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Screening of germplasm on mungbean against pod borer complex

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Abstract
Screening of germplasm of mungbean against pod borer complex was carried out during *Kharif* 2023 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). Among the 62 germplasm of mungbean, OBGG 110 observed the least pod damage (0.50%) caused by *Helicoverpa armigera*, whereas BM 4 observed least pod damage (1.00%) by *Maruca vitrata*. KM 2241 had maximum grain production of mungbean at 1225.00 kg/ha, followed by RMG1183 at 1145.00 kg/ha. Similarly, 9 germplasm are categorized under moderately resistant category followed by 21 germplasm under tolerant category, 27 germplasm are categorized under equal to check and 5 germplasm under moderately susceptible category. No germplasm was found to be under immune, highly resistant, resistant, susceptible and highly susceptible category.

Keywords: Mungbean, germplasm, screening, *Helicoverpa armigera*, *Maruka vitrata*

Introduction
Pulses, often known as "poor man's meat" and "rich man's vegetable," are major sources of proteins, vitamins, minerals and contribute significantly to the country's nutritional security. They are most popular in underdeveloped nations, but they are gradually being acknowledged as an important part of a balanced diet around the globe. Pulses, together with food grains and oilseeds, are key components of the Indian agricultural economy in terms of area, output, and economic value. The General Assembly of the United Nations has recognized pulses as an essential source of protein and apart of improving nutrition globally and declared 2016 as “The International Year of Pulses”. The United Nations Food and Agriculture Organization (FAO) has been nominated to proclaim a year for pulses, often known as legume.

Moong may be used as cattle fodder, and the seed husk can be soaked in water and used as well. These crops are grown in India throughout three separate seasons: *Kharif*, *Rabi*, and summer. Summer moong can be planted after pea, gram, potato, mustard, and linseed have been harvested. Plants are occasionally trimmed and ploughed into the soil to add nitrogen to the soil. Moong is used in a variety of forms in the home, including as whole grains, sprouted form, and dal. It is also grown as a green manure crop. It's a short-season crop that's drought-resistant and ideal for dry-land farming, and commonly employed in crop rotation (Ministry of Agriculture and Farmers Welfare, 2017).

Mungbean is preyed upon by a variety of insect pests. Insect pests that attack the mungbean plant can be categorized based on how they arrive in the field, which is linked to the phenology of the plant. Stem feeders, foliage feeders, pod feeders, and storage pests are the four types. This classification is useful for determining the economic importance of pests, particularly their impact on seed yield, as well as developing control strategies. Different insect pests attack mungbean, but sucking insect pests (aphids, jassids, leaf hoppers, and whiteflies) are the most common.

Materials and Methods
The experiment was carried out during *Kharif* 2023-2024 at the Research and Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya in Raipur (C.G.), by growing a total of 62 mungbean germplasm in RBD design with 2 replications. The crop was sown on 27th july during *Kharif* 2023; maintaining a row to row and plant to plant spacing of 30 cm × 10 cm,

respectively. The observations were recorded as (i) Pod damage (%), percent pods damaged were separated on the basis of shape and size of the hole of different pod borers in 100 randomly collected pods from each plot at the time of harvest and the nature of damage of *Helicoverpa armigera* is large round and regular holes on the pods while *Maruca vitrata* cause irregular scrapping and holes on the pods. (ii) Yield Parameters: Grain yield was recorded at the time of harvest. Afterward, the total number of pods and the number of damaged pods by pod borers on each demarcated plant were counted and converted into percentage. The percentage of pod damaged and grain yield Kg/ ha were estimated with the help of following formula:

$$\text{Pod damage (\%)} = \frac{\text{Number of infested pods}}{\text{Total Number of pods (Healthy + Damage)}} \times 100$$

$$\text{Grain yield (kg/ha)} = \frac{\text{Weight of grains in kg/plot}}{\text{Plot area in } m^2} \times 10{,}000$$

The percentage of pod damage at maturity of test entry is compared with that of the check cultivar in the trial. The test entries are then graded using a formula derived from Abott (1925):

$$\text{Pest Resistance (\%)} = \frac{\text{P.D. of check-P.D. of test genotypes}}{\text{P.D. check}} \times 100$$

