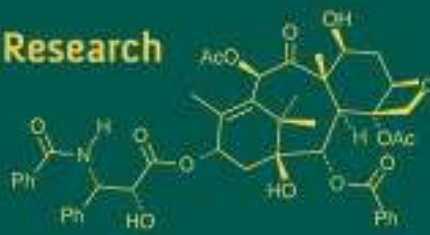
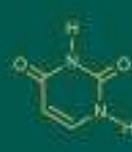
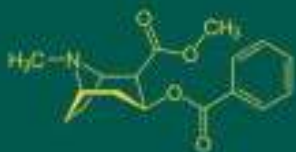


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Assessment of chickpea genotypes for the source of resistance against *Helicoverpa armigera* (Hübner)

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Abstract

Twenty-four genotypes along with three checks were screened for resistance against *Helicoverpa armigera* under field conditions during rabi season at hotspot location, Pantnagar for two years (2022-23 and 2023-24). In preliminary screening, the vegetative stage egg populations ranged from 0.24/plant (GNG 2557) to 1.56/plant (Phule G 181609), while larval populations ranged from 0.56/plant (NBeG 506) to 4.27/plant (GL 13001). At flowering stage, egg populations varied from 0.33 to 1.80 eggs/plant, and larval populations ranged from 2.07 to 9.33 larvae/plant. At pod maturity stage, egg populations decreased, while larval populations peaked. Pod damage was lowest in NBeG 506 (36.57%) and highest in RVSSG-107 (95.61%). Grain yields ranged from 372.45 kg/ha (RVSSG-107) to 1710.99 kg/ha (IG 21-03). Based on preliminary screening results twelve potential genotypes were categorised in 2023-24. Egg and larval populations during various growth stages showed significant variations. Pod damage ranged from 44.72% (NBeG 506) to 93.74% (CSJ 138). Grain yields varied from 515.16 kg/ha (CSJ 138) to 1066.67 kg/ha (NBeG 506). Principal component analysis (PCA) found key genotypes with high yield and low pod damage. This study showed that the promising genotypes with potential resistance to *H. armigera*, supports breeding programs to develop high-yielding, insect-resistant cultivars for sustainable agriculture.

Keywords: Chickpea, genotypes, *Helicoverpa*, PCA, resistance

Introduction

Chickpea (*Cicer arietinum* L.), belonging to the Fabaceae family, is the third most important pulse crop globally (Jukanti *et al.*, 2012) [10] and plays a crucial role in various cropping systems. It is known as Bengal gram, cultivated in tropical and subtropical regions, particularly in countries such as India, Pakistan, Australia, and Turkey (FAO, 2023) [5]. Chickpea is nutritionally rich, having 17-20% protein, 52-70% carbohydrates, 4-10% fat, and essential minerals like phosphorus, calcium, and iron (Shrestha *et al.*, 2011; Zaman *et al.*, 2012) [27, 28]. It also contributes significantly to sustainable agriculture due to its nitrogen-fixing ability and tolerance to high temperatures during flowering (Cumming and Jenkins, 2011) [3]. Globally, Bengal gram is grown in an area of about 14 million hectares with the productivity of 1221.8 kg/ha, making it a staple of Rabi season pulses in the world and area of about 10.7 million hectares and productivity of 1261 kg/ha in India. (FAO STAT, 2024) [6].

Despite its significance, chickpea yields have shown limited improvement over the past decade compared to cereals, largely due to various abiotic (wind, rainfall, humidity, and temperature) and biotic stresses (diseases, insect pests, and weeds) (Sharma, 2005) [24]. Among biotic factors, insect pests are the major contributors to yield losses, with the gram pod borer, *Helicoverpa armigera* (Hübner), being the most destructive and considered the key pest (Reed *et al.*, 1987) [17]. This pest, which is prevalent in Asia, Africa, and Australia, damages plants by feeding on leaves, flowers, and pods. Female *H. armigera* moths lay eggs on leaves, flowers, and young pods. Early instar larvae often destroy seedlings, while later instars bore into pods and consume developing seeds, resulting in yield losses ranging from 10.53% to 80%, depending on pest population density and environmental conditions (Khan and Faizullah, 1999; Sarwar *et al.*, 2009; Rutttoh *et al.*, 2013) [11, 21, 18]. Studies have shown that larvae can cause up to 26.27% yield loss under unprotected conditions, with losses escalating to 73.50% when six larvae are present per meter of row length (Singla and Singh, 2020) [25].

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The finding of Sehgal and Ujagir (1990) ^[29] documented pod damage in chickpea by *Helicoverpa armigera* ranging from 42.6% to 90% at Pantnagar during the Rabi seasons of 1979-80 and 1987-88. Also, the research conducted by Jaba *et al.* (2017) ^[9] reveals that pod damage ranged from 53.49% on ICCV 10 to 91.63% on ICC 14872, with a damage rate of 71.88% on the control cultivar L 550 throughout the rabi seasons of 2012-13 and 2013-14.

