod damage.

Based on this formula, the performance of each cultivar 1-9 scale as follows:

Pest susceptibility	Grade	Category
100%	1	Highly resistant
75 to 100%	2	Highly resistant
50 to 75%	3	Least susceptible
25 to 50%	4	Least susceptible
10 to 25%	5	Least susceptible
-10 to 10%	6	Moderately susceptible
-25 to -10%	7	Moderately susceptible
-50 to -10%	8	Highly susceptible
<-50%	9	Highly susceptible

Statistical analysis

The data for the two years were pooled as there were significant differences between years. The statistical procedures used include, Analysis of Variance (ANOVA) was used to compare variables using Statistical Package for Social Sciences (SPSS) softwares for indentifying promising genotypes. Where significant differences are observed critical difference (CD) at 5% level of probability was used to separate the test and means for difference. To obtain the RSI, genotypes were first ranked for each parameter (that is; 1 = best genotype and 8 = poorest genotype) and the parameter ranks summed to generate overall performance of each genotype. Hence, the lower the PSR of any genotype, the greater is its resistance and the better is its agronomic performance. Data on per cent pod damage and grain yield were subjected to principal component and similarity matrix analysis to assess the diversity in the reaction of wild relatives of chickpea for resistance to *H. armigera*.

RESULTS AND DISCUSSION

Estimation of egg population during 2012-13 and 2013-14

During first season the number of eggs of *H. armigera* per five plants was recorded during 11^{th} S.W to maturity 17^{th} S.W. (Table 1). During 11^{th} S.W.

Table 1 : Screening of different cultivars of chickpea against eggs and larvae of *H. armigera* during *Rabi*, 2012-13.

S.No.	Treatment	Screening against eggs of *H. armigera*								Screening against larvae of *H. armigera*							
		11th S.W.	12th	13th	14th	15th	16th	17th.	Mean	11th	12th	13th	14th	15th	16th	17th	Mean
1/	ICCV 09103	2.33 (1.47)	22.00 (4.56)	19.67 (4.38)	5.67 (2.36)	4.00 (1.97)	0 (0.00)	0 (0.00)	7.67 (2.11)	0.33 (0.33)	1.67 (1.27)	16.33 (4.02)	75 (8.62)	70 (8.35)	20.67 (4.44)	4.33 (1.96)	26.90 (5.23)
2/	ICCL86111	0.66 (1.71)	20.00 (6.05)	16.33 (4.86)	8.33 (2.64)	5.00 (2.16)	0 (0.00)	0 (0.00)	7.19 (2.49)	0.00 (0.00)	1.67 (1.27)	13.00 (3.52)	70.67 (8.23)	77.67 (8.80)	23.33 (4.82)	2.33 (1.24)	26.95 (5.23)
3/	ICCV09115	0.66 (1.00)	23.00 (4.21)	23.00 (6.21)	4.00 (1.60)	2.67 (1.57)	0 (0.00)	0 (0.00)	7.62 (2.08)	0.67 (0.47)	1.00 (0.80)	24.33 (4.84)	75.33 (8.67)	84.33 (9.17)	17.33 (3.93)	3.33 (1.49)	29.47 (5.47)
4	ICCV08108	1 (1.60)	13.67 (3.97)	28.33 (4.17)	5.00 (1.82)	3.00 (1.65)	0 (0.00)	0 (0.00)	7.29 (1.89)	1.00 (0.80)	0.33 (0.33)	15.67 (3.83)	84.67 (9.15)	85.67 (9.25)	9.67 (2.51)	1.67 (1.27)	28.38 (5.37)
5	ICCV97105	3 (1.68)	20.00 (4.22)	20.33 (3.63)	2.67 (1.62)	3.00 (1.71)	0 (0.00)	0 (0.00)	7.00 (1.84)	0.67 (0.67)	2.67 (1.60)	17.33 (4.05)	81.00 (8.97)	77.67 (8.77)	12.00 (3.29)	1.00 (0.80)	27.47 (5.28)
6	ICCV07306	5.33 (0.47)	38.67 (4.46)	25.67 (3.89)	7.00 (1.99)	5.00 (1.82)	0 (0.00)	0 (0.00)	11.67 (1.80)	1.00 (0.57)	2.33 (1.24)	16.67 (4.03)	64.00 (7.74)	73.33 (8.51)	5.00 (1.79)	1.00 (0.80)	23.33 (4.88)
7	ICCV92944	2.33 (1.14)	15.67 (3.88)	12.00 (3.42)	4.33 (2.03)	3.67 (1.47)	0 (0.00)	0 (0.00)	5.43 (1.71)	0.33 (0.33)	1.67 (1.27)	13.00 (3.49)	82.33 (9.07)	101.00 (10.03)	20.00 (4.34)	2.67 (2.67)	31.57 (5.66)
		(0.47)	(4.10)	(4.37)	(2.65)	(1.67)	(0.00)	(0.00)	(1.89)	(1.13)	(1.38)	(4.55)	(8.51)	(9.04)	(4.30)	(1.80)	(5.41)
9	ICCV07112	0.33 (0.33)	11.33 (4.16)	23.00 (4.62)	3.00 (2.65)	0.67 (.47)	0 (0.00)	0 (0.00)	5.48 (1.75)	0.67 (0.67)	1.00 (1.00)	8.33 (2.87)	69.00 (8.30)	86.67 (9.22)	8.33 (2.07)	0.67 (0.47)	24.95 (5.04)
10	ICCV08107	3.33 (1.71)	26.67 (4.08)	28.00 (4.93)	6.67 (2.47)	4.67 (2.00)	0 (0.00)	0 (0.00)	9.91 (2.17)	0.67 (0.67)	2.00 (1.38)	13.00 (3.55)	81.67 (9.02)	88.67 (9.41)	10.33 (3.17)	5.00 (2.15)	33.45 (5.82)
11	ICCL 86105	1.66 (0.67)	18.00 (4.69)	40.00 (4.72)	5.00 (2.21)	2.33 (1.48)	0 (0.00)	0 (0.00)	9.57 (1.97)	0.33 (0.33)	1.00 (0.80)	11.67 (3.30)	77.67 (8.78)	88.67 (9.41)	13.33 (3.63)	2.33 (1.24)	27.85 (5.32)
12	D 059	0.66 (2.10)	17.33 (4.48)	19.33 (5.19)	13.00 (3.39)	4.00 (2.00)	0 (0.00)	0 (0.00)	7.76 (2.45)	0.33 (0.33)	1.33 (0.67)	12.67 (3.49)	75.00 (8.65)	82.67 (9.08)	8.67 (2.82)	3.33 (1.79)	26.28 (5.17)
13	5034	2.33 (1.21)	44.00 (6.46)	32.67 (5.60)	5.67 (2.37)	4.67 (2.12)	0 (0.00)	0 (0.00)	12.76 (2.54)	1.67 (1.24)	2.33 (1.52)	13.00 (3.51)	77.67 (8.79)	75.33 (8.67)	19.67 (4.38)	5.00 (2.07)	27.81 (5.32)
14	ICC3137	1.66 (1.62)	39.00 (4.58)	35.00 (4.59)	11.00 (2.40)	3.33 (1.75)	0 (0.00)	0 (0.00)	12.86 (2.13)	2.00 (1.41)	3.67 (1.56)	22.00 (4.26)	100.67 (9.94)	87.33 (9.34)	9.33 (3.02)	2.67 (1.32)	32.52 (5.74)
15	ICC14872	0 (1.00)	15.67 (3.34)	19.33 (5.21)	11.67 (3.35)	7.00 (2.52)	0 (0.00)	0 (0.00)	7.67 (2.20)	1.00 (0.80)	2.00 (1.13)	12.33 (3.43)	74.00 (8.55)	87.00 (9.32)	9.67 (3.09)	5.00 (2.01)	27.28 (5.27)
16	ICC14364	3.33 (0.33)	17.00 (3.35)	18.67 (4.71)	3.67 (1.81)	2.67 (1.62)	0 (0.00)	0 (0.00)	6.48 (1.69)	0.33 (0.80)	1.33 (1.13)	12.00 (3.29)	71.00 (8.40)	81.00 (8.97)	9.33 (2.86)	4.67 (1.74)	25.66 (5.11)

