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Influence of Salinity on Yield and Mineral Compositions of Grains of Wheat, Barley, Millet and Cheena in Some Coastal Soils of Bangladesh

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Percent germination of seeds and the grain yield decreased significantly with increase in soil salinity from ECe 1.6 to 13.5 dS/m. Variation in germination of seeds over the salinity range was recorded as 88 to 36, 76 to 29, 79.5 to 15, and 82 to 9 % for wheat, barley, millet and cheena, respectively. Highest per cent reduction in yield over the maximum with the increase in salinity was 70.9, 60. 6, 84.9 and 81.2 for crops arranged in the similar order. The critical limits of the crops to salt tolerance (ECe) in the same order were worked out as 4.2, 4.7, 4.5 and 4.0 dS/m for 10% yield decrement, 6.8, 6.8, 7,0 and 6.0 dS/m for 25 % yield decrement, and 10.8, 10.2, 9.4 and 9.4 dS/m for 50% yield decrement.

Content of N, P and Na in grains of all the crops varied significantly with soil salinity. Content of K in grains of all the crops, Ca in case of wheat, millet and cheena. Mg in cheena and S in grains of millet showed no significant change in the salinity range used.

Salt affected soils in Bangladesh cover about 1 Mha of land (Karim *et al.*, 1990) varying in ECe from 2 to 18 dS/m during dry season (Sattar and Aich, 1988). Dry land crops may be grown during post-monsoon period but the informations regarding their salt tolerance limits are lacking. Kumar (1983) reported that salinity caused 50% yield decline in wheat at ECe range of 13 to 26 dS/m depending upon the crop cultivars Nair and Khulbe (1990) reported 28% reduction in germination of wheat at ECe 8 dS/m, and 50% yield reduction at ECe 12 dS/m. Karim *et al.*, (1982) reported an expected yield reduction of 10 to 25% for wheat, and 13.0 to 18.0 dS/m for barley with the increase in ECe from 9.5 to 13.0 dS/m. Reports are available that salinity may adversely affect the mineral nutrition of crops causing nutritional imbalance (Sharma, 1989; Singh *et al*, 1990). At higher salinity, higher Na : K ratio disturbs plant metabolism causing more injury to wheat than paddy (Gill and Dutt, 1987). An experiment was therefore conducted to

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evaluate the effect of soil salinity on the potential yield of wheat, barley, millet and cheena, and the mineral composition of their grains.

MATERIALS AND METHODS

The experiment was conducted in 1990-91 during *rabi* season at Benerpota Agricultural Research Station, BWDB, Satkhira. Experiments were conducted in concrete beds (1.5 m^3), which were filled up with air dried soils ($\angle$2 mm) collected from 0-15 cm depth at six sites in Satkhira representing wide range of soil salinity. The study was conducted in randomized block design with three replications. A basal dose of 60 kg P_2O_5 and one-third of 80 kg N/ha was applied. The rest of nitrogen was applied in two equal splits at crown root and booting stage of crop growth.

Four separate experiments were conducted with high yielding varieties of wheat *(Triticum aestivum* L. Kanchan), barley *(Hordeum vulgare* L. Centinella), millet *(Setaria italca* L. Shibnagar) and cheena *(Panicum miliaceum)* as test crops. Sowing was done on 1st December, 1990 with spacing between lines as 20 cm. Irrigation was given as and when required with pond water having EC 1.2 to 1.5 dS/m. The ECe of soil was determined at 20 day interval and the mean value is used to explain the results. The physico-chemical properties of the initial soils, as well as the yield and mineral composition of grains were determined following standard methods. The relative yield decrement due to salinity was calculated by using the eqation $Y = .00 - (ECe - a)\, b$, where Y = relative yield (%, ECe = mean soil salinity, a = the salinity at which yield begins to decline, and b = the rate of yield decline with increase in salinity (Mass and Hoffman, 1977).

RESULTS AND DISCUSSION

The relevant physico-chemical properties of the soils from six sites are shown in Table 1.

Data on germination of seeds and yield of grains of wheat, barley, millet and cheena as influenced by soil salinity have been presented in Table 2. Per cent germination of seeds and yield of grains of all the crops decreased significantly with increasing soil salinity. Similarly, the period for germination of seeds also increased significantly with salinity. Percent germination showed no significant difference over the salinity (ECe, dS/m) range of 1.6 to 8.5 and 11.5 to 13.5 in wheat, 1.6 to 8.5, 8.5 to 11.5 and 11.5 to 13.5 in barley, 1.6 to 8.5 and 11.5 to 13.5 in millet, and 1.6 to 8.5 and 8.5 to 13.5 in cheena. Variation in germination of seeds ranged from 88 to 36, 76 to 29, 79.5 to 15 and 82.5 to 9% for wheat, barley, millet and cheena,

Table 1. *Relevant initial physico-chemical properties of saline soils collected from six sites*

