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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (2): 175-177, 2001

Effect of Salt Stress on the Performance of Six Soybean Genotypes

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Abstract: The effect of salinity on growth and chlorophyll content of six soybean genotypes was investigated. Plants were grown in nutrient solution in a greenhouse experiment to determine the effect of salinity on growth and Chl. a and b content of soybean leaves. Salinity was induced by natural drainage water of salted field to the nutrient solution. Electrical conductivities of the nutrient solution were 2, 4, 6, 8 and 10 ds/m. Salinity induced marked decrease in plant growth and chlorophyll content of soybean genotypes. Increasing salinity level to 10 ds/m decreased plant height, shoot and root dry weight and Chlorophyll a and Chlorophyll b contents. Soybean genotypes responded differently to increasing salt concentrations. There was a consistent in the percentages reduction of shoot dry weight and Chorophyll a and Chlorophyll b contents. It seems that Lee, coniquitt and Clark 36k are more tolerant than other genotypes. Chlorophyll a and b content of soybean leaves with or without shoot dry weight can be use as a parameter in screening for salt tolerant in soybeans.

Key words: *Glycine max,* salinity, stress, tolerance, chlorophyll content

Introduction

Soil salinity is a problem that restricts yields on approximately one-third of the irrigated arid and semiarid land (Norlyn and Epstein, 1984; Ashraf and Waheed, 1993). The use of high amount of fertilizers, by rising water tables and the use of saline irrigation water (Sonneveld and Welles, 1988) cause soil salinity. Studies of the physiology of crop plants under saline conditions should be carried out with combined natural salts that are present in the field soils.

It has been found that increases salinity resulted in decrease of chlorophyll contents in soybean leaves (Thallotth and Kabesh, 1988; Tabbada, 1992) in field bean, sunflower and sugar beet. Salinity causes decrease both in growth and in net photosynthesis of higher plants (Long and Baker, 1986). There is evidence in the literature suggesting that the composition and function of photosynthetic apparatus of plants may under go changes in response to salinity (Sharma and Hall, 1990; Morales *et al*., 1992).

Many investigaters have studied plant responses to salinity levels by using a single salt. Since saline soils in the field often contain a mixture of salts instead of a single salt, it seemed desirable to study the effect of salinity on plant performance by using natural mixture salted solutions from a drainage canal. The objectives of this work is to determine the effect of various salt levels on the growth and chlorophyll content of soybeans genotype in the nutrient solution and the possibility of using chlorophyll content of leaves as a selection criteria for identification salt tolerance genotypes in soybean which can be used in breeding programs.

Materials and Methods

Six soybean genotypes, Lee, A6297, Coiquitt, Wricht Clark 63k and Forest were investigated. Seeds were surface sterilized in 96% (v/v) ethanol for 3 minutes, washed with sterile water and germinated on sterilized moist cotton. Seedlings were selected for size uniformity were planted (one per jar) in sterile I.25 L Leonard jars. Natural salted water (Drainage water) obtained from a nearby drainage canal was used as a source for salinity. The composition of the drainage water is shown in Table 1.

Salt treatments were applied using nutrient solution with salted drainage water of 2, 4, 6, 8 and 10 ds/m electrical conductivity (EC). Nutrient solution was prepared following the procedure of Sonneveld (1992). The jars were arranged randomly in a glasshouse under natural light conditions. A randomized block design with five replicates was employed. Plants were taken four weeks after transplanting for measurements. Plant height was recorded and a sample of 2.0 grams of the fresh weight was taken for chlorophyll determination. The remaining plant materials were separated into roots and shoots, then dried at 70°C for dry weight determination.

Chlorophyll was estimated following the procedure of Witham *et al*. (1971) with one gram of fresh leaves triturated in a porcelain mortar with 80% acetone and filtrated. The filtrate was made up to 100 ml, thoroughly mixed and used to determine chlorophyll a and b at 645 and 663 nm spectrophotometrically (SHIMADZU UV-160 A model). All results were subjected to a two-way analysis of variance and means were compared by the Least Significant Difference (LSD) according to Steel and Torrie (1980).

Results

The effect of salinity on plant height is shown in Table 2. A comparison of the response of the different genotypes indicated that at 19 ds/m the reduction of plant height comparing with 2 ds/m were 42, 49, 36, 65, 57 and 45% for Lee, A6297, Coiquitt, Forest, Wricht and Clark 36k, respectively. Salt stress significantly reduced shoot and root dry weight of soybean plants (Table 3). This effect of salinity was more pronounced for plants at higher salt concentration. Increased salinity to 10 ds/m resulted in reduction of 60, 80, 69, 82, 82 and 70% for Lee, A 6297, Coiquitt, Forest, Wricht and Clark 36k, respectively. Root dry weight diminished by 55, 49, 80, 44, 46 and 54 in Lee, A 6297, Coiquitt, Forest, Wricht and Clark 36k treated with 10 ds/m, respectively. Chlorophyll content of the plant exposed to increasing salt concentration in the nutrient solution is given in Table 4. Salinity contributed to a reduction in chlorophyll a and b contents of all six soybean genotypes, this decrease being more drastic in Chl a than in Chl b. At salt salinity of 10 ds/m

Table 1: Chemical composition of drainage water

Soluble Ions								
ppm		Meq/L					PH	EC(ds/m)
SO_4^{-2}	P	Cl^-	K^+	Na^+	Mg^{++}	Ca^{++}		
822.5	6.0	105.5	0.3	104.3	72.1	26.5	7.9	15.0

