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Screening of Urdbean germplasm against pod borers

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Abstract
Screening of Urdbean germplasm against pod borers was carried out during *Kharif* 2022-2023 at the research and instructional farm of Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). Among the 51 germplasm, KPU 2061 observed the least pod damage (1.0%) caused by *Helicoverpa armigera*, whereas SKNU 2005 observed least pod damage (4.50%) by Maruca *vitrata*. MBG 1133 had maximum grain production of Urdbean at 420.00 kg/ha, followed by LBG 941 at 398.33 kg/ha. Similarly, 5 germplasm are categorized under moderately resistant category followed by 7 germplasm under tolerant category, 17 germplasm are categorized under equal to check, 13 germplasm under moderately susceptible and 9 germplasm are categorized under susceptible category. No germplasm was found to be under immune, highly resistant, and resistant category.

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

Introduction
India's third-most significant pulse crop is black gram, *Vigna mungo* L. (Hepper) well-known leguminous crop native to Asia. Due to its short duration, this pulse can be grown in a variety of cropping systems, such as mixed crop and intercrop, in addition to sole cropping. Its popularity is primarily due to its superior or nutritional quality. It can be grown in conjunction with sugarcane, cotton, maize, sorghum, pigeonpea, and other crops. Both green manure and a fodder crop can be grown from it. In accordance with the soil and environmental conditions, the Nodulated Urdbean can fix 30 to 60 kg of nitrogen per ha (Panikkar *et al*., 1990) [6].
Additionally, it is used as a nutritious livestock feed. Urdbean is very nutrient-dense due to its high levels of protein (25 gm), calcium (0.13), fat (1.3 gm), phosphorus (385 mg/100 g), sodium (38 mg), potassium (983 mg), iron (42 gm), fiber (0.9 gm), calorific value (341 gm), carbohydrate (60 gm), moisture (10.9%), and other nutrients. It also has the highest concentration of phosphoric acid (Anonymous, 2018) [2].
Both biotic and abiotic variables reduce black gram production and productivity. Losses brought on by insects and diseases are examples of biotic stressors are really concerning. At various phases of the crop's development, 60 insect species are known to attack black gram crops in India. Spotted pod borer (*Maruca vitrata*), pea butterflies (*Lampides boeticus*), tobacco caterpillars (*Spodoptera litura*), and gram pod borer (*Helicoverpa armigera*) are the main pests of black gram (Soundararajan and Chitra, 2012) [7].

Materials and Methods
The experiment was carried out during *Kharif* 2022–2023 at the Research and Instructional Farm of Indira Gandhi Krishi vishwavidyalaya in Raipur (C.G.), by growing a total of 51 medium varieties group germplasm of urdbean im RBD design with 2 replications. The crop as sown on 15th july during *Kharif* 2022-23; 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) [1].

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

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

Table 1: 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, 2022

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) [4]. 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.

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

Results and Discussion

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

The incidence of gram pod borer *(Helicoverpa armigera)* was assessed in terms of the percentage pod damage at the harvesting stage of the crop. The germplasm differed significantly in terms of percent pod damage, which ranged from 1.0 to 8 percent (Table 2). Among the tested germplasm, the minimum pod damage by *H. armigera* was observed in germplasm KPU 2061 with 1.00 percent, which was found at par with KUG 1043, KUG 941, VBG 19-010 with 1.50 percent and IPU 94-1, KU 20-12, OBG 102, PU 10, SKAU – UB-3, SVU 6, with 2.00 percent pod damage, respectively, whereas the maximum pod damage was observed in germplasm IU 05-2 with 8.00 percent.

The current findings are in agreement with the findings of Chandekar *et al*. (2022) [3], who noted that among the tested germplasm, the minimum pod damage by *H. armigera* was observed in germplasm DKU116 with 0.5%. The maximum pod damage was observed in germplasm BCU 20 - 10 with 9.5%. Similarly, Kol *et al*. (2022) [5], who found that of the tested germplasm, germplasm OBGG 109 showed the least amount of pod damage caused by *H. armigera* (0.5 percent). The germplasm BCM 20–9 had 10.5 percent pod damage, which was the highest amount germplasm.

The current findings are also in consistent with those of Abhishek *et al*., (2021) [8], who found that the Azad Urd-1 genotype had the lowest pod infestation of 6.33 percent among all black gram genotypes, with KU-99-05, Shekhar-2, and PU-6, which have respective resistance percentages of 7.00, 9.33, and 10.67% and are labelled as resistant (R). While 10 genotypes-PU-19, PU-35, Azad Urd-2, KU-96-7, PU-40, KU-302, Shekhar-1, PU-30, Azad Urd-3, and KU-719-were found to be moderately resistant (MR) despite having pod infestations of 13.33, 15.67, 16.00, 18.67, 19.00, 20.67, 21.33, 22.00, and 24.00 percent, respectively. Only one genotype, KU-88-9-1, was found to have the most pod infestation and was classified as moderately susceptible (MS) with a 26.67% to *H. armigera*.

