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Varietal Screening in Chickpea Against Gram Pod Borer, *Helicoverpa armigera* (Hub.) in Field Conditions Using Biochemical Parameters

Pritish JAKHAR[1,*] **Yogesh KUMAR** **Arun JANU**

Dept. of Entomology, CCS Haryana Agriculturel University, Hisar
[1] Jagan Nath University, Jhajjar

[*] Corresponding author e-mail: pritishjakhar23@gmail.com

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ABSTRACT

A field experiment was conducted to screen the 15 chickpea genotypes against gram pod borer by using biochemical parameters at Research Farm of Pulses Section, Deptt. of G&PB, CCS Haryana Agricultural University, Hisar, Haryana (India). The pooled analysis of two winter season 2013-14 & 2014-15 revealed thatthe maximum and minimum mean larval population of *Helicoverpa armigera* was 17.99 and 28.50 l/mrlon GNG 1581 and HK-2 genotype, respectively. The yield, per cent pod damageand pest susceptibility rating (PSR) ranged from 136.94 to 326.94 kg/ha, 33.26 to 83.30% and 3 to 7, respectively. Among the 15 chickpea genotypes maximum yield (326.94 kg/ha) minimum pod damage (33.26%) and PSR (3) was recorded on GNG 1581 while, in HK-2 minimum yield (136.94 kg/ha),maximum pod damage (83.30%) and PSR (7) was observed. The content of different biochemical in chickpea plants*viz.,* Malic acid, Total phenol, Total soluble sugars, Cellulose, Hemicellulose and Lignin were evaluated for screening and these listed biochemicalranged from 137.51 to 265.65 mg/g, 35.62 to 60.06 mg/g, 2.28 to 4.12 mg/g, 16.05 to 27.15 mg/g, 16.30 to 22.65 mg/g and 6.80 to 12.10 mg/g, respectively. The significant and negative correlation coefficient was recorded between malic acid and mean larval population of *H. armigera* (r= -0.69**) while, all other parameters were correlated non-significantly. Thus malic can be used as selection criteria for identifying *H. armigera* tolerant genotypes in chickpea.

Keywords**:** biochemical, chickpea, *Helicoverpa*, pod borer, screening

Introduction

Chickpea (*Cicer arietinum* Linn.), also known as Bengal gram is one of the most important pulse crops of India and is considered as "king of' pulses" (Bhatt and Patel, 2001). Chickpea is an important source of carbohydrates, dietary fiber and protein, and the protein quality is considered to be better than other pulses (Jukanti *et al.*, 2012). Nearly sixty insect pest species feed on chickpea worldwide, of which gram pod borer, *Helicoverpa armigera* (Hubner) is the major insect pests in the Indian subcontinent.Gram pod borer, *H. armigera* is a polyphagous,multivoltine and cosmopolitan pest and is reported to feed and breed on 182 species of host plants belonging to 47 families in India (Sithanantham, 1987; Pawar, 1998). The yield loss in chickpea due to the pod borer has been estimated to be 10 to 60% under normal weather conditions and may elevate to 50 to 100% in favourable weather conditions (Vaishmpayam and Veda. 1980). Biochemical traits such as malic acid, phenolic compounds, cellulose, hemicelluloses, lignin, free amino acids, etc. of crops have been identified that could be responsible for resistance to insect pests (Yoshida *et al.,* 1995; Grija *et al.*, 2008). Identification and detailed knowledge of insect pest resistance traits of chickpea are of immense importance for developing resistant varieties.In present paper results on varietal screening conducted under field conditions in collection of fifteens genotypes has been reported.