Where,
P. D. = Mean of % pod damaged

The pest resistance percentage is then converted to 1 to 9 rating adopting the following scale

Pest Resistance (%)	Score	Pest Resistance Rating (PRR)
100	1	Immune
75 to 99	2	Highly resistant
50 to 75	3	Resistant
25 to 50	4	Moderately resistant
10 to 25	5	Tolerant
-10 to 10	6	Equal to check
-25 to-10	7	Moderately susceptible
-50 to-25	8	Susceptible
-50 or less	9	Highly susceptible

Source: Technical program, IIPR, Kanpur, 2023

Statistical analysis

The data obtained were statistically analyzed after using the appropriate transformation. Data obtained from the population complex of pod borer larvae were converted to a square root transformation; Using the formula ($\sqrt{x}$ + 0.5), data on pod and grain damage from plants were first collected and then converted to percentage. Percentage data were processed under the $\sin^{-1}$ arcsine transform ($\sqrt{x}/100$) before statistical analysis. Then these transformed data were analyzed using the analysis variance method described by Gómez and 18 Gómez (1984). The "F" test was used at a 5 percent level of significance. The following formulae were used for standard error, critical difference and coefficient of variance estimations:

$$C.D. = \sqrt{\frac{2EMSR}{R}} \times t\ (D.F.\ at\ 5\%)$$

Results and Discussion

Screening of germplasm on mungbean against gram pod borer, *Helicoverpa armigera* (Hubner)

The incidence of insect pest was assessed in the percentage pod damage at the harvesting stage of the crop. Germplasm differed significantly in terms of percent pod damage, which ranged from 0.50 to 10.50 percent. Among the tested germplasm, the minimum pod damage by *H. armigera* was observed in germplasm OBGG110 with 0.50 percent, which was at par with LGG 460 and PM 1711 with 1.00 percent and IPM 1603-3, IPM 20-1, MH 1830, ML 2506, ML 818, SML 2015 with 1.5 percent pod damage, respectively whereas the maximum pod damage was observed in germplasm BCM 20-5 with 10.50 percent (Table 1).

Our findings are similar with the findings of Yadav *et al.*, (2021), who estimated the minimal percentages of pod infestations by *H. armigera* in the four genotypes KU-99-05, Azad Urd-1, Shekhar-2, and PU-6 were noticed 5.83, 6.17, 8.50, and 9.83 percent, respectively. Kol *et al*., (2022) [3] tested seventy-six germplasm during *kharif* and the minimum pod damage percent was 0.5 in OBGG 109 and maximum was 10.5 in BCM 20-9.

Similar to this, Banu *et al.* (2007) found fifteen germplasm lines for resistance to *H. armigera* and discovered that ICPL-13201 had the lowest pod damage (25%) and greatest yield (60.35 g/plant), followed by ICPL-13028 (28%) and ICPL-11964 (29%).

Screening of germplasm on mungbean against spotted pod borer, *Maruca vitrata* (Geyer)

The insect pest incidence was observed in terms of percent pod damage at the harvesting stage of the crop. The germplasm showed significant differences with each other for percent pod damage, which varied from 1.00 percent to 13.00 percent. Among the tested germplasm, the minimum pod damage by *M. vitrata* was observed in germplasm BM-4 with 1.00 percent, which was at par with ML 2500 at 1.00 percent pod damage, MH 1142 with 2.5 percent pod damage, BCM 18-1, IPM 1604-1, IPMD 1603-7, Kopergoan at 2.5 percent pod damage, respectively. Whereas the maximum pod damage was observed in OBGG 107 with 13.00 percent (Table 1).

Our findings are also in agreement with the findings of Singh and Singh (2014) who tested the 30 mungbean genotypes against *Maruca vitrata*, in which RVSm-11-92 had the least pod damage, followed by PM-306-6, IEM 2K-15 4, MH-805, BM-4, DGGS-4, and BM-2002-2. Kol *et al*., (2022) [3] tested seventy-six germplam of Mungbean and she was found that the minimum pod damaged by *M. vitrata* was 1.00 percent in BM-4 and maximum 14.00 percent in OBGG104.