H. armigera is a serious pest of several crops worldwide due to its high mobility, fecundity, and overlapping generations (Sarode, 1999) ^[20]. The pest's high fecundity, facultative diapause, insecticide resistance, and wide host range including crops like cotton, okra, and pigeonpea (Patankar *et al.*, 2001) ^[15] make it particularly challenging to manage. Pod damage caused by this pest has been reported to vary widely, from 4.09% to 90.90%, depending on environmental and management conditions (Wakil *et al.*, 2005; Sarwar, 2013) ^[26, 22].

Despite the efficacy of insecticides in managing *H. armigera* in chickpea and other crops (Nimbalkar *et al.*, 2009) ^[14], their indiscriminate use has resulted in significant resistance to conventional insecticides (Kranthi *et al.*, 2002) ^[12]. Due to the economic importance of chickpea and the destructive impact of *H. armigera*, this study was conducted to screen chickpea genotypes for resistance against this pest. Evaluations were performed under natural field conditions to identify sources of resistance. These resistant genotypes can serve as a foundation for breeding programs aimed at developing high-yielding, insect-resistant cultivars, thereby contributing to sustainable chickpea production and enhanced food security.

Material and Methods

During Rabi season 2022-23 and 2023-24, the trials were carried out at Crop Research centre, GBPUAT, Pantnagar, Uttarakhand, India. Under field conditions, twenty-five genotypes of chickpea with diverse growth habits were selected from the coordinated trails of All India coordinated research project (AICRP) on rabi pulses (chickpea). Along with these genotypes, three checks ICC 3137 (National susceptible check), ICCL 86111 (National resistant check), and PG 186 (Pantnagar local check) were evaluated against gram pod borer, *H. armigera*. Under proper agronomic practices, the genotypes were seeded in 3 rows of 2 m row length each during the first week of December in an unprotected Randomised Block Design (RBD) using 3 replications. Weeding and intercultural practices were conducted as required. The chickpea crop was cultivated without insecticidal treatments to allow the unrestricted increase of the pest insects and its natural enemies. On five randomly selected plants, observations have been taken about the egg and larvae population during the vegetative stage, 50% flowering stage, and 50% maturity stage, in addition to the percentage of pod damage and the yield of grains.

According to the Pest Resistance Susceptible Rating (PRSR) grade (1–9), which goes from 1 (Immune) to 9 (Highly susceptible), genotypes were categorised as either resistant or susceptible (Lateef and Reed, 1980) ^[13]. A comparison was conducted between the percentage of pod damage at maturity among genotypes. The following formula was then used to grade the genotypes:

$$\text{Pest resistance(\%)} = \frac{\% \text{ Pod damage in check} - \% \text{ Pod damage in test genotype}}{\% \text{ Pod damage in check}}$$

The percentage of pest resistance was transformed into a 1–9 scale as follows:

Pest Resistance	Grade	Pest Resistance Susceptible Rating (PRSR)
100%	1	Immune
75 to 99%	2	Highly resistant
50 to 75%	3	Resistant
25 to 50%	4	Moderately Resistant
10 to 25%	5	Intermediate
-10 to 10%	6	Equal to susceptible check
-25 to -10%	7	Moderately susceptible
-50 to -25%	8	Susceptible
<-50% or less	9	Highly susceptible

Statistical analysis: Duncan's multiple range test (DMRT) was used to compare the differences among the genotypes means by employing the Statistical Package for Social Sciences (SPSS) software to show promising genotypes. When significant differences were found, the critical difference (CD) at a 5% probability level was used to distinguish the means. To calculate the Pest Resistance Susceptible Rating (PRSR), genotypes were ranked, and these ranks were summed to determine the overall performance of each genotype. Thus, a lower PRSR indicates greater resistance and better agronomic performance. Data on the percentage of pod damage and grain yield were analysed using principal component analysis and correlation matrix analysis to evaluate the response of chickpea genotypes to resistance against *H. armigera*.

Results and Discussion

Preliminary screening of chickpea genotypes against *H. armigera* under field conditions during 2022-23

In addition to the three checks ICC 3137, ICCL 8611, and PG 186, Twenty- four genotypes were assessed using a randomized block design. Table 1 presents the data on the number of eggs and larvae recorded at the vegetative, 50% flowering, and 50% podding stages and Table 2 displays the percent pod damage, Pest Resistance Susceptible Rating and grain yield.

Number of eggs and larvae per plant

During the vegetative stage, the mean egg population/plant varied significantly, ranging from a low of 0.24 on GNG 2557 to a high of 1.56 on Phule G 181609, compared to the susceptible check ICC 3137 (1.38), resistant check ICCL 86111 (0.67), and local check PG 186 (0.93). The larval population/plant also showed significant variation, with the lowest being 0.56 on NBeG 506 and the highest being 4.27 on GL 13001, in comparison to the susceptible check ICC 3137 (5.27), resistant check ICCL 86111 (3.00), and local check PG 186 (3.60).