Materials and Methods

The present experiment was conducted at Research Farm of Pulses Section, Deptt. of Genetics &Plant Breeding, CCS Haryana Agricultural University, Hisar, Haryana (India) during the two winter season 2013-14 and 2014-15. Fifteen genotypes of chickpea were screened against the gram pod borer under field conditions by using various biochemical parameters *viz.,* malic acid, total phenols, total soluble sugars, cellulose, hemicellulose and lignin. The experiment was laid in randomised block design with 3 replications with plot size of 5 rows of 4 m length. The observationson larvae of *H. armigera* were recorded from 3 selected places per meter row length in each plot after initiation of pest at 15 days interval.At the time of maturity all the pods of 10 randomly selected plants were plucked and number of healthy and damaged pods were counted and per cent pod damage was calculated. Pest Susceptibility rating was also calculated for the genotypes

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \text{x100}$$

$$\text{PSR} = \frac{\text{C - T}}{\text{C}} \text{x100}$$

C= Check genotype
T= Treatment genotype
Scale: 1 to 9
*1 – Resistance, **9 – Highly susceptible

Yield of each plot was recorded at harvest. The pods collected from 20 plants for recording per cent pod damage was also added to record the total yield/ plot. It was converted as kg/ha and analysed statistically. Correlation coefficient were computed between biochemical parameters and mean larval population.

Results and Discussion

The larval population of H. armigera

The pooled mean larval population (Table 1) of two years 2013-14 and 2014-15, the minimum mean larval population of *H. armigera* was recorded on GNG 1581 (17.99 l/mrl) and it was statistically on par with GNG 1488 (20.26 l/mrl) and H 07-121 (20.41 l/mrl). Maximum mean larval population was recorded on HK-2 (28.52 l/mrl) and it was statistically on par with ICC 3137 (26.92 l/mrl), C-235 (27.13 m/mrl) and HC-1 (28.06 l/mrl). None of the genotypes showed resistance against *H. armigera*. These results are in conformity with Shankar *et al.,* (2014) who reported that, larval population of *H. armigera* on chickpea genotype ICC 3137 (38.6 l/5plants) and ICCL 86111 (16.6 l/5plants) at flowering stage among the 10 selected genotypes. The results are not in agreement with Lateef (1985), Chhabra *et al.,* (1990), Singh and Yadav, (1999). Chickpea germplasm accessions with resistance to *H. armigera* have been identified by several workers. The genotypic responses have been found to be quite variable across seasons and locations (Sharma *et al*., 2003).

Biochemical traits of chickpea genotypes

Malic acid plays a major role against incidence of major insect pests in chickpea. Malic acid content in selected chickpea genotypes ranged from (Table 2) 137.51 to 265.65 mg/g. Maximum amount of malic acid was recorded on GNG 1488 (265.65 mg/g) and minimum on C-235 (137.51 mg/g). Negative and significant correlation (Table 3) was recorded between malic acid with larval population of *H. armigera* (r= -0.6901**), during pooled mean of 2013-14 and 2014-15, respectively.

Varieties with highest amount of malic acid had the highest resistance to *H. armigera* (Rembold, 1981; Rembold *et al*., 1990). Malic acid acts as deterrents to the *H. armigera* larva and pod borer resistant lines have more amount of malic acid than the susceptible lines (Bhagwat *et al*., 1995). Oxalic acid inhibits the growth of *H. armigera* larvae when incorporated in artificial diet, while malic acid shows no growth inhibition (Yoshida *et al*., 1995). Low acidity in the leaf extracts is associated with susceptibility to *H. armigera* however, resistance expressed by PDE 2-3, PDE 7-3 and ICC 506 of chickpea have been attributed to factors other than acidity while that of PDE 7-2 is due to high acidity (Patnaik and Senapati, 1995).

Pod damage and yield

Thepooled mean of two years 2013-14 and 2014-15 showed that minimum per cent pod damage was recorded on variety GNG 1581 (33.26%) and it was statistically on par with GNG 1488 (33.50%) and H 07-158 (40.66%), H 07-121 (38.42%) and H 03-56 (40.51%). Maximum per cent pod damage was recorded on HK-2 (83.30%) and it was statistically on par with HC-1 (75.11%) and C-235 (74.16%).

The pooled mean of years 2013-14 and 2014-15 showed that yield of the selected genotypes ranged from 102.50 to 371.67 kg/ha. Maximum yield was realized from H 03-56 (371.67 kg/ha) and it was statistically on par with H 07-121 (304.17 kg/ha), GNG 1581 (326.94 kg/ha) and HC-5 (335.56 kg/ ha) whereas minimum yield was from ICCL 86111 (102.50 kg/ha) and it was statistically on par with HC-1 (111.39 kg/ha) and C-235 (127.50 kg/ha).