Screening of Urdbean germplasm against spotted pod Borer, *Maruca vitrata* (Geyer): The incidence of spotted pod borer (*Maruca vitrata)* was measured 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 4.50% to 16.50% (Table 2). Among the tested germplasm, the minimum pod damage by *M. vitrata* was observed in germplasm SKNU 2005 with 4.50 percent, which was at par with PU 1920 at 5.50 percent pod damage, KU 96-3 with 6.50 percent pod damage, Jammu Urdbean 1, KUG 878, LBG 941, at 8.00 percent pod damage, RSVU 22-10 at 8.50 percent pod damage respectively. Whereas the maximum pod damage was observed in IPU 19-27 with 16.5 percent (Table 2).

The current findings are in agreement with Chandekar *et al.*, (2022) [3], who stated that of the tested germplasm, KUG 878 had the least amount of pod damage (3.5%) caused by *M. vitrata*. The highest amount of pod damage was found in IPU 11-02, as 26% (Table 01), Similarly, Kol *et al.*, (2022) [5], who found that of the tested germplasm, BM-4 with 1.00 percent had the least amount of pod damage caused by *M. vitrata*. Whereas OBGG 104 had the highest pod damage, as 14.00%.

The current findings are in consistent with those of Abhishek Yadav *et al*., (2021) [8], who found that the Azad Urd-1 had the lowest pod infestation of 10.33 percent and was classified as resistant (R) among all the genotypes of black gram. While nine genotypes, Shekhar-2, PU-6, PU-19, Azad Urd-2, KU-96-7, PU-35, PU-40, KU-302 and Shekhar-1, were found to be moderately resistant (MR) to *M. vitrata* with pod infestations of 13.67, 14.67, 15.00, 16.33, 17.00, 17.00, 19.33, 21.00, and 22.33 percent, respectively. However, against *M. vitrata*, four genotypes, PU-30 (25.67%), Azad Urd-3 (26.67%), KU- 719 (27.33%), and KU-88-9-1(28.67%), were shown to be moderately sensitive (MS). No genotype of the 15 genotypes of black gram was shown to be vulnerable to pod damage (> 30% pod damage) against *M. vitrata*.

Table 2: Percent pod damage by pod borers and grain yield in different germplasm of Urdbean (*Kharif* 2022-23)

