COMPARATIVE PERFORMANCE OF MODERN WHEAT VARIETIES IN DIFFERENT SALINITY

A. C. Aich[1], R. Mandal[2]
and A. H. M. Ahmed[3]

ABSTRACT

The relative yield performance and mineral composition of straw of six modern wheat varieties (Kanchan, Agrani. Akbar, Barket, Balaka and Ananda) grown in soils with differnt electrical conductivity and identical to saline soils have been investigated in green house at Benerpota Agriculatural Research Station, BWDB, Satkhira in 1990-91. The grain and straw yield of all the cultivars decreased significantly with increasing salinity. The highest yield for all the cultivars was recorded at the lowest salinity. Maximum grain yield was recorded for Kanchan (3.95 t ha^{-1}) followed by Agrani (3.92 t ha^{-1}) and Akbar (3.93 t ha^{-1}). Comparatively lower yield was observed for Braket, Balaka and Ananda yielding 3.10, 3.29 and 3.05 t ha^{-1} respectively. Grain/straw ratio also decreased with increase of salinity. Content of Na and Cl in straw increased significantly and that of K and Ca decreased remarkably with the increase in salinity. The Mg content increased insignificantly while K/Na and Ca/Mg ratios decreased appreciably with increasing salinity for all the cultivars. Cultivars of Kanchan, Agrani and Akbar showed comparatively higher K/Na and Ca/Mg ratios than the others indicating their relatively higher salt tolerance and could be cultivated in coastal areas (ECe 6 dSm^{-1}) without singificant yield reduction.

INTRODUCTION

Saline soil comprises significant proportion of cultivable land of Bangladesh which is mostly monocropped with rice during wet season having moderate to poor yield. During dry season, the land usually remains fallow due to high salt content and lack of fresh water for irrigation (Haq and Iqbal, 1992; Aich, 1992; Iqbal and Shoaib, 1993; Aich et al., 1994). Cultivation of winter crops like wheat is very limited in the coastal area because of poor grain yield though differs widely with cultivars (Ashraf and McNeilly, 1988). So selection of crop cultivar is very important (Gupta and Gupta, 1987). Nair and Khulbe (1990) found 50% yield reduction at ECe 12 dSm^{-1} for ten cultivars of wheat.

1. *Deputy Chief Agriculture Survey Officer, BWDB, Dhaka.*
2. *Professor, Department of Soil Science, Dhaka University, Dhaka.*
3. *Professor, Department of Chemistry, Dhaka University, Dhaka.*

Ehsan (1986) observed that salinity above 7.5 dSm^{-1} caused increasing mortality rates of seedlings and reduced grain yield in three varieties of wheat. Ojha and Bhargava (1988) found that only D291 was tolerant at 12 dSm^{-1} out of eighteen cultivars of wheat grown in saline soil (ECe 12-16 dSm^{-1}). Tolerance of salt was indicated by lower concentrations of Na and Cl and higher concentration of K in wheat (Sharma, 1989 Maftoun and Spaskhah, 1989).

Literature review shows that information on cultivation of wheat in coastal soils of Bangladesh is very limited. Thus, for potential use of such land, an attempt was made to assess the reponse of six modern cultivars of wheat in the South West zone of Bangladesh during winter season when the salinity remains between 3 to 15 dSm^{-1}.

MATERIALS AND METHODS

Six soils of differnt salinity (ECe 3.5, 5.6, 7.8, 9.6, 11.2 and 13.6 dSm^{-1}) were collected from salt affected areas of Satkhira to study their impact on six modern varieties of wheat namely, CV. Kanchan, Akbar, Agrani, Balaka, Barket and Ananda. Soils (0-15 cm) were air-dried, ground and sieved through 2 mm sieve and put into concrete tank (1.2 M^3). NPK was added at the rate of 80-60-40 kg ha^{-1}. One third N and all P and K were mixed as basal and the rest of N was applied in two equal splits at 30 and 45 days of sowing immediately before irrigation. The experiment was arranged in reandomized compete block design having three replications. Seeds (150 kg ha^{-1}) were sown on 3rd December, 1990 in continuous line 20 cm apart. Sweet water irrigation (EC 0.7 dSm^{-1}) was applied for germination of seeds. After germinatin, the beds were irrigated with pond water having salinity 2.5-3.0 dSm^{-1}. Fertility status of the soils was determined (Table 4) by standard methods. Soil salinity (ECe upto 50 cm) were monitored at an interval of 15 days and the mean of six observations were calculated. Grain and straw yield and mineral contents (Na, K, Ca, Mg and Cl) of straw (Yoshida et al. 1976) were determined.

