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Diversity among Greengram Germplasm to Powdery Mildew Resistance Caused by *Erysiphe polygoni* DC

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A B S T R A C T

Greengram also known as mungbean is an important pulse crop with remarkable source of high quality protein, vitamins, fibres and amino acid profiles. In India, it stands third in production. The lower productivity of greengram is attributed to biotic stresses, among which powdery mildew caused by *Erysiphe polygni* is one of the major fungal diseases and in severe cases it covers entire leaf area, affects the photosynthetic activity, reduces mungbean yield more than 50%. In the present study, 130 genotypes were screened against *E. polygoni* under natural epiphytotic condition at Main Agricultural Research Station, Dharwad during *kharif* and *rabi*, 2016. Among these, during *kharif* 2016 four genotypes (GPM-19, NUL-7, *Vigna umbellata* and *Vigna trilobata*) showed immune response, three genotypes (COGG-913, VAIBHAV and TARM1) were moderately resistant, six genotypes (GPM-10, GPM-23IPU-94-1, IPU-2-4, TBM-96-2 and IC277014)) showed susceptible reaction, 119 genotypes were highly susceptible to the disease. During *rabi* 2016, three genotypes viz., GPM-19, *V. umbellata* and *V. trilobata* showed immune response and four genotypes viz., NUL-7, COGG-913, TARM1 and Vaibhav showed moderately resistant response. Nine genotypes *viz*., IPU-94-1, IPU-2-43, TCR-262 *V. sylvestris*, GPM-23, GPM-10, TBM-96-2, IV277014 *V. sylvestris*, TCR-218 *V. sublobata* and IC-251416 *V. sublobata* showed susceptible reaction and the remaining 114 genotypes were rated as highly susceptible to the disease. None of the genotypes showed resistant response. These identified immune genotypes can be used in the development of resistant cultivars.

Introduction

Greengram is an important pulse crop with remarkable source of high quality protein, vitamins, fibers and amino acid profiles. In India, it stands third in production, occupying nearly 33.375 lakh hectare area with 15.383 lakh tones production with the productivity of 461 kg/hectare (Tiwari and Shivhare, 2016). The lower productivity in mungbean is attributed to biotic stress, among which powdery mildew caused by *Erysiphe polygni* is the major fungal disease of mungbean. It is a *kharif* season disease particularly when

there is a low temperature (20-25°C) and high air current which helps in the movement of the spore and high humidity (80-90 %) (Patil *et al.,* 1989). The fungus produces initially faint slightly dark areas on leaves. These areas develop into small white powdery patches. They enlarge and coalesce to form a complete coating of white powder on upper surface of the leaves, stem and pods. In case of severe infection, it spreads to all over the leaves and cause defoliation. The disease induces forced maturity in plants causing heavy yield losses. The disease usually covers host leaf surface area there by affecting the photosynthetic activity and physiological changes leads to the potential reduction in the yield. The yield reduction by this disease ranges from 20-40 % in the absence of prevention (Fernandez and Shanmugasundaram, 1988) and 100 per cent when it occurs at the seedling stage (Reddy *et al.,* 1994). Cultivation of resistant genotypes is an effective and reliable method to combat disease. Identification of resistant sources is the prerequisite in the development of resistant varieties. Therefore, in this study an attempt was made to identify resistant genotypes against powdery mildew.

Materials and Methods

Experimental location and weather condition

The field experiment was conducted at Main Agricultural Research Station (MARS), College of Agriculture, Dharwad. Geographically, Dharwad is located at 15^0 31' North latitude and 75^0 07' East longitudes at an altitude of 678 m above mean sea level with an average rainfall of about 720 mm.

Phenotypic screening of mungbean accessions for powdery mildew resistance

One hundred and thirty mungbean accessions (Table 1**)** were obtained from AICRP on MULLaRP UAS, Dharwad and Indian Institute of Pulse Research (IIPR), Kanpur. Seeds of these accessions were sown in augmented design in MARS, Dharwad field, during *kharif* and *rabi*, 2016.

