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Effect of water potential treatments on germination and seedling growth in some mungbean cultivars

A. ANDERSON AMALAN KUMAR
Department of Crop Physiology, Tamil Nadu Agricutural University., Coimbatore - 641 003, Tamil Nadu.

Abstract: Studies were conducted to find out the effect of reduced water potential treatments on germination and five seedling growth related characters *viz.*, plumule length, radicle length, vigour index, promptness index and germination stress index in mung bean genotypes. Decreasing water potential or increasing moisture stress adversely affected germination and all seedling growth related characters in that every attribute was significantly reduced with every level of decreasing water potentials. The extent of reduction varied with the genotypes and the reduced water potential. However, the reduced water potential at -0.25MPa did not affect germination. Four genotypes recorded no germination at -1.00MPa and this would be critical level of water stress for mungbean. Five genotypes viz., KM 2, Vamban 1, Pusa 9072, K 1, and TARM 1 with higher germination stress index were found to possess higher level of tolerance to drought.

Key words : Water potential, Germination, Stress index.

Introduction

Mungbean, known by its colour as greengram, is the third important pulse in India. It is mostly grown under rainfed conditions. Its complete dependence on monsoon rains for moisture in conjunction with rapidly diminishing rainfall is an impediment for normal physiological processes of growth and development. Water potential studies enabled the identification of varieties suitable for growing under moisture stress situations. Varieties that are found to germinate under reduced water potential do not usually fail to germinate and establish into seedlings. A critical value for external water potential is found to exist for any crop species below which germination seldom takes place (Hadas and Stible, 1973). Varieties have been found to show different levels of tolerance to both intensity and duration of soil moisture stress occurring in different stages of growth (Hsiao, 1982; Goswami and Baruah, 1994). The present study was undertaken in the Department of Crop Physiology, TamilNadu Agricultural University, Coimbatore during 1997 to find out the effect of water potential treatments on germination and seedling growth of some mungbean cultivars.

Materials and Methods

Ten genotypes of mungbean *viz.*, CO 4, CO 5, K 1, K 851, KM 2, ML 131, Pusa 9072, PS 16, TARM 1 and Vamban 1 constituted the material for the present study. Seeds of these cultivars were obtained from the Department of Pulses, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Caimbatore. Germination tests were conducted in petridish medium, moistened with each of five water potential treatments *viz.* 0.00 (control), -0.25, -G.503 -0.75 and -1.0 MPa of Poly Ethylene Glycol. (PEG - 6000), prepared by the following procedure of Michael and Kaufmann (1973). The experiment was conducted in a factorial CRD design with three replications. In each petridish (replication), total of 50 surface sterilized seeds was kept for germination. The petridishes were kept in laboratory under normal light and at room temperature. Taking emergence of 2mm radicle from the seed coat as the criteria for germination, germination counts were recorded on 2,4,6 and 8 days after soaking (DAS) and based on the cumulative germination, the average germination percentage was computed. The percentage values of germination were subjected to 'Arcsine' transformation for analysis of variance. Seedling characters of plumule and radicle length were measured on ten randomly selected 8 day old normal seedling in each replication and the means were utilized for statistical analysis. The above ten seedling were oven dried for 24 hours and weighed for recording the dry weight of seedlings. Based on the basic data on germination,

Table 1. Germination of greengram genotypes under reduced water potentials (after arcsine transformation)

Genotype	Treatments					
	0.00 MPa	-0.25 MPa	-0.50 MPa	-0.75 MPa	-1.00 MPa	Mean
CO 4	90.0 (100)	90.0 (100)	63.4 (80)	46.1 (52)	9.9 (3)	59.8 (67.0)
CO 5	90.0 (100)	81.8 (98)	46.7 (53)	36.8 (36)	5.7 (1)	52.2 (57.6)
K1	90.0 (100)	90.0 (100)	63.5 (80)	29.3 (24)	9.8 (3)	56.5 (61.4)
K 851	90.0 (100)	90.0 (100)	49.6 (58)	40.4 (42)	8.1 (2)	55.6 (60.4)
KM 2	90.0 (100)	90.0 (100)	62.0 (78)	62.0 (78)	0.0 (0)	60.8 (71.2)
ML 131	90.0 (100)	84.3 (99)	62.0 (78)	14.2 (6)	0.0 (0)	50.1 (56.6)
Pusa 9072	90.0 (100)	90.0 (100)	73.6 (92)	26.6 (20)	0.0 (0)	56.0 (62.4)
PS 16	90.0 (100)	68.0 (86)	41.5 (44)	33.2 (30)	9.9 (3)	48.5 (52.6)
TARM 1	90.0 (100)	74.7 (93)	72.5 (91)	48.4 (56)	9.9 (3)	59.1 (68.6)
Vamban 1	90.0 (100)	90.0 (100)	81.8 (98)	64.9 (82)	0.0 (0)	63.4 (76)
Mean	90.0 (100)	84.9 (97.6)	55.5 (75.2)	40.2 (42.6)	5.3 (1.5)	55.2 (63.4)

	G	T	G x T
SEd	1.39	0.99	3.12
CD (P=0.05)	2.79	1.99	5.27

Values in parentheses are means in original scale

plumule and radicle length and dry seedling weight, three physiological parameters *viz.* vigor index (VI), promptness index (PI) and germination stress index (GSI) were computed following the methods of Thandapani (1985), George (1967) and Dhopte and Livera (1989) respectively.

