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Research Article

EFFECT OF WATER STRESS ON ASSOCIATIONS OF DROUGHT TOLERANCE AND YIELD TRAITS IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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ABSTRACT
Thirty one mungbean accessions were studied under moisture stress conditions for associations among yield, yield contributing traits viz., days to 50% flowering, days to maturity, plant height, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, 100-seed weight, harvest index% and drought tolerance contributing traits like SPAD Chlorophyll Meter Reading (SCMR), Relative Water Content% (RWC), Relative Injury% (RI), chlorophyll content and Specific Leaf Area (SLA). The correlation studies revealed that seed yield per plant showed positive association with harvest index%, number of clusters per plant, number of pods per plant, relative injury%, days to maturity, number of seeds per pod, days to 50% flowering, plant height, 100-seed weight and chlorophyll content at both phenotypic and genotypic levels. Therefore, these parameters could be used as selection criteria in mungbean breeding programmes aiming to improve yield coupled with drought tolerance.

Keywords: *Mungbean, Correlation, Yield, Agronomic Traits, Physiological Traits*

INTRODUCTION
Mungbean is a one of the important crop among pulses owing to its short duration, suitable for different cropping systems, good nitrogen fixing ability and is favored for consumption due to its easy digestibility. However, the production and productivity levels are low due to various biotic and abiotic stresses. Among the abiotic stresses, water stress is considered to be the main cause affecting severely the crop productivity. Hence, there is an immediate need to strengthen the breeding programmes aimed towards development of high yield coupled with moisture stress tolerance genotypes. Since yield and moisture stress tolerance traits are highly complex in nature, study on association among different yield and moisture stress tolerance contributing characters is very essential for developing effective selection criteria. Though several studies on association of these traits are available, the assessments of these traits in the water stress conditions are limited and such studies are highly essential to assess the traits with greater precision. Hence, an effort was made in this study to estimate the genotypic and phenotypic correlation coefficients among nine agronomic traits and four drought tolerance contributing traits with yield under moisture stress condition.

MATERIALS AND METHODS
The experimental material for the present investigation consisted of thirty one mungbean genotypes obtained from Regional Agricultural Research Station, Lam, Guntur and Agricultural Research Station, Madhira. The experiment was conducted in randomized block design (RBD) with three replications during summer, 2013-14 at wet land farm, Sri Venkateswara Agricultural College, Tirupati. Each genotype was sown in three rows of 4 m length with a spacing of 30 cm between rows and 10 cm between plants within rows. In the present study, moisture stress was induced during pod filling stage by withholding irrigation for fifteen days. Observations were recorded on five randomly selected plants per replication for traits namely plant height, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, 100 seed weight, harvest index, SPAD chlorophyll meter reading (SCMR), Relative Water Injury (RWC), Relative Injury Percentage (RI), Chlorophyll

content and Specific Leaf Area (SLA). Whereas, traits days to 50 % flowering and days to maturity observations were recorded on plot basis. The mean values for each trait over the replications were subjected to the analysis of variance. Genotypic and phenotypic correlation coefficients were calculated by using the method given by Johnson *et al.,* (1955). The significance of correlation coefficients was tested by comparing the genotypic and phenotypic correlation coefficients with table value (Fishers and Yates, 1967) at (n-2) degrees of freedom at 5% and 1% levels, where, 'n' denotes the number of treatments used in the calculation.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences for all the characters among mungbean accessions, indicating substantial variation among these thirty one mungbean accessions and the data were analyzed for correlation analysis. The degree of correlation observable among attributes depends on the developmental relations between them and genetic linkage or pleiotropic effect of genes. In the present investigation, the phenotypic and genotypic correlation coefficients revealed that there was a close correspondence between phenotypic and genotypic correlation coefficients for most of the character combinations indicating low influence of the environment on these characters. Under water stress condition, the pattern of genotype and phenotype correlations were similar but the magnitude of genotypic correlation coefficients were relatively higher than of their corresponding phenotypic correlation coefficients in general, suggested the elimination of environmental correlation further strengthen the genetic association. Similar findings were also reported by Pandey *et al*., (2007) and Khajudparn and Piyada (2011).

Correlation with Yield

In the present study, seed yield per plant showed highly significant and positive correlation with harvest index followed by number of clusters per plant, number of pods per plant, relative injury, days to maturity and number of seeds per pod, days to 50% flowering, plant height, 100-seed weight and chlorophyll content showing that increase in these traits would result in direct increase in the seed yield. Similar results were also obtained by Aqsa *et al.,* (2010) and Tejbir *et al.,* (2009) for harvest index and Srivastava and Singh (2012), Sabra *et al.,* (2012) and Kodanda *et al.,* (2011) for number of pods per plant. The trait seed yield per plant showed non- significant positive association with RWC. On contrary, seed yield per plant exhibited non-significant negative correlation with SCMR, specific leaf area and number of pods per cluster, indicating that these traits had no influence in increasing yield.

