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Studies on biological parameters of gram pod borer, *Helicoverpa armigera* (Hübner) on interspecific chickpea genotypes

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Abstract
Seven interspecific chickpea genotypes along with ICCL 86111 and L 550 as resistant and susceptible checks were evaluated against *Helicoverpa armigera* under laboratory conditions during *rabi* 2014-15 and 2015-16. Pooled data revealed that the larval and pupal duration varied from 21.68 to 23.49 and 14.09 to 15.89 days in all the test genotypes. Genotype GLW 32 (23.49 days) had recorded longest larval duration and was at par with GLW 8, GLW 48 and GLW 84. Resistant and susceptible checks had recorded larval duration of 20.86 and 20.62 days and were at par with GLW 131 (21.68 days). Similar trend was followed for pupal duration. The larval and pupal survival was ranged from 61.27 to 85.99 per cent and 62.50 to 88.25 per cent, respectively. Genotype GLW 32 had recorded lowest larval survival (61.27%) and was at par with GLW 8. Susceptible check L 550 had recorded highest larval survival of 93.33 per cent. Similar trend was followed for pupal survival. Significantly lowest adult longevity of 11.17 days was also recorded in GLW 32, which was at par with GLW 8.

Keywords: Chickpea, *Helicoverpa armigera*, host plant resistance, interspecific genotypes

Introduction
Chickpea (*Cicer arientinum* L.), commonly known as Bengal gram and locally '*chana*', is the premier pulse crop belongs to the family Fabaceae. *Helicoverpa armigera* (Hübner) is an economically important polyphagous pest in India. In India, this insect occurs as a major pest in many economically important crops, including chickpea, pigeonpea, cotton, Egyptian clover, tomato, okra and blackgram, *etc*. *H. armigera* (Hübner) is the predominant species in Punjab causing economic damage to many *kharif* and *rabi* crops (Singh and Sidhu 1990) [7]. Despite considerable investment in breeding, average chickpea yield in major producing countries such as India stagnates at 0.6-0.7 mt ha^{-1} since past two to three decades. This low yield is far below the crop's potential of 3-5 mt ha^{-1} under optimal conditions (Molina *et al* 2008) [5]. Adult female lays 300-500 eggs on host plants. After hatching the larvae feed on the leaves, flower, floral buds and pods. Full grown larvae drop to the ground for pupation. The life cycle is completed in 30-37 days. There are 5-7 generations in a year (Malik 1994)[4]. A comprehensive account on biology of *H. armigera* has been given by Srivastava and Srivastava (1990) [8], Bhatt and Patel (2001) [3], Ali *et al* (2009) [1], Naseri *et al* (2009) [6] and Ali *et al* (2016) [2] on chickpea crop in India and Pakistan. The present study broadly confirms their findings but a number of variations have been recorded due to selecting area specific chickpea genotype and their physical environment in the present work. Hence, the present work has been planned to determine various biological parameters of this pest on interspecific chickpea genotypes.

Material and Methods
In the present study, seven interspecific chickpea genotypes *viz*., GLW 8, GLW 32, GLW 42, GLW 48, GLW 63, GLW 84, GLW 131 and two check cultivars ICCL 86111 and L 550 were selected based on their field reaction to pod borer in the previous years by screening 64 derivative lines of interspecific cross between ICCV 96030 (*Cicer arietinum*) × Acc.212 (*Cicer pinnatifidum*). These interspecific chickpea genotypes were evaluated under laboratory conditions for confirming their resistance against *H. armigera* by studying various biological parameters of *H. armigera* on these lines during *rabi* 2014-15 and 2015-16.

