Differential physiological response in root and leaf of mungbean [*Vigna radiata* (L) Wilczek] under salinity and drought stress

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Abstract

An experiment was conducted in the laboratories of Plant Physiology, Bidhan Chandra Krishi Viswavidyalaya of West Bengal, to study the contrasting physiological and biochemical response of root and leaf of mungbean under drought and salinity stress at early seedling growth stage. The drought and salinity stress was imposed using a solutions of 12% polyethylene glycol 6000 (PEG 6000) and 100 mM of NaCl, respectively. It was found that the seedling growth was not up to the mark and had more detrimental effect under salinity stress condition as compared to drought stress condition. The leaf showed much higher (368.892 µ mol g^{-1}) accumulation of osmolytes as compared to root (124.923 µ mol g^{-1}) under both stress treatments. However, the drought stress showed higher activities of ROS scavenging enzymes such as GPOX (118.400 $\Delta A470\ min^{-1}\ g^{-1}$) and catalase (236.876 µmol $H_2O_2\ min^{-1}\ g^{-1}$) in root than salinity, however SOD (28.970 Unit $min^{-1}\ g^{-1}$) activity higher in leaf. So, the salinity stress was found to be more detrimental than drought stress in causing inhibition of growth of embryonic axis and the emerging seedling in the present experiment.

Key word: *Drought, Mungbean, Nacl, Polyethylene Glycol, Salinity*

I. Introduction

Plants are frequently exposed to water stress induced by drought or salinity and it limits the productivity of crops. Over 800 million hectares of land throughout the world are salt affected, either by salinity or the associated condition of sodicity.Stress response is a developmentally regulated, stage-specific phenomenon, so that tolerance at one stage of development may not be correlated with tolerance at other developmental stages [9].Therefore, specific stages throughout the ontogeny of the plant, such as germination and emergence, seedling survival and growth, should be evaluated separately during the assessment of germplasm for stress tolerance. Such assessments may help in the development of cultivars with tolerance characteristics throughout the ontogeny of the plant. Mungbean [*Vigna radiata* (L.) Wilczek] is an important leguminous crop and is considered as one of the cheap sources of dietary proteins in our country. Different developmental stages of this crop are sensitive to drought and salinity stress. So far, some research works have already been carried out on the effect of drought stress and salinity stress on morpho-physiological and biochemical characteristics of mungbean [23] [6] .But still there is dearth of information regarding the physiological response of drought and salt stress during at early seedling stage in this crop. The present experiment was envisaged to study the contrasting physiological and biochemical response of root and leaf under drought and salinity stress at early seedling growth stage of mungbean.

II. Materials and Method

Seedlings of mungbean cultivar Pusa 9531 were allowed to grow in slanting glass plates for 8 days in presence of 50ml of PEG 6000 (12%) or NaCl (100 mM) solution. Three replicates were maintained in all cases including a control set containing distilled water. Eight days old seedlings were removed from the glass plate for studies on growth parameters and biochemical parameters of root and leaf separately. The data pertaining Proline content, soluble protein content, Superoxide dismutase activity, Catalase activity, Guaiacol peroxidase activity and Total phenol was estimated and analysed using INDOSTAT version 7.1 software.

III. Result and Discussion

The data presented on (table 1) clearly shows the higher reduction in length of root, shoot under salinity stress as compared to the drought stress. Such reports on decrease in root and shoot length under salinity stress [10] [11] and drought stress [12]

Table 1: Effect of drought and salinity stress on length, fresh weight, and dry weight of root, leaf and shoot of mungbean cultivar Pusa 9531

Treatment	Root Length (cm)	Shoot Length (cm)	Root FW*	Shoot FW*	Leaf FW*	Root DW*	Shoot DW*	Leaf DW*
Control	10.817	15.200	20.958	34.292	149.167	2.917	13.179	10.196
PEG 12%	11.002 (1.71)	12.698 (-16.46)	21.000 (0.20)	126.417 (268.65)	25.583 (-82.85)	3.071 (5.28)	13.783 (4.58)	4.525 (-55.62)
NaCl100mM	8.738 (-19.22)	12.395 (-18.45)	26.913 (28.41)	27.833 (-18.84)	135.588 (-9.10)	2.792 (-4.29)	4.067 (-69.14)	9.667 (-5.19)
S.E. m(±)	0.051	0.052	0.056	0.054	0.051	0.052	0.051	0.052
C.D.(P=0.05)	0.177	0.179	0.192	0.187	0.175	0.181	0.176	0.179

Data in parentheses indicate percent increase (+) or decrease (-) over control
*** Data expressed as mg per seedling , FW= Fresh Weight DW= Dry Weight**