In order to assess the disease incidence, double row of spreader variety *viz*., DGGV2 (highly susceptible to powdery mildew) was sown after every five rows of test entries and also around the border of the experimental plot. Common agronomical practices recommended to mungbean were adopted to grow healthy crop without adopting any plant protection measures. The genotypes were screened for powdery mildew disease in *kharif* and r*abi*, 2016 under natural epiphytotic conditions.

Genotypes were grouped into different classes based on two parameters *viz*.

Disease reaction
Percent disease index (PDI)

For disease reaction, percentage of leaf area covered by the disease powdery patches was scored manually. From each genotype five plants were randomly selected and from each plants three leaves *i.e.*, upper leaves, middle leaves and lower leaves were taken for calculation of percentage of leaf covered by the disease spores. The percentages was then translated into a disease rating of 0 to 9 following Mayee and Datar (1986) (Table 2) (Fig. 1), and then average was taken for the calculation of PDI using the formula (Wheeler, 1969), given below.

Percentage disease index were calculated using the formula

$$PDI = \frac{\text{Sum of individual ratings}}{\text{Number of leaves observed} \times \text{maximum scale}} \times 100$$

Results and Discussion

Screening of mungbean accessions for powdery mildew resistance

The per cent disease index (PDI) among 130 genotypes ranged from 0 to 98.3 %, during kharif, 2016. Among the accessions screened, four genotypes (NUL- 7, GPM- 19, *V. umbellata* and *V. trilobata*) showed immune response, three genotypes *viz*., COGG- 913, VAIBHAV and TARM1 showed moderately resistant response respectively. Six genotypes such as GPM- 10, GPM-23, IPU-94- 1, IPU-2- 43, TBM-96-2 and IC277014 *V. sylvestris* were rated as susceptible and the remaining 119 genotypes were rated as highly susceptible to the disease (Table 3).

During *rabi*, 2016, the PDI ranged from 0 to 93.10 %. Three genotypes *viz*., GPM-19, *V. umbellata* and *V. trilobata* showed immune response, four genotypes *viz*., (NUL-7, COGG-913, TARM1 and Vaibhav) showed moderately resistant response respectively.

Nine genotypes *viz*., IPU-94-1, IPU-2-43, TCR-262 *V. sylvestris*, GPM-23, GPM-10, TBM-96-2, IV277014 *V. sylvestris*, TCR-218 *V. sublobata* and IC-251416 *V. sublobata* showed susceptible reaction to the disease and the remaining 114 genotypes were rated as highly susceptible to the disease (Table 3).

Previously Kumar (2015) and Sarkale (2015) also observed immune response to powdery mildew by two wild relatives *V. umbellata* and *V. trilobata* and moderately resistant response by TARM1.

However, Khare *et al.,* (1998) reported resistant reaction of TARM1 to the powdery mildew disease. Also Mandhare *et al.,* (2008) evaluated eighty two genotypes against powdery mildew and yellow mosaic virus under natural epiphytotic condition. Of the eighty two genotypes screened, Vaibhav, BPMR-145, TARM18, Phule-M-2003-3, Phule-M-2002-13, Phule-M-2002-17, Phule-M-2001-3 and Phule-M-2001-5 were resistant to powdery mildew and moderately resistant to yellow mosaic virus.

Nair *et al.,* (2015) evaluated seventy diverse greengram genotypes in field under natural epiphytotic condition during *kharif*, 2010 and *rabi*, 2009-2010.

In *rabi* only two genotypes (TARM1 and Pragya) showed highly resistant response to the powdery mildew disease.

TARM1, a variety of mungbean grown in Chattisgarh and Raipur region and Vaibhav grown in Rahuri which were resistant to powdery mildew were found to be moderately resistant in the present study.

Genotypes do not perform same across seasons and environments because response of the genotypes to the disease under field conditions influenced by various factors such as pathogen race, congenial environmental conditions etc.

