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COMBINING ABILITY ANALYSIS FOR RESISTANCE TO PREHARVEST SPROUTING IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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ABSTRACT

The Combining ability analysis of 30 crosses, obtained from 5 lines and 6 testers, were made for preharvest sprouting in mungbean. Genetic analysis indicated the predominance of additive gene action for pod beak length, pod wall thickness and pod wall epicuticular wax, while hard seed per cent and preharvest sprouting were under the control of non-additive gene action. Both additive and non-additive gene actions were found to operate for moisture absorption rate through the pod wall. Among the lines LGG-450, LGG-440 and among testers ML-267, Pusa-105 and MGG-295 were found to be good general combiners for the traits responsible for resistance to preharvest sprouting. Five crosses viz., LGG-450 × PDM-54, LGG-450 × LGG-407, LGG- 440 × LGG-407, K-851 × MGG-295 and V-2764 × Pusa-105 were found to be the best specific combiners for developing preharvest sprouting resistant progenies in mungbean.

Key Words : Mungbean, resistance to preharvest sprouting, combining ability

Mungbean is an important rainy season pulse crop of India. The average productivity of this crop is low and uncertain due to neglected management and poor adoption of the production technology due to the risk of preharvest sprouting. Some times, losses due to preharvest sprouting will be as high as 60-70%. High yielding varieties developed/identified in recent years, despite their high yield potential, could not increase/stabilize the yields of this crop due to lack of resistance to preharvest sprouting. Therefore it is essential to develop resistant or tolerant varieties to preharvest sprouting by understanding the mechanism/genetics of resistance. Information on the genetics of preharvest sprouting and the traits responsible for preharvest sprouting are not available. Hence an attempt has been made in the present investigation to study the genetics of resistance to preharvest sprouting and the traits imparting resistance to preharvest sprouting through a line × tester programme.

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MATERIALS AND METHODS

The experimental material comprised of 30 F_1s derived by crossing 5 lines (LGG-450, LGG-440, K-851, PS-16 and V-2764) and 6 testers (ML-267, Pusa-105, PDM-54, LGG-407, WGG-2 and MGG-295). The experiment was laidout in a R.B.D. with three replications at Agricultural Research Station, Warangal during kharif 1993. Each genotype was sown in a single row of 4m length with 30 × 10 cm spacing. Observations on preharvest sprouting resistant traits and preharvest sprouting damage were recorded on 10 randomly selected plants in each combination and parents. Pod beak length (cm) was measured from the base of the beak to the tip of the beak. Pod wall thickness (μm) was measured with the help of digital micrometer. The epicuticular wax (μg/cm2) content of the pod wall was estimated by the gravimetric method. The technique used for estimation of sorghum leaf cuticular wax was standardised for greengram epicuticular pod wall wax. 50 discs of pod wall randomly selected per treatment (after measuring with leaf area metre) were taken and immersed in 20 ml of carbon tetrachloride (CTC) in a beaker for 60 seconds. The extract was filtered into a pre-weighed petri dish and the CTC was allowed to evaporate at room temperature. After complete evaporation of CTC, the petri dish was weighed again and the difference in the initial and final weights of the petri dish was taken as the wax content. Amount of wax was expressed in μg/cm2 of pod wall. Moisture absorption through pod wall (%) was recorded by differential weights/initial weight × 100. Hard seeds from the sample were counted and expressed in percentage. Data on preharvest sprouting (%) was collected by exposing the experimental material to alternate wetting and drying at maturity. Pods harvested from randomly selected plants were threshed and damaged seeds due to preharvest sprouting were counted and expressed in percentage. Line × tester analysis was done following Kempthorne model (1).

