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Response Evaluation of Chickpea Genotypes for Resisting *Helicoverpa armigera* (Hub) Throughout Growing Season & Correlating with Yield Parameter

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Abstract— *An investigation was worked out at the experimental Research Farm of the Department of Agricultural Entomology, VNMKV, Parbhani during Rabi, 2022 expecting resistive outcomes from responses of chickpea genotypes against gram pod borer (Helicoverpa armigera Hub.) for eggs and larval population including pod damage per cent from vegetative to maturity stage during growing meteorological weeks (MW). The correlation of the screening parameter with yield has also been calculated. The mean eggs, larval infestation and pod damage per cent of gram pod borer, H .armigera on genotypes under study is presented in the present investigation. It is found that on genotypes indicated significant differences regarding eggs, larval population and pod damage of H. armigera. The mean no. of eggs was reported on genotypes ICCL 86111 (0.24 eggs/plant). The least larval population was reported on genotypes ICCL 86111 (0.51 larvae/plant). The genotype ICCL 86111 had the least pod damage, 3.36 per cent and ICC 506 was (3.93 per cent) also fairly compatible genotype in this regard followed by BDNG 797 (4.26 per cent), ICC 92944 (5.46 per cent), ICCV 10 (5.88 per cent) and JG 62 (7.15 per cent) respectively. The chickpea yield showed significant correlation in negative manner with mean pod damage per cent (r = -0.774). Significantly Negative correlation was found with morning relative humidity with pest incidence in the genotypes viz., BDNG 797 and ICCL 86111.*

Keywords— ***Insect Ecology, Helicoverpa armigera, Eco-friendly, Host plant resistance, Pod damage, chickpea;***

I. INTRODUCTION

Chickpea (*Cicer arietinum* L.), being primary pulse crop of the Fabaceae family and often known as “Bengal gram” and locally as "chana." As a superior and less expensive source of protein than meat, chickpeas are locally referred to as "poor man's meat". Through biological nitrogen fixation of up to 140 kg of atmospheric nitrogen ha-1 year-1 ultimately preserves soil fertility. During the 2020–2021 growing season in Maharashtra, chickpeas were grown over an area of 16.94 lac/ha, yielding 13.97 lakh tonnes and 824 kg/ha of productivity. Production and productivity in the Marathwada region are 10.59 lakh/ha, 7.76 lakh tonnes and 707 kg/ha, respectively [1]. One of the most significant obstacles to the production of chickpeas worldwide is the chickpea pod borer (*H. armigera*). It infects more than 182 different crop types and is a serious pest. There is a large population of *H. armigera* throughout Asia, Africa, Australia, and Southern Europe [20]. *Helicoverpa armigera* affects chickpea from the early vegetative until podding stage, causing 60–80% of crop losses in Maharashtra state (India) [16]. The current research work was designed based on current hypotheses of *H. armigera* issue and the finding of pod borer (*H. armigera*) contesting genotypes of chickpea. Germplasm accessions have low to moderate levels of resistance to *H. armigera*. This has made it necessary to choose genotypes

with a higher capacity to withstand or regenerate from pod damage [13]. This promising method of pest management is even environmentally beneficial due to screening under natural environmental conditions and ultimately host plant resistance was evaluated. The researchers may use this data to adopt efficient and environmentally friendly chickpea genotypes and management strategies for this pest.

II. MATERIAL AND METHODS

Genotypes (ten) of chickpea with diverse growth habits were selected for their reaction to *H. armigera* under the screening studies. These genotypes were acquired from the Agriculture Research Station in Badnapur, VNMKV Parbhani (MH). viz., JG-11, JG 62, ICC 92944, BDNG-797, KAK 2 (Kabuli), ICCL-86111(R), ICC 506, ICCV 3137 (S), BDNGK-798 (Kabuli) and ICCV 10. The experiment was conducted at the experimental farm of the Department of Agricultural Entomology, VNMKV, Parbhani during Rabi 2021-22 under randomized block design (RBD) with three replications. The seeds were sown by dibbling during the 47 Meteorological week (25 Nov.). The standard dose of fertilizer was applied to all genotype tested for well growth. Other than that no other chemicals were sprayed. Three times hand weeding was done. Every plant of test genotype from each replication underwent weekly observations for the egg and larvae of *H. armigera* from 50 MW to 7 MW (Meteorological weeks) of *Rabi* 2021-22. The larvae of this insect pest rupture pods and penetrate into the pod and fed within, making seed unsuitable for human consumption [5]. To evaluate this effect of *H. armigera*, from pod initiation till plant harvest pod damage was monitored on every genotype. For estimation of pod damage per cent, from pod initiation until harvesting no. of healthy and injured pods per plant was recorded and the calculated per cent pod damage [6].

