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Screening of green gram varieties/genotypes for their resistance to spotted pod borer, *Maruca testulalis* Geyer

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Abstract
With a view to know the susceptibility of green gram genotypes/varieties to spotted pod borer, *Maruca testulalis* Geyer, an experiment was carried out at Pulse Research Station, Junagadh Agricultural University, Junagadh during summer season of 2021. The lowest larval population of spotted pod borer was recorded in GJM-1710 (4.32 larvae/plant), which was significantly lower than those recorded in the other genotypes/varieties. The next promising variety was GAM-5 (5.00). GJM-1821 (5.16), GJM-1803 (5.84), GJM-1703 (5.92) and GJM-1837 (6.00) were found mediocre in their effectiveness as the spotted pod borer population was higher in them. Variety GJM-1710 (2.08) was categorized into a group of highly resistant (HR) and variety GAM-5 (2.23) and GJM-1821 (2.26) was categorized into a group of resistant (R). Genotypes/varieties: GJM-1803 (2.40), GJM-1703 (2.43) and GJM-1837 (2.46) were categorized into a group of moderately resistant (MR). In contrast, the green gram variety GM-4 (2.53) exhibited greater susceptibility to spotted pod borer infestation and was therefore classified as moderately susceptible (MS). Meha (2.74) was categorized into susceptible (S). GJM-1714 (2.97) and GJM-1818 (3.23) were categorized into highly susceptible (HS).

Keywords: *Maruca testulalis Geyer*, spotted pod borer, green gram, susceptibility and genotypes/varieties

Introduction
Among the different pulses, green gram, *Vigna radiata* (Linnaeus) Wilczek is the ancient and well-known leguminous crop of Asia, belonging to Leguminoceae family. It is one of the thirteen food legumes grown in India and the third most important pulse crop of India after chickpea and pigeon pea. Green gram is known by several common names, mung, mungo, mung bean, golden gram, chickasaw pea and oregan pea, *etc*. In India, mungbean is commonly referred to as green gram (Chatterjee and Randhawa, 1952) [5].

The green gram is native to the India-Burma region of Southeast Asia. It is cultivated extensively in India, Burma and Thailand region of Asia. About 70 per cent of the world's production of green gram is in India wherein it is cultivated annually in an area of 2.99 million hectares with total production and average productivity of 1.02 million tonnes and 343 kg/ha, respectively (Anon., 2004). In India, green gram is cultivated in about 30.48 lakh ha with an annual production of 13.45 lakh tonnes and average productivity of 441 kg/ha (Anon., 2020).

The major green gram growing states are Orissa, Andhra Pradesh, Maharashtra, Karnataka, Gujarat and Bihar. It is grown in Gujarat state in an area of 2.92 lakh hectares contributing to the annual production of 0.37 lakh tonne with a yield of 1285.22 kg/ha as average productivity (Anon., 2018). Kutch, Junagadh, Banaskantha, Mahesana, Patan, Panchmahal, Anand, Sabarkantha, Navsari and Surat are the green gram growing districts in the state. Of late in India the average productivity of green gram crop has rather remained static due to several reasons *viz*., lack of suitable seed production techniques, cultural practices, inefficient harvest and post-harvest operations, improper storage management practices, *etc*. Green gram seed is bound to show rapid and greater losses both quantitatively and qualitatively due to attack of several insect pests at both pre- and post-harvest stages. As many as 65 different species of insects live and feed on green gram crops at different stages of pre-and post-harvest (Lal, 1985) [8].

Among the various insect pests, *Maruca testulalis* Geyer is the most formidable and potential pest of green gram (Saxena *et al*., 1972) [10]. The spotted pod borer is also known as legume pod borer, *Maruca testulalis* Geyer (Lepidoptera; Pyralidae) is a serious pest of grain legumes in the tropics and subtropics because of its extensive host range, distribution and destructiveness. It was first reported by Dietz (1914) [6] on beans in Indonesia and described by Hubner but the work was published later on by Geyer. Due to its destructiveness at critical stages of crop growth *viz*, flowering and pod development stages especially to the economic plant parts such as flower buds, flowers and pods, it becomes a significant constraint to attain the maximum productivity from grain legumes. The peak activity of *M. testulalis* has been observed during July, August and October (Lalasangi, 1988) [9]. The yield losses caused by *M. vitrata* have been estimated to be around 30 million dollars annually in India (Saxena *et al*., 2002) [11].