Rearing of *H. armigera*: A large number of larvae of *H. armigera* were collected from chickpea fields. The larvae were reared in laboratory at 25 °C and 65 per cent relative humidity, individually in plastic vials on natural food collected from the available crop. The larvae were transferred to natural food daily and those larvae which were about to pupate were shifted into plastic jars with a wet sponge underneath a filter paper to provide moisture for emergence. The jars were covered with muslin and fastened with the help of rubber bands. These jars were examined daily so as to collect the freshly emerged adult moths. The separation of males and females was done by identifying the male on the basis of tapering abdomen and small size, whereas female had broad abdomen with a tuft of creamish scales at the tip. They were also separated on the basis of colour as males had a greenish tinge on the wings and females were dark brown in colour. The moths, so collected, were kept in batches of two pairs in clean glass jars covered from sides by a black paper and top of which was covered with a muslin cloth and fastened with rubber band for egg laying. Cotton swab impregnated with 5 per cent honey solution was hanged with a pin in the jar as food for the moths. Jars having moth pairs were examined daily for oviposition. The eggs laid on the muslin were kept at 25 °C and 65 per cent relative humidity. After 3-4 days, the neonates hatched from the eggs were used for various experiments. To study the effect of interspecific chickpea genotypes on biological parametes of *H. armigera* an experiment in completely randomized design (CRD) with three replications was laid out at Entomological Laboratory of Pulses Section, PAU, Ludhiana. Five singly neonate larvae of *H. armigera* per replication were released on each of the interspecific chickpea genotypes along with ICCL 86111 and L 550 as resistant and susceptible checks in insect rearing cups. The fresh leaves of each interspecific chickpea genotypes along with resistant and susceptible check were provided as food to the larvae till pupation. The newly formed pupae were trasferred to plastic tubes @ one pupa per tube and kept there till the emergence of adults, for recording the adult longivity and sex ratio. The following observations were recorded on each of the interspecific chickpea genotypes along with resistant and susceptible checks:

- Larval duration
- Larval survival
- Pupal duration
- Pupal survival
- Adult emergence
- Adult longevity

The data pertaining to different biological parameters of *H. armigera* were analyzed using ANOVA to test for significance among different genotypes.

Result and Discussion

Laboratory screening

Larval duration: During 2014-15 the larval duration in all the test chickpea genotypes varied from 21.43 to 23.11 days. Significantly highest larval duration was observed in genotype GLW 32 (23.11 days) which was at par with GLW 8 (22.72 days) and GLW 84 (22.55 days). Resistant and susceptible check had observed larval duration of 21.13 and 20.66 days, respectively and resistant check was at par with GLW 131 with 21.43 days (Table 1). During 2015-16, the larval duration in all the test chickpea genotypes varied from 21.93 to 23.87 days. Significantly highest larval duration was observed in genotype GLW 32 (23.87 days) which was at par with all remaining interspecific genotypes *viz.,* GLW 8, GLW 42, GLW 48, GLW 63, GLW 84 and GLW 131, respectively. Resistant check and susceptible check had possessed lowest larval duration of 20.60 and 20.58 days (Table 2). For the pooled data, significantly highest larval duration was observed in genotype GLW 32 (23.49 days) which was at par with GLW 8, GLW 42, GLW 48, GLW 63, GLW 84 and GLW 131 with larval duration of 23.00, 22.24, 22.51, 22.26, 22.71 and 21.68 days, respectively. Resistant and susceptible check had possessed shortest larval duration of 20.86 and 20.62 days (Table 3). Ali *et al* (2009) [1] supported the present findings and reported the average duration of first, second, third, fourth, fifth and sixth instar larvae to be 2.27±0.08, 2.42±0.08, 2.67±0.07, 2.83±0.07, 3.40±0.10 and 3.37±0.11 days, respectively. Naseri *et al* (2009) [6] reported the total development time of *H. armigera* larvae ranged from 17.30 to 26.20 days on different soyabean cultivars. Ali *et al* (2016) [2] were in agreement with the present findings, who reported that larval period ranged from shortest 16.41 days on CMC-211s to longest 22.71 days on Pb-2008.

Larval survival: The larval survival in all the interspecific chickpea genotypes varied from 62.33 to 88.67 per cent during 2014-15 (Table 1). Significantly lowest larval survival was observed in GLW 32 which was at par with genotypes GLW 8, GLW 42 and GLW 48 with 62.57, 75.50 and 76.11 per cent, respectively. Significantly highest larval survival was observed in genotype GLW 131 (88.67%) which was at par with GLW 63 (78.71%) and GLW 84 (78.05%). Resistant and susceptible checks had recorded 90.00 and 93.33 per cent of larval survival. During 2015-16, the larval survival in all the test chickpea genotypes varied from 60.32 to 83.33 per cent (Table 2). Significantly lowest larval survival was observed in GLW 32 (60.32%) which was at par with genotypes GLW 8, GLW 42, GLW 48 and GLW 84 with survival of 62.41, 72.22, 75.40 and 77.78 per cent, respectively. Significantly highest larval survival was recorded in genotype GLW 131 (83.33%) which was at par with GLW 63 (80.00%). Resistant and susceptible check genotypes recorded 88.89 and 93.33 per cent larval survival. In the pooled data, the significantly lowest larval survival was observed in GLW 32 (61.27%) which was at par with genotypes GLW 8, GLW 42 and GLW 48 with survival of 62.49, 71.66 and 73.81 per cent, respectively. Genotype GLW 131 (85.99%) had recorded significantly higher per cent larval survival and was at par with resistant check ICCL 86111 (89.44%). However, susceptible check L 550 had recorded highest larval survival of 93.33 per cent (Table 3). Srivastava and Srivastava (1990) [8] agreed to the present findings, who reported survival of 77 per cent on comparatively resistant cultivar as compared to 90 per cent on susceptible cultivar of chickpea against *H. armigera* larvae. Ali *et al* (2016) [2] supported the present findings, who reported the percentage larval survival of *H. armigera* ranged from 73 per cent on Pb-2008 cultivar to 93 per cent on CMC-211s cultivar. Other remaining cultivars *viz.,* Bittal-98, Parbat, CM-2000 and Dasht had recorded larval survival of 78, 79, 87 and 88 per cent, respectively.