Similarly, Sandhya Rani *et al.* (2014) [1] found the preference of *M. vitrata* in five genotypes, where KM-9-128, KM-9-136, RMG-492, LGG-527, and LGG-538 were found to be tolerant, while the susceptibility of the other twenty-one genotypes ranged from 12.59 percent (MGG-332) to 20.0 percent (IPM-02-03 and LGG-522) and thirteen genotypes were highly susceptible ranging from 43.25 percent (KM-8-662). The others were extremely vulnerable, with a range of 20.21 (UPM-99-3) to 40.0 (KM-2241) percent.

Srivastava and Singh (2017) [6] also observed that, KM 2348 (19.26%) had the highest proportion of pod damage by *M. vitrata*, followed by BM 2012-9 (16.51%), AKM 12-17

(16.40%), PM 4 (15.06%) and IPM 312-20 (15.06%). Based on percent pod damage and the Pest Susceptibility Rating (PSR) score, VGG 10-008 was shown to be the genotype that was least susceptible to the spotted pod borer.

Table 1: Percent pod damage by pod borers and grain yield in different germplasm of mungbean (*Kharif* 2023).

S. No.	Germplasm	% Pod damage by *H. armigera*	% Pod damage by *M.* vitrata	Total% Pod damage by pod borers	PRR	Grain yield (kg/ha)
1.	AKM 1606	5.00(12.91)	5.00(12.65)	10.00(18.34)	6	930.00
2.	BCM 20-5	10.50(18.89)	5.00(12.90)	15.50(23.18)	7	1000.00
3.	BCM 20-73	7.00(15.32)	3.50(10.66)	10.50(18.86)	6	1100.00
4.	BM 2021-4	7.00(15.29)	3.00(9.93)	10.00(18.42)	6	1025.00
5.	BM 4	5.00(12.27)	1.00(6.73)	6.50(14.20)	4	1100.00
6.	DGG 214	10.25(18.65)	5.00(12.77)	15.25(22.92)	7	887.50
7.	IGKM 2021-1	7.50(15.81)	9.50(17.93)	17.00(4.30)	7	1005.00
8.	IPM 02-3	3.00(9.97)	5.00(12.65)	8.00(16.30)	5	1081.00
9.	IPM 1718-3	3.25(9.97)	12.00(20.11)	15.25(22.96)	7	1020.00
10.	IPM 2-14	2.50(8.90)	3.00(9.83)	5.50(13.56)	4	1000.00
11.	IPM 410-3	3.80(11.17)	5.00(12.85)	8.80(17.25)	5	900.00
12.	JLPM 707	6.00(14.12)	7.00(15.29)	13.00(21.13)	6	981.00
13.	JLPM 818-8	5.00(12.90)	5.00(12.91)	10.00(18.42)	6	1000.00
14.	KM 2241	3.00(9.93)	5.00(12.91)	8.00(16.42)	5	1225.00
15.	KM 2401	2.00(8.12)	10.00(18.06)	12.00(20.00)	6	1150.00
16.	KM 2417	3.05(10.75)	6.15(14.67)	10.00(18.41)	6	1015.00
17.	Kopargaon	5.25(13.20)	3.15(10.75)	8.75(17.16)	5	1035.00
18.	LGG 628	2.50(8.63)	8.00(16.3)	10.50(18.65)	6	965.00
19.	LGG 675	3.50(10.52)	3.25(10.37)	6.75(14.93)	5	1090.50
20.	LGG 685	1.50(6.93)	5.55(13.38)	7.05(15.30)	5	1046.50
21.	MGG 514	3.50(10.29)	6.00(13.92)	9.50(17.55)	5	906.49
22.	MGG 519	2.00(8.06)	3.00(9.830	5.00(12.90)	4	1112.00
23.	MH 1142	4.00(11.53)	3.50(10.66)	7.50(15.85)	5	1125.00