At the 50 percent flowering stage, the *H. armigera* population began to increase steadily. The mean egg population/plant ranged significantly from 0.33 to 1.80 eggs/plant, and the larval population varied significantly from 2.07 to 9.33 larvae/plant. The maximum egg population was recorded on IG 21-03 (1.80 eggs/plant), while the maximum larval population was observed on CSJK- 132 (9.33 larvae/plant).

During the 50 percent pod maturity stage, the larval population reached its peak, while the egg population decreased. The egg population ranged from a low of 0.40 on NBeG 1532 to a high of 1.47 on Phule G 201114, in

comparison to susceptible check ICC 3137 (0.87), resistant check ICCL 86111 (0.53), and local check PG 186 (1.07). The larval population per plant varied significantly, with the lowest being 3.27 on IG 2021-01 and the highest being 10.13 on IG 21-03, in comparison to the susceptible check ICC 3137 (11.53), resistant check ICCL 86111 (8.33), and local check PG 186 (3.13).

Percent pod damage and Pest Resistance Susceptible Rating

At the time of harvest, the percentage of pod damage was calculated, and the collected data were analysed to compare the averages. Percent pod damage ranged at par in most of the genotypes due to severe incidence of *H. armigera*. Pod borer damage varied from the lowest in NBeG 506 (36.57 percent) which is significantly at par with resistant check ICCL 86111 (42.50 percent) and local check (64.10 percent). However, highest pod damage was observed in RVSSG-107 (95.61 percent), followed by GNG 2562 (93.67 percent) as compared to susceptible check ICC 3137 (89.70 percent).

PRSR was calculated based on genotypes percent pod damage as compared to the susceptible check ICC3137. The PRSR ranged 3 to 7 among the genotypes. Out of twenty-four genotypes twelve genotype are selected viz NBeG 506, GJG 1913, GL 18149, GJG 1810, GJG 1917, KCMH420-17, CSJK- 132, IG2020-16, IG 21-03, GNG 2557, Phule G 171313, CSJ 138.

Grain yield

The grain yield was estimated at harvest, revealing significant variation among the genotypes. The yield ranged from 372.45 kg/ha to 1710.99 kg/ha. The minimum grain yield was recorded in RVSSG-107 (178.17 kg/ha) followed by IG 2021-01 (430.68 kg/ha) due to heavy infestation of *H. armigera* and maximum grain yield was obtained from IG 21-03 (1710.99 kg/ha) followed by NBeG 506 (1245.00 kg/ha), as compared to checks ICCL 86111, ICC 3137 and PG 186 with 1300.67, 454.84, 828.13 kg/ha respectively. The promising genotypes viz., NBeG 506, GJG 1913, GL 18149, GJG 1810, GJG 1917, KCMH420-17, CSJK- 132, IG2020-16, IG 21-03, GNG 2557, Phule G 171313, CSJ 138 were preferred for confirmatory screening under pesticide free field conditions during 2023-24.

Evaluation of selected chickpea genotypes for resistance to *H. armigera* during 2023-24

Twelve potential chickpea genotypes selected from preliminary screening of twenty-four genotypes were planted in randomized block design with three checks ICC 3137 (susceptible check), ICCL 86111 (resistant check) and PG 186 (local check), for confirmation of resistance. The observations recorded were presented in Table 3 and Table 4.

Number of eggs and larvae per plant

During the vegetative stage, the lowest mean egg population per plant was recorded on IG2020-16 (0.47), while the highest was noted on CSJK- 132. In comparison, the susceptible check ICC 3137 had 1.47 eggs, the resistant check 0.47 eggs, and the local check PG 186 had 1.40 eggs per plant. The larval population per plant during the vegetative stage varied from 0.6 on IG2020-16 to 1.53 on GJG 1917, compared to 0.47 on the susceptible check ICC 3137 and 1.4 on the resistant check ICCL 86111.

At the 50% flowering stage, the lowest egg population per plant was 0.47 on IG2020-16 and highest egg count of 1.73 was observed on CSJK- 132 as compared to the susceptible check ICC 3137 (2.07), the resistant check ICCL 86111 (1.33), and the local check PG 186 (2.00). The larval population/plant ranged significantly from a low of 1.17 on NBeG 506, to a high of 1.94 on GL 18149, compared to 2.24 on the susceptible check ICC 3137, 1.49 on the resistant check ICCL 86111, and 1.21 on the local check PG 186.

During the 50% pod maturity stage, the egg population/plant ranged from a low of 1.73 on IG 21-03 to a high of 10.27 on NBeG 506, compared to 6.53 on the susceptible check ICC 3137, 2.93 on the resistant check ICCL 86111, and 5.2 on the local check PG 186. The larval population increased across all genotypes at this stage and varied significantly from a low of 0.87 larvae per plant on IG 21-03, and highest of 4.80 larvae per plant on GNG 2557, compared to 4.47 on the susceptible check ICC 3137, 1.87 on the resistant check, and 3.07 on the local check PG 186. The current findings are consistent with those of Ramegowda *et al.* (2007) [16], who observed the lowest larval counts per plant in genotypes P-1772B, Phule-G-95412, and BGD-103, with values of 1.16, 1.32, and 1.38, respectively. Conversely, the highest larval infestations were recorded on genotypes BGD-245, GNG-1000, and GBS-963. These results are further corroborated by the studies of Deshmukh *et al.* (2010) [4] and Chandra and Nanda (2013) [12].