Pupal duration: The pupal duration in all the interspecific chickpea genotypes varied from 13.78 to 15.78 days during 2014-15 (Table 1). Significantly highest pupal duration was observed in genotype GLW 32 (15.78 days) which was at par

with GLW 8 (15.00 days). Genotype GLW 63 had significantly lower pupal duration of 13.78 days and which was at par with genotypes GLW 42, GLW 48, GLW 84 and GLW 131 with 14.89, 14.67, 14.44 and 13.89 days, respectively. Resistant and susceptible check genotypes observed significantly lowest pupal duration of 13.11 and 12.78 days. During 2015-16, the pupal duration in all the test chickpea genotypes varied from 14.03 to 16.00 days. Significantly highest pupal duration was observed in genotype GLW 32 (16.00 days) which was followed by GLW 8 (15.25 days) and was at par with GLW 42 (14.99 days). Significantly lower pupal duration was observed in genotype GLW 63 (14.03 days) which was at par with GLW 48, GLW 84 and GLW 131 with pupal duration of 14.34, 14.32 and 14.29 days, respectively. Resistant and susceptible check observed 13.31 and 13.00 days pupal duration (Table 2). In pooled data, significantly highest pupal duration was observed in genotype GLW 32 (15.89 days) which was at par with GLW 8 (15.12 days). Genotype GLW 63 had significantly lower pupal duration of 13.90 days and which was at par with other genotypes. Resistant and susceptible check genotypes observed 13.21 and 12.89 days pupal duration (Table 3). Ali *et al* (2016)[2] supported the present findings and found pupal durations of 9.50±0.02 on CMC-211s to 14.01±0.01 days on Pb-2008. Other cultivars *viz.*, Bittal-98, Parbat, CM-2000 and Dasht recorded the pupal duration of 13.25±0.05, 13.03±0.50, 11.52±0.03 and 10.29±0.15 days, respectively.

Pupal survival: The pupal survival in all the test chickpea genotypes varied from 58.33 to 88.17 per cent during 2014-15. Significantly lowest pupal survival was observed in GLW 32 (58.33%). Among the test genotypes significantly highest pupal survival was observed in genotype GLW 131 (88.17%) which was at par with GLW 8, GLW 42, GLW 48, GLW 63 and GLW 84 with 76.67, 81.50, 85.17 and 87.33 per cent, respectively. Resistant and susceptible check had recorded 95.17 and 96.19 per cent of pupal survival (Table 1). During 2015-16, the pupal survival in all the test chickpea genotypes varied from 66.67 to 88.33 per cent. Significantly lowest pupal survival was observed in GLW 32 (66.67%) which was at par with genotypes GLW 8 (80.00%). Significantly highest pupal survival was recorded in genotype GLW 131 (88.33%) which was at par with GLW 42, GLW 48, GLW 63 and GLW 84 with 85.00, 85.00, 86.67, and 86.11 per cent, respectively. Resistant check (ICCL 86111) and susceptible check (L 550) genotypes recorded 93.33 and 96.19 per cent pupal survival, respectively (Table 2). In pooled data, significantly lowest pupal survival was observed in GLW 32 (62.50%) followed by GLW 8 (78.33%). Significantly highest pupal survival was recorded in genotype GLW 131 (88.25%) which was at par with GLW 42, GLW 48, GLW 63 and GLW 84 with 83.25, 85.08, 87.00 and 86.28 per cent, respectively. Resistant check (ICCL 86111) and susceptible check (L 550) genotypes recorded 94.25 and 96.19 per cent pupal survival, respectively (Table 3). Ali *et al.* (2016) [2] partially agreed with the present findings, who reported minimum *H. armigera* pupal survival of 78 per cent on Pb-2008 which was maximum 94 per cent on CMC-211s cultivar of chickpea. Other test cultivars *viz.*, Bittal-98, Parbat, CM-2000 and Dasht had recorded pupal survival of 81, 81, 87 and 89 per cent, respectively.

