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GENOTYPICAL VARIATIONS AND ASSOCIATION BETWEEN GRAM POD BORER (*HELICOVERPA ARMIGERA*) AND PHYSIO-MORPHOLOGICAL TRAITS IN GRAM (*CICER ARIETINUM* L.)

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ABSTRACT

Chickpea (*Cicer arietinum* L.) commonly known as gram is a widely cultivated grain legume crop in the Leguminosae (Fabaceae) family. Gram pod borer (*Helicoverpa armigera*) is known as the most damaging pest of chickpea that damages various parts of plants at different growth stages. Various physio-morphological characteristics tend to affect the infestation of pod borer as pod wall thickness, pod trichomes density, and pod color. For this purpose, research was conducted in the field area of Entomological Research Institute, AARI, Faisalabad. Nine Kabuli chickpea genotypes i.e. PCK-15001, PCK-15019, PCK-16010, PCK-16027, PCK-17001, PCK-17007, PCK-17018, PCK-17030, and NOOR-2019 were sown under RCBD design having three replications. The results showed that the genotype "PCK-17030" had a significantly highest population of pod borer of 0.97larvae/plant and showed the highest pod damage of 7.39% while the genotype"PCK-16027" was the lowest infested with 0.69 larvae/plant of pod borer. On the other hand, the genotype "Noor-2019" showed the lowest pod damage of 6.42%. It is, therefore, concluded that pod wall thickness and density of pod trichomes had a negative relation to the damage of pod borer. As regards pod color, it was observed that there was the maximum pod borer damage in the genotypes having green colored pods as compared to the genotypes having pods with yellowish brown streaks.

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INTRODUCTION

Chickpea is an edible crop with high protein contents and is considered to be one of the earliest cultivated grain legumes (Athar and Bokhari, 2006; Redden and Berger, 2007). It is grown in both tropical and temperate climates. Chickpea is cultivated in more than 55 countries across the globe (FAOSTAT, 2020). At present, the leading chickpea growing countries are India, Iran, Pakistan, Burma, Turkey, Spain, Portugal, Ethiopia, Morocco, Tanzania, Myanmar, Mexico, Chile, Australia, Russian Federation, Italy, USA and many other regions of the world (Ahmed and Awan, 2013; Mari et al., 2013; Sharma et al., 2004). Pulses are cultivated on 5-6% of the total cropped area in Pakistan, and more than 62%

of the total production is utilized by human population, with an average of 4.18 kg/person per year and mostly in Rabi season (Kishore et al., 2017). It mostly contains protein (17.1%), carbohydrates (60.9%) and fibers (3.9%) and is primarily destined for consumption of human being (Bampidis and Christodoulou, 2011; Jukanti et al., 2012).

Chickpea crop is attacked by various insect pests from seedling to maturity stages. The major insect pest species associated with the chickpea crop belongs to the orders Lepidoptera, Diptera, Hemiptera, and Thysanoptera (Fichetti et al., 2009). The major insect pests that damage its plants are primarily *Helicoverpa armigera, Aphis craccivora* K., *Agrotisipsilon, Spodopteralitura* F., *Callosobruchus maculates* F., *Plusiaori chalchea,* and *B emisia tabaci* (Mari et al., 2013). *H. armigera* (Hubner) (Lepidoptera: Noctuidae) is an important old world species that inflicts serious damage to several crops. It is polyphagous and persistent pest that feeds on 182 species of host plants causing a yield loss of 70-95% (Aslam et al., 2019; Sharma et al., 2007; Ullah et al., 2015).

Pod borer infestation in chickpea appears to be influenced by several morphological characters such as pod and leaf trichome length and density as well as pod wall thickness (Brar and Singh, 2017; Kassi et al., 2018). Trichomes are essential part of a plant's defense system that spear the pests and contribute to the plant's chemical defense (Altaf et al., 2008; Kassi et al., 2019; Sallmath et al., 2008). As a result, they could serve as a potential resistance mechanism against pod borer and other chickpea pests (Yoshida et al., 1995).