In conclusion, of the one hundred and thirty genotypes screened during *kharif* and *rabi*, 2016, three genotypes *viz*., GPM-19, *V. umbellata*, *V. trilobata* (Fig. 2) showed immune response to the disease in both the seasons and genotypes COGG-913, TARM1 and Vaibhav showed moderately resistant response during *kharif*, 2016.

During *rabi* COGG-913, TARM1, Vaibhav and NUL-7 were found to be moderately resistant. None of the genotypes showed resistant and moderately susceptible response to the disease in both the season.

Table.1 List of mungbean accessions screened for powdery mildew incidence

Sl. No.	Varieties	Sl. No.	Varieties	Sl. No.	Varieties
1	China mung	45	GPM-10	89	ML- 1256
2	NL- 3	46	2.Mutant-29-3	90	ML- 729
3	GG- 38	47	11.Mutant-60-10	91	ML- 935
4	GPM- 21	48	GPM- 25	92	ML- 1059
5	GG- 22	49	9.Mutant-60-8	93	ML- 682
6	SEL- 4	50	DGGV2	94	IPM05- 3- 21
7	GG- 62	51	GPM- 3	95	IPM- 03-2
8	GG- 42	52	GPM- 4	96	IPM- 306-6
9	GPM- 18	53	12.Mutant-60-11	97	IPM9901- 10
10	NL- 10	54	13.Mutant-60-12	98	IPM03- 1
11	GG- 46	55	GG- 54	99	IPM-02- 23
12	GPM- 11	56	GPM- 12	100	IPM- 5-3-22
13	15.Mutant70-3	57	GPM- 20	101	IPM-99-3
14	GPM- 9	58	GPM- 28	102	IPM- 02-1
15	5.Mutant 29-6	59	GPM- 14	103	MH-3-18
16	TAP-7	60	10.Mutant-60-9	104	PUSA 672
17	GPM- 29	61	GPM- 24	105	DMG-1045
18	GPM- 23	62	GPM-13	106	BDYR- 1
19	NL- 8	63	COGG- 913	107	TMB-96-2
20	GPM- 17	64	IPM-31266K- 1	108	HUM- 1
21	GPM- 30	65	PANTMUNG	109	PM-3
22	Mutant- 29-4	66	IPM- 409- 4	110	AKM99-4
23	14.Mutant60-18	67	IPM- 205- 7	111	HUM-7
24	GPM- 74	68	NM- 1	112	GM- 4
25	1.Mutant 29-1	69	IPM- 430- 4	113	SML- 668
26	7.Mutant-60-4	70	IPM- 544-8	114	SM- 47
27	GPM- 19	71	IPM-312-134-135K	115	PUSA9531
28	GPM- 27	72	Vaibhav	116	UPM98-1
29	DLGG- 7	73	TARM1	117	PM-2
30	DLGG- 11	74	Ganga	118	BM- 63
31	NL- 2	75	PM- 5	119	BM- 64
32	GPM- 6	76	JBT/ 46/ 23	120	DMG-1030
33	8.Mutant-60-5	77	EC520011	121	UPM02-18
34	GG- 86	78	PDM- 191	122	IPU94-1
35	6.Mutant-29-10	79	PDM- 681	123	IPU2-43
36	GPM- 22	80	PDM- 87	124	NUL-7
37	PDM-99-28	81	PDM- 262	125	TCR-218 V. *sublobata*
38	GG- 79	82	PDM- 11	126	Ic277014 V. *sylvestris*
39	GPM-7	83	IPM- 5- 3- 6	127	TCR-262 V. *sylvestris*
40	ML- 881	84	ML- 512	128	IC-251416 V. *sublobata*
41	GG- 36	85	IPM- 2- 17	129	*Vigna umbellata*
42	3.Mutant-29-3	86	IPM2K14- 9	130	*Vigna trilobata*
43	GG- 23	87	ML-1257		
44	GPM-16	88	ML- 515		

Table.2 Disease rating scale used for scoring (Mayee and Datar, 1986)