RESULTS AND DISCUSSION

Analysis of variance revealed significant genetic variation among the lines and testers for most of the traits under study (Table 1). The proportion of mean squares due to 'lines' were greater than due to 'testers' for pod beak length, pod wall thickness, pod wall epicuticular wax, moisture absorption through pod wall while the proportion of 'tester' contribution was greater than that due to 'lines' for hard seed per cent indicating the wider variability for the respective traits among the 'lines' and 'testers'. The interaction component due to 'lines × testers' was of lower magnitude than either due to 'lines' or 'testers' except for hard seed indicating that additive gene action play a primary role in governing these traits. Further 'GCA' variance was greater than 'SCA' variance for pod beak length, pod wall thickness

Table 1. ANOVA for combining ability (mean squares) for pre-harvest sprouting resistance traits and pre-harvest sprouting in F1 generation

Source of variation	Degrees of freedom	Pod beak length (cm)	Pod wall thickness (cm)	Pod wall epicuticular wax (μg)	Hard seed (%)	Moisture absorption through pod wall		Pre-harvest sprouting (%)
						24 hr	48 hr	
Lines	4	0.0395**	0.0029**	25.9608**	28.6895	34.0938	558.5156**	264.1445**
Testers	5	0.0075**	0.0020**	2.0322**	97.1984	18.1219	211.1438	78.3313
Lines × testers	20	0.0031**	0.004**	0.1406**	125.4231**	20.0766**	94.8828**	48.3020**
Error	80	0.0014	0.0002	0.0049	0.5592	0.1285	1.1895	0.9017
gca/sca		2.0000	1.8600	18.6400	0.0900	0.0550	0.5627	0.4728

*Significant at 5% level **Significant at 1% level

and pod wall epicuticular wax suggesting involvement of additive gene action in the expression of these characters. Hard seed, rate of moisture absorption per cent through pod wall and preharvest sprouting was found to be governed by non-additive gene action as the 'SCA' variance was higher than 'GCA'.

Mean values of parents and crosses, general combining ability effects of parental lines are presented in Table 2, Table 3 and Table 3 respectively. The parents viz., PS-16, LGG-407 with significant negative 'gca' estimates LGG 440, LGG 450, and PDM 54 with non- significant negative 'GCA' estimates were good general combiners (Table 3) with low mean (Table 2) and possessed favourable genes for imparting smaller back to their progenies. Naidu et al [2] through association analysis reported that pod beak length had a positive and significant correlation with pod surface area and amount of water absorption indicating the desirability of smaller pod beak. Parents K-851 and LGG-407 recorded thicker pod wall (Table 2) as well as significant positive 'GCA' effects and thus found to be good general combiners for pod wall thickness. Teckrony [3] recommended for thick or dense pod walls for protection from preharvest sprouting in soybean. For pod wall epicuticular wax LGG-450, V-2764, ML-267, Pusa-105, LGG-407 and MGG-295 turned out to be good general combiners coupled with high *per se* performance. LGG-450 was reported to be resistant to preharvest sprouting by virtue of higher epicuticular wax on the pod wall surface [4]. Parents LGG-440, LGG-407, Pusa-105 and MGG-295 recorded significant desirable positive 'GCA' effects (Table 4) along with moderate to highest mean (Table 2) for

Table 2. Mean performance of mungbean parents for preharvest sprouting resistance traits and preharvest sprouting in mungbean

Character/ parent	Pod beak length (cm)	Pod wall thickness (um)	Pod wall epicuticular was (ug)	Hard seed (%)	Moisture absorption through pod wall		Pre-harvest sprouting (%)
					24 hr	48 hr	
LINES							
LGG 450	0.480	0.259	14.58	37.1	48.4	70.0	9.1
LGG 440	0.460	0.262	10.24	47.7	52.7	45.1	10.7
K 851	0.593	0.348	9.06	20.4	61.3	90.2	15.8
PS 16	0.457	0.231	7.99	29.9	62.3	75.2	22.2
V2764	0.513	0.244	11.25	45.4	53.2	74.6	14.5
TESTERS							
ML 267	0.520	0.220	8.09	33.8	66.9	85.3	18.7
PUSA 105	0.460	0.257	8.74	39.0	60.0	89.0	19.9
PDM 54	0.487	0.229	7.89	36.5	64.0	81.6	22.8
LGG 407	0.470	0.262	7.60	23.1	68.3	87.6	17.8
WGG 2	0.547	0.249	7.52	13.4	73.1	92.4	25.2
MGG 295	0.407	0.247	8.16	20.6	60.6	80.3	18.2
General mean	0.504	0.253	9.19	31.5	61.9	81.9	17.7
SE	0.020	0.006	0.09	0.70	0.30	11.50	0.20
CV%	4.750	2.760	1.15	2.60	0.80	2.80	0.90

