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Assessment of Susceptibility of Different Chickpea (*Cicer arietinum* L.) Genotypes against Gram Pod Borer (*Helicoverpa armigera* Hubn.)

Sabyasachi Ray, A. Banerjee

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ABSTRACT

The study was carried out using eight chickpea genotypes viz., Bidhan Chhola 1, RG 2011-2, KWR 108, ICCV-171106, Anuradha, KPG-59, GNG 2372 and JAKI 9218 (tolerant check) at 'A-B' Block Farm of Bidhan Chandra Krishi Viswavidyalaya located in Kalyani, Nadia, West Bengal to assess the genotypic susceptibility of chickpea against gram pod borer (*Helicoverpa armigera* Hubn.) during two consecutive *rabi* seasons of 2019-20 and 2020-21. From two years of experiment it was found that highly susceptible genotype to gram pod borer was Bidhan Chhola 1 and KWR 108 was found to be least susceptible genotype against *H. armigera* compared to the check variety JAKI 9218 as high population was recorded from Bidhan Chhola 1 during both the years. Highest per cent pod damage was also recorded from Bidhan Chhola 1 during both the years (25.07 % and 30.07%) whereas least per cent pod damage was recorded from KWR 108 (10.40 % and 14.43% during 2019-20 and 2020-21) followed by ICCV-171106. Significant lower pod damage was observed in KPG 59 and JAKI 9218 during both the years.

Keywords Chickpea, *Cicer arietinum,* Genotypes, *Helicoverpa armigera,* Susceptibility.

Sabyasachi Ray
PhD Student, Department of Agricultural Entomology,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia 741252, WB, India

A. Banerjee*
Assistant Professor (Agril. Entomology), AICRP on MULLaRP, Directorate of Research, B.C.K.V., Mohanpur, Nadia 741252, WB, India
Email : amitavakvk@gmail.com
*Corresponding author

INTRODUCTION

Bengal gram or gram or chickpea (*Cicer arietinum* L.) is generally referred as third most important pulse crop that is positioned after dry beans and peas (Narayanamma *et al.* 2007). As a winter crop chickpea is grown extensively in the dry and rainfed parts throughout the world and covered an area of 70.6 million hectares with a production of 61.5 million tons of grains and a productivity of 871 kg ha^{-1} (Anonymous 2017). In Indian sub-continent the crop occupies 9.01 million hectare area and produces almost about 7.58 million tons of seeds that cover almost 34.3 % and 45.6 % area and production, respectively among all pulses produced (Anonymous 2017). Gram production in India has been grown up from 38.55 lakh tones to 112.29 lakh tones during

2000-01 to 2017-2018 and area is also increased from 51.85 lakh ha to 105.61 lakh ha. As the consequence, the chickpea productivity is also increased from 744 kg ha^{-1} to 1063 kg ha^{-1} (Anonymous 2018). When the balanced diet required for the vegetarian population of the country is considered, chickpea must be included in the cereal based diet system for its excellent amount of proteins (21%) as well as vitamins and minerals (Saxena 1996). Being a leguminous crop it is also best known for fixing atmospheric nitrogen through symbiosis and chickpea is a very important component of cropping systems of the dry, rainfed areas, because it can fix 80 to 120 kg of nitrogen hectare^{-1} (Papastyllanou 1987). Production scenario of chickpea in West Bengal showed that approximately 26,177 ha area was under gram cultivation with 30,844 tons of total chickpea production. Among the districts Nadia was the major chickpea growing district having an area of 9,906 ha followed by Birbhum (6,781 ha) and Murshidabad (5,462 ha) but highest productivity was recorded from Birbhum district (1,390 kg ha^{-1}) (Roy *et al.* 2016). Besides other limiting factors, gram pod borer (*Helicoverpa armigera* Hubn.) is a great menace to the profitable chickpea production and it is regarded as the key pest of chickpea (Zulacki *et al*. 1986, Reed *et al*. 1987). Variation in gram yield loss was estimated ranging from 10 to 60% due to gram pod borer under prevailing normal climatic condition but when the different weather factors turn favorable for its growth and development, yield loss may reach up to 50 to almost 100 % (Vaishampayam and Veda 1980). Controlling the pest using chemical insecticides is still the last way for its management though it is very difficult due to its polyphagous, multivoltine and cosmopolitan nature (Sharma 2007). Random use of chemical insecticides resulted in population reduction of natural enemies as well as residue problem whereas the pest was reported to show resistance against several common insecticides used for managing the pest (Kranthi *et al*. 2002). For sustainable management of pest and profitable production particularly in subsistence farming it became necessary to develop resistant varieties that will not only reduce the cost of plant protection but also provide good yield and it becomes popular in the recent decades in the developing countries (Lateef *et al.* 1985, Maurya *et al*. 2007, Sarwar *et al.* 2009). Therefore, host plant resistance is the governing principle behind the sustainable pest management system in most of the agro ecosystems (Sharma 2007). Hence, keeping these principles in mind the present study was conducted to evaluate the susceptibility of different chickpea genotypes against gram pod borer using eight chickpea varieties.