The soils are clayey in nature having a pH range of 6.8 to 7.2 (Table 4).The concentration of soluble ions (Na, Ca, Mg, K, Cl and SO_4) generally increased with the increase of ECe of the soil. The SAR values were 7.6 at 3.5 dSm^{-1} and 31.3 at 13.6 dSm^{-1}. The variation of organic matter, total N, available P and CEC ranged from 1.76 to 2.16%, 0.13 to 0.167%, 11.8 to 13.8 mg kg-1 and 28.6 to 31.2 meg $100g^{-1}$ respectively. These indicate that soils are in close fertility except ECe.

RESULTS AND DISCUSSION

Grain and straw yields of wheat cultivars decreased significantly with increasing soil salinity (Table 1). Highest grain yield (3.95 t ha^{-1}) of Kanchan was recorded at ECe 3.5 dSm^{-1} and was identical with 3.59 t ha^{-1} yielded at ECe 5.6 dSm^{-1}. The yields of 3.92 and 3.46 t ha-1 of Agrani and 3.93 and 3.42 t ha^{-1} of Akbar were identical with those of Kanchan produced at ECe 3.5 and 5.6 dSm^{-1} respectively. At ECe 3.5 dSm^{-1}, Barket produced 3.29 t ha^{-1} which was also statistically similar to those of Kanchan, Agrani and Akbar. Thegtain yield varied from 3.95 to 1.05, 3.92 to 0.99, 3,93 to 0.98, 3.10 to 0.66, 3.29 to 0.75 ad 3.05 to 0.68 t ha^{-1} at ECe 3.5 to 13.6 dSm^{-1} for Kanchan, Agrani, Akbar, Balaka, Barket and Ananda respectively. Similarly, the yield of straw decreased significantly with increasing soil salinity. Dry matter yield decreased due to increased salinity was also reported by many investigators (Kumar, 1983; Ehsan, 1986 Nair and Khulbe; 1990). Maftour and Sepaskhah (1989) reported that above 24.00 ppm NaCl concentration, growth and yield of wheat decreased considerably. From the point of yield potential, Kanchan was the best cultivar followed by Agrani and Akbar. Balaka and Ananda considered to be the least yielding cultivars.

Analytical results of straw showed an increase in Na, Cl and Mg content with increasing soil salinity in all the cultivars (Table 2). However, K and Ca content tended to decrease in most of the cultivars (Table 2). Content of Na in straw varied from 0.57, 0.95, 0.60 to 1.12, 0.58 to 1.08, 0.60 to 1.18, 0.56 to 1.20 and 0.66 to 1.08% at ECe 3.5, to 13.5 dSm-1 for Kanchan, Agrani, Akbar Balaka, Barket and Ananda respectivelly. Similar results were reported by many investigators (Gill and Dutt, 1987; Sharma, 1989; Hamdy, 1988). Content of K decreased from 1.40 to 1.23, 1.39 to 1.28, 1.37 to 1.12, 1.38 to 1.24, 1.37 to 1.20 and 1.36 to 1.28% at ECe 3.5 to 13.6 dSm-1 respectively. The ratio of K/Na generally increased with the decrease of soil salinity in all the cultivars. Content of Ca decreased significantly with