S.N.	Germplasm	% Pod damage by *H. armigera*	% Pod damage by *M. vitrata*	Total% Pod damage by pod borers	PRR	Grain yield (kg / ha)
1.	AKU 16-13	5.00 (12.92)	11.0 (19.34)	16.00 (23.56)	6	245.00
2.	BCU 20-26	6.50 (14.75)	13.5 (21.47)	20.00 (26.49)	8	221.67
3.	BDU 2021-2	3.50 (10.75)	12.5 (20.38)	16.00 (23.31)	6	221.67
4.	Daftari 471	4.50 (12.07)	13.0 (21.07)	17.50 (24.61)	7	201.67
5.	IPU 11-02	3.00 (9.83)	9.00 (17.43)	12.00 (20.20)	5	283.33
6.	IPU 19-27	5.50 (13.43)	16.5 (23.95)	22.00 (27.94)	8	290.00
7.	IPU 18-02	2.50 (9.05)	11.5 (19.71)	14.00 (21.91)	6	275.00
8.	IPU 2-1-3	5.50 (13.43)	10.0 (18.41)	15.50 (23.11)	6	296.67
9.	IPU 2-43	4.00 (11.53)	15.0 (22.77)	19.00 (25.83)	8	250.00
10.	IPU 94-1	2.00 (7.85)[b]	12.5 (20.60)	14.50 (22.23)	6	290.00
11.	IU 05-2	8.00(16.39)	12.0 (20.11)	20.00 (26.38)	8	231.67
12.	IU 92-14	5.00 (12.85)	16.0 (23.56)	21.00 (27.24)	8	188.33
13.	Jammu Urdbean 1	3.00 (9.83)	8.00(16.39)[d]	11.00 (19.29)	4	340.00
14.	JAUG 2 (GAU 4)	5.50 (13.43)	10.0 (18.34)	15.50 (23.11)	6	351.67
15.	JLPU- 0014	3.00 (9.83)	14.5 (22.37)	17.50 (24.70)	7	236.67
16.	JLPU 819-18	6.50 (14.75)	11.0 (19.29)	17.50 (24.61)	7	166.67
17.	KPU 2061	1.00 (5.74)	15.0 (22.77)	16.00 (23.56)	6	263.33
18.	KPU 20-54	4.00 (11.44)	13.5 (21.52)	17.50 (24.72)	7	246.67
19.	KPU 405	7.50 (15.88)	10.5 (18.86)	18.00 (25.09)	7	285.00
20.	KU 20-12	2.00 (7.85)[b]	13.0 (21.07)	15.00 (22.68)	6	210.00
21.	KUG 1043	1.50 (6.93)[a]	11.5 (19.71)	13.00 (21.07)	5	276.67
22.	KUG 479	5.00 (12.92)	10.5 (18.78)	15.50 (23.11)	6	340.00
23.	KUG 878	2.50 (9.05)	8.00 (16.30)[c]	10.50 (18.78)	4	288.33
24.	KUG 941	1.50 (6.93)[a]	13.5 (21.38)	15.00 (22.68)	6	318.33
25.	LBG 752	6.50 (14.75)	14.0 (21.95)	20.50 (26.87)	8	241.67
26.	LBG 787	4.00 (11.53)	11.5 (19.71)	15.50 (23.11)	6	216.67
27.	LBG 941	3.50 (10.75)	8.00(16.30)[c]	11.50 (19.78)	5	398.33
28.	MBG 1133	7.50 (15.88)	5.5 (15.30)	13.00 (20.90)	5	420.00
29.	OBG 41	7.50 (15.88)	12.50(20.69)	20.00 (26.55)	8	256.67
30.	OBG 102	2.00 (7.85)[b]	13.0 (20.90)	15.00 (22.68)	6	246.67
31.	PU 10	2.00 (8.13)[c]	14.5 (22.35)	16.50 (23.94)	6	233.33
32.	PU 12	2.50 (9.05)	13.5 (21.52)	16.00 (23.56)	6	188.33
33.	PU 1804	4.50 (12.22)	14.0 (21.85)	18.50 (25.42)	7	236.67
34.	PU 1920	2.50 (9.05)	5.5 (13.54)[a]	8.00 (16.42)	4	230.00
35.	PU 1921	3.00 (9.97)	14.5 (22.30)	17.50 (24.70)	7	223.33
36.	PU 31	2.50 (9.05)	12.0 (20.11)	14.50(22.30)	6	178.33
37.	RSVU 22-6	7.50 (15.88)	10.5 (18.86)	18.00 (25.06)	7	191.67
38.	RSVU 22-10	4.00 (11.53)	8.5 (16.88)[e]	12.50 (20.69)	5	215.00
39.	RU 03-52	5.50 (13.43)	12.5 (20.60)	18.00 (24.96)	7	190.00
40.	SBC 51	5.00 (12.92)	14.5 (22.35)	19.50 (26.18)	8	190.00
41.	Shekhar-3(KU 309)	4.00 (11.53)	15.5 (23.17)	20.50 (26.90)	8	231.67
42.	SKAU –UB-3	2.00 (7.85)[b]	13.0 (21.11)	15.00 (22.73)	6	220.00
43.	SKNU 1809	5.00 (12.92)	12.0 (20.24)	17.00 (24.34)	7	335.00
44.	SKNU 2005	4.50 (12.22)	4.5 (12.07)	9.00 (17.43)	4	241.67
45.	SVU 6	2.00 (7.85)[b]	10.0 (18.34)	12.00 (20.11)	5	266.67
46.	VBG 19-010	1.50 (6.93)[c]	12.0 (20.11)	13.50 (21.47)	5	236.67
47.	VBG 20- 011	4.50 (12.22)	12.5 (20.69)	17.00 (24.34)	7	260.00
48.	RUG 59	5.00 (12.92)	13.0 (21.00)	18.00 (25.02)	7	295.00
49.	KU 96-3	2.50 (9.05)	6.50 (14.49)[b]	9.00 (17.35)	4	281.67
50.	NUL 7	5.50 (13.54)	11.5 (19.78)	17.00 (24.33)	7	290.00
51.	Barkha (R.C.)	3.00 (9.83)	12.2 (20.30)	15.05 (22.81)	6	188.00
	C.D at 5%	3.19	5.14	5.13		98.99
	SE (m)	1.12	1.80	1.80		34.74
	C.V	14.08	12.88	10.96		19.24

Figure in parenthesis () are angular transformed value, R. C. = Resistant check

Table 3: Reaction of Urdbean germplasm against pod borers during *Kharif* 2022-23