Table 1 continued....

Table 1 continued...

17	ICCV07104	0.33	17.67	21.67	9.00	3.00	0	0	7.38	1.33	0.00	9.67	64.33	80.67	14.33	3.00	24.76
		(1.00)	(6.15)	(5.86)	(2.83)	(1.62)	(0.00)	(0.00)	(2.49)	(0.91)	(0.00)	(3.06)	(8.00)	(8.97)	(3.76)	(1.71)	(5.02)
18	ICCV09118	4	23.33	21.67	8.00	3.67	0	0	8.67	0.67	0.67	17.33	87.67	79.00	7.00	4.67	28.14
		(0.94)	(3.98)	(5.38)	(2.77)	(1.38)	(0.00)	(0.00)	(2.06)	(0.67)	(0.67)	(4.06)	(9.35)	(8.88)	(2.15)	(1.99)	(5.35)
19	ICCV10	1.33	16.33	29.33	5.00	4.33	0	0	8.05	1.33	2.00	19.33	80.33	87.00	3.33	2.00	27.90
		(1.35)	(4.40)	(4.32)	(2.22)	(2.06)	(0.00)	(0.00)	(2.05)	(0.91)	(1.33)	(4.30)	(8.95)	(9.32)	(1.79)	(1.33)	(5.32)
20	ICCV95334	3.33	29.67	24.67	16.67	6.00	0	0	11.48	1.67	3.67	26.67	73.00	86.33	1.33	2.00	27.81
		(1.33)	(5.15)	(5.27)	(3.52)	(1.86)	(0.00)	(0.00)	(2.45)	(1.00)	(1.52)	(4.54)	(8.52)	(9.28)	(0.91)	(1.15)	(5.32)
21	PG186	3	19.00	13.33	8.33	3.00	0	0	6.67	0.67	0.33	13.00	70.67	86.67	2.67	1.33	25.04
		(0.00)	(3.83)	(4.35)	(2.75)	(1.67)	(0.00)	(0.00)	(1.80)	(0.67)	(0.33)	(3.59)	(8.05)	(9.14)	(1.60)	(0.91)	(5.05)
22	L550	3	17.67	26.67	3.00	4.00	0	0	7.76	0.67	0.33	21.00	83.33	88.67	2.67	0.67	28.19
		(1.79)	(5.25)	(4.87)	(1.00)	(1.98)	(0.00)	(0.00)	(2.13)	(0.67)	(0.33)	(4.30)	(9.11)	(9.41)	(1.28)	(0.67)	(5.35)
24	SEM±	3.32	6.34	6.22	4.03	1.78	0	0	-	0.55	0.88	4.78	10.87	7.59	3.81	1.42	-
		(0.71)	(.65)	(.63)	(.71)	(0.49)	(0.00)	(0.00)		(0.37)	(0.39)	(0.49)	(0.67)	(0.42)	(0.70)	(0.50)	
25	CD at 5%	9.48	18.10	17.76	11.50	5.09	0	0	-	1.58	2.52	13.66	31.03	21.67	10.90	4.06	-
		(2.04)	(1.87)	(1.81)	(2.05)	(1.42)	(0.00)	(0.00)		(1.06)	(1.13)	(1.42)	(1.89)	(1.21)	(1.99)	(1.44)	