These results are in agreement with Shankar *et al.,* (2014) who evaluated the chickpea genotypes for resistance to *H. armigera* under filed condition. Data revealed that grain yield was significantly greater in ICCV 10 (1732.0 kg/ha) than in susceptible check, ICC 3137 (73.3 kg/ha) and significantly maximum pod damage among the selected genotypes namely ICCL 86111, ICC 10393, ICC 12475, RIL 20, RIL 25, ICCV 10, EC 583264, KAK 2 and EC 583264. Nadeem *et al.,* (2011) studied ten advanced Kabuli genotypes against pod borer and reported that pod damage ranged from 8.2 to 15.8% whereas yield from 197 to 1259 g/plot.

Pest susceptibility rating

The pooled mean of two years 2013-14 and 2014-15, revealed that GNG 1581 and GNG 1488 were recorded with pest susceptibility rating 3, which was considered as increasing resistance. Moderately resistant genotypes *viz.,* H 07-158, HC-5, ICC 3137, H 07-121, H 03-45, H 01-27, H 03-56, GNG 1958 and ICCL 86111 were recorded with PSR of 4 and 5. Maximum PSR (7) was found in the HK-2 and considered as increasing susceptibility against the population of *H. armigera*. A method of grading the test materials by using a 1 to 9 rating scale based on pod damage was suggested by Lateef and Reed (1995). Hossain (2009) recorded pod damage range from 2.80 to 13.47/plant in 20 different chickpea genotypes and found that genotype with maximum pod damage was most susceptible.

Conclusion

Our studies revealed that chickpea genotypes differ in their response to insect pest (*Helicoverpa armigera*) attack as exhibited by differences in larval population and corresponding damage to chickpea pods and hence seeded. Studied 15 genotypes exhibited that GNG 1581 was fairly tolerant to *H. armigera* as it showed least larval population and yield damage. The biochemical analysis supplemented our field observations. The malic acid content was significantly negatively correlated with larval population and the malic acid was high in tolerant genotypes as well. Therefore our studies fairly conclude that large number of genotypes of chickpea should be screened under field conditions both for larval population, damage to pods and reduction in yield so that a set of genotypes with different genetic backgrounds could be identified for further breeding programme in chickpea for its tolerance to dreadful pest *H. armigera.*

Table 1. Larval population of *H. armigera*, pod damage, yield and PSR on different genotypes of chickpea (pooled data).