$$\text{Pod damage (\%)} = \frac{\text{No. of damaged pods}}{\text{Total no. of pods}} \times 100$$

Accordingly, from vegetative, flowering and pod formation stages of test genotypes of chickpea their mean no. of eggs and larvae including the percentage of pod damage throughout the season presented here.

Yield correlation:

Significant positive correlation examined between detrimental association of grain production/plant i.e., Yield and the no. of eggs and larva [8]. Thus correlation coefficient (r) was worked out between of *H. armigera* incidence with an average yield of chickpea. [10, 15, 19].

III. RESULTS AND DISCUSSION

Screening evaluation of ten chickpea genotypes in field for occurrence of eggs, larval population and pod damage per cent due to *H. armigera* under pesticide free condition was done during Rabi season of 2021-22.

3.1 Eggs of *H. armigera* on different chickpea genotypes during growing MW.

The information on eggs population of gram pod borer, *H. armigera* on different chickpea genotypes under study during 50 MW, 51 MW, 52 MW, 4 MW and 7 MW is presented in Table 1 and depicted in figure 1.

Table 1: Eggs population of H. armigera during 50, 51, 52, 4 and 7 Met. Week on chickpea genotypes.

Genotypes	No. of Eggs of *H.armigera*/plant				
	50 MW	51 MW	52 MW	4 MW	7 MW
JG-11	**0.59 (0.95)**	**0.30 (1.01)**	**0.15 (0.72)**	**0.77 (1.30)**	**0.83 (1.34)**
ICC 92944	**0.63 (1.10)**	**0.34 (1.10)**	**0.19 (0.80)**	**0.63 (1.26)**	**0.70 (1.29)**
KAK 2 (Kabuli)	**0.85 (1.17)**	**0.47 (1.20)**	**0.13 (0.68)**	**0.37 (1.16)**	**0.43 (1.20)**
ICC 506	**0.60 (0.92)**	**0.20 (1.10)**	**0.12 (0.65)**	**0.11 (1.05)**	**0.18 (1.09)**
BDNG-798 (Kabuli)	**1.00 (1.25)**	**0.57 (1.27)**	**0.26 (0.90)**	**0.79 (1.32)**	**0.86 (1.35)**
JG 62	**0.76 (1.04)**	**0.32 (1.04)**	**0.19 (0.78)**	**0.53 (1.22)**	**0.60 (1.25)**
BDNG-797	**0.83**	**0.40**	**0.16**	**0.19**	**0.26**

	(1.13)	**(1.13)**	**(0.75)**	**(1.08)**	**(1.12)**
ICCL-86111	**0.40 (0.86)**	**0.13 (0.92)**	**0.11 (0.57)**	**0.29 (1.13)**	**0.35 (1.16)**
ICC 3137	**1.10 (1.41)**	**0.70 (1.30)**	**0.27 (0.92)**	**1.23 (1.45)**	**1.30 (1.49)**
ICCV 10	**1.00 (1.25)**	**0.68 (1.29)**	**0.13 (0.67)**	**0.34 (1.15)**	**0.41 (1.18)**
SE(M)	**0.07**	**0.06**	**0.059**	**0.07**	**0.07**
CD @ 5%	**0.22**	**0.18**	**0.173**	**0.21**	**0.21**
CV %	**10.55**	**8.86**	**9.361**	**10.12**	**9.86**