*Data presented in parentheses are square root transformed value.

maximum number of eggs (13.33) were observed on cultivar JG 11and minimum (0.00) on ICC 14872 as against the check variety L-550 (3.00) and PG 186(3.00). Egg population during 12th S.W. varied significantly from lowest of 11.33 on ICCV 07112 to highest of 44.00 on 5034 as compared to 19.00 and 17.67 on checks PG 186 and L 550 respectively. During 14th S.W. the population varied non-significantly from 2.67 on ICCV 97105 to 13.00 on D 059 as against 8.33 and 3.00 on checks PG 186 and L 550 respectively. Egg population during 15th S.W. varied non-significantly from minimum (0.67) on ICCV 07112 to maximum (7.00) on ICC 14872 as compared to 3.00 and 4.00 on checks PG 186 and L 550 respectively.There was no egg population observed during 16th and 17th S.W. When overall mean of the eggs laid by *H. armigera* were considered together, there were significant differences among test cultivars. Eggs population per five plants ranged from 5.43 to 12.8. The minimum number of eggs (5.43) were observed on ICCV 92944 and the highest number of eggs were recorded on ICC 3137 (12.8).

The screenings of same cultivars were carried out during second season of *Rabi* 2013-14. The results revelaed that, the number of eggs of *H armigera* during 12thS.W. to maturity (16th S.W.) (Table 2). During 12th S.W. maximum number of eggs (9.67) were observed on cultivar 5034 and minimum (1.00) on ICCV 09103, ICCV 97105 and ICCV 07104 as against the check varieties L-550 (1.33) and PG 186(1.00). Egg population during 13th S.W. varied significantly from lowest of 11.33 on ICCV 07112 to highest of 44.00 on 5034 as compared to 19.00 and 17.67 on checks PG 186 and L 550, respectively. During 15th S.W. the population varied highly significantly from 0.67 on ICCV 09118 and ICC 3137 to 7.67 eggs / 5 plants on ICCV 09103 as against 3.67 on checks PG 186 and L 550. When overall mean of the eggs were considered, there were significant differences among test cultivars. Eggs population ranged from 3.6 to 8.07. The minimum number of eggs (3.6) were recorded on ICCV 92944 and ICCV 07306 and the highest number of eggs were observed on D 059 (8.07). There were no significant differences in egg population among the cultivars and their checks during both seasons. Above finding was supported by Ujagir and Khare (1988), the number of eggs varied from 1.8 (ICC) to 9.8 (ICC 873). Maurya (2003) observed that the number of eggs varied from 0.3 to 2.9. While in the present study the egg population varied from 5.43 to 12.8 it due to divergence in cultivars.

Table 2 : Screening of different cultivars of chickpea against eggs and larvae of *H. armigera* during *Rabi*, 2013-14.

