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Screening of Field Pea (*Pisum sativum* L.) Genotypes for their Susceptibility against Pod Borers

Shraddha Tare [a*], Nanda Khandwe [a], Subhashree Patnaik [a] and Ghanshyam Bamaniya [b]

[a] Department of Entomology, RVSKVV- RAK College of Agriculture, Sehore- 466001, Madhya Pradesh, India.
[b] Department of Genetics and Plant Breeding, RVSKVV- RAK College of Agriculture, Sehore -466001, Madhya Pradesh, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors ST, NK, SP and GB conceived, designed the study and conducted the experiment. Author ST performed the statistical analysis. Author ST wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation on the varietal screening of 13 pea genotypes including a check was carried out at Agricultural Research Farm, RAK College of Agriculture, Sehore, M.P. during *Rabi* 2020-2021. The larval population of *H. armigera* was found to be minimum in Pant P 484 with 1.21 larvae/ plant, with a pod damage of 2.28%, and maximum in KPMR 942 with 2.01 larvae/ plant, with a pod damage of 12.82% which was found statistically at par with HFP 16-02 with 1.91 larvae/ plant (12.37% pod damage). The maximum population of *L. boutiques* was also recorded on KPMR 942 (2.22 larvae/ plant) with pod damage of 15.00% followed by HFP 16-02 (13.40%) while it was

**Corresponding author: E-mail: tareshraddha09@gmail.com;*

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minimum in Pant P 484 (1.36 larvae/ plant) with 2.83% pod damage. The result on the yield was maximum in Pant P 484 with 2818 kg/ha and the minimum yield was recorded in KPMR 942 with 919 kg/ha during the crop period. Out of a total of 13 varieties tested for infestation by the pod borers, three varieties (Pant P 484, IPFD 20-03 and IPFD 12-02) were found to be highly resistant, two varieties (Pant P 480 and IPFD 11-05) were least susceptible, four varieties (Pant P 479, RNCP 14-13, IPFD 20-09 and IPFD 20-02) were considered to be moderately susceptible, and four varieties (KPMR 942, HFP 17-11, HFP 16-02 and IPFD 10-12) were reported to be highly susceptible. By identifying resistant genotypes, we can adopt more targeted and sustainable strategies to combat pod borers, reducing reliance on chemical pesticides and minimizing crop losses. These resistant genotypes could also serve as valuable genetic resources for future breeding programs aimed at developing improved cultivars with enhanced resistance and contribute to the broader field of integrated pest management in field pea cultivation.

Keywords: Reaction; Helicoverpa armigera; Lampides boeticus; resistant; susceptibility; larval population; pod damage; field pea.

1. INTRODUCTION

A staple of the vegetarian diet, field pea (*Pisum sativum* L.) also known as ‘matar’ in hindi are legumes, which are plants that grow pods with seeds or beans within. Field peas are a cool-season legume from the diverse genus *Pisum* of the Fabaceae family that is cultivated for fresh or dried seed and fodder in more than 100 different nations. It is grown largely for its high nutritional content and acts as an affordable source of digestible protein, carbs, fat, vitamins, and minerals [1]. One hundred grams of dried edible pea seed contain 62.1 grams of carbohydrates (19.2%), 22.5 grams of protein (7.2%), 1.8 grams of lipids and fat, 64 milligrams of calcium, 4.8 milligrams of iron, 0.15 milligrams of riboflavin (vitamin B2), 0.72 milligrams of thiamine (vitamin B1), 2.4 milligrams of niacin (vitamin B3), 80 per cent phosphorus, Vitamin, Vitamin C and 0.8 per cent mineral matters [2,3,4]. The high protein content of field peas makes them a valued vegetable. Moreover, they play a crucial role in restoring soil fertility because of their nitrogen-fixing ability. They also serve as a rotation crop to disrupt mono-cropping practices, which negatively impact the environment [5]. Field pea is cultivated on 0.64 million hectares in India, with a yield of around 0.88 million tonnes and productivity of 1375 kg/ha [6]. However, many constraints have been identified limiting its production and insect pests are one among them. Insect pests such as the pea leaf miner, *Phytomyza horticola* (Goureau), gram pod borer, *Helicoverpa armigera* (Hubner), blue butterfly *Lampides boeticus* (L.), pea pod borer *Etiella zinckenella* (Treitsshke), pea aphid, *Acyrthosiphon pisum* (Harris), pod fly, *Melanogromyza obtuse* (Malloch), severely affect crop production and causes huge losses in its production [7,8]. Pod borers of Lepidoptera have been reported to cause damage ranging from 5.5 to 12.5 per cent [9]. These pests are managed with a variety of controls, most notably chemical pesticides. When used for plant protection, chemicals now have a number of negative consequences for the environment and pest populations leading to the development of insecticide resistance, pest resurgence, secondary pest outbreak, etc. To address these issues, non-chemical approaches to pest control need to be promoted. One such technique of creation and search for resistant plant material can prove to be a promising strategy.

2. MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Farm, RAK College of Agriculture, Sehore during *Rabi*, 2020-21. The field was prepared by using the standard package of practices and the trial was laid out in a randomized block design with three replications. Thirteen field pea genotypes were sown in a plot size of 7.2 m^2 (1.8 x 4.0 m) with six rows keeping a distance of 30 cm and a plant-to-plant distance of 10 cm. The genotypes were screened for their susceptibility to pod borers under natural insect infestation in the field.

For the observation of the larval population of pod borers on plants, three randomly selected plants from each genotype were tagged and the larval population of borers were recorded at weekly intervals starting from the pod formation stage till the crop harvest and the overall mean population was computed. The groundsheet method was used to count the *H. armigera* larval population where we placed a sheet on the ground and counted the larvae that were caught

Table 1. Pest Susceptibility Rating

Pest Susceptibility Rating (PSR)	Pest susceptibility (%)/ resistance (%)	Remarks
1	100%	Highly
2	75 to 99.9%	resistant
3	50 to 74.9%	
4	25 to 49.9%	Least
5	10 to 24.9%	susceptible
6	-10 to 9.9%	Moderately
7	-25 to -9.9%	susceptible
8	-50 to -24.9%	Highly
9	-50% or less	susceptible

by shaking the plant. The population of *L. boeticus* was also counted using the ground sheet method and the visual count method (by opening 3 pods from randomly selected 3 plants of each replication). For this, pod damage and pod yield were recorded from the sampled plants after maturity. The damage of the pod borers was differentiated as, in *H. armigera*: pods with round holes and *L. boeticus*: flowers and young pods with boreholes and the presence of slug-like caterpillar.

The total number of pods and the damaged pods were counted per plant, and the data were analyzed to determine the per cent of pod damage caused by each borer using the formula:

$$Pod\ damage\ percent\ = \frac{\text{No. of damaged pods per plant}}{\text{Total no. of pods per plant}} \times 100$$

By using Pant P 479 genotype as a check, the Pest Susceptibility percent was calculated [10].

$$Pest\ susceptibility\ percent\ = \frac{\text{Pod damage (\%) of check} - \text{Pod damage (\%) of test of entry}}{\text{Pod damage (\%) of check}}$$

Susceptibility for pod borer complex damage in field pea genotypes was rated using a scale of 1-9 [11]. The percent pest susceptibility was further converted into 1 to 9 rating scale as mentioned in Table 1.

The grain yield (g) per plant was recorded at harvest and converted into kg/ha and calculated under different treatments as given below:

Yield /ha = Factor grain yield/plot

Where, Factor = (10,000/Net plot size) in sq. m.

3. RESULTS AND DISCUSSION

3.1 Gram Pod Borer, *Helicoverpa armigera* (Hubner)

The larvae of *Helicoverpa armigera* fed on leaves, inflorescence, pods, and seeds of the crop and caused significant damage. The larval population (Table 2 and Fig. 1) of *H. armigera* was found minimum in Pant P 484 with 1.21 larvae/ plant with per cent pod damage of 2.28 per cent followed by IPFD 12-02 (1.29 larvae/ plant) and IPFD 20-03 (1.35 larvae/ plant) with 2.86 per cent and 3.57 per cent respectively and were rated as highly resistant. The percentage of pod damage found in Pant P 480 (1.47 larvae /plant) was 5.56 per cent and IPFD 11-05 (1.40 larvae /plant) was 4.78% making them least susceptible. Further, IPFD 20-09 (1.53 larvae/ plant), Pant P 479(1.59 larvae/ plant), IPFD 20-02 (1.66 larvae/ plant) and, RNCP 14-13 (1.69 larvae/plant), were found to be moderately susceptible having percentage pod damage as 7.41, 7.90, 8.21 and 9.15 per cent respectively. Four varieties were categorised as highly susceptible to pod damage by *H. armigera* were KPMR 942 (2.01 larvae/plant) which reported the highest pod damage of 12.82 per cent followed by HFP 16-02 (1.91 larvae/ plant), IPFD 10-12 (1.83 larvae/ plant) and HFP 17-11(1.77 larvae/ plant) with 12.37,11.64 and 10.05 per cent of pod damage. These findings are in conformity with that of Abhilasha [12], who, out of 15 genotypes reported two varieties, GS-10 and DS-10 of peas to be moderately resistant to pod borers whereas, Arka Karthika, Arka Ajit, and Arka Sampoorna were rated as resistant and remaining were classified as intermediate and susceptible. Similarly, the findings of Singh et al. [13] also revealed that maximum pod damage in the HFP-716 pea variety with 12.00 per cent and a minimum of 1.91 per cent pod damage in Pant P-183, Pant P-184, RFP-61, KPMR-913, and VL-54. These results are also in agreement with