Parenthesis figures of eggs population are √x+0.5

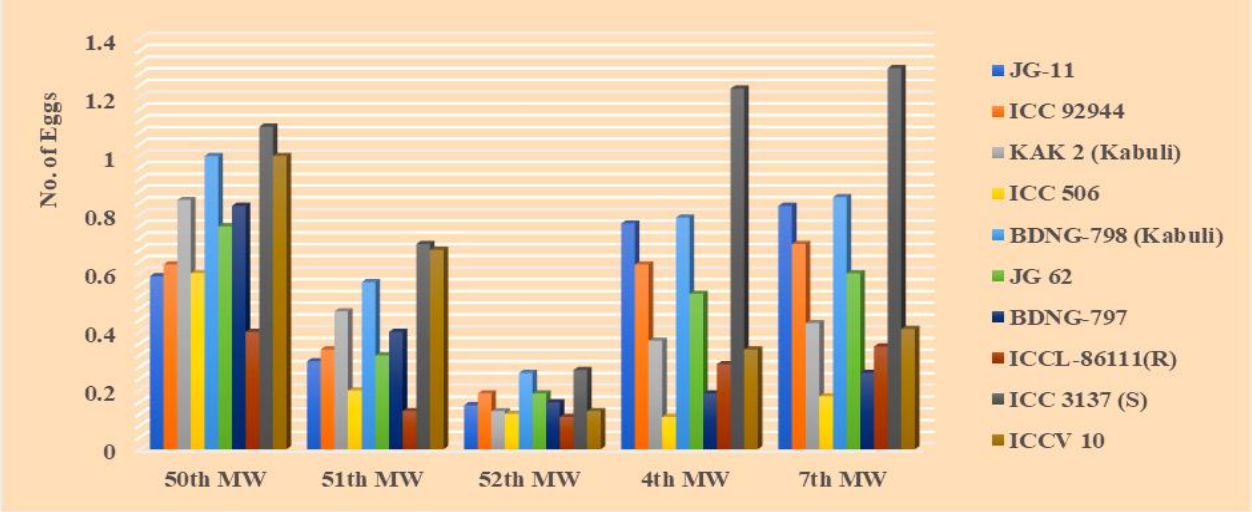

Fig.1: Eggs population of H. armigera during 50, 51, 52, 4 and 7 Met. week on chickpea genotypes.

The data revealed significant differences (Table 1; figure 1) among the genotypes regarding egg population of *H. armigera*. The eggs population per plant appeared in different parallel ranges of 0.40 to 1.10 eggs/plant, 0.13 to 0.70 eggs/plant, 0.11 to 0.27 eggs/plant, 0.11 to 1.23 eggs/plant and 0.18 to 1.30 eggs/plant respectively during five MW. This result coincides with reference research where 9 chickpea genotypes against *H. armigera* evaluated and the no. of eggs of *H. armigera* on different genotypes varied from 2.30 to 15.74 eggs and lowest oviposition was recorded on Genotype 5282. [4] ICCL 86111 performed well with the least no. of eggs reported during 50, 51 and 52 MW (0.40 eggs/plant, 0.13 eggs/plant and 0.11 eggs/plant respectively. After that during the 4 and 7 MW ICC 506 showed a least population of eggs viz., 0.11 eggs/plant and 0.18 eggs/plant respectively. ICC 3137 showed the highest level of eggs population appearance 11.10 eggs/plant, 0.70 eggs/plant, 0.27 eggs/plant, 1.23 eggs/plant and 1.30 eggs/plant during five weeks of observation respectively. During 50 MW JG 11 (0.59 eggs/plant) followed after ICC 506 (0.60 eggs/plant) and JG 62 (0.76 eggs/plant) performed at par with ICCL 86111. During 51 MW ICC 506 (0.20 eggs/plant) followed by JG 11 (0.30 eggs/plant), JG 62 (0.32 eggs/plant) and ICC 92944 (0.34 eggs/plant) were found statistically significant and at par with well-performing genotypes. 52 MW showed that ICC 506, KAK 2, ICCV 10 and JG 11 i.e., 0.12, 0.13, 0.13 and 0.15 eggs/ plant significantly at par with ICCL 86111. During the 4 MW BDNG 797 (0.19 eggs/plant) followed by ICCL 86111 (0.29 eggs/plant), ICCV 10 (0.34 eggs/plant) and KAK 2 (0.37 eggs/plant) performed well after ICCL 86111. [23] After evaluating 31 genotypes in the field for 100 days after germination showed the quantity of eggs/plants ranged highest in ICC 3137 (5.1 eggs/plants) among others. [22] This had also been discovered that the genotypes ICC-3137, K-850, and ICC-1403 were more defenseless and have privileged more eggs laying Ultimately during 7 MW BDNG 797 (0.26 eggs/plant) followed by ICCL 86111 (0.35 eggs/plant), ICCV 10 (0.41 eggs/plant), KAK 2 (0.43 eggs/plant) and JG 62 (0.60 eggs/plant) performed better for further recommendation.