Numerical rating	% of leaf area covered	Disease reaction
0	No symptoms on leaf	Immune
1	Small scattered powdery speaks covering 1 % or less area of leaf	Resistant
3	Small, scattered powdery lesions covering 1-10 % of the leaf area	Moderately resistant
5	Powdery lesions enlarging with grey coloured powdery mass covering 11-25 % of leaf area	Moderately susceptible
7	Grey coloured powdery growth covering 26-50 % of the leaf area	Susceptible
9	Gray coloured patches of powdery growth covering 51 % 0r more of leaf area on leaves, leaf become dry	Highly susceptible

Table.3 Grouping of mungbean accessions based on response to powdery mildew Disease according to Mayee and Datar (1986)

	Kharif, 2016	**Rabi, 2016**
Disease rating and Percent leaf area infected	**Genotypes**	
Immune 0 (0.00%)	GPM-19 & NUL-7, *Vigna umbellate* and *Vigna trilobata*	GPM-19, *Vigna umbellate* and *Vigna trilobata*
Resistant 1 (< 1%)	-	-
Moderately resistant 3 (1-10%)	COGG-913,TARM1 and VAIBHAV	COGG- 913, TARM1, VAIBHAV and NUL-7
Moderately susceptible 5 (11-25%)	-	-
Susceptible 7 (26-50%)	GPM-23, GPM-10, TMB-96-2, IPU-94-1, and IPU-2-43 IC277014 *V. sylvestris*	GPM- 23, GPM-10, TMB-96-2, IPU94-1, IPU2-43, TCR-218 *V. sublobata*, IC277014 *V. sylvestris*, TCR-262 *V. sylvestris* and IC-251416 *V. sublobata*
Highly susceptible 9 (> 51%)	China mung, NL-3, GG-38, GPM-21, GG-22, SEL-4, GG-62, GG-42, GPM-18, NL- 10, GG-46, GPM-11, 15. Mutant-70-3, GPM-9, 5. Mutant-29-6, TAP-7, GPM-29, GPM-23, NL-8, GPM-17, GPM-30, Mutant-29-4, 14. Mutant-60-18, GPM-74, 1. Mutant-29-1, 7.Mutant-60-4, GPM-27, DLGG-7, DLGG-11, NL-2, GPM-6, 8. Mutant-60-5, GG-86, 6. Mutant-29-10, GPM-22, PDM-99-28, GG-79, GPM-7, ML-881, GG-36, 3. Mutant-29-3, GG-23, GPM-16, 2. Mutant-29-3, 11. Mutant-60-10, GPM-25, 9. Mutant-60-8, DGGV2, GPM-3, GPM-4, 12. Mutant-60-11, 13. Mutant-60-12, GG-54, GPM-12, GPM-20, GPM-28, GPM-14, 10. Mutant-60-9, GPM-24, GPM-13, PANTMUNG-2, IPM-409-4, IPM-205-7, IPM-99-125, NM-1 IPM-430-4, IPM-544-8, Ganga-8, PM-5, JBT/46/23, EC520011, PDM-191, PDM-681, PD-87, PDM-	China mung, NL- 3, GG- 38, GPM- 21, GG- 22, SEL- 4, GG- 62, GG-42, GPM- 18, NL- 10, GG- 46, GPM- 11, 15.Mutant70-3, GPM- 9, 5.Mutant 29-6, TAP-7, GPM-29, NL- 8, GPM- 17, GPM- 30, Mutant- 29-4, 14.Mutant60-18, GPM- 74, 1.Mutant 29-1, 7.Mutant-60-4, GPM- 27, DLGG- 7, DLGG- 11, NL- 2, GPM- 6,, 3.Mutant-60-5, GG- 86, 6.Mutant, 29-10, GPM- 22, PDM-99-28, GG- 79, GPM-7, ML- 881, GG- 36, 3.Mutant-29-3, GG-23, GPM-16, 2. Mutant-29-3, 11.Mutant-60-10, GPM- 25, 9. Mutant-60-8, DGGV2, GPM- 3, GPM- 4, 12. Mutant-60-11, 13.Mutant-60-12, GG- 54, GPM- 12, GPM- 20, GPM- 28, GPM- 14, 10.Mutant-60-9, GPM- 24, GPM-13, IPM-31266K- 1, PANTMUNG, IPM- 409- 4, IPM- 205- 7, NM- 1, IPM-430- 4, IPM- 544-8, IPM-312-134-135K, Ganga, PM- 5, JBT/ 46/ 23, EC520011, PDM- 191, PDM- 681, PDM-87, PDM- 262, PDM- 11, IPM- 5- 3- 6, ML- 512, IPM-