Krishna et al. [14] who screened 50 field pea germplasms and found that VL 58 and Pant P 195 germplasms had the highest pod borer population of 4.47/5 plants, while IPFD 12-2 and RG 3 had the lowest population of 0.17 pod borer/5 plants. The findings are also in close agreement with that of Verma et al. [15] whose findings considered three genotypes (HFP-1137, HFP-530B and HFP-529) as resistant (PSR 2), thirteen genotypes as moderately resistant (PSR 3-5) and one genotype (HFP-8712) as highly susceptible (PSR-8) against *H. armigera.* Accordingly, screening by Chauhan et al. [16] also indicated a significant minimum larval population (0.39 larva/plant) on germplasm Pant P 418 and also recorded significantly lower (3.24%) pod damage while highest population was found on HFP 4.

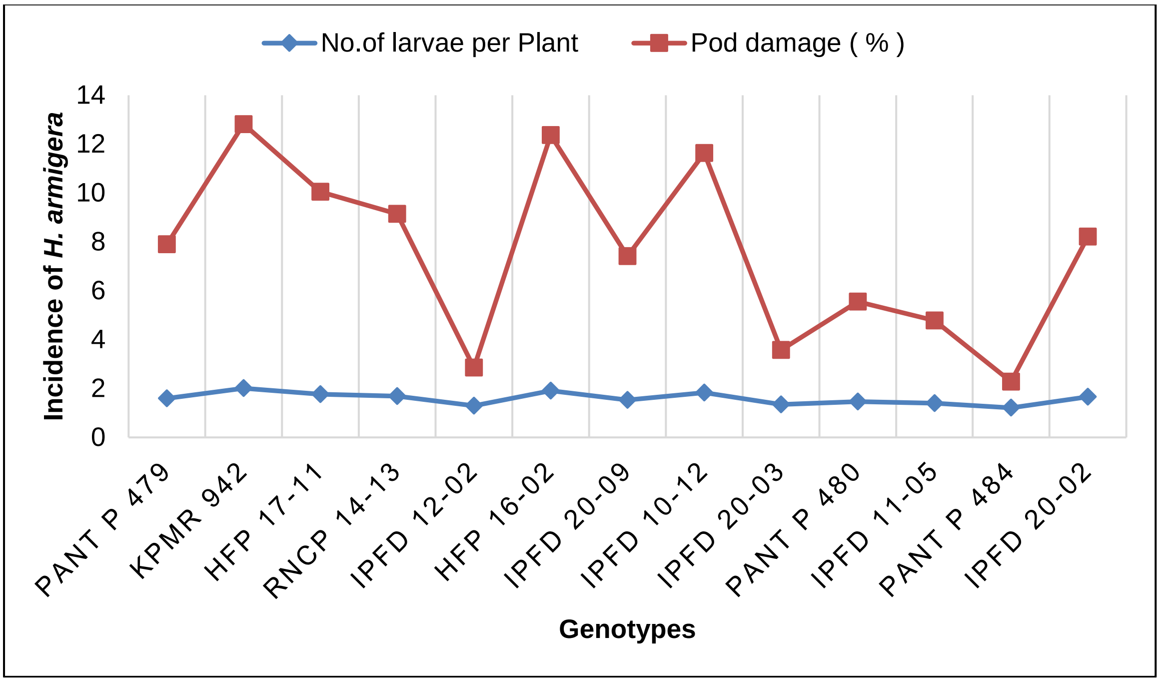

Fig. 1. Larval population and pod damage of *H. armigera* in pea during *Rabi*, 2020-21