hard seed per cent and thus found to be good general combiners. Susceptibility to preharvest sprouting was reported due to the absence of hard seededness and reduced seed coat thickness than any other character (5-7).

Parents LGG-450, LGG-440, PS-16, ML-267 and MGG-295 were found to be good general combiners along with low *per se* performance in desirable direction for moisture absorption through pod wall in 24 and 48 hours of soaking. Genotypic variation for pod permeability has been reported in soybean [8, 9]. The 'SCA' effects (Table 5) for this trait indicated the importance of both additive and non-additive gene action.

Table 3. Mean performance of mungbean for preharvest sprouting resistance traits and preharvest sprouting in F_1 generation

Cross	Pod beak length (cm)	Pod wall thickness	Pod wall epicuticular wax (μg/sq.cm)	Hard seed (%)	Moisture absorption through pod wall (%)		Pre-harvest sprouting (%)
					24 hr	48hr	
LGG-450 × ML-267	0.510	0.251	11.09	42.4	54.3	65.0	9.90
LGG-450×PUSA-105	0.553	0.254	11.62	27.4	55.3	62.1	9.87
LGG-450×PDM-54	0.523	0.241	10.87	23.0	56.7	65.0	10.63
LGG-450×LGG-407	0.423	0.265	10.56	43.0	60.0	75.7	8.03
LGG-450×WGG-2	0.537	0.282	10.14	31.0	53.7	64.8	18.03
lGG-450×MGG-295	0.450	0.266	11.20	35.5	52.7	61.3	16.93
LGG-440×ML-267	0.493	0.241	9.17	37.3	50.0	62.6	10.80
LGG-440×PUSA-105	0.523	0.257	9.51	37.1	62.7	66.4	10.67
LGG-440×PDM-54	0.504	0.263	9.01	20.4	55.0	71.8	11.10
LGG-440×LGG-407	0.427	0.289	8.75	45.3	56.0	73.3	7.40
LGG-440×WGG-2	0.513	0.286	8.02	40.5	65.0	73.0	13.70
LGG-440×MGG-295	0.520	0.257	8.99	49.0	56.3	67.6	8.40
K-851×ML-267	0.587	0.284	8.51	24.6	55.3	77.5	18.70
K-851×PUSA-105	0.580	0.282	8.68	44.5	64.3	98.0	25.30
K-851×PDM-54	0.573	0.277	8.25	30.9	66.3	80.7	28.70
K-851×LGG-407	0.600	0.303	8.01	44.5	67.7	95.4	27.00
K-851×WGG-2	0.630	0.295	7.86	11.5	56.0	79.2	24.40
K-851×MGG-295	0.610	0.276	8.44	33.4	61.3	80.2	9.40
PS-16×ML-267	0.473	0.239	7.85	36.4	62.3	65.5	14.50
pS-16×PUSA-105	0.470	0.268	8.28	36.9	52.0	58.0	13.73
PS-16×LGG-407	0.497	0.269	7.88	18.5	6.0	84.7	23.40
PS-16×WGG-2	0.513	0.239	8.10	44.5	61.0	72.8	24.80
PS-16×MGG-295	0.467	0.249	8.29	33.6	58.0	58.3	19.40
V-2764×ML-267	0.583	0.249	10.09	32.5	55.0	58.3	18.63
V-2764×PUSA-105	0.507	0.260	10.67	49.5	57.0	72.2	6.70
V-2764×PDM-54	0.503	0.246	9.84	33.0	61.7	74.0	17.70
V-2764×LGG-407	0.473	0.293	9.57	37.7	60.0	74.4	19.13
V-2764×WGG-2	0.557	0.257	9.42	25.6	58.3	88.0	25.70
V-2764×MGG-295	0.523	0.248	10.36	33.8	53.3	72.9	15.57
General mean	0.519	0.262	9.23	34.9	58.0	72.9	16.15
SE	0.033	0.024	0.040	0.50	0.30	0.50	0.90
CV%	7.890	11.140	0.520	1.80	0.70	1.10	4.70