The objective of the study was to evaluate the best variety of gram which can resist against the infestation of the pod borer. Physiomorphic characters were also evaluated to observe the plant character which produces tolerance or resistance within gram against pod borer so that future IPM strategies may be developed.

MATERIALS AND METHODS

The study was planned to check the impact of physico-morphic characters of different kabuli chickpea genotypes against gram pod borer (*Helicoverpa armigera*). Nine kabuli chickpea genotypes i.e. PCK-15001, PCK-15019, PCK-16010, PCK-16027, PCK-17001, PCK-17007, PCK-17018, PCK-17030 and NOOR-2019 were sown having 15 cm plant to plant distance and 30 cm row to row under Randomized Complete Block Design (RCBD) having three repeats at Entomological Research Institute (ERI), Ayub Agriculture Research Institute (AARI), Faisalabad. All the genotypes were obtained from Pulses Research Institute, AARI, Faisalabad. All the standard cultural practices were adopted. Meteorological data were obtained from Department of Crop Physiology, AARI, Faisalabad.

The data regarding population variation of pod borer and pod damage was recorded at weekly intervals after pest appearance till crop maturity. Five plants for pest population whereas in case of pod damage fifteen plants were selected randomly from each replication of each genotype and the population of pod borer and pod damage on each plant was counted. Average population of pod borer was taken by the following formula;

$$\text{Average pod borer population} = \frac{P1+P2+P3+P4+P5}{5}$$

In this formula, P1, P2,…., P5 are the plant samples collected from each genotypes.

The following formula was used to calculate the percentage of pod borer damage;

$$\text{Pod borer \% damage} = \frac{\text{No. of damaged pods/plant}}{\text{Total no. of pods/plant}} \times 100$$

Pods of each genotype having three replications were collected and pod wall thickness was determined by using Digital Screw Guage whereas pod trichomes density was counted by stereo microscope and pod color was observed visually.

The data collected were analyzed by using analysis of variance (ANOVA) and mean values between the genotypes were compared by using LSD Test at $P \leq 0.05$. Data of physio-morphic and abiotic factors were correlated with average pod borer damage and pod borer population respectively by using correlations (Pearson) on Statistix software.

RESULTS AND DISCUSSION

The results showed significant difference of pod borer attack among the genotypes. It was observed that genotype "PCK-17030" had significantly higher population of pod borer (0.97 larvae/plant) followed by genotype "PCK-16027" (0.93 larvae/plants) while the lowest pod borer population was recorded to be 0.73 larvae/plant on genotype "Noor-2019" so, genotype "Noor-2019" was found relatively resistant whereas genotype "PCK-17030" was the most susceptible (Table 1).

The results regarding pod/capsule damage showed that the genotype "PCK 17030" had the highest pod borer damage (10.78%) followed by genotype "PCK 16027" (10.49%) whereas the lowest pod borer damage was recorded in genotype “Noor-2019” (6.42%) (Table 1). In case of pod/capsule damage, genotype “Noor-2019” was relatively resistant while genotype “PCK-17030” was found susceptible.

Table 1: Screening of Kabuli gram genotypes against insect pests.

Genotype	Mean pod borer population (per plant)	Gram pod borer infestation (%)	Pod wall thickness (µm)	Pod hair density (per cm^2)	Pod color
PCK-17030	0.97 a	10.78 a	0.25 e	163.6 e	Green
PCK-16010	0.81 e	6.66 c	0.38 a	257.3 bc	Yellow streaks
PCK-16027	0.93 b	10.49 a	0.24 e	188.3 d	Green
PCK-15019	0.91 bc	10.34 a	0.37 a	291.0 a	Green
PCK-17002	0.81 e	6.62 c	0.28 d	193.0 d	Yellow streaks
PCK-17018	0.85 d	9.29 b	0.31 c	273.3 ab	Light green
PCK-17001	0.93 b	9.0 b	0.37 ab	246.3 c	Green
PCK-15001	0.89 cd	9.55 b	0.35 b	210.6 d	Light green
Noor-2019	0.73 f	6.42 c	0.38 a	204.3 d	Yellow streaks
LSD at 0.05	0.527	0.673	0.022	22.35	