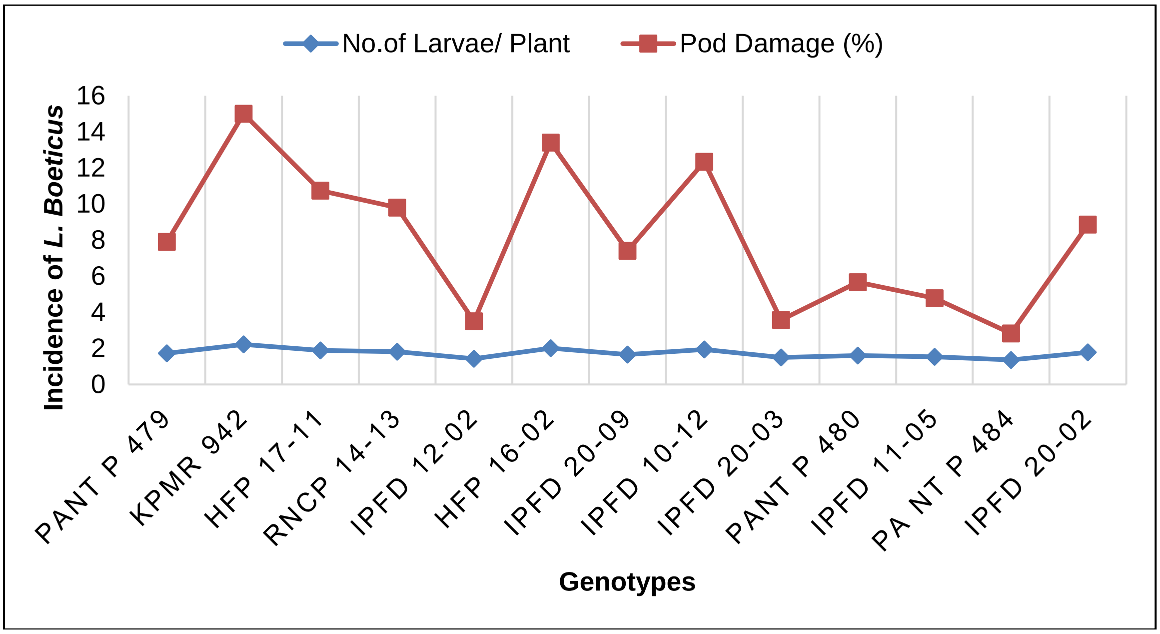

Fig. 2. Larval population and pod damage of *L. boeticus* in pea during *Rabi*, 2020-21

Table 2. Larval population, Pod damage (%) and Pest Susceptibility Rating (PSR) for *H. armigera* and *L. boeticus* in pea during *Rabi*, 2020-21 and yield of screened pea varieties

S. No.	Genotypes	*Helicoverpa armigera*			*Lampides boeticus*			Yield (Kg/ha)
		No. of larvae per plant	Pod damage (%)	Pest Susceptibility Rating (PSR)	No. of larvae per plant	Pod damage (%)	Pest Susceptibility Rating (PSR)	
1	Pant P 479	1.59 (1.61)*	7.90 (16.21)**	6	1.72 (1.65)*	7.90 (16.21)**	6	2426
2	KPMR 942	2.01 (1.74)	12.82 (20.81)	9	2.22 (1.79)	15.00 (22.47)	9	919
3	HFP 17-11	1.77 (1.66)	10.05 (18.26)	8	1.89 (1.70)	10.74 (18.84)	8	1853
4	RNCP 14-13	1.69 (1.64)	9.15 (17.44)	7	1.81 (1.68)	9.80 (18.00)	7	2065
5	IPFD 12-02	1.29 (1.51)	2.86 (9.63)	3	1.43 (1.56)	3.51 (10.55)	3	2787
6	HFP 16-02	1.91 (1.71)	12.37 (20.40)	9	2.02 (1.74)	13.40 (21.21)	9	1406
7	IPFD 20-09	1.53 (1.59)	7.41 (15.71)	6	1.66 (1.63)	7.41 (15.71)	6	2435
8	IPFD 10-12	1.83 (1.68)	11.64 (19.80)	8	1.94 (1.72)	12.34 (20.35)	9	1694
9	IPFD 20-03	1.35 (1.53)	3.57 (10.65)	3	1.49 (1.58)	3.57 (10.65)	3	2651
10	Pant P 480	1.47 (1.57)	5.56 (13.51)	4	1.60 (1.61)	5.67 (13.64)	4	2472
11	IPFD 11-05	1.40 (1.55)	4.78 (12.56)	4	1.54 (1.59)	4.78 (12.56)	4	2538
12	Pant P 484	1.21 (1.49)	2.28 (8.57)	2	1.36 (1.54)	2.83 (9.37)	3	2818
13	IPFD 20-02	1.66 (1.63)	8.21 (16.53)	6	1.78 (1.67)	8.86 (17.13)	7	2237
S.E.(m) ±		**0.01**	**0.55**	**-**	**0.01**	**0.72**	**-**	**156.8**
C.D. (p = 0.05)		**0.04**	**1.63**	**-**	**0.03**	**2.11**	**-**	**469.2**