This pest attacks during the flowering and pod formation stage. The infested flowers and pods are webbed together and larvae feed on webbed plant parts by remaining hidden within the nest. Sometimes larva may also bore into pods to feed on seeds and migrate from one pod to another by drawing adjacent pod, which is plugged with plenty of excreta (Chatterjee and Bhattacharya, 1986) [4]. It has been estimated that nearly 30 per cent of damage is caused by this pest (Sontakke and Muduli, 1990) [12]. Hence, by considering the importance of the pests and the crop in the national economy and human nutrition, a study was carried out to know resistance of green gram genotypes/varieties to spotted pod borer, *Maruca testulalis* Geyer at JAU, Junagadh, during summer season of 2021.

Materials and Methods

Different genotypes/varieties of green gram were tested for their susceptibility to spotted pod borer, *M. testulalis* under field condition at Pulse Research Station, Junagadh Agricultural University, Junagadh during the summer, 2021. Different 10 green gram genotypes/varieties (Table 1) were sown in the second week of March, 2021 a plot measuring 4.5 m × 2.7 m and 3.6 m × 2.4 m gross and net plot size respectively with the spacing of 45 cm x 15 cm between rows and plant in Randomized Block Design replicated three times. The crop was grown successfully using recommended agronomic practices.

For recording observation on spotted pod borer incidence, five plants were randomly selected and tagged in each net plot. The observations on spotted pod borer, *M. testulalis* larval population and pod damage were recorded at a weekly interval from germination to harvest the crop. The green gram seed yield was recorded from the net plot area after harvesting. The whole experimental plot was kept free from any pesticide application. The data obtained were subsequently subjected to statistical analysis to determine the relative response of different green gram genotypes/varieties to infestation by spotted pod borer, *Maruca testulalis*.

Categorization of genotypes/varieties

To assess the variation in infestation by spotted pod borer, *Maruca testulalis* Geyer among the ten green gram genotypes/varieties, they were classified into different categories. Kansagra (2018) has categorized the green gram genotypes/varieties into six groups *viz*., highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible. For this purpose, the mean value of individual genotype ($\bar{x}_i$) was compared with the mean value of all genotypes ($\bar{x}$) and standard deviation (SD). The retransformed data was used for computation of $\bar{x}$, $\bar{x}_i$ and SD in the case of this parameter. The scale used for categorizing different genotypes/varieties are as under;

Category of resistance	Scale for resistance
Highly resistant (HR)	$\bar{x}_i < (\bar{x} - 2SD)$
Resistant (R)	$(\bar{x} - 2SD) < \bar{x}_i < (\bar{x} - SD)$
Moderately resistant (MR)	$(\bar{x} - SD) < \bar{x}_i < \bar{x}$
Moderately susceptible (MS)	$\bar{x} < \bar{x}_i < (\bar{x} + SD)$
Susceptible (S)	$(\bar{x} + SD) < \bar{x}_i < (\bar{x} + 2SD)$
Highly susceptible (HS)	$\bar{x}_i > (\bar{x} + 2SD)$

Results and Discussion

To check the susceptibility of green gram genotypes/varieties, 10 genotypes/varieties were screened for the resistance/susceptibility to spotted pod borer at Pulse Research Station, Junagadh Agricultural University, Junagadh during summer, 2021. The results obtained for the larval population of the spotted pod borer, *Maruca testulalis* on ten different genotypes/varieties are presented in Table 1. The results presented in Table 1 revealed that all the genotypes/varieties exhibited infestation by the pest; and none was completely free from its occurrence. The infestation of this pest ranged from 4.32 to 10.43 larvae per plant in different varieties of green gram. The data in Column 2 of Table 1, revealed the order of various genotypes/varieties based on the number of spotted pod borer larvae per plant is given in bracket was: GJM-1710 (4.32) < GAM-5 (5.00) < GJM-1821 (5.16) < GJM-1803 (5.84) $\leq$ GJM-1703 (5.92) $\leq$ GJM-1837 (6.00) < GM-4 (6.46) < Meha (7.52) < GJM-1714 (8.80) < GJM-1818 (10.43).