24.	MH 1890	1.75(7.57)	4.20(11.65)	5.95(14.05)	4	951.52
25.	MH1908	3.50(10.66)	7.00(15.29)	10.50(18.90)	6	1005.00
26.	MH 2-15	4.00(11.15)	3.00(9.97)	7.00(15.18)	5	966.50
27.	MI 13-47	2.50(9.09)	5.00(12.85)	7.50(15.85)	5	1049.00
28.	MI-2023-01	2.25(8.50)	6.00(14.16)	8.25(16.64)	5	1000.50
29.	ML 2738	2.00(7.85)	5.50(13.54)	7.50(15.88)	5	1031.42
30.	ML 2748	2.25(8.50)	1.50(6.93)	6.75(14.74)	4	1000.45
31.	ML 2878	1.00(5.73)	4.50(12.22)	5.50(13.54)	4	1032.00
32.	ML 2844	1.50(6.93)	4.00(11.44)	5.50(13.43)	4	957.50
33.	ML 818	1.50(7.03)	4.80(12.55)	6.30(14.47)	4	1042.00
34.	OBGG 107	2.15(9.04)	13.00(21.11)	15.50(23.17)	7	1015.43
35.	OBGG 110	0.50(4.05)	3.50(10.66)	4.00(11.44)	4	1004.39
36.	PM 2015	3.00(9.89)	6.75(14.84)	9.75(18.15)	6	1039.00
37.	PM 1918	4.25(12.24)	5.00(12.27)	9.50(17.73)	5	981.50
38.	PM 2031	7.00(15.29)	5.50(13.54)	12.50(20.66)	6	1059.50
39.	PM 4	3.75(11.15)	8.00(16.39)	11.75(20.03)	6	1047.00
40.	PM-6	3.00(9.83)	6.25(14.46)	9.25(17.66)	5	1093.50
41.	PMD 15	4.00(11.44)	3.50(10.77)	7.50(15.85)	5	1001.00
42.	PMS 8	3.50(10.75)	7.00(15.25)	10.50(18.88)	6	1119.00
43.	PUSA 0672	4.50(12.22)	5.00(12.91)	9.50(17.94)	6	1052.52
44.	PUSA 1371	5.00(12.82)	7.00(14.98)	12.00(20.00)	6	905.35
45.	PUSA 2371	4.00(11.53)	6.50(14.75)	10.50(18.90)	6	1040.50
46.	RM 03-79	5.00(12.85)	5.50(13.54)	10.50(18.86)	6	1046.00
47.	RMB 15-14	4.12(12.24)	7.00(15.25)	11.50(19.78)	6	1007.00
48.	RMG 1164	4.00(11.44)	6.00(13.97)	10.00(18.41)	6	1009.00
49.	RMG 1181	2.00(7.85))	6.00(13.97)	8.00(16.14)	5	1103.00
50.	RMG 1183	6.00(13.71)	4.50(12.22)	10.50(18.78)	6	1145.00
51.	RMG 1188	2.50(9.04)	5.00(12.91)	7.50(15.88)	5	1109.00
52.	RVSM 2213	4.50(12.22)	3.00(9.97)	7.50(15.88)	5	1062.50
53.	RVSM 22-3	5.00(12.91)	4.00(11.44)	9.00(17.43)	5	1000.00
54.	SKNM 2105	5.00(12.91)	5.50(13.54)	10.50(18.88)	6	1010.00
55.	SVM 106	4.25(11.63)	7.00(15.29)	11.25(19.45)	6	1008.00
56.	T-44	3.40(10.60)	8.25(16.46)	11.65(19.78)	6	812.50
57	TAKM 141	5.00(12.09)	5.00(12.49)	10.00(18.34)	6	890.50
58.	VBN 5	4.30(11.72)	6.00(13.86)	10.30(18.33)	6	1028.00
59.	VGG 20-157	4.00(11.51)	5.00(12.09)	9.00(17.43)	5	1013.33
60.	VGG 20-234	4.00(11.44)	4.50(12.16)	8.50(16.94)	5	1032.50
61.	IPM 512-1	3.75(11.00)	3.75(11.15)	7.50(15.85)	5	1082.50
62.	Pusa vishal (S.C.)	4.00(11.51)	7.50(15.81)	11.50(19.80)	6	860.00
	C.D at 5%	4.34	4.97	5.04		170.70
	SE (m)	1.53	1.75	1.78		60.21
	C.V	19.60	18.82	14.23		8.34

Figure in parenthesis is angular transformed value.