Percent pod damage and Pest Resistance Susceptible Rating

The percentage of pod damage varied significantly, ranging from 44.72 to 93.74%. The lowest pod damage (Table 4) was recorded in NBeG 506 (44.72%), followed by CSJK-132 (58.97%). Conversely, the highest pod damage was observed in CSJ 138 (93.74%), followed by GJG 1810 (92.15%), compared to the susceptible check ICC 3137 (89.64%), the resistant check ICCL 86111 (42.91%), and the local check PG 186 (63.41%). The current investigation results are in agreement with Gowda *et al.* (2005) [7], who identified significantly lower pod damage percentages of 11.86% and 10.84% on BGD-237, while the highest pod damage percentages were observed on JAKI-5226 and BK-36, comparable to H-82-2, OLS-8663, ICC-11322, ICC-90039, KW-104, PHULE 0954198, GBS-963, ICC-438, and Annigeri-1. These findings are also consistent with the studies of Hossain *et al.* (2008) [8] and Shafique *et al.* (2009) [23]. Similarly, Jaba *et al.* (2017) [9] reported mean pod damage percentages ranging from 68.49% to 100%.

PRSR obtained between 3 and 4 by comparing pod damage of test genotypes with susceptible check ICC3137 (Table 4). Out of twelve test genotypes, one genotype NBeG 506 recorded PRSR rating of 3 resistant which were at par with resistant check ICCL 86111. Whereas CSJK- 132 and IG 21-03 have recorded PRSR rating 4 as compared with susceptible check ICC 3137 recorded PRSR rating 6. The current research findings align with those of Sanap and Jamadagni (2005) [19] regarding *H. armigera* in chickpea.

Grain yield

The grain yield in genotypes varied between 515.16 kg/ha and 1066.67kg/ha. NBeG 506 recorded the highest yield (1066.67kg/ha) and the lowest yield was observed in CSJ 138 (515.16 kg/ha), followed by Phule G 171313 (560 kg/ha), compared to the susceptible check ICC 3137 (404.44

kg/ha), the resistant check ICCL86111 (1186 kg/ha), and the local check PG 186 (822.22 kg/ha). (Table 4)

The current findings are consistent with Chandra and Nanda (2013) [2], who reported the highest yields of 14.73 and 14.45 quintals per hectare from GNG-1488 and RSG-931, respectively. These genotypes exhibited the least susceptibility, while the lowest yields of 11.04 and 12.70 quintals per hectare were observed in BG-256 and RSG-895, respectively, which were highly susceptible to *H. armigera* and are in close agreement with Mansour and Mohammad (2014) [1], who reported that the Hawata cultivar produced the highest seed yield at 1482 kg/ha, followed by Atmore with 1276 kg/ha, and Shandi with 1246 kg/ha.

Principal component analysis and correlation coefficients matrix analysis

The principal component analysis resulted in the grouping of the test genotypes into different categories (Fig. 1). Among the twelve genotypes evaluated, the source exhibiting resistance to the gram pod borer, *H. armigera* was analysed in relation to pod damage and yield outcomes. NBeG 506 and ICCL 86111 are grouped under the category of resistant, while CSJK-132, IG 21-03, and PG-186 were placed under moderately resistant. This indicates a significant variation in the genotypes exhibiting resistance to *H. armigera*. While genotypes depicted moderately susceptible were GNG 2557 and CSJ 138 as compared to ICC 3137, which is a susceptible check. The PCA analysis revealed that the first principal component (PC1) captures 99.644% of the variance and is primarily associated with yield (Y/HA).

The second principal component (PC2) captures 0.332% of the variance and is primarily associated with percent pod damage (PDP). Genotypes with high positive scores on PC1, such as ICCL 86111 and NBeG 506, exhibit higher yields. Genotypes with high negative scores on PC2, such as GJG

1810 and IG2020-16, exhibit lower pod damage. Based on the analysis, NBeG 506 stands out as the best cultivar with both high yield and low pod damage. The research carried out by Jaba *et al.* (2017) [9] also demonstrated that Principal Component Analysis revealed three distinct groups among chickpea genotypes, demonstrating significant differences in resistance to the pod borer, *H. armigera*. ICCV 92944, ICCV 097105, and PG 186 shown significant resistance and were categorised collectively. Moderate resistance had been noticed in ICCV 10, ICCL 86105, and ICCL 86111, constituting an additional group. Susceptible genotypes, such as ICC 3137 and LL 550, were categorised into a distinct group.