MATERIALS AND METHODS

The present field experiment was carried out at 'A-B' Block Farm of Bidhan Chandra Krishi Viswavidyalaya located at Kalyani, Nadia, West Bengal which was situated in the new alluvial zone during two successive *rabi* seasons of 2019-20 and 2020-21. Eight genotypes having almost similar maturity periods viz., Bidhan Chhola 1, RG 2011-2, KWR 108, ICCV-171106, Anuradha, KPG-59, GNG 2372 and JAKI 9218 (tolerant check) were studied to evaluate the susceptibility of them to gram pod borer. The seeds of the mentioned chickpea genotypes maintaining a seed rate of 60 kg ha^{-1} were sown during 29th day of November during both the years following Randomized Block Design with four replications considering the genotypes as a treatment. Plot size for each treatment was 3 m x 0.9 m maintaining the row to spacing of 30 cm and plant to plant spacing of 10 cm within row. Before sowing, the seeds were dressed with *Rhizobium* and also with a fungicide mixture containing Carbendazim 12 % + Mancozeb 63% WP for preventing seed borne diseases. Necessary agronomic package of practices was followed to establish the crop and insecticide free environment was maintained during entire study period. For assessing the susceptibility of different genotypes of chickpea against gram pod borer, observations were recorded from three weeks after sowing (WAS) of the crop at weekly interval till the maturity of the crop with fewer disturbances of the plants which accommodated 14 observations during first year and 12 observations during second year. Because of sudden temperature rise during reproductive stage of the crop in second year, the crop was matured and was forced to be harvested at least fifteen days earlier. Total number of larvae per plant from randomly selected five plants from each plot of each treatment was recorded and during harvest per cent pod damage was also calculated. The separate pest population data for each genotype were taken into consideration. Per cent pod damage was calculated by counting the total number of pods per plant and number of damaged pods per plant using the following formula stated by Kumar *et al.* (2013):

$$\text{Per cent pod damage} = \frac{\text{No. of damaged pod per plant}}{\text{Total number of pods per plant}} \times 100$$

The data obtained from observations were analyzed statistically by calculating the mean population of *Helicoverpa armigera* from each genotype and further analyzed by analysis of variance technique. Significance of the treatment means were tested with "F" test and after finding significant difference between the treatment means, it was again tested for critical differences (CD) at 5% level of significance (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Pattern of incidence of *H. armigera* on different chickpea genotypes during 2019-2020

Incidence pattern of pest population on different chickpea genotypes during first year of the study i.e. 2019-20 is presented in Table 1 and graphically through Fig. 1. It was observed that most of the genotypes were differed among themselves in larval population significantly. It was revealed that the most susceptible variety was Bidhan Chhola 1 (0.86 larvae plant^{-1}) followed by GNG 2372 (0.68 larvae plant^{-1}) and Anuradha (0.54 larvae plant^{-1}). Moderate infestation was found in RG 2011-02 (0.45 larvae plant^{-1}) and KPG 59 (0.38 larvae plant^{-1}). The lowest population was recorded in KWR 108 (0.23 larvae plant^{-1}) followed by JAKI 9218 (0.27 larvae plant^{-1}) and ICCV 171106 (0.32 larvae plant^{-1}). If the genotypes according to the decreased order of susceptibility based on the larval population can be furnished then it will be, Bidhan Chhola 1 > GNG 2372 > Anuradha > RG 2011-02 > KPG 59 > ICCV 171106 > JAKI 9218 > KWR 108. However, the present study reveals the significant superiority of KWR 108 over other two chickpea genotypes viz. Bidhan Chhola 1 and GNG 2372 in terms of less infestation of gram pod borer.