S.No.	Treatment	Screening against eggs of *H. armigera*						Screening against larvae of *H. armigera*					
		12th S.W.	13th S.W.	14th S.W.	15th S.W.	16th S.W.	Mean	12th S.W.	13th S.W.	14th S.W.	15th S.W.	16th S.W.	Mean
1.	ICCV 09103	1.00(1.17)	11.00(3.08)	15.00(3.91)	7.67(2.73)	0.33(0.89)	7.0(2.73)	0.00(0.70)	13.00(3.65)	21.33(4.53)	37.33(5.81)	10.67(2.92)	16.47(4.12)
2.	ICCL86111	4.33(2.12)	9.67(3.10)	16.33(4.06)	6.67(2.65)	0.67(0.99)	7.53(2.83)	0.00(0.70)	15.00(3.93)	28.33(5.36)	46.67(6.61)	23.00(4.81)	22.60(4.81)
3.	ICCV09115	2.67(1.64)	7.67(2.77)	12.67(3.55)	3.33(1.77)	0.00(0.70)	5.27(2.40)	0.00(0.70)	13.00(3.66)	34.00(5.81)	32.67(5.74)	9.67(3.17)	17.87(4.29)
4.	ICCV08108	1.33(1.28)	12.00(3.46)	15.33(3.86)	2.67(1.61)	0.00(0.70)	6.27(2.60)	0.33(0.87)	20.00(4.46)	33.33(5.81)	30.33(5.53)	12.33(3.57)	19.27(4.45)
5.	ICCV97105	1.00(1.17)	15.00(3.91)	14.33(3.60)	4.33(1.93)	0.00(0.70)	6.93(2.72)	2.00(1.32)	21.00(4.56)	41.33(6.45)	43.33(6.55)	15.67(3.97)	24.67(5.02)
6.	ICCV07306	3.67(1.96)	7.00(2.69)	6.00(1.90)	1.33(1.17)	0.00(0.70)	3.60(2.0)	0.33(0.87)	22.67(4.75)	24.67(4.76)	30.00(5.42)	11.67(3.47)	17.87(4.29)
7.	ICCV92944	1.67(1.25)	4.33(2.19)	8.00(2.85)	4.00(2.08)	0.00(0.70)	3.60(2.02)	0.00(0.70)	9.33(3.13)	27.67(5.30)	26.00(5.13)	8.00(2.90)	14.20(3.83)
8.	JG 11	1.33(1.28)	11.33(3.18)	15.33(3.44)	4.00(1.84)	0.33(0.87)	6.47(2.63)	0.00(0.70)	13.00(3.65)	27.00(5.22)	32.33(5.65)	12.33(3.57)	16.93(4.18)
9.	ICCV07112	3.00(1.70)	5.67(2.41)	10.67(3.32)	3.33(1.77)	0.00(0.70)	4.53(2.24)	0.33(0.70)	18.33(4.33)	29.67(5.49)	33.33(5.76)	12.00(3.47)	18.73(4.39)
10.	ICCV08107	1.33(1.26)	9.33(3.11)	13.67(3.61)	4.33(2.18)	0.00(0.70)	5.73(2.49)	0.33(0.87)	21.00(4.63)	41.33(6.40)	47.67(6.80)	13.33(3.71)	24.73(5.02)
11.	ICCL 86105	3.00(2.32)	17.67(4.25)	9.67(3.07)	1.33(1.17)	0.00(0.70)	6.87(2.71)	0.67(1.05)	18.67(4.35)	48.00(6.76)	34.00(5.86)	10.67(3.34)	22.40(4.79)
12.	D 059	1.33(1.64)	16.67(4.05)	14.67(3.83)	6.33(2.56)	0.00(0.70)	8.07(2.92)	0.00(0.70)	17.00(4.15)	30.00(5.52)	40.67(6.33)	12.00(3.52)	19.93(4.52)
13.	5034	5.67(2.35)	13.00(3.59)	12.00(3.49)	3.33(1.90)	0.00(0.70)	6.80(2.70)	0.00(0.70)	18.33(4.31)	36.00(5.97)	44.33(6.67)	15.67(3.98)	22.87(4.83)
14.	ICC3137	5.67(2.81)	10.33(3.23)	7.33(2.49)	0.67(0.99)	0.00(0.70)	5.60(2.46)	0.67(0.99)	20.00(4.49)	43..00(6.58)	42.00(6.44)	13.67(3.75)	23.87(4.94)
15.	ICC14872	9.67(1.46)	7.00(2.71)	12.67(3.61)	4.33(1.89)	0.00(0.70)	5.20(2.38)	0.00(0.70)	11.33(3.43)	29.00(5.40)	37.00(5.88)	11.00(3.34)	17.67(4.26)
16.	ICC14364	2.00(1.17)	7.67(2.58)	11.00(2.95)	3.33(1.73)	0.00(0.70)	4.60(2.25)	0.67(1.05)	14.00(3.73)	28.67(5.26)	25.00(4.98)	13.00(3.63)	16.27(4.09)
17.	ICCV07104	1.00(1.61)	13.67(3.75)	8.00(2.58)	7.00(2.60)	1.33(1.17)	6.53(2.65)	0.00(0.70)	115.00(3.93)	27.67(5.27)	37.33(6.00)	14.00(3.78)	18.80(4.39)
18.	ICCV09118	2.67(1.65)	12.33(3.47)	12.00(3.41)	0.67(0.99)	0.33(0.87)	5.53(2.45)	0.00(0.70)	13.33(3.46)	26.67(5.211)	34.00(5.71)	11.33(3.23)	17.07(4.19)
19.	ICCV10	2.33(2.17)	13.00(3.67)	15.33(3.97)	5.00(2.11)	1.00(1.09)	7.80(2.88)	0.00(0.70)	17.67(4.23)	29.00(5.41)	29.00(5.37)	17.00(4.16)	18.53(4.36)
20.	ICCV95334	4.67(2.67)	18.00(4.06)	9.67(3.01)	1.00(1.09)	0.00(0.87)	7.20(2.77)	2.67(1.77)	23.33(4.81)	32.00(5.52)	17.00(4.00)	1.67(1.25)	15.33(3.98)
21.	PG186	1.00(1.095)	15.00(3.75)	13.00(3.66)	3.67(2.11)	0.00(0.70)	6.53(2.65)	2.00(1.48)	14.33(3.73)	36.33(6.06)	42.67(6.43)	20.67(4.59)	23.20(4.87)
22.	L550	1.33(1.26)	14.00(3.28)	8.67(2.89)	3.67(1.09)	0.00(0.70)	5.53(2.45)	0.33(0.87)	16.33(4.05)	24.00(4.82)	19.00(4.32)	9.00(3.05)	13.73(3.77)
24.	SEM±	0.439	6.34	-	0.379*	-		0.19*	-	-	-	0.405**	
25.	CD at 5%	1.25	18.10	-	1.08	-		0.55	-	-	-	1.15	

*Data presented in parentheses are square root transformed value.