have also be reported earlier. The fresh weight of shoot and leaf decreased in salinity in comparison with the control, but the fresh weight of root increased by 28.41% over control. In case of drought stress, the fresh weight of shoot indicated a remarkable increase over control whereas the leaf fresh weight decreased notably (82.85%). The root dry weight under drought stress registered an increase of 5.28% over control, while the leaf dry weight showed 55.62% decrease over control (Table 1). Thus, the seedlings under drought stress exhibited greater biomass allocation towards the root than the leaf under osmotic stress. The dry weight of the root, shoot and leaf registered decrease under salinity stress with the extent of decrease being more in shoot. The results were altogether consistent with early findings [19] [24] [5] [15]. The treatments showed significant variations among them for both root and leaf proline content. However, the two organs exhibited contrasting patterns in respect of proline content under stress treatments. The root proline content decreased over in both the stress treatments with PEG 12% showing the more drastic reduction (37.46% over control) than the NaCl 100 mM (20.36% over control). In contrast, the leaf proline content increased to an extent of 14.51% and 39.65%, under PEG 12% and NaCl 100 mM treatments, respectively, as compared to the control condition (Table 2). This increase in leaf proline content might help the plant for turgor maintenance under osmotic stress. The increase in proline content under salinity stress was also observed in different crops [2] [20] [13].The protein content in root was reduced under both the abiotic stress condition. The salinity stress showed greater reduction (37.88% over control) in protein content than the PEG 12% treatment (21.75% over control) in respect of root protein (Table 2). In contrast, both the stress treatments registered moderate increase in leaf protein and the corresponding values for PEG and NaCl treatments were 2.58% and 8.61%, over control respectively. Such an increase in leaf protein in response to stress exposure might be

Table 2: Effect of drought and salinity stress on proline and protein content in root and leaf of mungbean cultivar Pusa 9531

Treatment	Proline[a]		Protein [b]	
	Root	Leaf	Root	Leaf
control	156.856	264.152	86.677	107.248
PEG 12%	98.099 (-37.46)	302.471 (14.51)	67.820 (-21.75)	110.018 (2.58)
NaCl 100mM	124.923 (-20.36)	368.892 (39.65)	53.842 (-37.88)	116.479 (8.61)
S.E. m(±)	0.057	0.055	0.057	0.054
C.D.(P=0.05)	0.196	0.189	0.196	0.187

Data in parentheses indicate percent increase (+) or decrease (-) over control
[a]Data expressed as µ mol g^{-1} fresh weight
[b]Data expressed as mg/g fresh weight

attributed mainly to the increased synthesis of stress proteins. The leaf and root displayed different pattern of antioxidative responses in respect of enzymatic activities under the stress treatments under study. The highest activity of SOD (28.970 Unit min^{-1} g^{-1} fresh weight) was registered in leaf under drought stress and it was 18.97% higher than the control seedlings (Table 3). In contrast, the root showed only a slight increase in SOD activity under drought stress. While in case of salinity stress, the trend was different. Under this stress, the root registered higher increase (13.32% over control) in SOD activity than the leaf (6.73% over control). The induction of SOD activity under oxidative stress created by salinity and drought was reported [7] [1] [16].The root registered higher increase (19.64%) in GPOX activity under drought stress than the leaf (5.87%) as compared to control. The contrasting response of GPOX was also found between root and leaf under salinity stress. Under such condition, the GPOX activity in the root decreased to a level of 4.53% over control while that in the leaf registered an increase of 3.33% over control (Table 3).The correlation of peroxidase enzyme and osmotic stress tolerance induced by drought and salinity [22] [8] [17] .The activity of CAT decreased in both root and leaf of mungbean seedling under salinity stress in the experiment with the enzyme activity being more adversely affected in root

than leaf [21] [4]. In this experiment, the induction of drought stress triggered

Table 3: Effect of drought and salinity stress on activity of superoxide dismutase (SOD), gauiacolperoxidase (GPOX), catalase (CAT) enzyme and phenol content in root and leaf of mungbean cultivar Pusa 9531

Treatment	SOD[a]		GPOX[b]		Catalase[c]		Phenol[d]	
	Root	Leaf	Root	Leaf	Root	Leaf	Root	Leaf
control	19.750	24.350	98.960	50.400	211.213	402.008	1.470	2.082
PEG 12%	19.900 (0.76)	28.970 (18.97)	118.400 (19.64)	53.360 (5.87)	236.876 (12.15)	428.787 (6.66)	1.977 (34.49)	3.173 (52.40)
NaCl 100mM	22.380 (13.32)	25.990 (6.73)	94.480 (-4.53)	52.080 (3.33)	162.120 (-23.24)	378.577 (-5.83)	1.661 (12.99)	2.795 (34.24)
S.E. m(±)	0.055	0.056	0.058	0.054	0.056	0.056	0.056	0.058
C.D.(P=0.05)	0.189	0.195	0.200	0.187	0.194	0.195	0.196	0.200

Data in parentheses indicate percent increase (+) or decrease (-) over control

[a]Data expressed as Unit min^{-1} g^{-1} fresh weight

[b]Data expressed as ΔA470 min^{-1} g^{-1} fresh weight

[c]Data expressed as µmol H_2O_2 min^{-1} g^{-1} fresh weight

[d]Data expressed as millimol of gallic acid g^{-1} fresh weight

increase in GPOX activity in both the organs. However, the root registered higher increase (12.15%) than leaf (6.66%) as compared to control (Table 3). The results were concordant with the early observations, an increase in the activity of CAT under drought stress [14] [18]. Thus, it might be noted that the root and leaf displayed contrasting responses of antioxidative enzymes under stress in the present study. The observation corroborated well the early finding [3].

IV. Conclusion

Salinity stress was caused more detrimental than drought stress in causing inhibition of growth of seedling in mungbean cultivar Pusa 9531. The root and leaf of the seedling also showed differences in behaviour in respect of antioxidative enzyme activities and osmolyte accumulation

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