	262, PDM-11, IPM-5-3-6, ML-512, IPM-2-17, IPM2K14-9, ML-1257, ML-515, ML-1256, ML-729, ML-935, ML-1059, ML-682, IPM05-3-21, IPM-03-2, IPM-306-6, IPM9901-10, IPM03-1, IPM-02-23, IPM-5-3-22, IP-99-3, IPM-02-1, MH-3-18, PUSA 672, DMG-1045, BDYR-1, TMB-96-2, HUM-1, PM-3, NM-1, AKM99-4, HUM-7, GM-4, SML-668, PUSA 9531, UPM98-1, PM-2, BM-63, BM-64, DMG-1030, UPM-02-18, TCR-218 *V. sublobata*, TCR-262 *V. sylvestris*, IC-251416 *V. sublobata*, IPM-99-125	2- 17, IPM2K14-9, ML-515, ML-1256, ML- 1257, ML-729, ML- 935, ML- 1059, ML- 682, IPM05- 3- 21, IPM-03-2, IPM- 306-6, IPM9901- 10, IPM03- 1, IPM-02- 23, IPM- 5-3-22, IPM-99-3, IPM- 02-1, MH-3-18, PUSA 672, DMG-1045, BDYR- 1, HUM- 1, PM-3 , NM- 1, AKM99-4, HUM-7, GM- 4, SML- 668, SM- 47, PUSA9531, UPM98-1, PM-2, BM-63, BM- 64, DMG-1030, UPM02-18, IPM-99-125

Fig.1 Disease rating scale used for powdery mildew

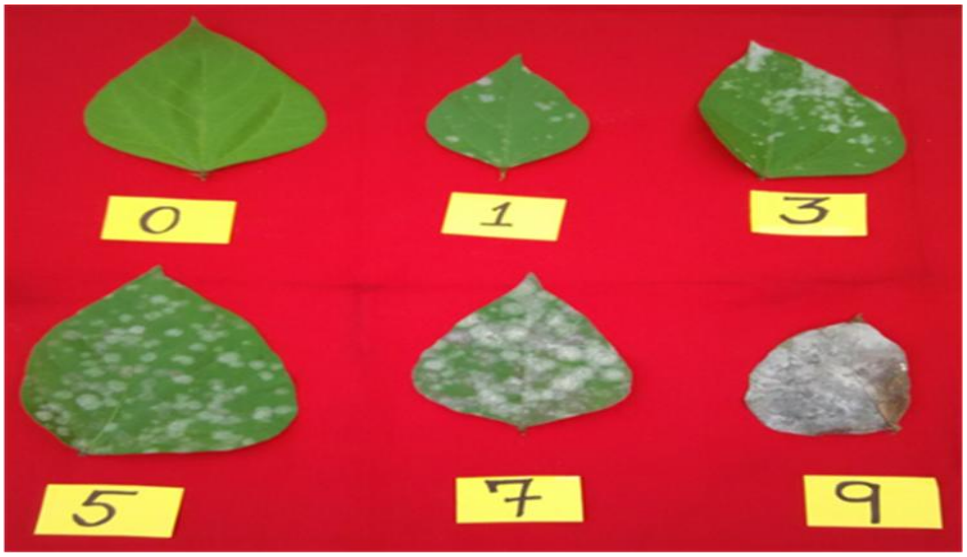

Fig.2 From top left DGGV2, Vigna umbellate, Vigna trilobata and GPM-19




The identified immune genotypes in the present study can be utilized in the breeding programme for the development of powdery mildew resistant. Therefore these genotypes could be used further in development of mungbean variety resistant to powdery mildew.

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