3.2 Larval population of *H. armigera* on different chickpea genotypes throughout growing MW.

Larval population of borer catterpiller, on different chickpea genotypes were undertook for study throughout plant growing ten weeks (50 MW to 7 MW) showed here (Table 2 and depicted in figure 2). The figures revealed significant differences among the genotypes regarding larval population of *H. armigera*. The no. of larvae per plant of *H. armigera* during ten experimental MW appeared in different parallel ranges of 0.66 to 1.11 larvae / plant, 0.26 to 0.80 larvae / plant, 0.18 to 0.91 larvae / plant, 0.26 to 0.98 larvae / plant, 0.58 to 1.50 larvae / plant, 0.41 to 1.54 larvae per plant, 0.65 to 1.77 larvae / plant, 0.83 to 1.63 larvae / plant, 0.80 to 2.03 larvae / plant and 0.99 to 1.99 larvae / plant respectively on the chickpea genotypes under study. The result coincides with BG-372, HC-1, SAKI-9516, Vijay and Avrodhi were relatively less susceptible as these harbored lower larval population (1.07 to 1.32 larvae/plant) [7]. The lowest no. of larvae during 50, 51, 52, 2, 3, 6 MW recorded on genotypes ICCL 86111 (0.66 larvae/plant, 0.26 larvae/plant, 0.18 larvae/plant, 0.58 larvae/plant, 0.41 larvae/plant and 0.80 larvae/ plant respectively). ICC 506 during 4, 5 and 7 MW showed 0.65 larvae/plant, 0.83 larvae/plant and 0.80 larvae/ plant respectively. But during 1 MW least larval population was reported on genotypes ICC 92944 (0.26 larvae/plant) [12] Equivalent results were obtain according resistant genotype C 235 showed lowest larvae population (0.5/10 plants) and utmost no. of larvae (3.0/10 plants) and susceptible genotype H 82-2.

Table 2. Larval population of H. armigera on chickpea genotypes during growing meteorological weeks.