The Pysico-morphic characters significantly affected the attack of pod borer. Genotype “PCK-15019” showed the highest trichome density of 291.0/cm^2 while the minimum density was present in genotype “PCK-“17030” which was 163.6/cm^2 (Table 1). So, it was concluded that trichome density significantly and negatively affected the pod borer infestation. These results were similar to those of Peter et al. (1995) and Shanower et al. (1997) who described that *Cajanus* spp. having trichomes on pods were found to have a major clash with the pod borer. Pal et al. (2020) described the similar results and concluded that the varieties having more trichomes were less infested by pod borer. They suggested that raising the thickness of non-glandular trichomes in pods of pigeon pea would minimize the amount of damage and injury caused by the pod borer. On the other hand, the maximum pod wall thickness was present in genotype “PCK-15019” (0.37µm) and “PCK-17001” (0.37 µm) followed by PCK-17002 (0.28 µm) and showed the minimum pod damage caused by pod borer while the minimum wall thickness was found in genotypes “PCK-16027” (0.24 µm) and “PCK-17030” (0.25 µm) (Table 1). Kumar et al. (2019a) and Kumar et al. (2019b) showed the similar results that the varieties having more trichomes and wall thickness significantly affect the pod borers. In the present study, a significant negative correlation was recorded between pod borer and pod wall thickness, while a negative and non-significant correlation was observed between pod borer and pod hair density. It indicated that the higher the trichome density and pod wall thickness, the less the pod borer damage there would be (Table 2). Similar results were mentioned by Sallmath et al. (2008) that resistant genotype had more trichomes and thicker pod shell, therefore were less damaged. Similarly Karthik and Vastrad (2018) showed similar results as mentioned below. The results also matched to the findings of Shabbir et al. (2014) who reported that chickpea genotypes with longer and denser trichomes as well as thicker pod walls were found to be more resistant to pod borer infestation. Haralu et al. (2018) also depicted the same results and concluded that the biophysical characteristics showed significant impact on infestation by pod borer.

Table 2: Correlation between pod wall thickness, trichome density and insect population.

	Pod wall Thickness (µm)	Trichome Density
Pod borer	- 0.315	- 0.304
	(0.019)	(0.123)

The regression line also showed the significant negative relationship between pod wall thickness and trichome density with percentage pod borer infestation. It showed that the pod borer and these physicomorphic characters were inversely proportional so if one increased the other one will be decreased (Figure 1 and 2). The findings were similar to those of Jat et al. (2018) who reported that among different genotypes, the thickness of the pod wall was higher in moderately resistant genotypes as compared to other genotypes. There was maximum pod borer damage in the genotypes having green colored pods as compared to the genotypes having pods with yellowish brown streaks. It was observed that pod borer was highly attracted to the green colored pods as compared to the pods having yellowish brown streaks. So it showed that phsicomorphic characters directly affected the attack of pod borers. Similarly, Kumar et al. (2019b) showed that abiotic factors also played a vital role in population fluctuation of *H. armigera*. The findings also matched with the studies of Jagtap et al. (2014) who described that genotypes with green and green with brown streaks coloured pods had lower preference for *H. armigera* larvae as compared to the genotypes having green pods with purple streaks. Ali et al. (2009) also mentioned above said character and reported similar results regarding the attack of pod borer on chickpea plants.