Screening of chickpea cultivars against pod borer

Population estimation on larvae 2012-13 and 2013-14

The first season of *Rabi* 2012-13 results were dipicated here, the initial observations on larvae of *H. armigera* were recorded from time of build-up of the population *i.e.* 11th S.W. till the maturity i.e. 17th S.W. (Table 1). During 11th S.W. the maximum number of larvae (2.00) was observed on cultivar ICC 3137 and minimum number (0.00) on ICCL 86111 as against 0.67 in check cultivars, PG 186 and L550. 12th S.W. population ranged non-significantly from 0.00 on ICCV 07104 to maximum of 3.67 on ICC 3137 and ICCV 95334 as compared to 0.33 larvae in check cultivars PG 186 and L550. Larval population during 13th S.W. varied from lowest of 8.33 on ICCV 07112 to highest of 26.67 on ICCV 95334 as compared to checks 13.00 in PG186 and 21.00 in L550. During 15th S.W. ranged non-significantly from minimum of 70.00 on ICCV 09103 and maximum of 101.00 on ICCV 92944 as compared to 86.67 and 88.67 larvae per 5 plants in check cultivars PG 186 and L550, respectively. Larval population during 16th S.W. varied significantly from lowest of 1.33 on ICCV 95334 to highest of 23.33 on ICCL 86111 as compared to checks 2.67 on PG 186 and L 550, respectively. The peak period larvae were observed during 15th S.W. i.e. pod formation stage of the crop. The polled mean larave for the rabi 2012-13, there were significant differences among test cultivars. Larval population ranged from 24.76 to 33.45. The minimum number of eggs (24.76) were recorded on ICCV 07104 and ICCV 07306 and the highest number of eggs were observed on ICCV 08107 (33.45). The screenings of same cultivars were carried out during second season of *Rabi* 2013-14. The results are represented here, the number of larvae of *H. armigera* during 12thS.W. till the maturity (16th S.W.) (Table 2). During 12th S.W. the maximum number of larvae (2.67) was observed on cultivar ICCV 95334 and minimum number (0.00) on ICCL 86111, ICCV 09103, ICCV 09115, ICCV 097105 and ICCV 07306, as against in check cultivars with 2.00 and 0.33 respectively for PG 186 and L 550. Number of larvae per five plants during 13th, 14th, and 15th S.W. showed non-significant difference were observed between cultivars and their commercial check entries. Larval population during 16th S.W. showed highly significant variation between cultivars and their check. It varied from lowest of 8.33 on ICCV 092944 to highest of 23.00 on ICCL 86111 as compared to checks 20.67 in PG186 and 9.00 in L550. The overal mean population of larave for the 2013-14, the lowest larval populaion was recorded on LL 550 (13.37) and highest recorded on ICCV 08107 (24.73). As soon as commencement of pod maturity, result in decline of larval population in cultivars. No significant differences were observed between cultivars and their checks.The present investigation work is cogent evidence with Chatar *et al* (2010), who revealed that, the pest appeared from 2nd week of December and attained a peak of 3.12 larvae per plant during 2nd week of January. The pest was active during the last week of December to 3rd week of January.

Pod borer damage in chickpea cultivars during 2012-13 and 2013-14

During 2012-13, the per cent pod damage ranged significantly ranged from 53.56 percent on to 85.52 percent (Table 3). Minimum pod damage was observed in ICCV 97105 (53.56%), followed by ICCV 92944 (57.65%), ICCV 10 (66.83%) and as compared to 58.84, 77.88 percent on check varieties PG186, L550, respectively. However, maximum pod damage was observed in ICC 3137 (85.52%), followed by ICCV 14872 (81.32%), ICC 14364 (80.46%), ICCV 09103 (80.51%), ICCV 09115 (80.37%).

During 2013-14, the per cent pod damage ranged significantly from 68.49 percent on ICCV 092944 to 98.40 percent on ICC 3137 as compared to 91.20 percent on check variety L550 (Table 4). Minimum pod damage was observed in ICCV 092944 (68.49%), followed by ICCV 097105 (77.91%) and in check variety PG 186 (82.66%). However, maximum pod damage was observed in ICCV 95334 (100%), followed by ICC 3137 (98.40%) and D 059 (97.41%). During second season *Rabi* 2013-14, there was lower yield in all entries , due to intermittent rainfall, variation in relative humidity and temperature during vegetative and flowering stage result in heavy incidence of *Aschochyta blight* in 13 cultivars of chickpea *viz*., (ICCV 95334, ICCV 97105, ICCV 09103, ICCV 9118, 5034, ICCV 10, ICCV 07104, ICC 3137, ICC14364, ICCV 7306, ICCV 86111, ICCV 7112, D 059, ICCV 9115, ICCV 8107, ICCV 8108, ICCV 86105, PG 186) in all three replication. Among 22 cultivars ICCV 92944 and ICCV 97105 showed some extent tolerant to *Aschochyta* blight and obtain consistent yield when compare to other cultivars. During both years, the per cent pod damage due to *H. armigera* larvae presented in Table 3 and 4 is partial similar with Girija *et al* (2008) reported that, extent of pod damage among the 19 cultivars ranged from 37.59 to 6.65%. Cultivars differed significantly for percent pod damage. ICCV 2 and annigeri showed significantly higher pod damage than other cultivars suggestive of their high susceptible nature to pod borer. least pod damage was observed in ICCL 87317 (6.65%) followed by ICC 12479 (7.35%) and ICC 506 (7.52%). The cultivars, ICC 86102, ICCV 95992, ICCV 96752, ICCL 87315, ICCL 87314,

Table 3 : Per cent pod damage due to *H. armigera*, yield and pest susceptibility rating of chickpea cultivars for 2012-13.