Genotype	No. of larval population of *H.armigera*/plant during MW									
	50 MW	**51 MW**	**52 MW**	**1 MW**	**2 MW**	**3 MW**	**4 MW**	**5 MW**	**6 MW**	**7 MW**
JG-11	0.76 (1.01)	0.77 (1.32)	0.42 (1.15)	0.90 (1.23)	1.20 (1.59)	1.24 (1.63)	1.43 (1.55)	1.57 (1.59)	1.63 (1.68)	1.63 (1.70)
ICC 92944	0.88 (1.12)	0.38 (1.11)	0.44 (1.16)	0.26 (1.00)	0.84 (1.41)	0.88 (1.43)	0.96 (1.39)	1.10 (1.43)	1.16 (1.45)	1.17 (1.45)
KAK 2 (Kabuli)	0.92 (1.15)	0.49 (1.20)	0.61 (1.28)	0.70 (1.30)	0.87 (1.40)	0.91 (1.47)	0.90 (1.36)	1.03 (1.40)	1.10 (1.43)	1.11 (1.43)
ICC 506	0.86 (0.98)	0.31 (1.06)	0.38 (1.12)	0.57 (1.11)	0.64 (1.17)	0.68 (1.21)	0.65 (1.25)	0.83 (1.32)	1.00 (1.38)	0.99 (1.38)
BDNG-798 (Kabuli)	1.05 (1.29)	0.76 (1.30)	0.67 (1.32)	0.83 (1.23)	1.28 (1.63)	1.32 (1.67)	1.53 (1.59)	1.67 (1.63)	1.73 (1.65)	1.74 (1.65)
JG 62	0.89 (1.09)	0.50 (1.28)	0.56 (1.25)	0.77 (1.34)	0.95 (1.45)	0.99 (1.49)	1.07 (1.42)	1.20 (1.46)	1.30 (1.50)	1.31 (1.50)
BDNG-797	0.8 (1.19)	0.43 (1.15)	0.47 (1.18)	0.47 (1.13)	0.64 (1.17)	0.59 (1.21)	0.86 (1.33)	0.86 (1.33)	1.04 (1.40)	1.02 (1.38)
ICCL-86111	0.66 (0.92)	0.26 (0.98)	0.18 (0.93)	0.52 (1.10)	0.58 (1.10)	0.41 (1.10)	0.75 (1.31)	0.97 (1.38)	0.80 (1.33)	1.04 (1.39)
ICC 3137	1.11 (1.28)	0.80 (1.45)	0.91 (1.46)	0.98 (1.42)	1.50 (1.72)	1.54 (1.79)	1.77 (1.66)	1.63 (1.71)	2.03 (1.74)	1.99 (1.73)
ICCV 10	1.05 (1.20)	0.68 (1.27)	0.23 (0.98)	0.70 (1.27)	0.91 (1.41)	0.95 (1.49)	0.87 (1.35)	1.01 (1.39)	1.07 (1.42)	1.08 (1.42)
SE(M)	0.06	0.04	0.08	0.15	0.13	0.17	0.06	0.076	0.05	0.07
CD @ 5%	0.18	0.12	0.26	0.45	0.39	0.38	0.18	0.227	0.15	0.22
CV %	10.44	9.92	8.864	10.62	10.15	10.19	9.80	8.947	8.69	8.57