Table 2: Reaction of mungbean germplasm against pod borers during *Kharif* 2023

Pest Resistance Rating (PRR)	Categories	Total% Pod damage by pod borers	Grain yield (kg/ha)	No. of germplasm	Germplasm
1.	Immune	-	-	-	-----
2.	Highly resistant	-	-	-	-----
3.	Resistant	-	-	-	-----
4.	Moderately resistant	11.44-14.73	1000.45-1004.39	9	OBGG 107, BM 4, ML2 844, IPM 2-14, MH 1890, MGG519, ML 2748, ML 2878, ML2844, ML818.
5.	Tolerant	15.30-17.66	900.00-1103.00	21	IPM 02-3, IPM 410-3, KM 2241, Kopargaon, LGG 657, LGG 685 MGG 514, MH 1142, MH 2-15, MI 13-47, MI-2023-01, ML 2738, PM-6, PMD 15, RMG 1181, RMG 1188, RVSM 2213, RVSM 22-3, VGG 20-157, VGG 20-234, IPM 512-1.
6.	Equal to check	18.09-21.12	812.50-1145.00	27	AKM 1606, BCM 20-73, BM 2021-4, JLPM 707-27, JLPM 818-8, KM 2401, KM 2417, LGG 628, MH 1908, PM 1918, PM 2031, PM-4, PMS 8, PUSA 0672, PUSA 137, PUSA 2371, RM 0379, RMB 15-14, RMG 1164, RMG 1183, PM 2015, SKNM 2105, SVM 106, T-44, TAKM 141, VBN 5, Pusa vishal.
7.	Moderately Susceptible	22.92-24.30	887.00-1020.00	5	BCM 20-5, DGG 214, IGKM 2021-1, IPM 1718-3, OBGG 107.
8.	Susceptible	-	-	-	--------
9.	Highly susceptible	-	-	-	--------

Plate 1: Pod damage by gram pod borer (*Helicoverpa armigera*)

Plate 2: Pod damage by spotted pod borer (*Maruca vitrata*)

Screening of mungbean germplasm against gram pod borers and spotted pod borers (*H. armigera* and *M. vitrata*) during *Kharif* 2023

Out of 62 germplasms accessions, total 20 germplasms were selected for further studies (table 2). 20 germplasm accessions were selected, five from each category immune, *viz*., highly resistant, resistance, moderately resistant, tolerant, equal to check, moderately susceptible, susceptible and highly susceptible. The basis of germplasms selection was respect to pod damage percent by *Helicoverpa armigera*, *Maruca vitrata* and grain yield (kg/ha) in mungbean germplasm. From moderately resistant to tolerant category, germplasms showing least percent (11.44-17.66 percent) pod damage, total pod damage by pod borer and more yield were selected. From equal to check to moderately susceptible category, germplasm having more percent (18.09-24.30 percent) pod damage, total pod damage percent by pod borer and less yield were selected. The data of susceptible check (Pusa vishal) was the average of equal to check.

The more or less similar result found by Sandhya *et al.* (2014) [1] reported that, the five genotypes, KM-9-128 (3.5%), KM-9-136 (5.8%), RMG-492 (8.34%), LGG-527 (9.5%) and LGG-538 (10.0%) were found as tolerant and twenty one genotypes showed susceptibility with a range from 12.59 (MGG-332) to 20.0 (IPM-02-03 and LGG-522) percent and 13 genotypes were highly susceptible with a range from 43.25 (KM-8-662) to 68.39% (KM-173) pod damage. The remaining showed moderate susceptibility with a range from 20.21 (UPM-99-3) to 40.0 (KM-2241) percent.