No.	Genotypes	8th	10th	12th	14th	16th	Average	Pod damage (%)	Yield (kg/ha)	PSR
1	GNG 1581	0.00 (1.00)	0.22 (1.10)	1.12 (1.45)	6.61 (2.76)	82.02 (9.11)	17.99 (4.36)	33.26 (35.19)	326.94	3
2	GNG 1958	0.00 (1.00)	0.61 (1.27)	1.89 (1.70)	9.28 (3.21)	107.79 (10.43)	23.91 (4.99)	60.70 (51.18)	193.61	5
3	GNG 1488	0.00 (1.00)	0.50 (1.22)	1.45 (1.56)	8.00 (3.00)	91.35 (9.61)	20.26 (4.61)	36.19 (36.88)	260.00	3
4	CSJ-140	0.00 (1.00)	0.84 (1.35)	2.39 (1.84)	10.06 (3.32)	112.52 (10.65)	25.16 (5.11)	69.95 (56.75)	176.11	6
5	HK-2	0.00 (1.00)	1.61 (1.62)	3.06 (2.01)	12.73 (3.70)	125.98 (11.27)	28.52 (5.43)	83.30 (66.78)	136.94	7
6	H 07-158	0.00 (1.00)	0.73 (1.31)	2.00 (1.73)	9.45 (3.23)	105.37 (10.31)	23.51 (4.95)	43.88 (41.45)	265.28	4
7	HC-5	0.00 (1.00)	0.78 (1.33)	2.00 (1.73)	9.45 (3.23)	110.68 (10.57)	24.58 (5.06)	51.55 (45.87)	335.56	4
8	ICC 3137	0.00 (1.00)	0.89 (1.37)	2.44 (1.85)	10.11 (3.33)	121.17 (11.05)	26.92 (5.28)	49.58 (44.74)	139.72	4
9	ICCL 86111	0.00 (1.00)	0.62 (1.27)	2.06 (1.75)	8.95 (3.15)	103.96 (10.24)	23.12 (4.91)	67.08 (55.01)	102.50	5
10	H 07-121	0.00 (1.00)	0.39 (1.18)	1.28 (1.51)	7.34 (2.89)	93.07 (9.70)	20.41 (4.63)	42.27 (40.45)	304.17	4
11	H 03-45	0.00 (1.00)	0.73 (1.31)	1.78 (1.67)	9.39 (3.22)	112.57 (10.66)	24.89 (5.09)	44.07 (41.58)	220.00	4
12	H 01-27	0.00 (1.00)	0.67 (1.29)	1.84 (1.68)	9.34 (3.21)	106.57 (10.37)	23.68 (4.97)	49.25 (44.55)	242.50	4
13	H 03-56	0.00 (1.00)	0.56 (1.25)	1.67 (1.63)	8.11 (3.02)	98.60 (9.98)	21.79 (4.77)	46.00 (42.68)	371.67	4
14	HC-1	0.00 (1.00)	1.06 (1.43)	2.78 (1.94)	10.50 (3.39)	125.20 (11.23)	28.06 (5.39)	75.11 (60.55)	111.39	6
15	C-235	0.00 (1.00)	0.89 (1.37)	2.67 (1.92)	10.11 (3.33)	121.96 (11.09)	27.13 (5.30)	74.16 (59.47)	127.50	6
CD at 5%		(N.S.)	(0.10)	(0.10)	(0.28)	(0.52)	(0.26)	(7.90)	98.82	
SEm(±)		-	(0.03)	(0.03)	(0.10)	(0.20)	(0.08)	(2.71)	33.94	

Data presented in parentheses are square root transformed value

Table 2. Bio-chemical constituentsin different genotypes of chickpea.

No.	Genotypes	Malic Acid	Total Phenol	Total Soluble Sugars	Cellulose	Hemicellulose	Lignin
1	GNG 1581	260.26	45.70	3.21	19.10	21.90	9.05
2	GNG 1958	240.62	46.87	3.38	22.40	21.50	7.80
3	GNG 1488	265.65	53.34	2.42	27.15	21.10	10.20
4	CSJ-140	200.77	60.06	4.12	19.20	21.20	9.60
5	HK-2	213.04	37.55	2.62	20.35	21.15	9.95
6	H 07-158	207.41	45.11	3.14	15.85	20.05	8.50
7	HC-5	195.11	35.87	2.99	19.30	20.25	9.00
8	ICC 3137	230.54	37.63	3.82	20.20	20.80	9.25
9	ICCL 86111	210.81	27.97	2.83	21.40	22.40	9.95
10	H 07-121	242.30	49.31	2.53	21.60	22.65	9.10
11	H 03-45	218.32	41.08	2.28	16.05	21.80	9.15
12	H 01-27	212.45	47.80	3.91	21.10	19.33	8.65
13	H 03-56	236.24	40.40	3.21	19.10	14.50	12.10
14	HC-1	199.68	38.22	4.07	21.35	19.45	6.80
15	C-235	137.51	35.62	4.12	19.95	16.90	6.90

Table 3. Correlation coefficients among biochemical traits of chickpea genotypes with mean larval population of *H. armigera* (pooled data).

No.	Biochemical traits	*H. armigera*
		Pooled
1	Malic acid	-0.69**
2	Total phenols	-0.37^{ns}
3	Total soluble sugars	0.43^{ns}
4	Cellulose	-0.18^{ns}
5	Hemicellulose	-0.18^{ns}
6	Lignin	-0.39^{ns}

** significant at P≤0.01
ns non-significant

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