The data on per cent pod damage (Column 3 in Table 1) noted that the genotypes/varieties GJM-1710, GAM-5, GJM-1821, GJM-1803, GJM-1837 and GJM-1703 were found resistant as they recorded 7.52, 8.08, 8.64, 9.13, 9.23 and 9.30 per cent pod damage, respectively. Whereas, the GM-4 (9.71 per cent pod damage) was found moderately susceptible and Meha (10.35 per cent pod damage) was found susceptible. The genotypes GJM-1714 and GJM-1818 were found highly susceptible which gave 11.22 and 12.94 per cent pod damage, respectively.

The incidence of spotted pod borer in green gram varied significantly among the different genotypes/varieties. The genotype GJM-1710 (4.32 larvae/plant) recorded significantly lower infestation than the rest of the genotypes/varieties followed by GAM-5 (5.00) and GJM-1821 (5.16). The next best genotypes/varieties are GJM-1803 (5.84), GJM-1703 (5.92) and GJM-1837 (6.00) which was at par with each other in their susceptibility. Green gram variety GM-4 (6.46), Meha (7.52) and GJM-1714 (8.80) were found less resistant towards the susceptibility to this pest. Among the evaluated genotypes/varieties, the highest (10.43) spotted pod borer, *M. testulalis* population was noticed in variety GJM 1818. In all, the infestation of *M. testulalis*, was found minimum in the green gram variety GJM-1710 while the highest infestation was found in the green gram variety GJM-1818.

Table 1: Relative susceptibility of different genotype/variety of green gram to spotted pod borer, M. testulalis

Name of genotype / variety	Mean number of larvae per plant	Pod damage (Per cent)	Yield (kg/ha)
1	2	3	4
GJM-1714	2.97* (8.80)	19.52** (11.22)	492.81
Meha	2.74 (7.52)	18.75 (10.35)	573.09
GJM 1837	2.46 (6.00)	17.66 (9.23)	778.32
GM-4	2.53 (6.46)	18.11 (9.71)	589.80
GJM 1710	2.08 (4.32)	15.89 (7.52)	843.67
GJM 1803	2.40 (5.84)	17.58 (9.13)	781.33
GJM-1703	2.43 (5.92)	17.74 (9.30)	749.18
GAM-5	2.23 (5.00)	16.47 (8.08)	815.33
GJM 1818	3.23(10.43)	21.07(12.94)	455.32
GJM 1821	2.26 (5.16)	17.06 (8.64)	799.31
General Mean	2.53	-	687.82
ANOVA			
S. Em.	0.15	0.53	43.70
C. D. at 5%	0.45	1.57	119.83
C. V. %	10.27	9.52	11.01

Notes

1. $*\sqrt{x}$ transformation, ** Arcsine transformation
2. Figures in parentheses are retransformed values

Categorization of green gram genotypes/varieties for susceptibility

The different green gram genotypes/varieties were also grouped into six categories of resistance *viz*., highly resistant (HR), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) based on spotted pod borer population and its damage on green gram flower by comparing the mean incidence of individual genotypes/varieties ($\bar{x}_i$) with a mean incidence of all genotypes/varieties ($\bar{x}$) and standard deviation (SD). The categorization of different green gram genotypes/varieties are summarized in Table 2.

Table 2: Categorization of green gram genotype/variety for their susceptibility to spotted pod borer, M. testulalis

Category of resistant	Scale	Genotype/variety
1	**2**	**3**
Highly resistant	$\bar{x}_i < (2.11)$	GJM-1710 (2.08)
Resistant	$(2.11) < \bar{x}_i < (2.32)$	GAM-5 (2.23), GJM-1821 (2.26)
Moderately resistant	$(2.32) < \bar{x}_i < (2.53)$	GJM-1803 (2.40), GJM-1703 (2.43), GJM-1837 (2.46)
Moderately susceptible	$(2.53) < \bar{x}_i < (2.74)$	GM-4 (2.53)
Susceptible	$(2.74) < \bar{x}_i < (2.95)$	Meha (2.74)
Highly susceptible	$\bar{x}_i > (2.95)$	GJM-1714 (2.97), GJM-1818 (3.23)