Parenthesis figures of eggs population are $\sqrt{x+0.5}$

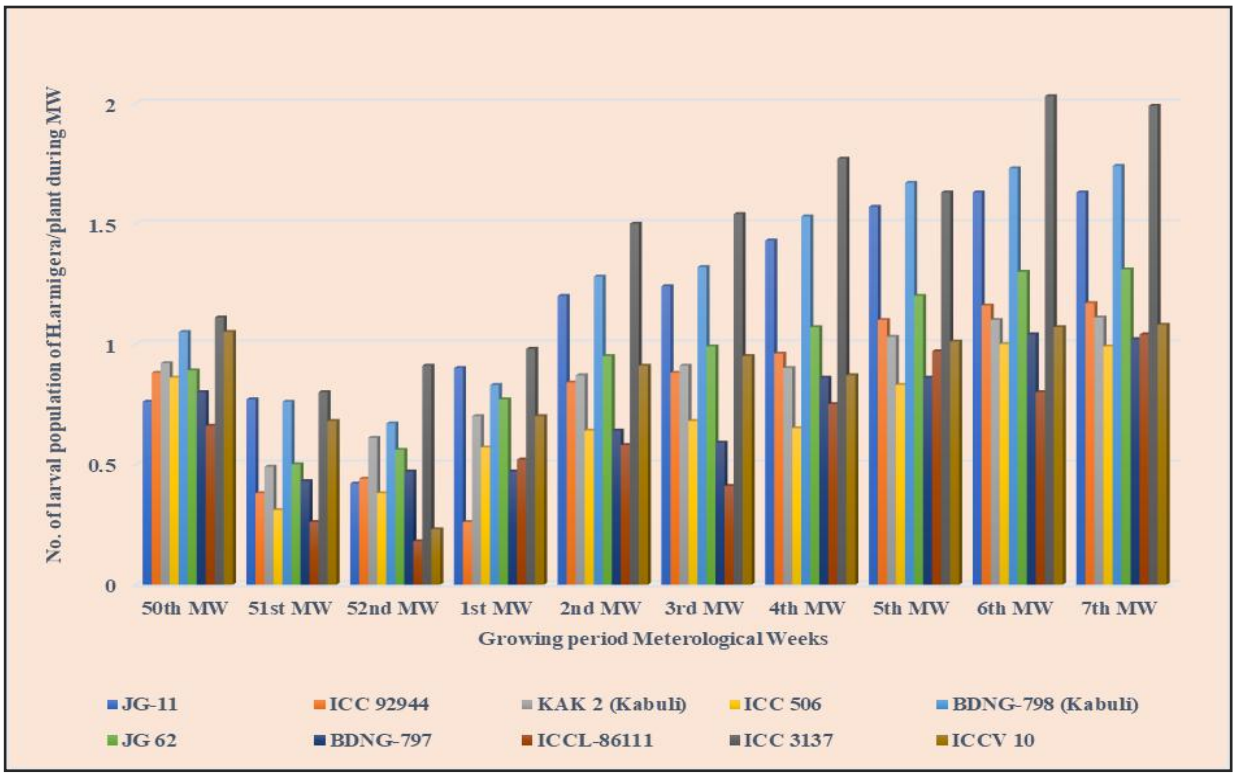

Fig. 2: Larval population of H. armigera on chickpea genotypes during growing meteorological weeks.

As discussed earlier least no. of larvae was observed on ICCL 86111 but after that ICC 506 (0.86, 0.31, 0.38, 0.57, 0.64, 0.68, 0.65, 0.83, 1.00 and 0.99 larvae / plant) and BDNG 797 (0.8, 0.43, 0.47, 0.47, 0.64, 0.59, 0.86, 0.86, 1.04, 1.02 larvae / plant) during every screening week proved themselves better fit after ICCL 86111. Kabuli chickpea types *viz.*, KAK 2 (0.92, 0.49, 0.61, 0.70, 0.87, 0.91, 0.90, 1.03, 1.10 and 1.11 larvae / plant) and BDNG 798 (1.05, 0.76, 0.67, 0.83, 1.28 1.32, 1.53, 1.67, 1.73 and 1.74 larvae / plant) also showed less than ICC 3137 but maximum positive response to larval feeding preference than other genotypes during screening weeks. Other genotypes *viz.*, JG-11, ICC 92944, JG 62 and ICCV 10 showed moderate level of resistance and medium level of infestation of larvae throughout MW. Accordingly highest population of *H. armigera* larvae throughout experimental growing season in respective ten MW was recorded on ICC-3137 (1.11 larvae/plant, 0.80 larvae/plant, 0.91 larvae/plant, 0.98 larvae/plant, 1.50 larvae/plant, 1.54 larvae/plant, 1.77 larvae/plant, 1.63 larvae/plant, 2.03 larvae/plant and 1.99 larvae/plant respectively. After assessing *H. armigera* resistance responses from 11 different chickpea cultivars Chaffe (14.32) and ICCV 10 had the lowest larvae whereas Phule G 5 (26.33), PG 8111 (24.90), GNG 465 (23.61) and BG 391 had the greatest larval incidence (23.31) [3].

3.4 Mean Eggs, Larvae, Pod damage, and effect on yield due to *H.armigera* during Met. Week on chickpea

The data pertaining mean eggs, larval infestation and per cent pod damage of gram pod borer, H .armigera on genotypes under study is presented in (Table 3 and depicted in fig. 3). It is found that on genotypes indicated significant differences regarding eggs, larvae and pod damage due to *H. armigera*. The mean results were observed in the range of 0.24 to 1.06 eggs per plant, 0.51 to 1.46 larvae/plant and 3.36 to 9.85 per cent respectively on the different genotypes. The lowest degree of mean infestation because of *H. armigera* was observed on genotype ICCL 86111 (0.24 eggs/plant, 0.51 larvae/plant and 3.36 per cent) which was at par with ICC 506 (0.27 eggs/plant, 0.64 larvae/plant and 3.93 per cent), BDNG 797 (0.35 eggs/plant, 0.67 larvae/plant and 4.26 per cent) and KAK 2 (0.43 eggs/plant, 0.80 larvae/plant and 7.25 per cent) respectively. Followed by ICCV 10 (0.49 eggs/plant and 0.83 larvae/plant), JG 11 (0.52 eggs/plant and 1.06 larvae/plant), ICC 92944 (0.52 eggs/plant and 0.82 larvae/plant). BDNG 798 (8.88 per cent) indicating moderate pod damage due to pod borer at par damage with after ICC 3137. Highest mean no. of eggs per plant, larvae per plant of *H. armigera* and per cent pod damage due to *H. armigera* was observed on genotype (1.06 eggs/plant, 1.46 larvae /plant and 9.85 per cent). Results concurs intervention with other reports [14] that the pod damage varies from 9.43 to 24.80 per cent. It is seen that variety Vijay had the least amount of pod damage (19.73 and 23.33%), followed by RSG 888 (20.46 and 27.67) but

