Proc. Indian natn. Sci. Acad. **B49** No 6 pp 702–705 (1983)

Effect of Salinity on Germination and Free Proline Content of Bajra (*Pennisetum typhoides* S & H) Seedlings

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(Received 10 January 1983; after revision 1 July 1983)

Salt tolerance capacity of pearl millet at different salinity levels of KCl, NaCl, K_2SO_4 and Na_2SO_4 was observed during early seedling growth. Germination was generally not affected except for that it was delayed. Root and shoot lengths decreased considerably. Proline content decreased as the seedling growth progressed but it increased with increasing salt concentrations. High amount of proline was accumulated under NaCl stress. Sodium in combination with chloride was effective in accumulating proline.

Key Words: Pearl millet, Salinity, Germination, Proline

Introduction

Salinity is one of the important constraints in crop productivity. Salts in the root medium alter a wide array of physiological processes culminating in stunted growth. Barnett and Naylor (1966) reported changes in amino acids levels in plants under stress conditions, particularly free proline. Free proline accumulation has been suggested to be an indicator of drought resistance (Singh et al. 1974). Although proline is normally a minor component of the pool of free amino acids in glycophytes, it has been observed to accumulate in response to salinity stress (Palfi & Juhasz 1970, Stewart & Lee 1974); water stress (Singh et al. 1973) and temperature stress (Chu et al. 1974). The present study is an attempt to study the behaviour of germination and free proline content of pearl millet at different salinity levels.

Materials and Methods

Seeds of pearl millet (*Pennisetum typhoides* S & H var. B.J. 104) were surface sterilised with 0.1% $HgCl_2$ for 2–3 min and washed thoroughly with tap water and distilled water and sown 50 seeds per Petri dish (15 cm) having monol-X-No.1 filter paper. Salinity treatments were given by adding known volume of aqueous solution of each of the four salts namely NaCl, KCl, Na_2SO_4 and K_2SO_4 at

concentrations of 0.4% and 0.8%. Distilled water was added to the Petri dish for control. The Petri dishes were kept in continuous light (1000 lux) at laboratory temperature (28 ± 2°C). The solutions were renewed every day to prevent microbial contaminations.

The physical data of both low and high concentrations of the four salts are presented below:

Treatments		Electrical conductivity at 30°C (m mohs/cm)	Molarity*	Meq/litre
NaCl	0.4%	8.03	0.06843	68.43
	0.8%	15.51	0.13686	136.86
KCl	0.4%	7.46	0.05397	53.97
	0.8%	12.62	0.10794	107.94
Na_2SO_4	0.4%	5.16	0.02816	28.16
	0.8%	9.75	0.05632	56.32
K_2SO_4	0.4%	5.16	0.02315	23.15
	0.8%	9.16	0.04632	46.31

*Milliequivalents/litre

Percentage germination was taken after 72 hrs; and growth measurement at 24, 48 and 72 hrs after sowing.

Proline content of the seedlings (Endosperm and embryo axis separately) was estimated at 24 hrs interval till 96 hrs following the method of Bates et al. (1973). The results are the mean of five replications.

Results and Discussion

Table 1 shows that germination was not adversely affected by salinity treatments except that germination was delayed. Length of the embryo axis and radicle decreased considerably under salinity treatments. The chloride salts were more effective than the sulphate ones. Inhibition effect was more on radicle. At 72 hrs germination stage, 0.4% KCl showed growth similar to that of control. The decreased growth rate in salt-treated seedlings is due to the combined osmotic and toxic effects and also due to the nutritional imbalance caused by the salts.

Concentrations of four salts (NaCl, KCl, Na_2SO_4, K_2SO_4) showed a marked

Table 1 *Effect of different types of salinity on germination, radicle and embryo axis length of pearl millet (cm)*

Treatments		Percent germination over control	Radicle hrs after sowing			Embryo axis hrs after sowing		
			24	48	72	24	48	72
Control		100	2.25	6.16	9.75	0.81	3.88	5.60
NaCl	0.4%	93	2.12	5.45	7.60	0.80	3.22	4.25
	0.8%	73	1.6	3.00	3.20	0.56	2.36	3.50
KCl	0.4%	92	2.13	5.52	8.10	0.80	3.43	5.60
	0.8%	76	1.65	3.95	4.05	0.59	2.65	3.60
Na_2SO_4	0.4%	89	2.26	5.63	8.30	0.81	3.45	5.40
	0.8%	89	1.85	4.13	5.00	0.72	2.18	4.10
K_2SO_4	0.4%	92	2.23	5.72	8.40	0.81	3.61	5.30
	0.8%	86	1.80	4.15	7.60	0.71	2.25	4.80