The correlation matrix analysis for promising chickpea genotypes provides relationships between DF-days to 50% flowering, ECV- Egg counts at vegetative stage, ECF-Egg counts at flowering stage, ECV- Egg counts at podding stage, LCV-larval counts at vegetative stage, LCF-larval counts at flowering stage, LCP -larval counts at podding stage, PDP-pod damage percent, Y/HA- Yield kg per Hectare influencing resistance to the pod borer, *H. armigera* (Fig. 2).

Results of the correlation coefficient matrix indicated that the percent pod damage was positively correlated to larval count at flowering and podding stages while negatively correlated at vegetative stage. The percent pod damage was also found positively correlated to egg count at flowering stage and negatively correlated at vegetative and podding stage. The number of days to 50% flowering was positively correlated with larval count at vegetative stage and percent pod damage. In Matrix, strong negative correlation between pod damage and yield, reinforcing that higher pod damage results in lower yields. These correlations highlight critical factors in chickpea resistance to *H. armigera*. Therefore, correlation highlights and PCA analysis provide a basis for selecting genotype for breeding programs aimed at improving resistance and yield under field conditions.

Table 1: Preliminary screening of chickpea genotypes against *H. armigera* during 2022-23

S. No.	Genotypes	50% flowering	Vegetative Stage		%50 Flowering		Podding Stage	
			Egg/plant	Larva/plant	Egg/plant	Larva/plant	Egg/plant	Larva/plant
1.	BG4029	82	0.72±0.26bc	2.67±0.18abcd	0.53±0.07bc	4.87±0.07bcde	1.33±0.44ab	5.73±0.52hi
2.	NBeG 506	84	0.87±0.35bc	0.56±0.24d	1.07±0.57abc	3.53±0.67de	0.67±0.07ab	4.73±0.52kl
3.	IG 2021-01	82	0.87±0.35bc	4.27±0.77ab	0.60±0.23abc	6.93±1.57abc	0.93±0.35ab	3.27±0.77p
4.	GNG 2562	84	1.29±0.68bc	2.53±0.93bcd	0.87±0.48abc	3.13±0.57de	1.00±0.35ab	4.13±0.52mn
5.	GL 13001(Ch.)	86	1.27±0.66bc	2.73±1.33abcd	1.27±0.55 abc	3.20±0.50de	1.00±0.35ab	3.53±0.52op
6.	JAKI 9218(Ch.)	84	0.91±0.39bc	2.27±0.47bcd	0.67±0.07 abc	4.73±0.35bcde	0.80±0.20ab	5.13±0.52jk
7.	GJG 1913	82	2.64±1.26a	2.87±1.10abcd	0.93±0.37 abc	2.07±0.47e	1.00±0.20ab	4.53±0.52lm
8.	GL 18149	78	1.13±0.59bc	2.07±0.33bcd	0.60±0.40 abc	2.07±0.07e	0.93±0.29ab	5.73±0.52hi
9.	JG 16(Ch.)	82	1.38±0.71bc	2.73±1.17abcd	0.53±0.07 bc	2.87±0.64de	0.47±0.18ab	3.73±0.52no
10.	GJG 1810	84	1.20±0.61bc	0.60±0.12d	0.73±0.24abc	3.53±0.33de	0.60±0.50ab	4.73±0.52kl
11.	Phule G 181609	84	1.56±0.68bc	1.73±0.58bcd	0.47±0.13bc	4.60±0.50bcde	0.67±0.18ab	7.53±0.52d
12.	GJG 1917	82	0.71±0.31b	3.13±0.71abcd	0.40±0.20c	4.13±1.44cde	0.80±0.35ab	6.13±0.52gh
13.	KCMH420-17	86	0.80±0.31bc	3.07±1.07abcd	1.00±0.40abc	3.67±0.74cde	0.87±0.24ab	3.93±0.52no
14.	PG 296	82	1.36±0.64bc	2.53±0.88bcd	1.67±0.79ab	4.13±0.48cde	0.73±0.24ab	4.13±0.52mn
15.	CSJK- 132	82	0.53±0.43bc	2.27±0.71bcd	0.33±0.07c	9.33±2.49a	0.87±0.07ab	5.73±0.52hi
16.	RVSSG-107	84	1.20±0.53bc	1.53±0.37cd	0.47±0.07bc	3.33±0.13de	0.67±0.18ab	8.13±0.52c
17.	NBeG 1532	82	1.04±0.42bc	2.33±0.18bcd	0.73±0.07abc	3.00±0.64de	0.40±0.31b	5.93±0.52gh
18.	IG2020-16	82	0.71±0.37bc	2.67±0.84abcd	0.53±0.18bc	3.80±1.33cde	0.67±0.37ab	5.33±0.52ij
19.	IG 21-03	82	1.38±0.93bc	2.93±1.52abcd	1.80±0.70a	4.67±0.82bcde	0.87±0.18ab	6.33±0.52fg
20.	JG 2021-69	79	0.96±0.45bc	1.80±0.23bcd	1.20±0.70abc	5.53±1.22bcd	0.80±0.35ab	10.13±0.52b
21.	GNG 2557	82	1.13±0.48bc	3.07±0.68abcd	0.87±0.27abc	4.80±0.60bcde	0.93±0.07ab	6.73±0.52ef
22.	Phule G 201114	82	0.24±0.18c	2.07±0.74bcd	0.47±0.18bc	3.80±0.90cde	1.47±0.37a	7.53±0.52d
23.	Phule G 171313	84	0.82±0.51bc	2.67±0.75abcd	0.33±0.07c	4.40±1.36cde	1.00±0.35ab	5.13±0.52jk
24.	CSJ 138	84	1.24±0.80bc	2.00±1.06bcd	0.60±0.00abc	5.87±1.27bcd	0.80±0.12ab	7.13±0.52de
25.	ICCL 86111	86	0.67±0.29bc	3.00±0.92abcd	0.73±0.33abc	7.67±0.52ab	0.53±0.33ab	8.33±0.52c
26.	ICC 3137	80	1.38±0.93bc	5.27±0.57a	0.87±0.07abc	3.73±1.07cde	0.87±0.07ab	11.53±0.52a
27.	PG-186	84	0.93±0.37bc	3.60±1.30abc	1.00±0.31abc	4.33±1.18cde	1.07±0.37ab	3.13±0.70p