Similar results was reported by Vaishnaw *et al*., (2023) among all the 51 germplasm of urdbean no germplasm was found immune, highly resistant and resistant with respect to pod damage against *H. armigera* and *M. vitrata in* urdbean. Whereas, 5 germplasm *viz*., Jammu Urdbean 1, KUG 878, PU 1920, SKNU 2005, KU 96-3 were categorized as moderately resistant with percent pod damage of 8.00 to 11.00 percent and 230.00 to 340.00 grain yield (kg/ha). The

7 germplasm *viz*., IPU 11-02, KUG 1043, LBG 941, MBG 1133, RSVU 22-10, SVU 6, VBG 19-010 were categorized as tolerant with 11.50 to 13.50 percent pod damage and 215.00 to 420.00 grain yield (kg/ha).

However, 17 germplasm *viz*., AKU 16-13, BDU 2021-2, IPU 18-02, IPU 2-1-3, IPU 94-1, JAUG 2 (GAU 4), KPU 2061, KU 20-12, KUG 479, KUG 941, LBG 787, OBG 102, PU 10, PU 12, PU 31, SKAU-UB-3, Barkha were categorized as equal to check with 14.00 to 16.50 percent pod damage and 188.00-351.67 grain yield (kg/ha). The 13 germplasm *viz*., Daftari 471, JLPU-0014, JLPU 819-18, KPU 20-54, KPU 405, PU 1804, PU 1921, RSVU 22-6, RU 03-52, SKNU 1809, VBG 20-011, RUG 59, NUL 7 were categorized as moderately susceptible with 17.00 to 18.50 percent pod damage and 166.67 to 335.00 grain yield (kg/ha). The 9 germplasm *viz*., BCU 20-26, IPU 19-27, IPU 2-43, IU 05-2, IU 92-14, LBG 752, OBG 41, SBC 51, Shekhar-3 (KU 309) were categorized as susceptible with 19.00 to 22.00 percent pod damage and 188.33 to 290.00 grain yield (kg/ha). Among all the 51 germplasm of urdbean no germplasm was found highly susceptible with respect to pod damage against *H. armigera* and *Maruca vitrata* in urdbean.

Grain Yield

The grain yield of various mungbean genotypes ranged from 812.50 kg/ha to 1225.00 kg/ha. The genotype KM 2241 was produced the highest grain yield as 1225.00 kg/ha, followed by genotype RMG 1188 as 1145.00 kg/ha. Whereas genotype T-44 was produced the lowest grain yield as 812.50 kg/ha, followed by genotype Pusa vishal as 860.00 kg/ha (Table 2).

The present findings are in agreement with the findings of Srivastava and Singh (2017) [6] who discovered that the lowest grain yield was from KM 2348 (416 kg/ha), as compared to check cultivar, HUM-12 (590 kg/ha), and that the maximum grain yield was recorded from VGG 10-008 (819 kg/ha), which was substantially different from other genotypes. Singh and Singh (2014) also observed that AKM-4 had the highest yield, which was then followed by KM-2293, AKM-09-2, IPM-3066, and ML-1628.

Similarly, Kol *et al*., (2022) [3], who reported that the maximum grain yield was obtained by the germplasm KM 2241 (1343.34 kg/ha), followed by MH 1142 (1260.00 kg/ha). In contrast, genotype IPM 1604-1 has the lowest grain yield (730.00 kg/ha), followed by germplasm IPM 20-2 (890.00 kg/ha).

Conclusion

The 62 Germplasm of Mungbean were screened against pod borer complex. Pod borers, *Helicoverpa armigera* and *Maruca vitrata*, had the least influence on the germplasms OBGG 110 and BM 4 in terms of percent pod damage. The highest grain yield was produced by the genotype KM 2241, while the lowest grain yield was recorded by the germplasm T 44. Among the 62 mungbean germplasm screened 9 germplasm were categorized under moderately resistant category followed by 21 germplasm under tolerant category, 27 germplasm were categorized under equal to check and 5 germplasm under moderately susceptible category. No germplasm was found to be under immune, highly resistant, susceptible and highly susceptible category.

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