Pattern of incidence of *H. armigera* on different chickpea genotypes during 2020-2021

Larval population of gram pod borer recorded from different genotypes during second year (2020-2021) of experiment is presented in Table 2 and graphically through Fig. 2. Results showed significant differences

Table 1. Seasonal incidence of *Helicoverpa armigera* in different genotypes of chickpea during 2019-2020.

Genotypes	Pest population (No. of larvae plant^{-1}) recorded in different periods of observation							
	3 WAS (51)*	4 WAS (52)	5 WAS (1)	6 WAS (2)	7 WAS (3)	8 WAS (4)	9 WAS (5)	10 WAS (6)
Bidhan Chhola 1	0.0 (0.70)**	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.25 (0.87)	0.75 (1.12)	0.50 (1.00)	1.50 (1.41)
RG 2011-02	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.0 (0.70)	0.50 (1.00)	0.50 (1.00)
KWR 108	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.0 (0.70)	0.25 (0.87)	0.25 (0.87)	0.0 (0.70)
ICCV 171106	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.25 (0.87)
Anuradha	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.0 (0.70)	0.50 (1.00)	0.25 (0.87)	1.00 (1.22)
KPG 59	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.50 (1.00)	0.0 (0.70)	0.25 (0.87)	0.50 (1.00)
GNG 2372	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.0 (0.70)	0.25 (0.87)	0.25 (0.87)	0.50 (1.00)
JAKI 9218	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.25 (0.87)	0.0 (0.70)	0.25 (0.87)	0.25 (0.87)
SEm (+/-)								
CD (5%)								
CV (%)								

Table 1. Continued.

Genotypes	Pest population (No. of larvae plant^{-1}) recorded in different periods of observation						
	11 WAS (7)	12 WAS (8)	13 WAS (9)	14 WAS (10)	15 WAS (11)	16 WAS (12)	Mean
Bidhan Chhola 1	0.25 (0.87)	0.75 (1.12)	1.00 (1.22)	0.25 (0.87)	4.25 (2.18)	2.25 (1.66)	0.86 (1.09)
RG 2011-02	0.75 (1.12)	0.50 (1.00)	0.50 (1.00)	0.0 (0.70)	2.25 (1.66)	1.00 (1.22)	0.45 (0.93)
KWR 108	0.0 (0.70)	0.50 (1.00)	0.25 (0.87)	0.50 (1.00)	1.00 (1.22)	0.25 (0.87)	0.23 (0.84)
ICCV 171106	0.25 (0.87)	0.75 (1.12)	0.50 (1.00)	0.0 (0.70)	1.75 (1.50)	0.75 (1.12)	0.32 (0.88)
Anuradha	0.50 (1.00)	1.00 (1.22)	0.50 (1.00)	0.25 (0.87)	2.25 (1.66)	1.00 (1.22)	0.54 (0.98)
KPG 59	0.50 (1.00)	0.25 (0.87)	0.50 (1.00)	0.25 (0.87)	1.50 (1.41)	0.75 (1.12)	0.38 (0.92)
GNG 2372	0.75 (1.12)	1.00 (1.22)	1.25 (1.32)	2.00 (1.58)	1.75 (1.50)	1.50 (1.41)	0.68 (1.04)
JAKI 9218	0.25 (0.87)	0.50 (1.00)	0.50 (1.00)	0.25 (0.87)	1.25 (1.32)	0.25 (0.87)	0.27 (0.86)
SEm (+/-)							0.06
CD (5%)							0.18
CV (%)							12.22

* Figures in the parentheses are Standard Meteorological Weeks
** Figures in the parentheses are square root transformed values ($\sqrt{x+0.5}$)
NB. WAS = Weeks After Sowing.

