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Screening of Wheat Lines for Salinity Tolerance

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ABSTRACT

Salt tolerance of 50 wheat lines (produced by using tissue culture technique) was studied in solution culture set up. The experiment was conducted in the University of Agriculture Faisalabad. In glasshouse, these lines were subjected to stepwise increase in salinity i.e. EC 1.5 (control), 15 and 30 dS m^{-1}. It was found that increase in salinity drastically affected the seedling growth i.e. fresh and dry weight of shoot and root 30 days after completion of salinity produced by NaC1. Mineral analysis of cell sap indicated that tolerant lines have minimum Na^+ and Cl^- concentration at EC of 15 dS m^{-1}; whereas, reverse was the case at EC of 30 dSm^{-1}. As the salinity increased, the concentration of Na and C1 also increased sharply while Ca has opposite trend of variation but K and Mg have different behaviors at both the salinity levels with respect to control.

Key Words: Wheat; Salt tolerance; Salinity

INTRODUCTION

Soil salinity is an important constraint that limits crop productivity over a vast area in the world. Excessive accumulation of salts in the root zone is a problem in agriculture, economic and social significance in the arid and semi-arid regions of the world.

In Pakistan, it is estimated that about 5.67 million hectares of agricultural land in the most important and productive part of the Pakistan, i.e. Indus plain, are affected by salinity of varying degrees (Sandhu & Qureshi, 1986). To be able to utilize effectively the saline lands and water resources, we can either increase the salt tolerance in our currently used crops or develop new crops that have high productivity under high saline environment. Most of the cultivated crops presently under use are sensitive to salts. However, some inherent variability in the available gene stock of wheat has been reported (Rashid, 1986). Therefore, 50 wheat lines were tested, and correlated their salts tolerance ability with chemical analysis. Wheat (*Triticum aestivum* L.) is the main cereal crop and the staple food of people of Pakistan. Wheat is grown under a wide variety of soil and climatic conditions. It is grown on an area of 7.98 million ha with total annual production of 18.47 million tons and national average yield of 2314 kg ha^{-1} (G.O.P., 2002). Due to increasing population, the demand for wheat is increasing day by day. Inspite of immense importance of wheat, its average yield is very low as compared to its inherent potential of 6.5 tons per hectare (Govt. of Punjab, 1997), with an exploitation of only 70% of its inherent potential (G.O.P., 2001).

MATERIALS AND METHODS

The studies on "screening of wheat lines for salinity tolerance" were carried out in the department of Soil Science, University of Agriculture, Faisalabad. The experiment was conducted in solution culture, having salinity levels of EC 1.5 (control), 15 and 30 dS m^{-1} developed in Hoagland's Nutrient solution (Hoagland & Arnon, 1950) with NaCl salt. Seeds of selected wheat lines were kindly supplied by Dr. Mujeeb Kazi from CIMMYT. The experiment was conducted in the glasshouse. Sufficient healthy seeds of each line were sown in plastic iron trays and irrigated with canal water. Seven days old seedlings were randomly transferred to foam plugged holes in the thermopal sheets suspended over 100 liters of 1/2 strength Hoagland's nutrient solution in growth tanks. The solution was aerated with air compressor during the day time at least for 8 h. After three days of seedling establishment, NaC1 was added to salinize the medium in increments of 2.5 dS m^{-1} per 24 h upto the final salinity level. Each variety was replicated three times in each growth tank. Just before harvesting the plants, fully expanded leaf from the top of each plant was taken for extraction of cell sap and determination of Na, K, Cl, Ca and Mg concentrations. The plants were harvested 30 days after the completion of salinity levels. Shoot and root, fresh and dry weight were recorded. The data collected was subjected to Fisher's analysis of variance technique and LSD test at 5% probability level to compare the differences among treatments means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Effect of Salinity on Growth of Plants

Shoot fresh weight. An increase in salinity decreased the fresh weight of shoot of all the 50 wheat lines at both the salinity levels (Table I). The decrease in shoot fresh weight may be due to low uptake of water by plants as well as toxicity of Na and C1 because of their high concentration in the nutrient solution (Aslam & Muhammed, 1972).