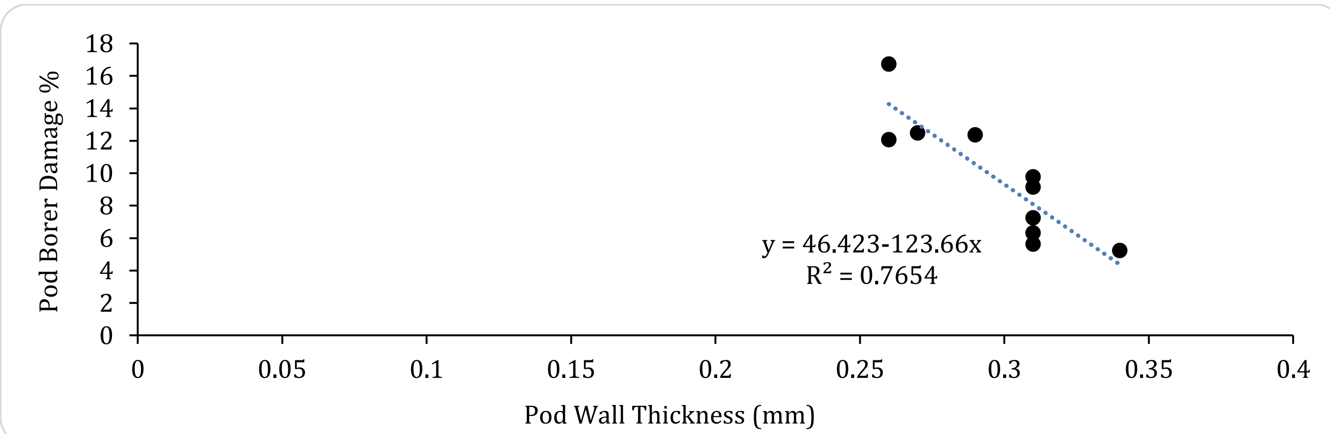

Figure 1: Relationship between pod wall thickness and pod borer damage (%).

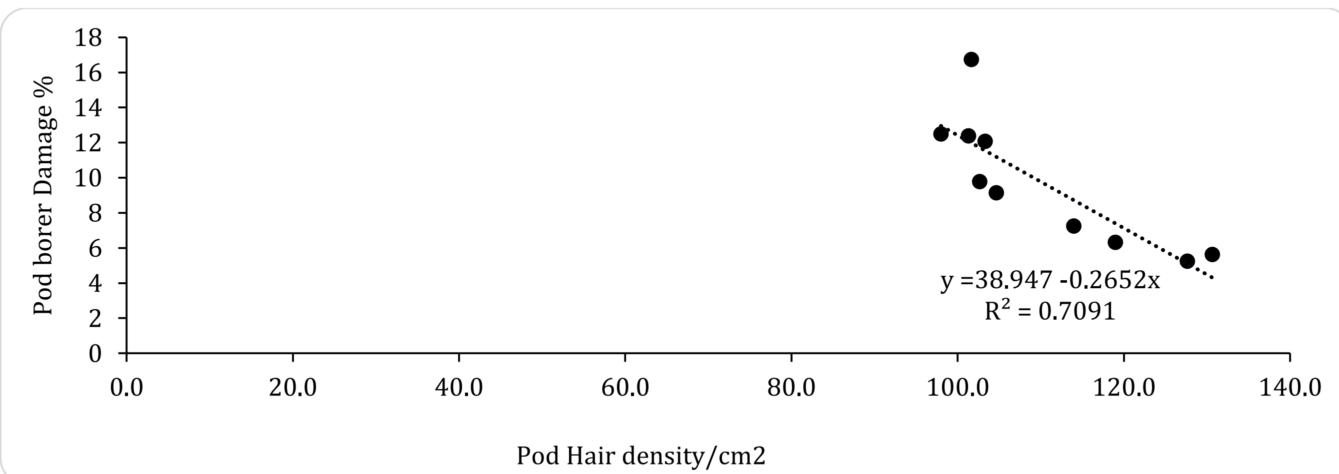

Figure 2: Relationship between pod hair density and pod borer damage (%).

CONCLUSION

The results concluded that the varieties having more trichomes, pod hair density and pod thickness were less attacked by pod borer while dark green color without brown streaks attracted pod borer than light green color having brownish streaks.

AUTHORS' CONTRIBUTION

QA and IN designed and supervised the study, MKM, MBBI, MS and AA executed the trial, MFA, MS and AA wrote the research article, executed the trial, HM, AA and NAA statistically analysed the data, MUQ provided helping material to the researchers, QA, IN, KH and MUQ proof read the research article and AA corresponded for publication.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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