in pest population among the chickpea genotypes. Like previous season Bidhan Chhola 1 recorded highest pest population (1.47 larvae plant^{-1}) followed by GNG 2372 (1.22 larvae plant^{-1}), Anuradha (1.02 larvae plant^{-1}) and RG 2011-02 (0.85 larvae plant^{-1}). Moderate susceptibility was shown by KPG 59 which recorded 0.65 larvae plant^{-1} followed by JAKI 9218 (0.52 larvae plant^{-1}) and ICCV 171106 (0.47 larvae plant^{-1}). The lowest larval population was recorded in KWR 108 (0.33 larvae plant^{-1}), so it was found to be least susceptible genotype against gram pod borer compared with other genotypes and the check

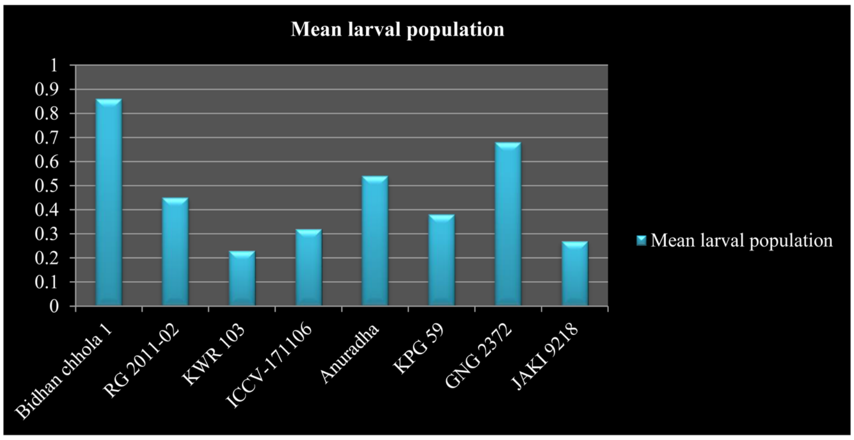

Fig. 1. Mean *Helicoverpa* population in different genotypes of chickpea during 2019-20.

Table 2. Seasonal incidence of *Helicoverpa armigera* in different genotypes of chickpea during 2020-2021.

Genotypes	Pest population (No. of larvae plant^{-1}) recorded in different periods of observation						
	3 WAS (51)*	4 WAS (52)	5 WAS (1)	6 WAS (2)	7 WAS (3)	8 WAS (4)	9 WAS (5)
Bidhan Chhola 1	0.0 (0.70)**	0.0 (0.70)	0.40 (0.95)	0.0 (0.70)	0.60 (1.05)	0.60 (1.05)	1.40 (1.38)
RG 2011-02	0.0 (0.70)	0.0 (0.70)	0.20 (0.84)	0.60 (1.05)	0.40 (0.95)	0.20 (0.84)	0.20 (0.84)
KWR 108	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.20 (0.84)	0.40 (0.95)
ICCV 171106	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.20 (0.84)	0.0 (0.70)	0.20 (0.84)	0.40 (0.95)
Anuradha	0.0 (0.70)	0.0 (0.70)	0.40 (0.95)	1.00 (1.22)	0.60 (1.05)	0.40 (0.95)	0.80 (1.14)
KPG 59	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.20 (0.84)	0.40 (0.95)	0.20 (0.84)	0.40 (0.95)
GNG 2372	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.40 (0.95)	0.40 (0.95)	0.60 (1.05)	1.60 (1.45)
JAKI 9218	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.0 (0.70)	0.20 (0.84)	0.0 (0.70)	0.40 (0.95)
SEm (+/-)							
CD (5%)							
CV (%)							

Table 2. Continued.

Genotypes	Pest population (No. of larvae plant^{-1}) recorded in different periods of observation					
	10 WAS (6)	11 WAS (7)	12 WAS (8)	13 WAS (9)	14 WAS (10)	Mean
Bidhan Chhola 1	2.20 (1.64)	2.80 (1.82)	4.40 (2.21)	3.20 (1.92)	2.00 (1.58)	1.47 (1.31)
RG 2011-02	1.00 (1.22)	2.20 (1.64)	3.60 (2.02)	0.60 (1.05)	1.20 (1.30)	0.85 (1.10)
KWR 108	0.80 (1.14)	1.20 (1.30)	0.40 (0.95)	0.60 (1.05)	0.40 (0.95)	0.33 (0.89)
ICCV 171106	0.60 (1.05)	1.00 (1.22)	1.60 (1.45)	1.20 (1.30)	0.40 (0.95)	0.47 (0.95)
Anuradha	1.00 (1.22)	1.80 (1.52)	3.00 (1.87)	2.00 (1.58)	1.20 (1.30)	1.02 (1.18)
KPG 59	0.80 (1.14)	1.60 (1.45)	2.80 (1.82)	0.60 (1.05)	0.80 (1.14)	0.65 (1.02)
GNG 2372	2.60 (1.76)	2.80 (1.82)	3.20 (1.92)	1.80 (1.52)	1.20 (1.30)	1.22 (1.24)
JAKI 9218	1.20 (1.30)	0.80 (1.14)	2.20 (1.64)	1.00 (1.22)	0.40 (0.95)	0.52 (0.96)
SEm (+/-)						0.07
CD (5%)						0.20
CV (%)						13.64