Data represent the value is an average of 3 replicates ± SE, figures not sharing the same letters in column differ significantly at $p \leq 0.05$ level of probability. Means followed by same letters in a column are non-significantly different at 5% probability level.

Table 2: Pod damage percentage (%), PRSR and yield of different chickpea genotypes during 2022-23

S. No.	Genotypes	% Pod damage	PRSR	Category	Yield (kg/ha)
1.	BG4029	84.73±5.05bcdef	6	Equal to susceptible check	885.85±54.96bcdefgh
2.	NBeG 506	36.57±7.52h	3	Resistant	1245.50±60.07bc
3.	IG 2021-01	93.38±1.73ab	6	Equal to susceptible check	430.68±55.06ij
4.	GNG 2562	93.67±1.35ab	6	Equal to susceptible check	450.18±61.98hij
5.	GL 13001(Ch.)	86.38±1.76abcdef	6	Equal to susceptible check	577.13±85.06fghij
6.	JAKI 9218(Ch.)	88.37±2.77abcd	6	Equal to susceptible check	639.98±55.61fghij
7.	GJG 1913	63.84±4.34g	4	Moderately Resistant	883.73±55.97bcdefgh
8.	GL 18149	66.42±2.92g	4	Moderately Resistant	894.22±41.27bcdefg
9.	JG 16(Ch.)	85.34±3.34bcdef	6	Equal to susceptible check	615.38±59.53fghij
10.	GJG 1810	66.87±5.41g	4	Moderately Resistant	659.82±65.23efghij
11.	Phule G 181609	78.97±0.95def	5	Intermediate	612.93±92.29fghij
12.	GJG 1917	66.85±1.45g	5	Intermediate	775.38±130.07efghij
13.	KCMH420-17	81.12±2.92cdef	6	Equal to susceptible check	883.44±176.99bcdefgh
14.	PG 296	82.99±4.41cdef	6	Equal to susceptible check	922.76±29.95bcdef
15.	CSJK- 132	43.80±0.38h	3	Resistant	213.29±251.12bcd
16.	RVSSG-107	95.61±0.64a	6	Equal to susceptible check	372.45±60.83j
17.	NBeG 1532	78.07±0.80ef	5	Intermediate	1087.96±90.72bcde
18.	IG2020-16	62.31±4.07g	4	Moderately Resistant	786.36±180.72efghij
19.	IG 21-03	42.81±2.03h	3	Resistant	710.99±603.44a
20.	JG 2021-69	87.68±0.76abcde	6	Equal to susceptible check	807.94±73.44defghij
21.	GNG 2557	90.05±1.02abc	6	Equal to susceptible check	870.84±26.87cdefgh
22.	Phule G 201114	76.94±0.57f	5	Intermediate	518.77±54.12fghij
23.	Phule G 171313	64.07±3.49g	4	Moderately Resistant	732.44±59.56efghij
24.	CSJ 138	92.97±0.62ab	7	Moderately susceptible	473.87±72.08ghij
25.	ICCL 86111	42.50±2.95h	3	Resistant	1300.67±27.21b
26.	ICC 3137	89.70±0.83abc	-	Susceptible	454.84±75.13hij
27.	PG-186	64.10±4.24g	4	Moderately Resistant	828.13±51.23cdefghi

Data represent the value is an average of 3 replicates $\pm$ SE, figures not sharing the same letters in column differ significantly at $p \leq 0.05$ level of probability. Means followed by same letters in a column are non-significantly different at 5% probability level. PRSR- Pest Resistance Susceptible Rating

Table 3: Confirmation of resistance in promising chickpea genotypes against *H. armigera* during 2023-24