Adult emergence: In different interspecific chickpea genotypes a significantly varied adult longevity was observed with 11.00 to 14.00 days during 2014-15. Significant differences were observed on healthy and malformed adult emergence of *H. armigera*. Significantly lowest adult longevity was observed in GLW 32 (11.00 days) which was at par with GLW 8 (11.33 days). Significantly highest adult longevity was observed in genotype GLW 63 and GLW 131 (14.00 days). Resistant and susceptible check cultivars had also recorded adult longevity of 14.00 days (Table 1). During 2015-16, significantly varied adult longevity was observed from 11.33 to 14.00 days. Significantly lowest adult longevity was observed in GLW 32 and GLW 8 (11.33 days). Significantly higher adult longevity was observed in genotype GLW 63 and GLW 131 (14.00 days) which was at par with GLW 84 (13.67 days). Resistant and susceptible check genotypes had recorded highest adult longevity of 14.00 days (Table 2). In the pooled data, adult longevity of 11.17 days was recorded in GLW 32 and was at par with GLW 8 (11.33 days). Highest longevity was recorded in GLW 131 (14.00 days) which was at par with resistant and susceptible check (Table 3). The longivity of *H. armigera* adult was significantly greater in susceptible genotype which contains lower concentrations of secondary metabolites as compared to resistant test genotypes.

Male: Female sex ratio of 1:1 was observed in (GLW 8, GLW 32, GLW 48 and GLW 84), whereas the others genotypes had GLW 42 and GLW 131 (1.5:1) and GLW 63 (1.7:1), respectively. Resistant check ICCL 86111 recorded (1:1.5) against susceptible check L550 (1:1.7) during 2014-15 (Table 1). During *rabi* 2015-16, male: female sex were observed 1:1 in (GLW 8, GLW 32, GLW 42 and GLW 48), whereas the genotypes GLW 63, GLW 84 and GLW 131 had 1.3:1, 1.5:1 and 1.6:1, respectively. Resistant check ICCL 86111 recorded (1:1.3) against susceptible check L550 (1:1.5) in Table 2. In pooled data, Male: Female sex of 1:1 was recorded in GLW 32, GLW 8 and GLW 48, respectively. Resistant check ICCL 86111 and susceptible check L 550 had recorded sex ratio of 1:1.4 and 1:1.6, respectively (Table 3). Bhatt and Patel (2001) [3] partially supported the present findings, who reported that male moth emerged within 9.17±0.42 days and female moth took 11.74±0.51days to complete development.

The present study concluded that genotypes GLW 32, GLW 8, GLW 42 and GLW 48 exhibited lower larval survival, pupal survival, adult longevity and higher larval duration, pupal duration. High and moderate resistance shown by interspecific chickpea genotypes in our study represent a valuable tolerance source against *H. armigera* that could be exploited as a variety or by development of resistant germplasm by using them in breeding programme.

Table 1: Biological parameters of *H. armigera* on different chickpea genotypes during 2014-15

S. No.	Genotypes	Larval duration*	Per cent larval survival**	Pupal duration*	Per cent pupal survival**	Adult longevity (days)	M:F
1	GLW 8	22.72(4.87)	62.57(52.28)	15.00(4.00)	76.67(61.12)	11.33(3.46)	1:1
2	GLW 32	23.11(4.91)	62.22(52.13)	15.78(4.10)	58.33(49.98)	11.00(3.46)	1:1
3	GLW 42	21.97(4.79)	71.11(57.52)	14.89(3.98)	81.50(64.82)	12.00(3.60)	1.5:1