ECe dS/m	pH	Soluble ions in saturation extract meq/L. Na	Ca	Mg	K	Cl	HCO_3^-	SO_4	% O.M.	% Total N	Avail. Olsen P (ppm)	CEC meq/ 100g	SAR
2.0	7.0	8.2	4.2	3.4	0.54	5.35	7.4	3 6	1.98	0.20	28	31.2	4.20
3.8	6.8	28.3	8.5	7.2	0.21	29.7	4.7	9.8	1.76	0.19	20	30.4	10.1
6.8	6.9	40.0	21.0	10.2	0.59	56.3	3.4	8.5	1 96	0.16	21	28.7	10.1
8.8	7.3	65.6	25.0	14.2	1.07	81.3	6.4	17.2	2.16	0.17	18	29.5	14.8
11.8	7.2	86.9	32.5	24.4	1.23	108.7	6.7	13.4	2.13	0.18	20	28.6	16 3
14.0	7.2	104.3	27.2	14.1	1.18	120.2	5.7	20.5	1.96	0.19	22	29.2	22.9

Table 2. *Grain yield of wheat, barley, millet and cheena as influenced by soil salinity*

ECe dS/m (Mean)	Wheat				Barley			
	Germination		Grain yield		Germination		Grain yield	
	Per-cent	Days	t/ha	%reduction over maximum	Per-cent	Days	t/ha	%reduction over maximum
1.6	88a	4e	1.81a	—	76a	5bc	2.62a	—
3.8	76a	4e	1.79a	11.0	77a	6bc	2.33a	11.0
6.5	66a	7d	1.17b	35.3	68a	7ab	1.91b	27.0
8.5	64a	9c	1.14b	37.0	58ab	8ab	1.63b	37.7
11.5	44ab	12b	1.053b	41.9	44bc	9a	1.24bc	52.6
13.5	36bc	15a	0.53c	70.9	29cd	11a	1.03bc	60.6
	Millet				Cheena			
1.6	79.5a	5c	2.66a	—	82.5a	5d	1.65a	—
3.8	84.0a	7c	2.33a	12.4	70.5a	6c	1.39a	15.7
6.5	78.0a	10bc	1.92b	27.8	58.5a	10bc	1.03b	37.5
8.5	60.0a	12ab	1.69b	36.4	24.0ab	12ab	0.82bc	50.3
11.5	23.5b	14a	0.91b	65.7	12.0bc	14a	0.78c	52.7
13.5	15.0b	16a	0.40bc	84.9	9.0bc	16a	0.31c	81.2

Means followed by same letter(s) are not significantly different at 5% level by L. S. D.

respectively. Hamdy (1988) stated that wheat is resistant upto EC 8 dS m. Increase in salinity signficantly reduced the yield of wheat grain (Tripathi and Pal, 1979; Rawson *et al.*, 1988). No significant difference in yield of grain was however observed in this study due to increase in salinity (ECe, dS/m) from 1.6 to 3.6 and 6.5 to 11.5 in wheat, 1.6 to 3.8 and 6.5 to 13.5 in millet and barley, and 1.6 to 3.8, 6.5 to 8.5 and 11.5 to 13.5 in case of cheena. Per cent reduction in yield ever the maximum in this salinity range varied from 11 to 70.9 for wheat, 11 to 60.6 for barley, 12.4 to 84.9 for millet and 15.7 to 81.2 for cheena.