increase in salinity whereas that of Mg though tended to increase but found statistically insignificant (Table 2). The variation in Ca content ranged between 0.48 and 0.36, 0.44, and 0.34, 0.43 and 0.35, 0.40 and 0.29, 0.41 and 0.26, 0.40 and 0.37% at ECe 3.50 and 13.60 dSm^{-1} for the cultivars respectively. Similarly, ratio of Ca/Mg varied from 1.60 to 0.98, 1.52 to 0.92, 1.59 to 0.89, 1.25 to 0.80, 1.28 to 0.68 and 1.18 to 0.97 at ECe 3.5 to 13.6 dSm-1. Content of Cl in tissues showed similar trend as Na with the increase of salinity. Content of Cl varied from 0.56 to 0.98, 0.57 to 1.15, 0.68 to 0.98, 0.56 to 1.22, 0.62 to 1.08 and 0.62 to 1.15% at ECe 3.5 to 13.6 dSm-1 for six cultivars of wheat (Table 3). The ratio of Na/Cl did not vary appreciably. The higher concentration of Na in wheat straw was also reported by many investigators (Gill and Dutt, 1987 Sharma; 1989, Hamdy, 1988). Sharma (1989) reported that the criteria of salt tolerance of wheat is indicated by its lower concentration of Na and Cl with higher concentration K in the plant. Kanchan, Agrani and Akbar showed comparatively higher K/Na ratios than Balaka, Barket and Ananda. Kanchan produced relatively higher yield as compared to other cultivars of wheat irrespective of soil salinity. Na concentration generaly iduces K deficiency which was manifested by lower K/Na ratios in the plants with increasing salinity (Finck. 1977). The accumulation of K in plants might be an important mechanism of salt tolerence since Na is prevented from entering in excessive quantities (Hamdy, 1989). Maftoun and Sepaskhah (1989) stated that Na and Cl contents increased in wheat shoot due to increasing concentrations of NaCl in the growth medium. The authors further reported that salt tolerant cultivars had higher shoot K and Cl with lower Na accumulation resulting the wider K/Na ratios. Lower K/Na ratio was observed at higher salinity which might have disturbed plant metabolic functioning and caused injury to wheat. The influence of K on the translocation of Ca and Mg had little effect. Excess absorption of Mg significantly depressed the uptake of both K and Ca in wheat and decreased K/Na and Ca/Na ratios in plants creating a grossly imbalanced nutrient status and consequently might have suppressed growth and yield of wheat. Similar views were stated by Yadav and Girdhar (1981). Summarization of the results suggests that Kanchan had highest salt toerance capacity followed by Agrani and Akbar. Balaka and Ananda are relatively more sensitive to salt injury.

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Table 1. Influence of soil salinity on the grain and straw yield (t ha^{-1}) of 6 modern wheat cultivars

Treatments (dSm^{-1})	Kanchan		Agrani		Akbar		Balaka		Barkar		Ananda		Grain/straw ratios					
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Kanchan	Agrani	Akbar	Balaka	Barket	Ananda
3.5	3.95^{a}	5.29^{a}	3.92^{a}	5.16^{a}	3.93^{a}	5.32^{a}	5.10^{b}	3.95^{b}	3.29^{ab}	4.29^{ab}	3.05^{bc}	4.12^{ab}	0.75	0.76	0.74	0.78	0.77	0.74
5.6	3.59^{a}	4.89^{a}	3.46^{ab}	4.55^{ab}	3.42^{ab}	4.21^{ab}	2.82^{bc}	3.62^{bc}	3.17^{b}	4.15^{ab}	2.91^{bc}	4.05^{b}	0.73	0.76	0.81	0.78	0.76	0.72
7.8	2.41^{d}	3.54^{bc}	2.33^{d}	3.11^{c}	2.45^{cd}	4.40^{bc}	2.34^{d}	3.07^{c}	2.13^{d}	2.90^{c}	2.28^{d}	3.18^{c}	0.68	0.75	0.56	0.76	0.73	0.69
9.6	1.88^{dc}	2.70^{cd}	2.02^{dc}	3.09^{c}	1.98^{dc}	2.53^{cd}	1.63^{cf}	2.20^{cd}	1.82^{dc}	2.57^{cd}	1.76^{dc}	2.62^{cd}	0.69	0.65	0.78	0.74	0.71	0.67
11.2	1.63^{cf}	2.33^{cd}	1.56^{cf}	2.23^{cd}	1.58^{cf}	2.33^{cd}	1.20^{b}	1.66^{dc}	1.42^{cf}	1.99^{d}	1.01^{b}	1.56^{dc}	0.70	0.70	0.68	0.72	0.71	0.65
13.6	1.05^{fg}	1.72^{dc}	0.99^{g}	1.43^{cd}	0.98^{g}	1.74^{dc}	0.66^{gh}	0.97^{cf}	0.75^{gh}	1.06^{c}	0.68^{gh}	1.07^{c}	0.61	0.69	0.56	0.68	0.70	0.63