S. No.	Genotype	Pod damage (%)	Susceptibility	PSR**	Susceptibility category	Yield (Kg/ha)
1	**ICCV 09103**	80.51(64.45)	-3.38	8	Highly susceptible	809.72
2	**ICCL86111**	71.76(58.09)	7.86	7	Moderately susceptible	488.89
3	**ICCV09115**	80.37(64.91)	-3.19	8	Highly susceptible	440.28
4	**ICCV08108**	69.37(57.15)	10.94	5	Least susceptible	880.56
5	**ICCV97105**	53.56(47.084)	31.22	4	Least susceptible	1491.67
6	**ICCV07306**	64.98(53.77)	16.57	5	Least susceptible	86.11
7	**ICCV92944**	57.65(49.40)	25.98	4	Least susceptible	1401.39
8	**JG 11**	79.99(63.93)	-2.71	8	Highly susceptible	663.89
9	**ICCV07112**	77.35(63.90)	0.69	7	Moderately susceptible	966.67
10	**ICCV08107**	70.47(58.52)	9.52	6	Moderately susceptible	680.56
11	**ICCL86105**	67.37(55.89)	13.49	5	Least susceptible	884.72
12	**D 059**	74.73(60.30)	4.05	6	Moderately susceptible	633.33
13	**5034**	75.09(61.23)	3.58	6	Moderately susceptible	408.33
14	**ICC3137**	85.32(67.80)	-9.81	8	Highly susceptible	158.33
15	**ICC14872**	81.31(66.44)	-4.40	8	Highly susceptible	680.56
16	**ICC14364**	80.46(65.12)	-3.31	8	Highly susceptible	698.61
17	**ICCV07104**	71.77(58.03)	7.85	6	Moderately susceptible	609.72
18	**ICCV09118**	70.95(58.09)	8.90	6	Moderately susceptible	670.83
19	**ICCV10**	66.83(57.05)	14.19	5	Least susceptible	915.28
20	**ICCV95334**	80.50(64.00)	-3.36	8	Highly susceptible	122.22
21	**PG186**	58.84(50.14)	24.45	5	Least susceptible	997.22
22	**L550**	77.88(62.50)	-	-	-	736.11
	S Em±	5.78*				-
	CD at 5%	15..59				

*Data presented in parentheses are square root transformed value.

Table 4 : Per cent pod damage due to *H. armigera*, yield and pest susceptibility rating of chickpea cultivars 2013-14.

S. No.	Genotype	Pod damage (%)	Susceptibility	PSR**	Susceptibility category	Yield (Kg/ha)
1	**ICCV 09103**	91.03(79.58)	0.19	6	Moderately susceptible	200.0
2	**ICCL86111**	95.60(82.89)	-4.82	6	Moderately susceptible	105.6
3	**ICCV09115**	88.59(74.35)	2.86	6	Moderately susceptible	247.2
4	**ICCV08108**	89.79(75.88)	1.55	6	Moderately susceptible	455.6
5	**ICCV97105**	77.91(64.46)	22.16	5	Least susceptible	569.4
6	**ICCV07306**	96.74(83.92)	-6.07	7	Highly susceptible	11.1
7	**ICCV92944**	68.49(55.90)	25.20	4	Least susceptible	972.2
8	**JG 11**	86.53(73.52)	5.12	6	Moderately susceptible	580.6
9	**ICCV07112**	91.30(78.34)	-0.10	7	Highly susceptible	308.3
10	**ICCV08107**	95.60(82.89)	-4.82	7	Highly susceptible	250.0
11	**ICCL86105**	88.50(75.18)	2.96	6	Moderately susceptible	319.4
12	**D 059**	97.41(82.43)	-6.81	7	Highly susceptible	38.9
13	**5034**	95.37(79.91)	-4.57	7	Highly susceptible	450.0
14	**ICC3137**	98.40(85.78)	-7.89	7	Highly susceptible	5.6
15	**ICC14872**	95.76(79.54)	-5.00	7	Highly susceptible	172.2
16	**ICC14364**	96.85(84.03)	-6.19	7	Highly susceptible	361.1
17	**ICCV07104**	91.73(76.92)	-0.58	7	Highly susceptible	86.1
18	**ICCV09118**	92.61(77.66)	-1.54	7	Highly susceptible	372.2
19	**ICCV10**	87.97(73.96)	3.55	6	Moderately susceptible	205.6
20	**ICCV95334**	100.00(90.00)	-9.65	7	Highly susceptible	58.3
21	**PG186**	82.66(73.31)	9.36	6	Moderately susceptible	816.7
22	**L550**	91.20(79.69)	-	-	-	483.3
	S Em±	2.66(1.96)				-
	CD at 5%	7.59(5.60)				-

*Data presented in parentheses are square root transformed value.