Table 4. Estimates of general combining ability (gca) effects of parents in F1 generation for pre-harvest sprouting resistance traits and pre-harvest sprouting in mungbean

Character/ parent	Pod beak length (cm)	Pod wall thickness (μm)	Pod wall epicuticular wax (μg)	Hard seed (%)	Moisture absorption through a pod wall		Pre-harvest sprouting (%)
					24 hr	48 hr	
LINES							
LGG 450	–0.0192	–0.0050	1.6802**	–0.8161**	–1.4753**	–4.9754**	–3.1764**
LGG 440	–0.0220	0.0007	–0.3170**	1.8061**	–0.2603*	–2.8710**	–4.7670
K 851	0.0780**	0.0215**	–0.9431**	–1.5144**	2.2736**	9.4112**	4.4086**
PS 16	0.0426**	–0.0113**	–1.1764**	0.3456	–0.3642**	–1.5938**	2.0847**
V 2764	0.0058	–0.0058	0.7563**	0.1789	–0.1737	0.0290	1.4502**
SE	0.0087	0.0031	0.0166	0.1762	0.0845	0.2571	0.2238
TESTERS							
ML 267	0.0107	–0.0122**	0.1078**	–0.2593	–1.4904**	–4.8640**	–1.2197**
PUSA 105	0 0080	–0.0004	0.5198**	2.3920**	0.1456	0.1360	–2.5850
PDM 54	–0.017	–0.0080*	–0.0529*	–2.9273**	0.1029	1.0517**	2.0330
LGG 407	–0.0347*	0.0191**	0.2829**	1.4720**	1.5862**	5.6307**	0.2463
WGG 2	0.0313*	0.0068	–5136**	–3.1353**	0.6062**	1.4695**	3.2710**
MGG 295	–0.0047	–0.0054	0.2218**	2.4580	–0.9504**	–3.4247**	–1.7457**
SE	0.0095	0.0034	0.0181	0.1931	0.0926	0.2816	0.2452

*Significant at 5% level, *Significant at 1% level

In respect of preharvest sprouting LGG-450, LGG-440, ML-267, Pusa-105 and MGG-295 with low to moderate mean (Table 2) and significant 'GCA' (negative) effects (Table 4) were found to be good general combiners. Five crosses, LGG-450 × PDM-54 (H × L), LGG-450 × LGG-407 (H × L), LGG-440 × L LGG-407 (H × L) showed significant 'SCA' effects (Table 5) in desirable direction (Table 3) and involved parents with high and low 'GCA' effects indicating the predominance of non-additive gene effects. The above cross combinations may be advanced through bi-parental or recurrent selection method in the early generations followed by single plant selection

Table 5. Estimates of specific combining ability (sca) effects of crosses in F_1 generation for preharvest sprouting resistance traits and preharvest sprouting in mungbean