Means followed some letter(s) are not significantly different at 1% level by LDC

Table 2 Influence of soil salinity on the mineral (Na, K, Ca and Mg) content of straw of 6 modern wheat cultivars

Treatments (dSm^{-1})	Kanchan			Agrani			Akbar			Balaka			Barket			Ananda		
	Na	K	K/Na	Na	K	K/Na	Na	K	K/Na	Na	K	K/Na	Na	K	K/Na	Na	K	K/Na
3.5	0.57^{ij}	1.40^{a}	2.45	0.60^{i}	1.39^{a}	2.32	0.58^{i}	1.37^{a}	2.36	0.60^{i}	1.38^{a}	2.30	0.56^{i}	1.37^{a}	2.36	0.66^{h}	1.36^{a}	2.06
5.7	0.59^{i}	1.37^{a}	2.32	0.62^{hi}	1.38^{a}	2.23	0.60^{i}	1.37^{a}	2.28	0.62^{hi}	1.37^{a}	2.20	0.62^{hi}	1.35^{a}	2.18	0.68^{g}	1.37^{a}	2.01
7.8	0.67^{a}	1.32^{a}	1.95	0.68^{g}	1.32^{a}	1.94	0.66^{h}	1.32^{a}	2.00	0.68^{g}	1.28^{a}	1.88	0.71^{fg}	1.38^{a}	1.94	0.77^{f}	1.32^{a}	1.71
9.6	0.78^{c}	1.29^{a}	1.67	0.82^{dc}	1.30^{a}	1.58	0.84^{d}	1.30^{a}	1.54	0.78^{c}	1.26^{ab}	1.61	0.73^{f}	1.29^{a}	1.79	0.80^{dc}	1.30^{a}	1.62
11.2	0.81^{d}	1.22^{ab}	1.50	0.96^{c}	1.26^{ab}	1.31	0.98^{c}	1.28^{a}	1.30	0.88^{d}	1.28^{a}	1.45	0.87^{d}	1.28^{a}	1.47	0.99^{c}	1.29^{a}	1.30
13.6	0.95	1.23^{ab}	1.29	1.12^{b}	1.28^{a}	1.14	1.08^{b}	1.12^{bc}	1.03	1.18^{a}	1.24^{ab}	1.05	1.20^{a}	1.20^{b}	1.00	1.08^{b}	1.28^{ab}	1.13
	Ca	Mg	Ca/Mg	Ca	Mg	Ca/Mg	Ca	Mg	Ca/Mg	Ca	Mg	Ca/Mg	Ca	Mg	Ca/Mg	Ca	Mg	Ca/Mg
3.5	0.48^{a}	0.30	1.60	0.44^{a}	0.29	1.52	0.43^{a}	0.27	1.59	0.40^{a}	0.32	1.25	0.41^{a}	0.32	1.28	0.40^{a}	0.34	1.18
5.6	0.42^{a}	0.31	1.35	0.43^{a}	0.32	1.34	0.40^{a}	0.30	1.33	0.39^{a}	0.31	1.25	0.42^{a}	0.35	1.20	0.39^{a}	0.39	1.00
7.8	0.38^{a}	0.30	1.26	0.38^{a}	0.31	1.22	0.39^{a}	0.31	1.25	0.38^{a}	0.34	1.12	0.39^{a}	0.34	1.14	0.39^{a}	0.32	1.21
9.6	0.37^{ab}	0.34	1.08	0.39^{a}	0.32	1.22	0.37^{ab}	0.35	1.05	0.28^{ab}	0.38	0.74	0.40^{a}	0.34	1.17	0.37^{ab}	0.34	1.08
11.2	0.35^{ab}	0.34	1.02	0.36^{ab}	0.32	1.21	3.38^{ab}	0.34	1.11	0.30^{ab}	0.35	0.85	0.33^{ab}	0.38	0.56	0.36^{ab}	0.38	0.94
13.6	0.36^{ab}	0.38	0.98	0.34^{ab}	0.37	0.92	0.35^{ab}	0.39	0.89	0.29^{ab}	0.36	0.80	0.26^{bc}	0.38	0.68	0.37^{ab}	0.38	0.97