Table 2 *Effect of different types of salinity on proline content of pearl millet µg/g fresh weight*

Treatment		Endosperm hrs after sowing				Embryo axis hrs after sowing			
		24	48	72	96	24	48	72	96
Control		124.84 ±1.45	90.96 ±1.53	63.33 ±2.05	26.80 ±2.99	94.58 ±1.51	55.56 ±3.13	43.36 ±0.56	24.55 ±2.08
NaCl	0.4%	173.34 ±5.9	161.00 ±1.09	126.71 ±1.56	59.99 ±1.23	159.66 ±3.42	85.84 ±3.28	55.18 ±1.80	40.10 ±2.01
	0.8%	190.81 ±1.69	199.84 ±4.00	148.49 ±2.04	125.45 ±2.40	296.28 ±5.79	127.87 ±5.22	118.05 ±3.36	140.09 ±5.34
KCl	0.4%	134.74 ±1.72	121.98 ±2.55	63.94 ±2.77	51.90 ±1.44	95.83 ±3.14	43.66 ±2.7	50.55 ±2.66	34.73 ±2.58
	0.8%	169.95 ±1.26	180.38 ±2.45	121.23 ±1.83	88.98 ±4.06	167.64 ±17.97	101.02 ±2.86	61.20 ±1.77	94.63 ±2.68
Na_2SO_4	0.4%	139.80 ±1.55	124.66 ±4.30	121.07 ±1.70	43.25 ±3.46	90.19 ±2.6	59.55 ±0.82	46.52 ±2.3	26.81 ±1.47
	0.8%	164.38 ±1.28	175.76 ±3.1	135.13 ±4.67	94.78 ±1.88	179.57 ±1.64	96.76 ±4.63	74.71 ±2.52	95.69 ±1.75
K_2SO_4	0.4%	127.75 ±2.18	123.42 ±2.19	55.41 ±2.19	45.57 ±2.10	95.86 ±1.14	61.09 ±2.08	52.54 ±2.18	25.85 ±1.44
	0.8%	161.52 ±2.77	182.14 ±2.59	92.01 ±1.81	78.51 ±2.88	154.25 ±6.13	92.12 ±1.67	75.97 ±1.34	88.66 ±2.88

increase in proline content in endosperms as well as in embryo axis over control (table 2). The proline content increased gradually as the salt concentration increased. All the low concentrations (0.4%) showed a decreased proline accumulation as the germination hours advanced, whereas in high concentrations (0.8%) endosperm showed anincreased trend from 24 to 48 hr germination stage; later it decreased in 72 and 96 hrs stages, but in embryo axis in 96 hrs germination stage showed an increased accumulation of proline compared to previous hours. High amounts of proline were found to be accumulated—199.84 and 296.28 µg/g fresh weight in 0.8% NaCl and lowest 161.52 and 154.25 µg/g fresh weight in 0.8% K_2SO_4 in endosperm and embryo axis respectively. The proline content was more in 24 hr old embryo axis and endosperm with exception, where 48 hr old endosperm showed a little increase in high concentration (0.8%). Sodium combination with chloride and sulphate seems to be more effective in accumulating proline.

Proline accumulated rapidly in plants subjected to salinity stress, where there is a fall in leaf water potential (Chu et al. 1976). Proline which accumulates during salt and water stress plays a pivotal role in regulating the internal osmotic adjustment of the cell (Stewart & Lee 1974). Singh et al. (1972) indicated that barley varieties having different degrees of drought resistance also differed in their capacity to accumulate proline under stress. Salts in the medium generally decrease the water availability to the roots thus creating

a physiological drought situation. In this present study sodium in combination with chloride showed high concentrations of proline than other salts. The increased content of proline under chloride salinity may be due to increased water deficit whereas under sulphate salinity plants might have made complete osmotic adjustment (Hason-Porath et al. 1972).

Acknowledgement

The award of fellowship to M P Reddy by The Council of Scientific and Industrial Research is gratefully acknowledged.

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