variety Samrat had the most pod damage (30.40 and 34.33%) [9]. Also genotypes ICC 506, ICCV 10, ICCL 86102, and ICCV 95992 were shown to have low pod damage ratings of 3 from one to nine scale [2]. [18] Most promising strain, BRC-4, and the least vulnerable strain, BRC-1, both had pod damage levels of 9.38 and 21.49 per cent with grain yields of 0.333 and 0.137 kg/plot, respectively.

Table 2. Mean Eggs, Larvae, pod damage and yield due to H.armigera during Met. Week on chickpea

Genotype	Mean eggs-larvae and per cent pod damage			
	Eggs of *H.armigera*/plant	**Larva of *H.armigera*/plant**	**Pod Damage (%)**	**Yield (Kg/Ha)**
JG-11	0.52 (1.23)	1.06 (1.42)	7.72 (16.03)	1376
ICC 92944	0.52 (1.23)	0.82 (1.34)	5.46 (13.48)	1567
KAK 2 (Kabuli)	0.43 (1.19)	0.80 (1.33)	7.25 (15.55)	970
ICC 506	0.27 (1.12)	0.64 (1.28)	3.93 (11.43)	1654
BDNG-798 (Kabuli)	0.68 (1.29)	1.18 (1.47)	8.88 (17.24)	1421
JG 62	0.47 (1.21)	0.88 (1.36)	7.15 (15.28)	1341
BDNG-797	0.35 (1.16)	0.67 (1.29)	4.26 (11.88)	1477
ICCL-86111	0.24 (1.11)	0.51 (1.22)	3.36 (10.50)	1705
ICC 3137	1.06 (1.42)	1.46 (1.56)	9.85 (18.21)	876
ICCV 10	0.49 (1.21)	0.83 (1.35)	5.88 (13.92)	1620
SE(M)	0.03	0.03	0.56	19.40
CD @ 5%	0.08	0.10	1.61	58.10
CV %	8.46	8.89	9.82	17.80

Parenthesis figures of eggs population are $\sqrt{x+0.5}$

Figures of percentage in parenthesis are angular transformed values.

3.5 Average grain yield of test chickpea genotypes

The figures on average grain yield of test chickpea genotypes are specified in Table 3 and fig 4. It ranged from 870 to 1705 kg/ha. The uppermost grain yield was recorded by genotypes ICCL 86111 (1705 kg/ha) which was at par with the genotypes ICC 506 (1654 kg/ha) followed by ICCV 10 (1620 kg/ha), ICC 92944 (1567 kg/ha), BDNG 797 (1477 kg/ha), BDNG 798 (1421 kg/ha), JG 11 (1376 kg/ha) and JG 62 (1341 kg/ha) respectively. The lowest grain yield among the genotypes tested were recorded by KAK 2 (970 kg / ha) and ICC 3137 (876 kg/ha). It has been also found that the grain production per plot ranged from 23.33 to 192.00 gm /plant with larvae ranging from 1 to 50 [17]. [11] While comparing genotype ICC 506 to Annegeri, ICC 506 showed (2.08) and achieved yield of 797 kg/ha, whereas Annigeri with higher damage rating (8.33) and achieved 620 kg/ha. Chaffa, the cultivar that experienced the least pod damage (9.55%), was the most resilient.