S. No.	Genotypes	50% flowering	Vegetative Stage		%50 Flowering		Podding Stage	
			Egg/plant	Larva/plant	Egg/plant	Larva/plant	Egg/plant	Larva/plant
1.	NBeG 506	86	1.13±0.07abc	1.07±0.07ab	0.80±0.35ab	1.17±0.20b	10.27±5.17a	2.07±0.77abc
2.	GJG 1913	86	0.67±0.07bc	0.80±0.31ab	1.00±0.50ab	1.63±0.32ab	8.40±3.41ab	4.40±0.90ab
3.	GL 18149	84	1.07±0.13abc	0.67±0.41ab	0.73±0.24ab	1.94±0.25ab	3.20±1.14ab	1.33±0.59bc
4.	GJG 1810	88	0.40±0.20c	1.27±0.24ab	1.00±0.12ab	1.66±0.27ab	1.87±0.48b	2.00±0.70abc
5.	GJG 1917	89	0.67±0.27bc	1.53±0.85a	1.20±0.46ab	1.49±0.82ab	3.07±1.56ab	2.27±1.23abc
6.	KCMH420-17	86	0.53±0.07c	0.80±0.00ab	1.47±0.71ab	1.60±0.10ab	4.13±0.84ab	3.13±0.90abc
7.	CSJK- 132	84	1.47±0.47a	0.87±0.24ab	1.73±0.41ab	1.54±0.14ab	8.33±4.12ab	3.87±0.13abc
8.	IG2020-16	88	0.47±0.27c	0.60±0.23ab	0.47±0.29b	1.31±0.16ab	7.13±2.25ab	2.67±1.47abc
9.	IG 21-03	86	0.58±0.10c	1.33±0.07ab	1.00±0.2ab	1.92±0.22ab	1.73±1.03b	0.87±0.57c
10.	GNG 2557	84	1.07±0.37abc	0.93±0.13ab	1.27±0.29ab	1.46±0.09ab	7.47±1.34ab	4.80±1.97a
11.	Phule G 171313	86	0.80±0.23abc	0.93±0.18ab	0.60±0.20ab	1.83±0.31ab	2.07±1.47b	2.67±0.57abc
12.	CSJ 138	86	0.67±0.18bc	1.00±0.42ab	1.00±0.12ab	1.70±0.21ab	3.93±1.23ab	1.40±0.58bc
13.	ICCL 86111	82	0.47±0.07c	1.40±0.31ab	1.33±0.66ab	1.49±0.15ab	2.93±0.52ab	1.87±0.52abc
14.	ICC 3137	84	1.47±0.44a	0.47±0.18b	2.07±0.59a	2.24±0.22a	6.53±3.12ab	4.47±0.70ab
15.	PG-186	86	1.40±0.12b	0.87±0.27ab	2.00±0.50a	1.21±0.12b	5.20±1.03ab	3.07±0.77abc

Data represent the value is an average of 3 replicates $\pm$ SE, figures not sharing the same letters in column differ significantly at $p \leq 0.05$ level of probability. Means followed by same letters in a column are non-significantly different at 5% probability level.

Table 4: Percent Pod damage, PRSR and yield of different chickpea genotypes during 2023-24

S. No.	Genotypes	% Pod damage	PRSR	Category	Yield(kg/ha)
1.	NBeG 506	44.72±0.29g	3	Resistant	1066.67±55.51ab
2.	GJG 1913	77.05±0.20c	5	Intermediate	653.33±30.79ef
3.	GL 18149	69.73±0.40d	5	Intermediate	684.44±42.40def
4.	GJG 1810	92.15±0.09a	6	Equal to susceptible check	991.11±164.62bc
5.	GJG 1917	67.97±0.74d	5	Intermediate	617.78±8.89f
6.	KCMH420-17	81.70±1.29b	6	Equal to susceptible check	626.67±20.37f
7.	CSJK- 132	58.97±0.43f	4	Moderately Resistant	991.11±83.03bc
8.	IG2020-16	77.56±1.35c	5	Intermediate	853.33±75.82cd
9.	IG 21-03	66.49±3.69de	4	Moderately Resistant	840.00±73.43cd
10.	GNG 2557	89.83±0.36a	7	Moderately susceptible	915.56±23.52bc
11.	Phule G 171313	69.53±3.33d	5	Intermediate	560.00±30.79fg
12.	CSJ 138	93.74±0.20a	7	Moderately susceptible	515.56±23.52fg
13.	ICCL 86111	42.91±2.00g	3	Resistant	1186.67±48.07a
14.	ICC 3137	89.64±0.86a	-	Susceptible	404.44±43.77g
15.	PG-186	63.41±0.70e	4	Moderately Resistant	822.22±19.37cde