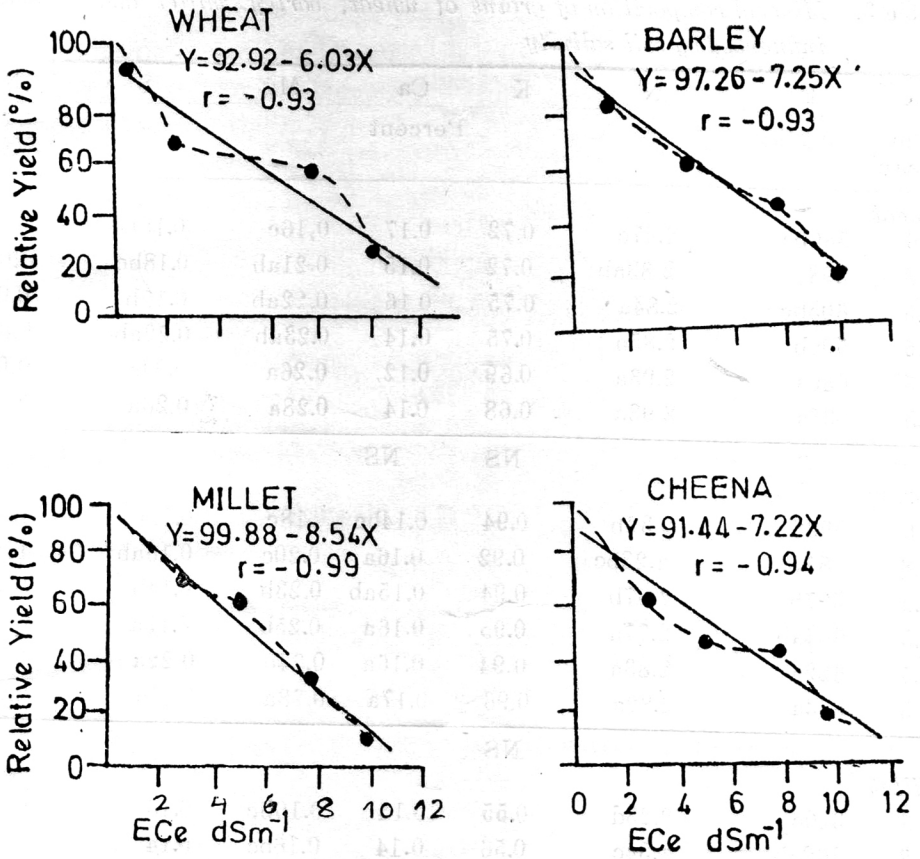

Fig. 1. Relative yields of different crops as influenced by soil salinity.

The relative yields of wheat, barley, millet and cheena as influenced by soil salinity are presented in Fig. 1. The critical limits of tolerance (ECe, dS/m) to soil sslinity for wheat, barley, millet and cheena were worked out as 4.2, 4.7, 4.5 and 4 8 for 10% yield decrement, 6.8, 6 8, 7.0 and 6.0 for 25% yield decrement, and 10.8 10.2, 9.4 and 9 4 for 50% yield decrement.

Mineral composition of grains of the crops have been shown in Table 3. Contents of N, P and Na in grains of all the crops varied significantly with increase in soil salinity. However, no such significant change in N content of grain over soil salinity (ECe, dS/m) was observed due to increase in salinity from 3.8 to 13.5 for wheat, 1.6 to 6.5 and 8.5 to 13.5 for barley, 6.5 to 13.5 for millet, and 1.6 to 3.8, 3.8 to 6.5 and 6.5 to 13.5 for cheena. Almost similar trends with soil salinity change were recorded in case of Mg and S contents

Table 3. *Mineral composition of grains of wheat, barley, millet and cheena as influenced by soil salinity*

ECe	P	N	K	Ca	Mg	S	Na
dS/m (mean)	mg/kg			Percent			
Wheat							
1.6	580bc	2.47c	0.72	0.17	0.16c	0.18bc	0.06bc
3.8	598b	2.83ab	0.72	0.15	0.21ab	0.18bc	0.07b
6.5	605bc	2.84a	0.75	0.16	0.22ab	0.19b	0.08ab
8.5	590b	2.85a	0.75	0.14	0.23ab	0.22ab	0.09a
11.5	640a	2.93a	0.69	0.12	0.26a	0.24a	0.09a
13.5	636a	2.93a	0.68	0.14	0.28a	0.26a	0.10a
			NS	NS			
Barley							
1.6	590b	2.32b	0.94	0.14bc	0.18c	0.15b	0.12c
3.8	587b	2.23bc	0.92	0.16a	0.20c	0.16ab	0.14c
6.5	597b	2.37b	0.94	0.15ab	0.23b	0.14b	0.16b
8.5	604ab	2.77a	0.95	0.16a	0.25b	0.19a	0.17b
11.5	622a	2.83a	0.94	0.16a	0.24b	0.22a	0.21a
13.5	634a	2.82a	0.96	0.17a	0.28a	0.21a	0.23a
			NS				
Millet							
1.6	340c	2.23d	0.55	0.14	0.16bc	0.13	0.07bc
3.8	360ab	2.34c	0.56	0.14	0.16bc	0.14	0.09ab
6.5	358ab	2.38ab	0.57	0.13	0.17bc	0.13	0.11a
8.5	364ab	2.44ab	0.56	0.12	0.20b	0.11	0.10a
11.5	370a	2.46a	0.59	0.14	0.24a	0.15	0.11a
13.5	380a	2.53a	0.58	0.15	0.28a	0.14	0.11a
			NS	NS		NS	
Cheena							
1.6	460bc	2.43c	0.59	0.12	0.16	0.09c	0.06ab
3.8	467ab	2.50bc	0.49	0.13	0.18	0.12b	0.06ab
6.5	470ab	2.55ab	0.50	0.13	0.18	0.09c	0.07a
8.5	472a	2.66a	0.55	0.12	0.18	0.13a	0.07a
11.5	481a	2.59a	0.52	0.14	0.19	0.16a	0.08a
13.5	480a	2.67a	0.49	0.10	0.18	0.15a	0.08a
			NS	NS	NS		

Means followed by same letter(s) are not significantly different at 5% level by L.S.D.

in grains. In case of P in grains no significant change was observed over soil salinity (ECe, dS/m) values in the range of 1.6 to 8.5 and 11.5 to 13 5 in wheat, 1.6 to 8.5 and 8.5 to 13.5 in barley, 3 8 to 13.5 in millet, and 1.6 to 6 5 and 3.8 to 13.5 in cheena. Content of K in grains of all the crops, Ca in case of wheat, millet and cheena, Mg in cheena, and S in millet showed no significant change due to increase in salinity from 1.6 to 13 5 dS/m.

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