ICCL 87316 and ICC 12494 also registered significantly lesser pod damage (8.0-9.8%) as compared to the Annigeri and ICCV 2.The lines ICCL 86111 (18.13%), ICCL 87211 (14.86%), ICC 12494 (13.81%) and ICCV 10 (14.56%) were moderately tolerant to pod borer. It shows that there were significant differences among the cultivars. Above finding was supported by Sehgal and Ujagir (1990) reported 42.6 to 90 % percent pod damage in chickpea by *Helicoverpa armigera* at pantnagar during Rabi season 1979-80 and 1987-88. While in the present studies pod damage varied from 53.49% on ICCV 10 to 91.63% on ICC 14872 with 71.88% on check cultivar L 550.

Pest susceptibility rating (PSR) in 22 early maturity cultivars during 2012-13 and 2013-14

During *Rabi* 2012-2013, the 22 early maturity cultivars including check grouped into three groups on basis of pod damage susceptibility rating that is least susceptible, moderately susceptible and highly susceptible over pod damage of check cultivar L 550. ICCV 97105, ICCV92944, ICCV10 was least susceptible and had damage rating of 4 for former two cultivar and 5 respectively over the check variety, L 550. While ICCV 07112**,** ICCV 08108, ICCV 97105, ICCV 07306 and ICCV 92944 were also moderately susceptible with damage rating of 6-7. Rest cultivars were highly susceptible to pod borer damage. During 2013-14, ICCV 92944 and ICCV 097105 were least susceptible and had damage rating of 4 over check variety, L 550. While JG11, ICCL 86105, ICCV 08108, ICCV 9115, ICCL 86111, ICCV 10 and ICCV 09103 were also moderately susceptible with damage rating of 6 (Tables 3 and 4).

Grain yield of chickpea cultivars during 2012-13 and 2013-14

The grain yield obtained during *Rabi* 2012-13 are given in (Tables 3 and 4). The grain yield ranged from 86.11 kg/ha to 1491.67 kg/ha. The minimum grain yield was recorded in ICCV 07306 (86.11kg/ha) followed by ICCV 095334 (122.22kg/ha) and maximum grain yield was obtained from ICCV 097105 (1491.67Kg/ha) followed by ICCV 92944 (1401.39Kg/ha), when compared to check PG 186, L550 with 997.22, 736.11 Kg/ha respectively. During 2013-14 the grain yield kg / ha minimum recorded with 5.6 kg/ha on ICC 3137 and maximum was recorded with 972.23 kg/ha in ICCV 092944 as compared to check cultivars PG 186 (816.7 kg/ha) under unprotected conditions. There was non-significant difference in grain yield between cultivars and their checks. It also showed that there were poor yield due to severe attack of *H. armigera*.

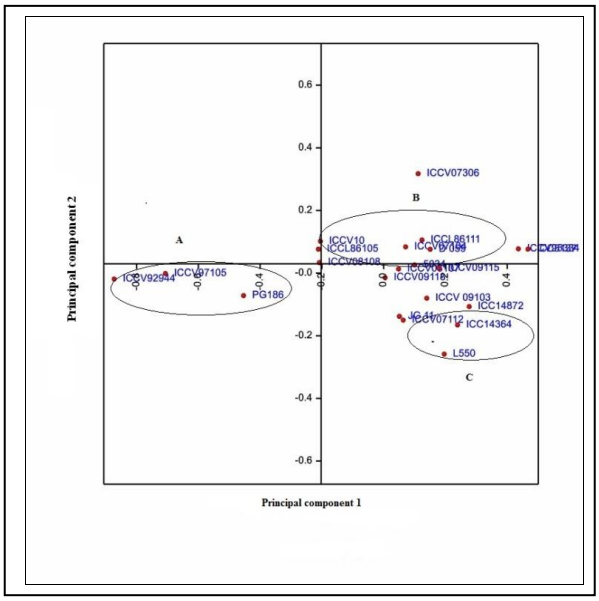

Fig. 1 : Principal component analysis of 22 cultivars of chickpea based on *H. armigera* per cent pod damage and grain yiled (kg/ha) under filed conditions

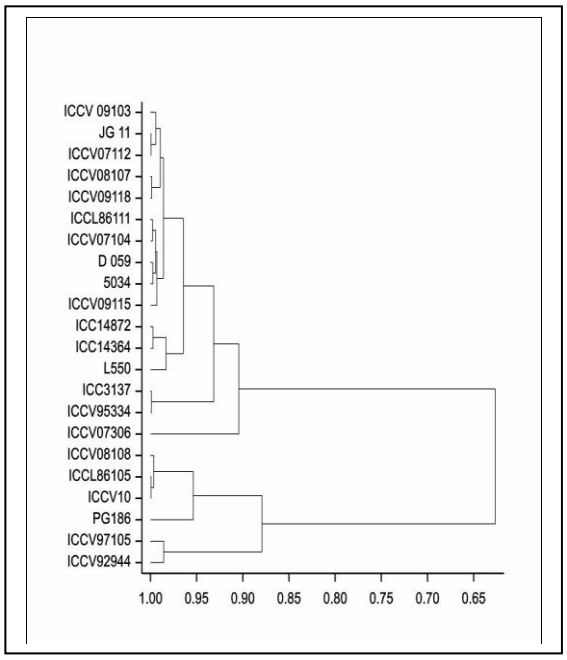

Fig. 2 :. Dendrogram depicting genetic similarity between 22 accessions of wild relatives of chickpea and three cultivated chickpea genotypes for their reaction to *H. armigera*