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	8.00 - 11.00	230.00-340.00	5	Jammu Urdbean 1, KUG 878, PU 1920, SKNU 2005, KU 96-3.
5.	Tolerant	11.50 - 13.50	215.00-420.00	7	IPU 11-02, KUG 1043, LBG 941, MBG 1133, RSVU 22-10, SVU 6, VBG 19-010.
6.	Equal to check	14.00 - 16.50	188.00-351.67	17	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.
7.	Moderately susceptible	17.00 – 18.50	166.67-335.00	13	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.
8.	Susceptible	19.00 – 22.00	188.33-290.00	9	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).
9.	Highly susceptible	-	-	-	------

Screening of Urdbean germplasm against gram pod borers (*H. armigera* and *M. vitrata*) during *Kharif* 2022-23.

The 51 urdbean germplasm were screened to check the resistance and susceptibility against *H. armigera* and *Maruca vitrata*. The statistical analyzed data present in Table 3. 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 *Maruca vitrata* in urdbean. Whereas, 5 Germlasm *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.

The current findings are in consistent with those of Abhishek *et al*., (2021) [8], who found that the Azad Urd-1 genotype had the lowest pod infestation of 6.33 percent among all black gram genotypes, with KU-99-05, Shekhar-2, and PU-6, which have respective resistance percentages of 7.00, 9.33, and 10.67% and are labelled as resistant (R). While 10 genotypes—PU-19, PU-35, Azad Urd-2, KU-96-7, PU-40, KU-302, Shekhar-1, PU-30, Azad Urd-3, and KU-719-were found to be moderately resistant (MR) despite having pod infestations of 13.33, 15.67, 16.00, 18.67, 19.00, 20.67, 21.33, 22.00, and 24.00 percent, respectively. Only one genotype, KU-88-9-1, was found to have the most pod infestation and was classified as moderately susceptible (MS) with a 26.67% resistance to *H. armigera*. No genotype of black gram was found to be vulnerable (> 30% pod damage) to pod damage against *H. armigera* in black gram among the 15 genotypes.

The current findings are in consistent with those of Abhishek Yadav *et al*., (2021) [8], who found that the Azad Urd-1 had the lowest pod infestation of 10.33 percent and was classified as resistant (R) among all the genotypes of black gram. While nine genotypes, Shekhar-2, PU-6, PU-19, Azad Urd-2, KU-96-7, PU-35, PU-40, KU-302 and Shekhar-1, were found to be moderately resistant (MR) to *M. vitrata* with pod infestations of 13.67, 14.67, 15.00, 16.33, 17.00, 17.00, 19.33, 21.00, and 22.33 percent, respectively. However, against *M. vitrata*, four genotypes, PU-30 (25.67%), Azad Urd-3 (26.67%), KU- 719 (27.33%), and KU-88-9-1(28.67%), were shown to be moderately sensitive (MS). No genotype of the 15 genotypes of black gram was shown to be vulnerable to pod damage (> 30% pod damage) against *M. vitrata*.

Grain yield

The grain yield of different urdbean genotypes ranged from 166.67 kg/ha to 420.00 kg/ha. The genotype MBG 1133 produced the highest grain yield with a yield of 420.00 kg/ha, followed by genotype LBG 941 with a yield of 398.33 kg/ha. Whereas genotype JLPU 819-18 germplasm had lowest grain yield as 166.67 kg/ha, followed by genotype PU 31 as 178.33 kg/ha (Table 3).

These findings are in agreement with Chandekar *et al.*, (2022) [3], who reported that the maximum grain yield was obtained by the germplasm RVSU 21-2 (754.83 kg/ha), followed by LBG 787 (741.67 kg/ha). In contrast, genotype Daftri 471 has the lowest grain yield (448.33 kg/ha), followed by germplasm IPU 19-9 (485 kg/ha). Similarly, Kol *et al*., (2022) [5], 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 51 germplasm was evaluated on a variety of parameters, including percent pod damage and grain yield. Significant variations amongst the analysed germplasm were discovered during the screening process. Pod borers, *Helicoverpa armigera* and *Maruca vitrata*, had the least influence on the germplasms KPU 2061 and SKNU 2005 in terms of pod damage. The highest grain yield was produced by the genotype MBG 1133, while the lowest grain yield was produced by the germplasm JLPU 819-18.

Among the 51 urdbean germplasm screened 5 germplasm are categorized under moderately resistant category followed by 7 germplasm under tolerant category, 17 germplasm are categorized under equal to check, 13 germplasm under moderately susceptible, and 9 germplasm are categorized under susceptible category. No germplasm was found to be under immune, highly resistant and resistant category.

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