Means followed same letter(s) are not significantly different at 1% level by L. S. D.

Table 3. Influence of soil salinity on the Cl content (%) of straw of six modern wheat cultivars

Treatments (dsm^{-1})	Kanchan		Agrani		Akbar		Balaka		Barket		Ananda	
	Cl	Na/Cl	Cl	Na/Cl	Cl	Na/Cl	Cl	Na/Cl	Cl	Na/Cl	Cl	Na/Cl
3.5	0.56^{de}	1.01	0.57^{de}	1.05	0.68^{cd}	0.85	0.56^{de}	1.07	0.62^{cd}	0.20	0.62^{cd}	1.06
5.6	0.61^{cd}	0.96	0.64^{cd}	0.97	0.64^{cd}	0.94	0.59^{cd}	1.05	0.58^{de}	1.03	0.68^{cd}	0.88
7.8	0.64^{cd}	1.04	0.71^{cd}	0.95	0.68^{cd}	0.99	0.76^{bc}	0.89	0.72^{cd}	0.98	0.70^{cd}	1.00
9.6	0.73^{c}	1.06	0.82^{bc}	1.00	0.88^{b}	1.07	0.78^{bc}	1.00	0.77^{bc}	0.95	0.78^{bc}	1.02
11.2	0.87^{bc}	0.93	1.02^{ab}	0.94	1.02^{ab}	0.96	0.96^{ab}	0.92	0.96^{ab}	0.91	0.02^{ab}	0.97
13.6	0.98^{ab}	0.97	1.15^{a}	0.97	0.98^{ab}	1.10	1.22^{a}	0.96	1.08^{a}	1.11	1.15^{a}	0.94

Means followed same letter(s) are not significantly different at 1% level by LSD.

Table 4. Initial fertility status of the saline soils examined.

Treatments Ece dSm^{-1}	Soluble Ions in sutuation extract meq L^{-1}							SAR	O.M	Total N	Availolsen "P" (Mgkg-1)	CEC Meq $100g^{-1}$	Texture
	pH	Na^{+}	Ca^{++}	Mg^{++}	K^{+}	Cl^{-}	$HCO^{-}3$	$SO^{=}4$					
3.5	7.0	22.5	10.4	7.2	0.34	22.9	8.6	8.5	7.6	1.98	0.14	13.8	31.2	Clay
5.6	6.8	54.0	12.1	8.4	0.51	53.3	7.8	13.3	16.8	1.76	0.13	12.6	30.4	Clay
7.8	6.9	80.5	13.3	12.2	0.86	84.9	8.3	16.2	22.5	1.96	0.15	11.8	28.7	Clay
9.6	7.3	103.8	18.3	13.1	0.48	107.9	5.2	21.8	26.2	2.16	0.15	12.9	29.5	Clay
11.2	7.2	118.5	18.8	16.2	0.67	122.5	6.2	25.4	28.3	2.13	0.16	12.5	28.6	Clay
13.6	7.2	137.0	21.2	17.2	1.22	144.4	7.0	30.2	31.3	1.96	0.14	12.2	29.2	Clay