The maximum per cent shoot fresh weight (more than 29.5%) was observed in tolerant wheat lines that are TC-46 (238, 45, 46 & 56). On the other hand, moderately tolerant wheat lines i.e., TC-46 (26, 27, 35, 38, 39, 44, 49, 53, 58, 66, 67 & 69) ranged (19.4-24.5%), moderately tolerant wheat lines i.e. TC-46 (23, 24, 25, 29, 30, 34, 36, 37, 47, 50, 59, 60, 63, 65, 68, 70 & 71) ranged (14.4-19.3%), moderately sensitive wheat lines i.e. TC-46 (333, 40, 41, 48, 52, 55, 61 & 62) ranged (14.4-19.3%) and sensitive wheat lines i.e., TC-46 (31, 32, 42, 43, 51, 57, 64 & 72) having less than 14.4% of control, at EC 15 dS m^{-1}. Whereas, at EC level of 30 dS m^{-1}, the maximum per cent shoot fresh weight (more than 10.32%) was noted in tolerant lines which are TC-46 (50, 68 & 70). Moderately tolerant wheat lines i.e.TC-46 (39, 40, 47 & 67) ranges (8.3-10.3%), moderate i.e. TC-46 (23, 29, 46, 48, 49, 57, 58, 59 & 69) ranges (6.2-88.2%) and moderately sensitive wheat lines i.e. TC-46 (25, 26, 30, 34, 36, 37, 42, 43, 55, 56, 61, 65, 66 & 71) having less than 6.1% of control while all the wheat lines i.e. TC-46(24, 27, 28, 31, 32, 33, 35, 38, 41, 44, 45, 51, 52, 53, 54, 60, 62, 63, 64 & 72) died and placed in highly sensitive group at this level of salinity.

In general, similar trend of decrement was noted in fresh and dry roots, also in dry shoots in all the lines at both the salinity levels. Similar results were recorded by Mahmood *et al*. (1990) that the fresh weight of shoot is decreased by the increase of salinity in the soil.

Number of tillers per plant. Crop yields are generally dependent upon many yield contributing components, tillering being the most important one. Generally, greater number of tillers ensures better crop stand and ultimately the yield. Salinity decreases the tillering capacity of the crops. The number of tillers as affected by salinity is shown in Table I. The decrease in tillering capacity might be due to the toxic effect of salt on plant growth. The data show that tolerant group has maximum number of tillers at both the salinity levels. The development of more tillers may be a mechanism of salt tolerance (dilution) by wheat (Rashid, 1986; Aslam *et al*., 1989).

Effect of salinity on chemical composition of plants. The data given in (Table II) reveal that increase in the level of salinity resulted in significant increase in Na and Cl (Zia & Yasin, 1988). While K concentration decreased at EC 15 dS m^{-1} but at EC of 30 dS m^{-1}, the K concentration increases significantly with respect to control. Calcium has antagonistic effect with increase in salinity in rooting medium (Kumar & Singh, 1984), whereas Mg has the variable trend with increase in the salt stress. Yasin and Niazi (1990) also reported that P, K, Ca and Mg content of shoot decreased as the salinity increased in wheat varieties. A careful perusal of the data indicated that tolerant lines accumulated minimum Na and Cl concentration at EC 15 dS m^{-1} but opposite is the case at EC of 30 dS m^{-1}. On the other hand, tolerant lines have the low Na: K ratio at both the salinity levels which is a salt tolerant mechanism (Shannon, 1978).

Table I. Average number of tillers of wheat lines at different salinity levels

S.No	Group	No of tillers. EC 15 dS m^{-1}	No of tillers. EC 30 dS m^{-1}
1	Tolerant	3.65	3.00
2	Moderately tolerant	3.50	2.82
3	Moderate	3.45	2.52
4	Moderately sensitive	3.45	2.32
5	Sensitive	3.25	-

Table II. Inorganic solutes of shoot tissue sap of different groups of wheat lines

S.No	Group	Na^+ EC15	Na^+ EC30	K^+ EC15	K^+ EC30	Cl^+ EC15	Cl^+ EC30
1	Tolerant	210.8	779.6	132.8	656.7	133.5	724.0
2	Moderately tolerant	309.2	681.7	162.7	342.8	243.5	636.8
3	Moderate	310.3	625.3	174.7	222.1	267.4	522.3
4	Moderately sensitive	318.2	519.5	178.5	272.0	273.0	474.6
5	Sensitive	344.7	-	150.3	-	289.1	-

CONCLUSION

It is concluded from the study that with an increase in salinity, concentration of Na and Cl also increases while the Ca has opposite trend. So, the increase in salinity drastically affected the fresh weight of shoot, dry weight of shoot and No. of tillers per plant.

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