Annals of Arid Zone 26(1 & 2) : 25-32

EFFECTS OF SOIL SALINITY AND ALKALINITY ON MORPHO-PHYSIOLOGICAL PARAMETERS OF PEARL MILLET

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ABSTRACT

A pot experiment was conducted in completely randomised design with two levels of salinity (ECe 3.7 and 10. 8 mmhos/cm) and two levels of alkalinity (SAR 14. 5 and 34. 5) in the soil to study their effect on morpho-physiological parameters of pearl millet cv BJ-104 and BK-560 during vegetative phase of growth. There was a general reduction in all the growth parameters under salinity-alkalinity stress. An increase in leaf proline content of BJ-104 was noted. There was no significant effect on mid-day stomatal behaviour of the plants. Both the genotypes were found susceptible to the combined stress due to salinity and alkalinity but exhibited moderate tolerance towards either salinity or alkalinity stress.

INTRODUCTION

Salt affected soils commonly occur in arid and semi-arid agroclimatic zones where pearl millet is often the only choice of cereal cultivation. Little information is available on various morpho-physiological parameters as affected by salinity and alkalinity stress in pearl millet. Hence, the present investigation was undertaken to study the effect of salinity and alkalinity stress on plant growth, photosynthetic area development, photosynthetic pigment, proline accumulation, leaf diffusive resistance and transpiration in pearl millet at early growth stages.

MATERIAL AND METHODS

Two pearl millet cultivars, namely BJ-104 and BK-560 were cultured in ceramic pots, each containing 9.0 kg of sandy soil of varying salinity and alkalinity. Soils represented two levels of salinity (ECe 3.7 -S_1, and 10 8 mmhos/cm -S_2) and two levels of sodicity (SAR 14.5 -A_1, and 34.5 -A_2). Thus, four types of salt affected soils (S_1 A_1, S_1 A_2, S_2 A_1, and S_2 A_2) were obtained by leaching and equilibrating the soil with solutions containing different amounts of $CaCl_2$, $MgCl_2$, NaCl, Na_2SO_4, Na_2CO_3 and $NaHCO_3$. The original soil was loamy-sand in texture having bulk density 1. 48 g/cm^3, field capacity 11.8%, ECe 1.1 mmhos/cm, pH 8.2, SAR 12.5 and 0.75 per cent $CaCO_3$. Four plants were raised in each pot with optimal supply of water.

Table-1 : Average effect of soil salinity (S) and alkalinity (A) on different morpho-physiological parameters in pearl millet varieties

*Treatments	Root wt per plant (g)	Shoot wt per plant (g)	Leaf area (cm^2)	Root shoot ratio	Specific leaf weight (mg/cm^2)	LDR (sec/cm)	TR (mg/cm^2/sec)	Tl°C
S_1	1.34	4.51	366.11	0.30	4.36	5.03	6.36	36.05
S_2	0.88	2.17	126.43	0.41	3 67	3.90	8.91	36.90
CD (5%)	0.359	0.689	38.31	NS	0.594	NS	NS	NS
A_1	1.53	3.90	294.97	0.41	4.53	5.28	6.09	36.1
A_2	0.69	2.78	250.91	0.25	3.68	3.70	9.19	36.9
CD (5%)	0.359	0.684	38.31	0.157	0.594	NS	NS	NS
V_1	1.10	3.57	343.17	0.33	4.04	4.3	8.29	37.6
V_2	1.12	3.10	249.38	0.38	3.99	4.63	6.98	35.3
CD (5%)	ns	ns	38.31	ns	ns	ns	ns	ns

S_1 — ECe 3.7 mmhos/CM, S_2 — ECe 10.8 mmhos/CM, A_1 — SAR 14.5, A_2— SAR 34.5
V_1 — cv 'BJ-104' V_2 — cv 'BK-560'

Total chlorophyll, chlorophyll a and b (Arnon, 1949), proline (Bates et al., 1973); leaf diffusive resistance (LDR), transpiration rate (TR) and leaf temperature (Tl, Steady state porometer -LI-1600), were measured at 45 days after sowing. Porometric observations were recorded between 11.0 to 12. 30 hrs on both the surfaces of leaf. Leaf diffusive resistance was calculated as :

$$\text{LDR (sec/cm)} = \frac{\text{LDRAd x LDRAb}}{\text{LDRAd} + \text{LDRAb}}$$

Where, LDRAd and LDRAb represent leaf diffusive resistances of adaxial and abaxial surfaces, respectively.

Transpiration represents the summation of TR of both the surfaces. Growth observations were recorded at 50 days after sowing. Observations were recorded in four replicates and were analysed using completely randomised design.

RESULTS AND DISCUSSION

It is apparent from Tables 1 and 2 that higher levels of soil salinity and alkalinity caused a general reduction of the growth parameters namely, root weight, shoot weight and leaf area. Stunting and reduction in leaf area are characteristic effects of salinity (Oertli, 1976). Increase in alkalinity (A_2) also reduced total chlorophyll, chlorophyll a and chlorophyll b. Strogonov (1973) observed upsetting of the balance of photosynthetic pigments in many plants especially in the salt sensitive species. In the present investigation BJ-104 contained more total chlorophyll (chlorophyll a and chlorophyll b) than that in BK-560 at comparable levels of salinity and alkalinity. Nevertheless, the ratio of chlorophyll ato chlorophyll b was higher in BK-560 than that in BJ-104. At higher salinity levels, there was a slight increase in transpiration rate, leaf temperature, root-shoot ratio and total chlorophyll (a and b).

Effects of salinity are likely to be mediated by toxicity of accumulating ions existing with or without a disturbed water balance (Levitt, 1980). Increase in salinity and alkalinity also caused reduction in specific leaf weight but in subsequent analysis such effect was not clearly discernible. Effects of salinity on specific leaf weight are known to be variable on account of their greater dependence on ambient humidity (Poljakoff-Mayber and Gale, 1975). A significant increase in the proline content at higher salinity level particulary in cv BJ-104 under S_2A_2, was also evident (Table 2). The effect of alkalinity on proline content was not significant. Accumulated proline has been ascribed to bio-polymer protection and osmotic adjustment (Greenway and Munns, 1980).

The average leaf area and proline content of BJ-104 were significantly, higher than that of BK-560. However, chlorophyll a:b ratio was significantly higher in case of BK-560 (Tables 1 and 2). Both the varieties did not show significant differences in other characteristics.

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