Results and Discussion

Genotypewise germination in different water potential treatments including control is given in Table 1. In the control, each genotype registered cent per cent germination, the mean germination of all genotypes in the reduced water potential was reduced, the extent of reduction in germination varying with the genotypes in the individual treatments. In the lowest water potential *i.e.* -0.25 MPa, six genotypes *viz.* CO 4, KI, K 851, KM 2, Pusa 9072 and Vamban 1 registered cent per cent germination and the rest of the genotypes recorded germination between 86.0 and 99.0 per cent. Therefore the mean germination of all genotype in -0.25 Mpa was quite high (97.6%) and comparable with the control. Such a high germination in the reduced water potential at -0.25 MPa was possible due to the absence of any untoward influence of reduced water potential on germination.

In reduced water potentials lower than -0.25 MPa, significant differences were observed in the germination of genotypes. In -0.50 MPa, the germination varied from 44.0% (PS 16)-to 98.00/o (Vamban 1) the mean of all genotypes

Table 2. Length (cm) of plumule (P) and radicle (R) in 10 day old seedling of mungbean genotypes under reduced water potentials

Genotype		Treatments				Mean
		0.00 MPa	-0.25 MPa	-0.50 MPa	-0.75 MPa	
CO 4	P	12.56	2.63	0.43	0.31	3.98
	R	3.50	3.90	3.38	1.87	3.16
CO 5	P	11.12	2.78	0.78	0.30	3.74
	R	4.50	3.22	2.40	2.50	3.15
K1	P	10.37	5.15	0.42	0.52	4.12
	R	3.25	3.00	3.25	1.75	2.81
K 851	P	10.65	2.95	0.97	0.52	3.77
	R	3.85	3.82	3.47	2.47	3.40
KM 2	P	12.56	2.63	0.43	0.31	4.64
	R	5.50	4.85	4.30	2.66	4.33
ML 131	P	10.68	3.15	0.76	0.51	3.77
	R	3.10	3.16	2.75	1.50	2.63
Pusa 9072	P	13.85	4.30	0.70	0.18	4.78
	R	5.50	5.36	3.50	1.00	3.84
PS 16	P	13.00	4.43	0.42	0.20	4.51
	R	3.10	3.85	2.26	1.50	2.68
TARM 1	P	14.55	1.00	0.96	0.20	4.18
	R	8.05	4.50	2.95	3.00	4.62
Vamban 1	P	9.05	2.58	0.50	0.25	3.10
	R	6.50	5.03	2.52	2.78	4.21
Mean	P	11.98	3.25	0.67	0.35	4.06
	R	4.68	4.07	3.08	2.10	3.48
		G	T	G x T		
SEd	P	0.312	0.197	0.64		
	R	0.376	0.238	0.752		
CD (P=0.05)	P	2.79	1.99	5.27		
	R	0.761	0.481	1.521		

being 75.2% which declined further to 43.60% in -0. 75 MPa and 1. 5% in - 1. 00 MPa. It was thus, apparent that germination significantly decreased in highly reduced water potentials or increased moisture stress. ML 131 recorded germination as low as 6.0% in -0.75 MPa when KM 2 showed 82.0% germination. Decreasing germination with increasing moisture stress was observed by Singh and Singh (1983), Goswami and Baruah (1994) and Redona and Michael (1996) in rice, Hadas (1976) in leguminous seeds and Winter *et al.* (1989) and Singh and Singh (1982) in winter wheat.

Reduced germination in increased moisture stress was attributed to the additive effects of both the water and osmotic potentials inhibit seed germination (Bemstein, 1961). A far as the highly reduced water potential i.e -1.00 MPa was concerned, it was found have a detrimental effect on germination. Fo cultivars *viz.* KM 2, ML 131, Pusa 9072 a Vamban 1 recorded nil germination, otherwi failed to germinate. Other cultivars record insignificantly small germination of 1.0 to 3.001 Due to the failure of a number of genotyp to germinate and also the low germination majority of genotypes, the mean germinati of all the genotypes at -1.00 MPa was ve low (1.5%). Zayed and Zeid (1998) observ no seedling emergence in osmotic potential lov than - 1. 00 MPa in mungbean. The cumulati

Table 3. Vigour index (VI), Promptness index and Germination Stress Index (GSI) of greengram genotypes under reduced water potentials