* Figures in the parentheses are Standard Meteorological Weeks
** Figures in the parentheses are square root transformed values ($\sqrt{x+0.5}$)
NB WAS = Weeks After Sowing

variety. The genotypes according to the decreasing order of susceptibility are as follows: Bidhan Chhola 1 > GNG 2372 > Anuradha > RG 2011-02 > KPG 59 > JAKI 9218 > ICCV 171106 > KWR 108. The results of the second year of the study reveals that the chickpea variety KWR 108 was significantly superior

Table 3. Occurrence of *Helicoverpa armigera* along with pod damage caused by it in different genotypes of chickpea during 2019-20.

Genotypes	Mean larval population of *H. armigera*	Pod damage percentage (%)
Bidhan Chhola 1	0.86 (1.09)*	25.07 (29.95)**
RG 2011-02	0.45 (0.93)	19.16 (25.75)
KWR 108	0.23 (0.84)	9.42 (17.70)
ICCV 171106	0.32 (0.88)	10.40 (18.23)
Anuradha	0.54 (0.98)	21.69 (27.67)
KPG 59	0.38 (0.92)	13.79 (21.56)
GNG 2372	0.68 (1.04)	23.49 (28.99)
JAKI 9218	0.27 (0.86)	14.81 (21.95)
SEm (+/-)	0.06	1.95
CD (5%)	0.18	5.65
CV (%)	12.22	18.27

Table 4. Occurrence of *Helicoverpa armigera* along with pod damage caused by it in different genotypes of chickpea during 2020-21.

Genotypes	Mean larval population of *H. armigera*	Pod damage percentage (%)
Bidhan Chhola 1	1.47 (1.31)*	30.07 (33.19)**
RG 2011-02	0.85 (1.10)	24.18 (29.32)
KWR 108	0.33 (0.89)	14.43 (22.24)
ICCV 171106	0.47 (0.95)	15.41 (22.83)
Anuradha	1.02 (1.18)	26.71 (31.06)
KPG 59	0.65 (1.02)	18.80 (25.56)
GNG 2372	1.22 (1.24)	28.51 (32.27)
JAKI 9218	0.52 (0.96)	19.25 (25.75)
SEm (+/-)	0.07	1.61
CD (5%)	0.20	4.66
CV (%)	13.64	13.00

* Figures in the parentheses are square root transformed values ($\sqrt{x+0.5}$)
** Figures in the parentheses are angular transformed values.

over other four genotypes viz. Bidhan Chhola 1, GNG 2372, Anuradha and RG 2011-02 in respect of pod borer incidence.

Based on the observations during two years of experiment, conclusion can be drawn as, highly susceptible chickpea genotype to gram pod borer was Bidhan Chhola 1 and the variety KWR 108 was found to be the least susceptible against *H. armigera* compared to the check variety JAKI 9218.