4	GLW 48	21.35(4.73)	72.22(58.44)	14.67(3.96)	85.17(67.54)	12.33(3.65)	1:1
5	GLW 63	22.31(4.83)	78.71(62.65)	13.78(3.84)	87.33(69.21)	14.00(3.87)	1.7:1
6	GLW 84	22.55(4.85)	78.05(62.17)	14.44(3.93)	86.44(68.52)	13.33(3.78)	1:1
7	GLW 131	21.43(4.73)	88.67(70.56)	13.89(3.86)	88.17(70.54)	14.00(3.87)	1.5:1
8	ICCL 86111	21.13(4.70)	90.00(71.54)	13.11(3.75)	95.17(80.03)	14.00(3.87)	1:1.5
9	L 550	20.66(4.65)	93.33(77.68)	12.78(3.71)	96.19(80.81)	14.00(3.87)	1:1.7
	CD (p=0.05)	(0.06)	(8.94)	(0.15)	(10.88)	(0.08)	

* Figures in parentheses are the transformed √n+1 values
** Figures in parentheses are the transformed arc sine values

Table 2: Biological parameters of *H. armigera* on different chickpea genotypes during 2015-16

S. No.	Genotypes	Larval duration*	Per cent larval survival**	Pupal duration*	Per cent pupal survival**	Adult longevity (days)	M:F
1	GLW 8	23.28(4.93)	62.41(52.18)	15.25(4.03)	80.00(63.52)	11.33(3.51)	1:1
2	GLW 32	23.87(4.98)	60.32(50.96)	16.00(4.12)	66.67(54.76)	11.33(3.51)	1:1
3	GLW 42	22.52(4.85)	72.22(58.43)	14.99(4.00)	85.00(67.95)	12.33(3.65)	1:1
4	GLW 48	23.67(4.96)	75.40(60.40)	14.34(3.92)	85.00(67.38)	12.67(3.70)	1:1
5	GLW 63	22.22(4.81)	80.00(63.41)	14.03(3.88)	86.67(68.83)	14.00(3.87)	1.3:1
6	GLW 84	22.87(4.88)	77.78(62.15)	14.32(3.91)	86.11(68.20)	13.67(3.83)	1.5:1
7	GLW 131	21.93(4.79)	83.33(65.88)	14.29(3.91)	88.33(70.66)	14.00(3.87)	1.6:1
8	ICCL 86111	20.60(4.65)	88.89(73.90)	13.31(3.78)	93.33(77.68)	14.00(3.87)	1:1.3
9	L 550	20.58(4.64)	93.33(77.68)	13.00(3.74)	96.19(80.81)	14.00(3.87)	1:1.5
	CD (p=0.05)	(0.21)	(11.81)	(0.04)	(10.85)	(0.10)	

* Figures in parentheses are the transformed √n+1 values
** Figures in parentheses are the transformed arc sine values

Table 3: Pooled data of biological parameters of *H. armigera* on different chickpea genotypes during 2014-15 and 2015-16

S. No.	Genotypes	Larval duration*	Per cent larval survival**	Pupal duration*	Per cent pupal survival**	Adult longevity (days)	M:F
1	GLW 8	23.00(4.90)	62.49(52.23)	15.12(4.01)	78.33(62.32)	11.33(3.51)	1:1
2	GLW 32	23.49(4.95)	61.27(51.51)	15.89(4.11)	62.50(52.37)	11.17(3.49)	1:1
3	GLW 42	22.24(4.82)	71.66(57.98)	14.94(3.99)	83.25(66.39)	12.17(3.63)	1.3:1
4	GLW 48	22.51(4.85)	73.81(59.31)	14.50(3.94)	85.08(67.46)	12.50(3.67)	1:1
5	GLW 63	22.26(4.82)	79.36(63.03)	13.90(3.86)	87.00(69.02)	14.00(3.87)	1.5:1
6	GLW 84	22.71(4.87)	77.91(62.16)	14.38(3.92)	86.28(68.36)	13.50(3.81)	1.3:1
7	GLW 131	21.68(4.76)	85.99(68.22)	14.09(3.88)	88.25(70.60)	14.00(3.87)	1.5:1
8	ICCL 86111	20.86(4.67)	89.44(72.72)	13.21(3.77)	94.25(78.86)	14.00(3.87)	1:1.4
9	L 550	20.62(4.65)	93.33(77.68)	12.89(3.73)	96.19(80.81)	14.00(3.87)	1:1.6
	CD (p=0.05)	(0.11)	(6.28)	(0.07)	(6.74)	(0.06)	

* Figures in parentheses are the transformed √n+1 values
** Figures in parentheses are the transformed arc sine values

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