Notes

1. S.D.: 0.21
2. Figures in parentheses are larvae/plant on green gram

Based on the infestation of spotted pod borer, *M. testulalis*

Variety GJM-1710 (2.08) categorized into a group of highly resistant (HR) as the infestation was recorded < 2.10 larvae/plant and variety GAM-5 (2.23) and GJM-1821 (2.26) categorized into a group of resistant (R) as the infestation ranged from 2.11 to 2.32 larvae/plant. Genotypes/varieties: GJM-1803 (2.40), GJM-1703 (2.43) and GJM-1837 (2.46) categorized into a group of moderately resistant (MR) as the infestation levels varied from 2.32 to 2.53 larvae/plant. In the case of GM-4 (2.53), the infestation ranged from 2.53 to 2.74 larvae/plant and so was categorized into moderately susceptible (MS) group. In Meha (2.74), the infestation was recorded in the range of 2.74 to 2.95 larvae/plant and so was categorized into susceptible (S) group. While in the case of GJM-1714 (2.97) and GJM-1818 (3.23), the infestation was recorded more than 2.95 larvae/plant and so was categorized into highly susceptible (HS) group.

While spanning the information on this aspect from the published reports, variety GM-4 was considered as moderately susceptible by recording 2.29 larvae per plant as well as13.59 per cent pod damage (Umbarkar and Parsana, 2013) [13]. In all, GJM-1710, GAM-5, GJM-1821, GJM-1803, GJM-1703 and GJM-1837 recorded lowest population and found resistance to *M. testulalis*.

Yield

The different genotypes/varieties of green gram tested for spotted pod borer to their susceptibility, the data (Column 4 in Table 1) significant differences were observed among the genotypes/varieties with respect to seed yield. The chronological order of various genotypes/varieties recorded the highest yield, based on seed yield (kg/ha) given in bracket was: GJM-1710 (843.67) $\geq$ GAM-5 (815.33) $\geq$ GJM-1821 (799.31) $\geq$ GJM-1803 (781.33) $\geq$ GJM-1837 (778.32) $\geq$ GJM-1703 (749.18) > GM-4 (589.80) $\geq$ Meha (573.09) $\geq$ GJM-1714 (492.81) > GJM-1818 (455.32). Among the different genotypes/varieties, GJM-1710 was found the best variety and recorded significantly higher (843.67 kg/ha) seed yield than rest of the genotypes/varieties but it was at par with the GAM-5 (815.33), GJM-1821 (799.31), GJM-1803 (781.33), GJM-1837 (778.32) and GJM-1703 (749.18) which was followed by GM-4 (589.80). There was no statistical difference in seed yield obtained from the genotypes/varieties GM-4 and

Meha, GJM-1714 as they did not differ significantly from each other. GJM-1818 was recorded significantly the lowest (455.32 kg/ha) seed yield under the investigation.

Conclusion

Among the different genotypes/varieties of green gram screened for their relative vulnerability to spotted pod borer, the lower incidence of spotted pod borer was observed in GJM-1710 (4.32 larvae/plant) than the rest of the genotypes/varieties. The next promising variety was GAM-5 (5.00). GJM-1821 (5.16), GJM-1803 (5.84), GJM-1703 (5.92) and GJM-1837 (6.00) exhibited moderate performance in their effectiveness as the spotted pod borer population was higher. Variety GJM-1710 (2.08) categorized into a group of highly resistant (HR) as the infestation was recorded < 2.10 larvae/plant and variety GAM-5 (2.23) and GJM-1821 (2.26) categorized into a group of resistant (R) as the incidence was recorded in the range of 2.10 to 2.31 larvae/plant. Genotypes/varieties: GJM-1803 (2.40), GJM-1703 (2.43) and GJM-1837 (2.46) categorized into a group of moderately resistant (MR) as the infestation was noticed in the range of 0.31 to 2.53 larvae/plant. While, green gram variety GM-4 (6.46) was found less resistant towards the susceptibility of this pest and thus, this variety was classified as moderately susceptible (MS). Meha (7.52) was categorized into susceptible (S). GJM-1714 (8.80) and GJM-1818 (10.43) were classified as highly susceptible (HS).

Considering the yield of the genotypes/varieties, the highest (843.67 kg/ha) seed yield was harvested from the variety GJM-1710 than the remaining genotypes/varieties followed by GAM-5 (815.33), GJM-1821 (799.31), GJM-1803 (781.33), GJM-1837 (778.32) and GJM-1703 (749.18). The next genotypes/varieties which yielded lower were GM-4, Meha and GJM-1714 in which yield was recorded in the range of 589.80 to 492.81 kg/ha. Variety GJM-1818 recorded significantly the lowest (455.32 kg/ha) seed yield under the investigation.

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