Occurrence of pod damage due to *H. armigera* in different chickpea genotypes during 2019-20

The genotypes of chickpea were differed significantly among themselves in per cent pod damage caused by *H. armigera* and the per cent pod damage observed on different genotypes is presented in Table 3 and graphically through Fig. 3. Variation in per cent pod damage was ranging from 9.42% to 25.07% Maximum pod damage (25.07 per cent) was recorded from Bidhan Chhola 1 followed by GNG 2372 (23.49%). Moderate pod damage was recorded in RG 2011-02 (19.16%) and Anuradha (21.69%). On the other hand, the least pod damage was recorded from KWR 108 (9.42%) followed by ICCV 171106 (10.40%). The per cent pod damage recorded in chickpea variety, KWR 108 was significantly less than that of Bidhan

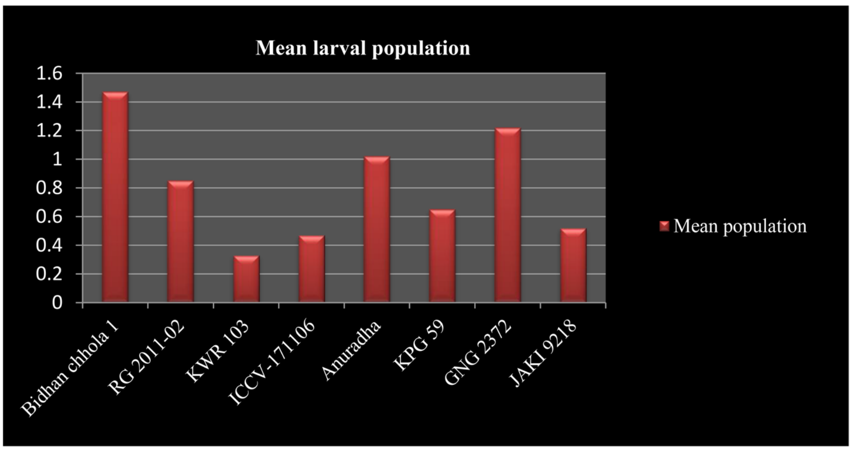

Fig. 2. Mean *Helicoverpa* population in different genotypes of chickpea during 2020-21.

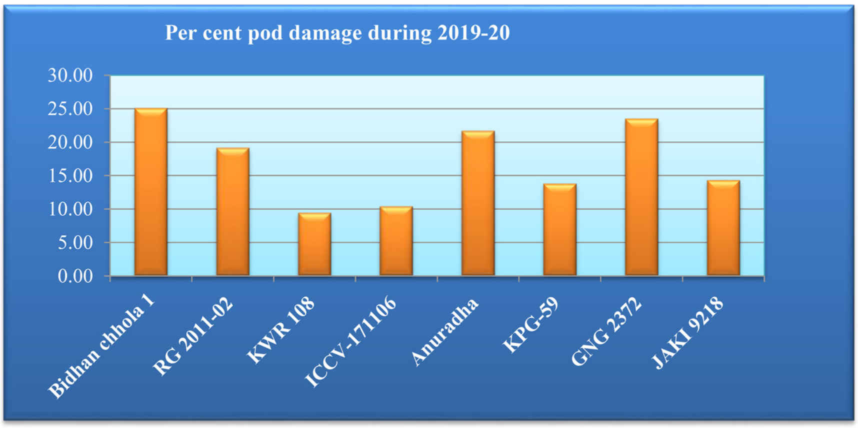

Fig. 3. Pod damage due to gram pod borer in different varieties of chickpea during 2019-20.

Chhola 1, GNG 2372, Anuradha and RG 2011-02.

Occurrence of pod damage due to *H. armigera* in different chickpea genotypes during 2020-21

Per cent pod damage caused by *H. armigera* on different genotypes of chickpea during second year is presented in Table 4 and graphically through Fig. 4. Results showed the similar trend of per cent pod damage on different genotypes but overall damage was higher compared to previous season and there was significant variation in per cent pod damage (from 14.43% to 30.07%) occurred on the chickpea genotypes. Pod damage was significantly lowest on KWR 108 (14.43%) followed by ICCV 171106 (15.41%), JAKI 9218 (19.25%) and KPG 59 (18.80%). Moderate pod damage was recorded in RG 2011-02 (24.10%), Anuradha (26.71%) and GNG 2372 (28.51%). The highest pod damage was recorded in Bidhan Chhola 1 (30.07%). During second year also, KWR 108 was revealed to be significantly superior chickpea variety to four other genotypes viz. Bidhan Chhola 1, GNG 2372, Anuradha and RG 2011-02.