Cross	Pod beak length (cm)	Pod wall thickness (μm)	Pod wall epicuticular wax (μg/sq.cm)	Hard seed (%)	Moisture absorption through pod wall (%)		Pre-harvest sprouting (%)
					24 hr	48 hr	
LGS-450×ML-267	–0.0001	0.0032	0.0711	5.4888**	0.8693**	4.4010**	–0.7109
LGG-450×PUSA-105	0.0459*	–0.0056	0.1891**	–6.2292**	–0.2067	–2.3599**	0.6544
LGG-450×PDM-54	0.0346	–0.0104	0.0084	3.8199**	0.5093	–1.5266**	–3.2669**
LGG450×LGG-407	–0.0414	–0.0141	–0.0749	4.0841**	–1.0593**	0.7888	–4.0502**
LGG-450×WGG-2	0.0059	0.0152*	–0.2576**	1.5648**	–1.6073**	–2.0632**	1.5918**
LGG-450×MGG-295	–0.0448*	0.0118	0.0638	–1.0886*	–0.6240**	0.7508	5.7818**
LGG-440×ML-267	–0.0140	–0.0126	0.1417**	–0.2401	–2.8523*	0.8723	1.7297**
LGG-440×PUSA-105	0.0187	–0.0077	0.0763	–2.8915**	2.8683**	–1.8710**	2.9750**
LGG-440×PDM-54	0.0173	0.0056	0.1423**	8.2555**	–1.5723**	0.5657	–1.2430*
LGG-440×LGG-407	–0.0353	0.0042	0.1123**	2.8052**	–2.4790**	–2.9023**	–3.1330**
LGG-440×WGG-2	–0.0147	0.0138	–0.3270**	4.6359**	3.7843**	0.9157	–0.2510
LGG-440×MGG-295	0.0290	–0.0033	–0.1457**	3.9459**	0.2510	2.4197**	–0.0777
K-851×ML-267	–0.0207	0.0100	0.114**	–4.7129**	–2.3462**	–2.0432**	–1.0059
K-851×PUSA-105	–0.0247	0.0035	–0.1309**	4.7458**	1.2911**	13.3234**	4.9394**
K-851×PDM-54	–0.0127	–0.0015	0.0094	1.9951**	2.5571**	–5.6766**	2.5081**
K-851×LGG-407	0.0380	–0.0023	–0.0016	5.6691**	1.9071**	3.4054**	3.2148**
K-851×WGG-2	0.0020	–0.0017	0.0791	–11.7469**	–4.0239**	–7.4266**	–1.4732**
K-851×MGG-295	0.0180	0.0044	–0.0696	4.0498**	0.6238**	–1.5826*	–8.1832**
PS-16×ML-267	–0.0134	–0.0026	–0.3156**	0.8038	4.3949**	1.3084*	–1.9220**
PS-16×PUSA-105	–0.0141	0.0150*	–0.2942**	–1.5476**	–3.4044**	–7.9082**	–1.2233*
PS-16×PDM-54	–0.0288	0.0109	–0.0582	8.4951**	–3.5918**	7.5551**	–3.4913**
PS-16×LGG-407	0.0552*	–0.0032	0.1018*	–12.5709**	–0.2451	3.9404**	3.1620**
PS-16×WGG-2	0.0059	–0.0216**	0.5591**	8.4164**	1.5116**	–0.4916	1.1173*
PS-16×MGG-295	–0.0048	0.0014	0.0071	–3.5969**	1.3349**	–4.4042**	2.3573**
V-2764×ML-267	0.0482*	0.0019	–0.0117	–1.3396**	–0.0657	–4.5477**	1.9091**
V-2764×PUSA-105	–0.0258	0.0018	0.1597**	5.9224**	–0.5483	–1.1843	–7.3456**
V-2764×PDM-54	–0.0104	–0.0046	–0.1010	1.5851**	2.0977**	–0.9177	5.4931**
V-2764× LGG-407	–0.0164	0.0153*	–0.1377**	0.0124	–0.2423	–5.2323	0.8064
V-2764×WGG-2	0.0009	-0.0091	-0.0537	-2.8702**	0.3443	9.0657	-0.9849
V-2764×MGG-295	0.0036	–0.0055	0.1443**	–3.3102**	–1.5857	2.8163	0.1218
SE	0.0213	0.0076	0.0405	0.4317	0.2070	0.6297	0.5482

**Significant at 1% level *Significant at 5% level so as to exploit both additive and non-additive gene effects. Crosses involving H × H combinations for other traits imparting resistance to preharvest sprouting damage may be advanced through pedigree method of breeding to exploit additive gene effects.

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