Table 2: Effect of salt treatment on plant height (cm) for six genotype of soybeans

Ec (ds/m)	Plant Height (cm)					
	Genotypes					
	Lee	A6297	Coiguitt	Forest	Wricht	Clarck 63K
2	40.16	59.83	40.16	55.00	53.00	50.16
4	40.16	56.33	39.33	46.00	49.33	49.73
6	39.66	41.16	38.33	44.83	47.00	48.13
8	36.33	37.33	36.33	44.66	45.00	43.50
10	23.66	30.60	25.66	19.33	23.00	27.83

$LSD_{0.05} = 9.10$

Table 3: Effect of salt treatment on shoot dry and root dry weight for six genotype of soybeans

Salinity levels (ds/m)	Shoot dry weight (g)					
	Genotypes					
	Clarck 63K	Wricht	Forest	Coiguitt	A6297	Lee
2	0.780	0.537	0.640	0.747	0.947	0.533
4	0.477	0.477	0.623	0.600	0.803	0.487
6	0.567	0.403	0.605	0.550	0.703	0.293
8	0.447	0.350	0.407	0.450	0.510	0.257
10	0.233	0.106	0.113	0.230	0.193	0.213

$LSD_{0.05} = 0.11$

Salinity levels lds/m)	Root dry weight (g)					
	Genotypes					
	Clarck 63K	Wricht	Forest	Coiguitt	A6297	Lee
2	0.061	0.055	0.041	0.089	0.137	0.055
4	0.033	0.053	0.056	0.061	0.073	0.040
6	0.042	0.046	0.050	0.050	0.078	0.027
8	0.032	0.042	0.033	0.040	0.072	0.040
10	0.028	0.030	0.023	0.018	0.070	0.055

$LSD_{0.05} = 0.03$

Table 4: Effect of salt treatment on Chlorophyll a and b contents for six genotvoe of soybeans

Salinity levels (ds/m)	Chlorophyll a Concentration (mg/g)					
	Genotypes					
	Clarck 63K	Wricht	Forest	Coiguitt	86297	Lee
2	4.70	5.24	5.59	5.44	4.53	4.86
4	4.34	4.18	4.38	5.05	3.15	4.25
6	3.53	3.11	3.65	4.00	2.18	3.34
8	3.00	1.96	3.07	3.81	1.84	3.09
10	1.16	0.56	1.02	3.00	0.79	2.21

$LSD_{0.05} = 1.28$

Salinity levels (ds/m)	Chlorophyll b Concentration (mg/g)					
	Genotypes					
	Clarck 63K	Wricht	Forest	Coiguitt	A6297	Lee
2	1.75	1.88	2.30	2.39	1.71	1.71
4	1.70	1.55	1.89	2.25	1.25	1.57
6	1.42	1.33	1.70	1.80	0.90	1.24
8	1.29	0.98	1.65	1.78	0.88	1.20
10	0.75	0.36	0.72	1.57	0.45	0.94

$LSD_{0.05} = 0.88$

Chl a was decreased 53, 83, 45, 82, 89 and 75% and Chlorophyll b was decreased 45, 74, 34, 70, 81 and 57% in Lee, A6297, Coiquitt, Forest, Wricht and Clark 36k, respectively.

Discussion

Salinity in the nutrient solution induced major decreases in plant height, shoot and root dry weight of all soybean genotypes. These results are in good agreement with those reported by Cusido *et al*. (1987), Cordovilla *et al*. (1995), Gunes *et al*. (1996) and Yousef and Al-Saadawi (1997). The reduction of plant growth under saline conditions may either be due to osmotic reduction in water availability which resulted in increasing stomatal resistance as reported by Gunes *et al*. (1996), or to excessive ions, Na and Cl accumulation in the plant tissues (Cusido *et al*., 1987; Gunes *et al*., 1996; Yousef and Al-Saadawi, 1997). It has been reported that salinity stress significantly reduced net photosynthetic rates, increased energy losses for salt exclusion mechanism, largely decreased nutrient uptake and finally reduced plant growth (Long and Baker, 1986; Seemann and Sharkey, 1986). The reduction of biomass production reported in this investigation is in agreement with the findings of Morales *et al*. (1992), Cordovilla *et al*. (1995) and Gunes *et al*. (1996).

Salinity inhibits the growth of the plants by affecting both water absorption and biochemical processes, such as nitrogen and carbon dioxide assimilation and protein biosynthesis (Cusido *et al*., 1987). Under saline conditions, plants fail to maintain the required balance of organic and inorganic constituents leading to suppress growth and yield (Gunes *et al*., 1996).

Soybean genotypes responded differently to increasing salinity levels. The reduction percentages in shoot dry weight fairly corresponded with the reduction of Chlorophyll a and Chlorophyll b for all genotypes of soybean studied. Less reduction in growth and chlorophyll content was observed with increasing salinity levels in Lee, Coiquitt and Clark 36k than in A6297, Forest and Wricht. It can be concluded that Lee, Coiquitt and Clark 36k are more tolerant to salinity than the other genotypes. However reduction in root dry weight did not show a similar consistent with the reduction in chlorophyll content due to increasing salinity.

On the basis of this study, it would be possible that one could use chlorophyll content of soybean leaves with or without shoot dry weight as a simple and reliable method in screening salt tolerance in soybeans. However, it needs further confirmation by using genotypes covering a broader range of genetic diversity.

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