Genotype		Treatments 0.00 MPa	-0.25 MPa	-0.50 MPa	-0.75 MPa	-1.00 MPa	Mean	GSI%
CO 4	VI	1200	503	242	101	-	512	35.6
	PI	250.00	182.5	89.00	55.50	2.25	115.85	
CO 5	VI	1072	443	157	100	-	443	26.2
	PI	250.00	147.50	65.50	44.0	0.75	101.55	
K1	VI	1005	606	214	39	-	466	40.8
	PI	250.00	219.00	102.00	36.75	2.25	122.00	
K851	VI	113	649	210	100	-	518	35.7
	PI	250.00	189.25	89.25	61.00	1.50	118.20	
KM2	VI	1200	577	233	58	-	517	61.7
	PI	250.00	221.75	154.25	49.75	0.00	145.15	
ML 131	VI	790	358	157	7	-	328	36.0
	PI	247.00	170.25	89.00	6.00	0.00	102.45	
Pusa 9072	VI	1330	660	282	28	-	575	43.4
	PI	250.00	230.00	108.5	19.00	0.00	121.50	
PS 16	VI	1445	651	103	30	-	557	14.3
	PI	249.00	148.75	35.25	27.00	2.25	92.45	
TARM 1	VI	720	165	114	157	-	264	39.9
	PI	249.00	164.75	89.50	65.50	2.25	14.20	
Vamban 1	VI	1391	680	265	221	-	639	51.7
	PI	250.00	158.25	129.25	91.25	0.00	125.75	
Mean	VI	1127	529	198	74	-	482	38.5
	PI	249.00	183.20	95.15	50.57	1.12	115.01	
							SEd	3.33
							CD (P=0.05)	7.54

		G	T	G x T
SEd	VI	12.75	8.06	25.51
	PI	2.31	1.63	5.16
CD (P=0.05)	VI	25.80	16.31	51.59
	PI	4.64	3.28	10.38

germination that ranged from 52.60% in PS 16 to 76.0% in Vamban 1 and the existence of significant differences for cumulative germination in the genotypes indicated that the physiological means of tolerance to moisture stress varied with the genotypes. Such differences to moisture stress in the genotypes would be helpful in identification of genotypes tolerant to drought.

The plumule and radicle length of individual genotypes in different water potential treatments are given in Table 2. The plumule length in different genotypes was found to be significantly different from one another. The mean plumule length of all genotypes measured 11.98 cm, 0.67 cm and 0.35 cm in the control, -0.25 MPa, -0.50 MPa and -0.75 MPa respectively. It could be seen from the above that there was a sudden fall in the length of plumule from 11.98 cm in the control to 3.25 cm in -0.25 MPa, the lowest reduced water potential. The extent of reduction in plumule length worked out to 72.9%, 94.0% and 97.0% in -0.25 MPa,

-0.50 MPa, and -0.75 MPa respectively compared to the control. The radicle length in individual genotype was found to be significantly different from one another in the individual treatments. The mean radicle length of all genotypes measured 4.68 cm, 3.08 cm and 2.10 cm in the control, -0.25 MPa, -0.50 MPa and -0.75 MPa respectively. As in the case of germination and plumule length, reduction in radicle length was noticed in the highly reduced water potential, the extent of reduction being gradual in the successive reduced water potentials. The reduction in radicle length worked out to 13.0% in - 0.25 MPa, 34.20% in -0.50 MPa and 55. 1% in -0.75 MPa. Increased moisture stress reduced the plumule and radicle length and thus, the normal growth and development. In between plumule and radicle length, plumule length was found very much affected by an increased moisture stress in that the plumule was very much retarded in its growth compared with the radicle. Under reduced water potential germination and seedling growth were variously affected, the variation being specific for genotype (Redona and Mackill, 1996).

The tendency of the highly reduced water potential either to inhibit germination or suppressed the growth and development of seedlings was also noticed for vigour index and promptness index calculated for different cultivars (Table 3). The mean vigour index of all genotypes at 1127 in the control significantly decreased to 527, 198 and 74 in -0.25 MPa, -0. 50 MPa and -0. 75 MPa respectively. The reduction in vigour index worked out to 53%, 83% and 94% in -0.25 MPa, -0.50 MPa and -0,75 MPa respectively compared with the control. The cumulative vigour index was maximum in Vamban 1 (639), followed by Pusa 9072 (575), PS 16 (557), K 851 (518), KM 2 (517) and CO 4 (512). These above genotypes had high cumulative germination as well. Those genotypes that had high germination had also high vigour index. The promptness index (PI) is indicative of the speed of germination and quick establishment in reduced water potentials. The higher the PI quicker the establishment capacity of the genotype. The cumulative PI was quite high in KM 2(145.15), Vamban 1(125.75), K 1(122.0), Pusa 9072(121.50) and K 851 (1 18.20) each of which was also characterized by a higher level of germination. Maibangsa (1998) reported that rice genotypes with higher germination had higher PI under reduced water potentials.

The germination stress index (GSI) worked for the individual genotype is given in Table 3. The GSI was maximum in KM 2 (61.7%) followed by Vamban 1 (51.7%), Pusa 9072 (43.40/o), K1 (40.8%) and TARM 1 (39.9%). The high GSI in these above genotypes would indicate higher level of tolerance to drought in them. Dhopte and Livera (1989) emphasized the use of GSI in screening drought tolerance in pulses.

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