Principal component and similarity index analysis

Principal component analysis placed the test genotypes into three groups (Fig. 1). Of the cultivated chickpeas tested, the resistant source against pod borer *H. armigera* in context to pod damage and grain yield was in ICCV 92944, ICCV 097105 and PG 186 was in

group A and the susceptible check and local landrace LL 550 in group C. and moderate resistance (ICCV 10, ICCL 86105, ICCL 86111) was comes under group B. This suggests that there is considerable diversity in the genotypes showing resistance to *H. armigera*. Based on similarity matrix on per cent pod podamage and grain yield, the test genotypes into four at 0.95 level of similarity index (Fig. 2). The genotypes showing resistance to *H. armigera* were placed in different groups, ICCV 097105 and ICCV 92944 tolerant group were placed in one group, while the genotypes comes under modretly tolerent categiers, ICCV 10, ICCL 86105, ICCV 08108 and check cultivar PG 186 indicating that there is considerable diversity among the lines showing resistance to *H. armigera*. Genotypes showing high levels of resistance and placed in different groups can be used to increase the levels and diversify the basis of resistance to this pest. Sucpetible genotyeps depicted were ICC 3137, LL 550 (Check), ICCV 07306, ICCV 95334 and ICC 14364 and ICC 14872.

CONCLUSION

It was concluded that none of the tested genotypes were free from *H. armigera* infestation. However, based on the percent pod damage, the genotype PG-186, ICCV 07306, ICCV 92944, ICCV 10, ICCV 97105 and ICCV 08108 were found to be least prefered and while ICC 3137, L 550, ICC 14872, ICCV09115 and ICCV 09103 were declared as the most susceptible cultivars. Further study is needed to explore the influence of physical plant characters and infulence of climate change on tested genotypes in relation to resistance against *H. armigera*.

REFERENCES

Anonymous (2015) *Report of expert group on pulses*. Department of Agriculture & Co-operation Government of India, Ministry of Agriculture. 1-148.

Chatar V P, Raghvani K L, Joshi M D, Ghadge S M, Deshmukh S G and Dalave S K (2010) Population dynamics of pod borer, *Helicoverpa armigera* (Hubner) infesting chickpea. *International Journal of Plant Protection* **3**(1), 65-67.

Girija, Salimath P M, Gowda C L L and Sharma H C (2008) Biophysical and biochemical basis of host plant resistance to pod borer (*Helicoverpa armigera*) in chickpea (*Cicer arietinum* L.). *Indian Journal of Genetics* **68**, 320-323.

Kumar Jeewesh, Singh D C, Singh A P and Verma S K (2013) Screening of chickpea genotypes for resistant against pod borer, *Helicoverpa armigera* (Hubner). *Trends in Bioscience* **6**(1), 101-103.

Lateef S S and sachan J N (1990) Host plant resistance of *Helicoverpa armigera* (Hubner) in different agro-ecological context. In: *Chickpea in Nineties Proceedings of the Second international Workshop on Chickpea*, ICRISAT Center, Patancheru, Andhra Pradesh-502 324, lndia. pp.181-189.

Leuck B, Hammons R, Morgan I W and Harvey J E (1967) Insect preference for peanut varieties. *Journal of Economic Entomology* **60**, 1546-1549.

Narayanamma V L (2005) Genetics of resistance to pod borer, *Helicoverpa armigera* in chickpea (*Cicer arietinum*). *Ph.D. Thesis*, Department of Entomology College of agriculture, Rajendranagar Acharya N. G. Ranga agricultural university, Rajendranagar, Hyderabad. pp. 197.

Sarwar M (2013) Survey on screening resistance resources in some chickpea (*Cicer arietinum* L.) genotypes against gram pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera : Noctuidae) pest. *Int. J. of Agri. Sci.* **3**(3), 455-458.

Sehgal V K and Ram Ujagir (1990) Effect of synthetic pyrethroids, neem extracts and other insecticides for the control of pod borer damage by *Heliothis armigera* in chickpea and pod damage yield relationship at Pantnagar in N. India. *Crop Protection* **9**, 29-32.

Sharma H C (2005) Techniques to screen for resistance to cotton bollworm/ legume pod borer. *Helicoverpa armigera*.In Souvenir, National Symposium on *Helicoverpa* Management -A National Challenge, 27 - 28 Feb 2005. Indian Society of Pulses Research and Development, Indian lnstitute of Pulses Research. Kanpur, Uttar Pradesh, India.

Ujiagir R and Khare B P (1988) Screening of chickpea (*Cicer arielinum* I.) against *Heliothis armigera* Hub. (In En.) Summaries in Integrated Pest Control. Progress and Perspectives : Proceedings of the National Symposium, 15-17 Oct 1987 (Mohandas, N. and Koshy, G. Eds) *lndian Association for Advancement of Entomology*, Trivendrum, Kerala. pp.129-132.