Inter-Correlation among Traits

Days to 50% flowering registered highly significant positive association with days to maturity, plant height, relative injury, number of clusters per plant and chlorophyll content. Days to maturity had significant and positive association with relative injury followed by plant height, chlorophyll content and number of clusters per plant. The trait plant height recorded significant and positive association with relative injury, harvest index. Number of clusters per plant recorded positive and significant association with number of pods per cluster, number of pods per plant and RWC. Number of pods per cluster registered positive significant association with SCMR, RWC, harvest index and number of pods per plant. Number of pods per plant recorded significant positive association with harvest index and RWC. 100-seed weight and specific leaf area registered significant positive correlation with number of seeds per pod. The trait harvest index had positive and significant association with RWC. SCMR had significant positive correlation with specific leaf area. Chlorophyll content also had significant positive association with RWC. Similarly, Relative injury recorded positive and non-significant association with chlorophyll content. Chlorophyll content was found to be associated positively and significantly with specific leaf area. For the development of efficient breeding strategy for evolving superior genotypes with drought tolerance, identification of important yield and drought tolerance traits, their components and information about the association with yield and also with each other is essential. Therefore, inter relationship of these characters could also be considered during selection process to bring about improvement for highest yield under water stress condition.

Table 1: Phenotypic (r_p) and genotypic (r_g) correlation coefficients among fifteen characters in thirty one genotypes of mungbean under water stress condition

Character		Days to maturity	Plant height (cm)	No. of clusters/ plant	No. of pods/ cluster	No. of Pods/ plant	No. of seeds/ pod	100 seed weight (g)	Harvest index (%)	SCMR	Relative water content (%)	Relative injury (%)	Chlorophyll content	Specific leaf area ($cm^2 g^{-1}$)	Seed yield/ plant (g)
Days to 50% Flowering	r_p	0.7683**	0.4174**	0.2542*	-0.1704	-0.0925	-0.2035	-0.2454*	-0.0559	-0.2459*	-0.2250*	0.3077**	0.1953*	0.0471	0.2487*
	r_g	0.8236	0.4282	0.2890	-0.1743	-0.1019	-0.2141	-0.2518	-0.0614	-0.2630	-0.2588	0.3145	0.2098	0.0441	0.2538
Days to maturity	r_p		0.3278**	0.2969**	-0.0129	-0.1787	-0.2074*	-0.1464	0.0610	-0.2534*	0.0629	0.3659**	0.3053*	-0.1909	0.2648**
	r_g		0.3563	0.3580	-0.0118	-0.2043	-0.2442	-0.1602	0.0654	-0.2902	0.1262	0.3893	0.3437	-0.2255	0.2846
Plant height (cm)	r_p			0.1167	0.0997	0.1425	0.0288	-0.2193*	0.2270*	-0.2207*	-0.0941	0.3720**	-0.1482	-0.1092	0.2138*
	r_g			0.1318	0.0997	0.1469	0.0293	-0.2195	0.2286	-0.2340	-0.1026	0.3761	-0.1509	-0.1110	0.2143
No. of Clusters/ plant	r_p				0.2857**	0.2928**	-0.2895**	0.1539	-0.0387	-0.1663	0.2702**	0.0898	0.1618	-0.1700	0.3243**
	r_g				0.3192	0.3167	-0.3360	0.1724	-0.0470	-0.1988	0.2943	0.0948	0.1798	-0.2176	0.3586
No. of Pods/ cluster	r_p					0.1944*	-0.1612	-0.0797	0.2694**	0.4310**	0.3942**	-0.1046	-0.1036	0.0174	-0.0130
	r_g					0.2002	-0.1653	-0.0796	0.2709	0.4551	0.4260	-0.1053	-0.1051	0.0185	-0.0131
No. of Pods/ plant	r_p						-0.1451	0.0298	0.2550*	-0.0661	0.2337*	-0.2633**	-0.3121**	-0.0168	0.2774**
	r_g						-0.1588	0.0288	0.2688	-0.0630	0.2720	-0.2737	-0.3238	-0.0244	0.2846
No. of Seeds/ pod	r_p							0.3198**	0.1370	0.1142	-0.1130	0.0288	0.1802	0.2445*	0.2546*
	r_g							0.3265	0.1415	0.1267	-0.1333	0.0279	0.1896	0.2557	0.2606
100 seed weight (g)	r_p								-0.0104	0.0755	0.0355	-0.0705	-0.0169	0.1087	0.1998*
	r_g								-0.0099	0.0783	0.0366	-0.0701	-0.0184	0.1110	0.2003
Harvest index (%)	r_p									0.0985	0.3757**	0.0428	0.0145	0.0450	0.5241**
	r_g									0.1065	0.4026	0.0442	0.0161	0.0454	0.5281
SCMR	r_p										0.1132	-0.1608	-0.1276	0.4545**	-0.1440
	r_g										0.1153	-0.1631	-0.1392	0.4876	-0.1498
Relative water content (%)	r_p											-0.0132	0.3295**	-0.1440	0.1369
	r_g											-0.0120	0.3560	-0.1393	0.1491
Relative injury (%)	r_p												0.0482	-0.3006**	0.2652**
	r_g												0.0538	-0.3089	0.2661
Chlorophyll content	r_p													0.1916*	0.1942*
	r_g													0.1964	0.1997
Specific leaf area ($cm^2 g^{-1}$)	r_p														-0.0170
	r_g														-0.0168

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

Critical analysis of the present results implied that the characters number of clusters per plant, number of pods per plant, 100-seed weight and harvest index exhibited significant positive association with seed yield per plant, indicating that increase in these traits would result in increase in the seed yield per plant under water stress conditions. Whereas, seed yield per plant exhibited positive significant association with plant height under moisture stress condition which implied that tall plant stature could be exploited to produced more yields under drought condition. Likewise, chlorophyll content showed positive significant association with seed yield per plant under moisture stress condition, which explains that the genotypes with high chlorophyll content could with stand better under moisture stress conditions. Hence, selection criteria based on these traits could be considered while designing the breeding programmes aimed to develop high yielding coupled with drought tolerance genotypes in mungbean.

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