	DF	ECV	ECF	ECP	LCV	LCF	LCP	PDP	Y/HA
DF	1								
ECV	-0.409	1							
ECF	-0.367	0.591*	1						
ECP	-0.144	0.504	0.147	1					
LCV	0.218	-0.466	-0.134	-0.462	1				
LCF	-0.248	0.056	0.092	-0.417	-0.239	1			
LCP	-0.212	0.463	0.486	0.608*	-0.508	-0.027	1		
PDP	0.286	-0.142	0.024	-0.142	-0.352	0.422	0.283	1	
Y/HA	-0.223	-0.103	-0.083	0.181	0.423	-0.600*	-0.165	-0.584*	1

DF-days to 50% flowering, ECV- Egg counts at vegetative stage, ECF-Egg counts at flowering stage, ECV- Egg counts at podding stage, LCV-larval counts at vegetative stage, LCF-larval counts at flowering stage, LCP -larval counts at podding stage, PDP-pod damage percent, Y/HA- Yield kg per Hectare. *-significant at $p \leq 0.05$

Fig 1: Correlation coefficients of *H. armigera* larvae infestation at vegetative, flowering, podding, pod damage percent, yield.

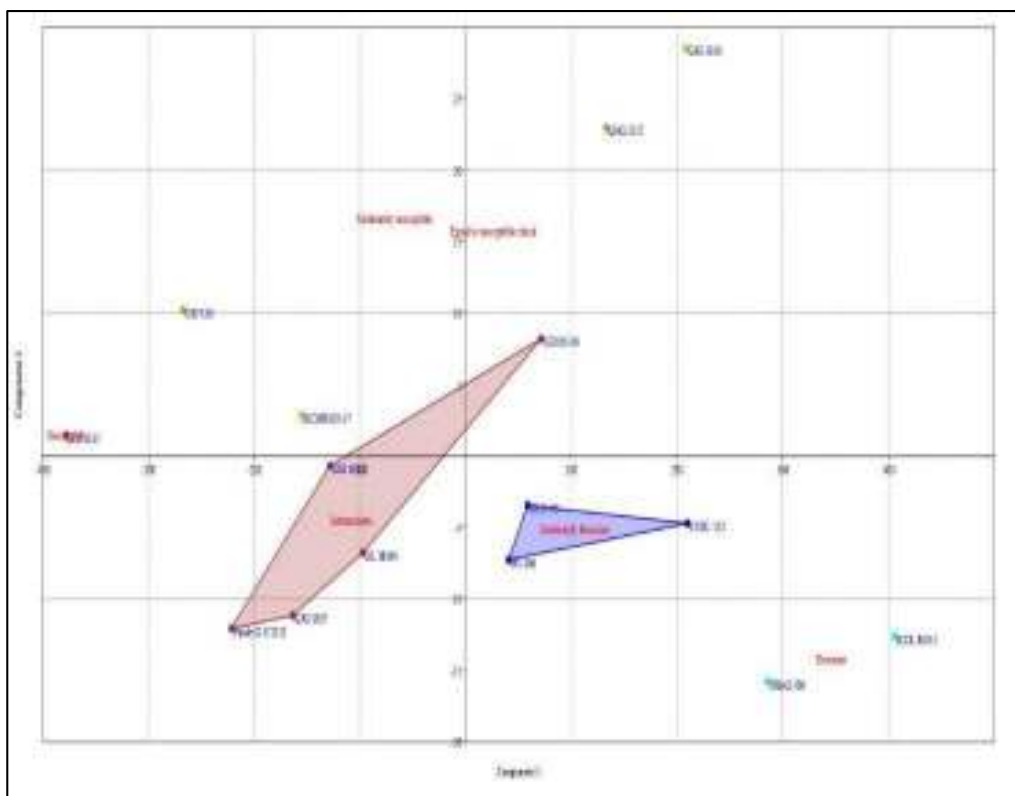


Fig 2: Principal component analysis of 12 promising genotypes of chickpea based on per cent pod damage and grain yield (kg/ha) under field conditions.

Conclusions

Host plant resistance is a very effective and promising strategy for managing pod borer populations in chickpea cultivation systems. This research showed that *H. armigera* infestation significantly varied among different genotypes, which in turn affected chickpea yield. Varieties with higher *H. armigera* populations showed more damaged pods. Additionally, environmental factors played a significant role in the population dynamics of this pest on chickpea crops. The study concluded that based on lower egg laying, larval population, percent pod damage, and PRSR values, the genotypes NBeG 506, CSJK- 132, IG 21-03 were found to be the least preferred by *H. armigera*. Therefore, they could serve as a source of resistance for developing chickpea varieties resistant to *H. armigera*. These findings observed differences in relative resistance to pod borer populations across the evaluated genotypes. Pest-resistant genotypes may be adapted to their specific environmental conditions, offering targeted, persistent protection while conserving beneficial species. Furthermore, these characteristics must be integrated into chickpea breeding programs in

accordance with modern ecological and consumer requirements for safer and more sustainable farming methods. Understanding the importance of chickpea genotypes for the integrated management of *H. armigera*, we advise farmers to use authorized resistant cultivars and to include these qualities into future breeding plans.

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