From the two years of study period it was found that the highest pod damage caused by *H. armigera*

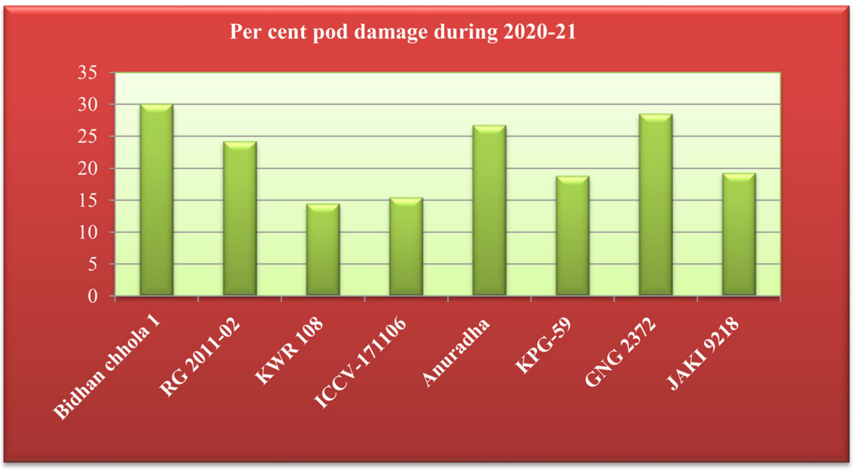

Fig. 4. Pod damage due to gram pod borer in different varieties of chickpea during 2020-21.

was occurred on chickpea genotype Bidhan Chhola 1 and it was recorded lowest in KWR 108. The probable cause behind this may be the variation in larval load on these particular varieties. Several chickpea genotypes were screend against gram pod borer throughout the past decades and a huge number of scientists worked on it (Das and Kataria 1999, Bhagwat and Sharma 2000, Bhatt and Patel 2001, Jitpure 2005, Parsai 2005, Chandraker *et al*. 2006, Kushwah 2006, Chaturvedi and Ali 2010, Deshmukh *et al.* 2010, Sharma *et al*. 2018). However, the varieties they used do not resemble to present varieties, therefore their findings cannot be properly compared with present findings. In those experiments varietal susceptibility was evaluated based on three parameters which were considered by several scientists and the parameters are population build up on different varieties, extent of crop damage and number of damaged pods per plant. The present experiment was also conducted considering two parameters viz. population build up on different varieties and extent of crop damage out of those three. The present study recorded less than 20 % pod damage by *H. armigera* in chickpea variety JAKI 9218 (14.81 and 19.25 during two years of study, respectively) which partially supports the findings of Haralu *et al.* (2018). They also reported almost similar kind of pest population in unit area. However, Karthik and Vastrad (2018) from Dharwad, Karnataka recorded very less pest density as well as pod damage caused by pod borer in chickpea variety JAKI 9218. The present research findings are in agreement with Deepak *et al*. (2018) who also reported very less pest population of *H. armigera* in chickpea variety KWR 108 from Varanasi, UP, though they recorded 20.48% pod damage which is relatively higher in present experiment. Their observation regarding the pest density as well as pod damage in variety KPG 59 is in line with the present experiment. Actually, several factors probably contribute to the resistance of different chickpea genotypes against *H. armigera*. Sharma *et al.* (1999) reported that the legume pod borer resistant reaction in legume is conditioned by a combination of factors such as oviposition, antibiosis and tolerance. The host selection process of *H. armigera* was influenced by a large number of factors, including plant species, plant height and plant physiological stage as reported by Jallow and Zalucki (1996). An additional possible cause for the observed oviposition response was the chickpea foliar secretions containing high concentrations of malic acid (Rembold 1981).

From the two tears of study period it can be concluded that the most susceptible genotype to gram pod borer was Bidhan Chhola 1 as it recorded maximum larval load as well as highest pod damage followed by GNG 2372, Anuradha and RG 2011-02 whereas moderate susceptibility was recorded from KPG 59 compared to the check variety JAKI 9218. KWR 108 was proved to be the least susceptible variety compared to the other genotypes including the check as it recorded lowest pest population as well as per cent pod damage followed by ICCV-171106. Therefore, these two varieties (KWR 108 and ICCV-171106) need to be tested across many locations in farmers' fields to confirm their wide utility as well as these can be used as sources in breeding programs to enhance resistance/ tolerance to pod borer in upcoming commercial cultivars, while Bidhan Chhola 1 may be used as a donor for susceptibility.

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