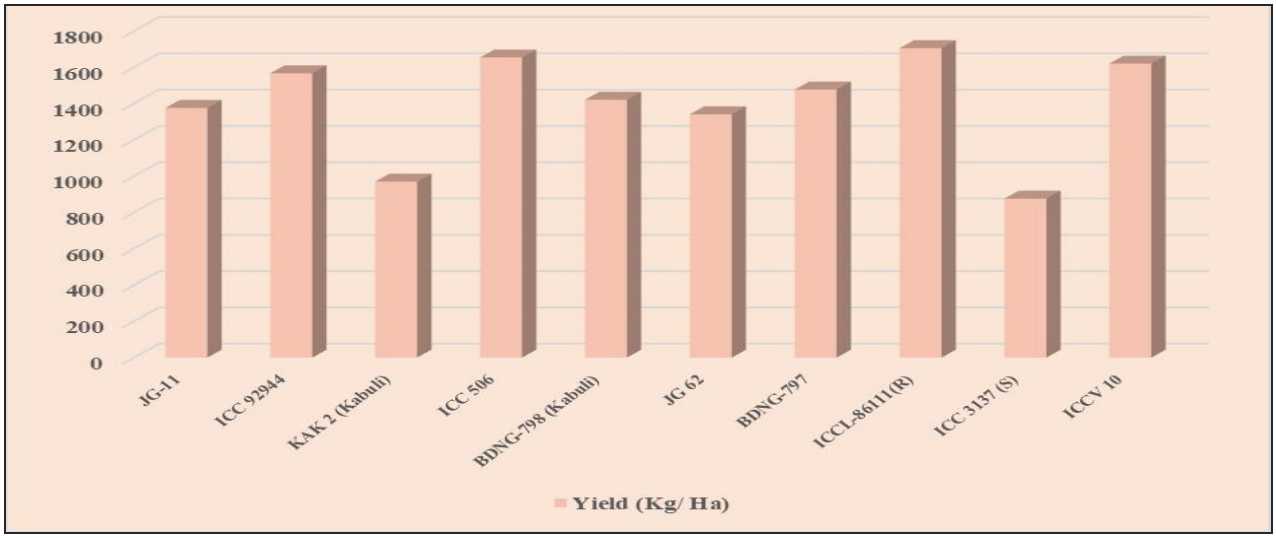

Fig. 2: Average grain yield (Kg/ha) of chickpea genotypes

3.6 Correlation of yield with *H. armigera* damage parameters.

The chickpea yield showed significantly negative correlation (Table 4) with mean per cent pod damage (r = -0.774) and Mean Eggs of H.armigera, Mean Larvae of H.armigera (r = -0.690, -0.688, respectively) indicating correlation of higher pod damage with lower the yield of chickpea.

Table 4. Correlation (r) of yield with screening attributes against H. armigera

Sr. no	**Screening attributes against *H. armiger***	**Yield**
1	Mean Eggs Population of *H.armigera*	-0.690
2	Mean Larval Population of *H.armigera*	-0.688
3	Mean Pod damage % due to *H.armigera*	-0.774**

**Significance Level at 0.01 % (0.765)

The present findings are supported by earlier research reports [10] yield obtained in ICCV 10, ICC 506 and ICCL 86111 were 1641, 1887 and 2120 kg/ha., respectively. [1] report depicts that ICCV 10 exhibited high yield potential and ICCV 09118 also showed a grain yield potential of >15.2 q/ha. The genotypes ICCV 07104 and ICCV 10 showed a yield potential of >15.0 q/ha compared to 5 q/ha in ICC 3137. Decrease in grain yield was lowermost in resistant check [21].

IV. CONCLUSION

The present findings are supported by earlier research reports [10] yield obtained in ICCV 10, ICC 506 and ICCL 86111 were 1641, 1887 and 2120 kg/ha., respectively. Anonymous (2010) reported that ICCV 10 exhibited high yield potential and ICCV 09118 also showed a grain yield potential of >15.2 q/ha. The genotypes ICCV 07104 and ICCV 10 showed a yield potential of >15.0 q/ha compared to 5 q/ha in ICC 3137. Decrease in grain yield was lowermost in resistant check [21].

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