**values in parentheses are $\sqrt{x+0.5}$ transformed values; **values in parentheses are arc sine transformed values*

3.2 Blue Butterfly, *Lampides boeticus* (Linnaeus)

The crop was observed to be impacted by *L. boeticus* larvae, which bore into the floral buds and pea pods and severely damaged them with internal feeding. The maximum population (Table 2, Fig. 2) of *L. boeticus* was recorded on KPMR 942 (2.22 larvae/ plant) with 15 per cent pod damage, followed by HFP 16-02 (2.02 larvae/ plant), IPFD 10-12 (1.94 larvae/ plant) and by HFP 17-11 (1.89 larvae/ plant), having pod damage of 13.40 per cent, 12.34 per cent, and 10.74 per cent respectively and all were rated as highly susceptible cultivars, while the attack was minimum in Pant P 484 with 1.36 larvae/ plant and pod damage of 2.83 per cent and was categorized as highly resistant followed by IPFD 12-02 (1.43 larvae/ plant) and IPFD 20-03 (1.49 larvae/ plant) with pod damage of 3.51 and 3.57 per cent respectively. Four varieties, IPFD 20-09 (1.66 larvae/ plant), Pant P 479 (1.72 larvae/ plant), IPFD 20-02 (1.78 larvae/ plant), and RNCP 14-13 (1.81 larvae/ plant) fall under the category of moderately susceptible cultivars with pod damage of 7.41, 7.90, 8.86 and 9.80 per cent respectively and the remaining two varieties Pant P 480 (1.60 larvae/ plant) and IPFD 11-05 (1.54 larvae/ plant) with pod damage of 5.67 and 4.78 per cent were considered as least susceptible. The present results are consistent with Vishal and Ram [11] who reported eleven genotypes as moderately resistant (PSR: 3-5) and six genotypes as highly susceptible (PSR: 8-9). Similarly, Kooner and Cheema [17] also identified three different pea genotypes, AL 1498, AL 1502, and AL 1340 as resistant and were deemed to be encouraging after being compared to check varieties (AL 15, AL 201, and T 21) and the infestor. Likewise, Singh et al*.* [18] evaluated early and late maturing field pea genotypes and revealed that per cent pod damage in early maturing genotypes was minimum (1 per cent) in Pant P-11, HUDP-15, LFP-283, KPMR-526 and KPMR 593 and maximum in HUDP 17 (4.0 per cent).The findings are also in accordance with Thilagam et al. [19] who found that the pod damage ranged from 1.3-30.5 per cent and out of seventy entries, sixty one entries were found to be highly susceptible, five entries were susceptible and three entries were moderately susceptible and AC9060 was moderately resistant to podborer complex.

3.3 Yield

The yield data (Table 2) revealed that Pant P 484 (2818 kg/ha) was recorded with the highest yield which was at par with IPFD 12-02 (2787 kg/ha) followed by IPFD 20-03 (2651 kg/ha) which was found at par with IPFD 11-05 (2538 kg/ha). Further, the yield of Pant P 480 was 2472 kg/ha which was found at par with IPFD 20-09 (2435 kg/ha) and Pant P 479 (2426 kg/ha). However, the lowest yield was recorded from HFP 16-02 (1406 kg/ha) which was at par with KPMR 942 (919 kg/ha).

4. CONCLUSION

Among thirteen genotypes, no genotype was discovered to be entirely free from infestation of pod borers. Larval population per plant was ranged from 1.21 to 2.01 and 1.36 to 2.22 for *H. armigera* and *L. boeticus,* respectively. The pea genotype KPMR 942 had the highest mean larval population and the highest percentage of pod damage, while Pant P 484 had the lowest mean larval population and the lowest percentage of pod damage for both the pod borers, and correspondingly, the yield was relatively highest in Pant P 484 and lowest in KPMR 942. It was also noted that out of 13 genotypes, three genotypes (Pant P 484, IPFD 20-03 and IPFD 12-02) were considered to be highly resistant, two genotypes (Pant P 480 and IPFD 11-05) were least susceptible, four genotypes (Pant P 479, RNCP 14-13, IPFD 20-09 and IPFD 20-02) were considered to be moderately susceptible, and four genotypes (KPMR 942, HFP 17-11, HFP 16-02 and IPFD 10-12) were reported to be highly susceptible to both the pod borer species.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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