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IMPACT OF SALINITY ON GROWTH, YIELD AND SALT TOLERANT LIMIT OF HYV RICE (BR-16) IN COASTAL SALINE SOIL

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Effect of salinity (0.7-6.0 dSm^{-1}) on the growth and yield of HYV rice (BR-16) was studied consecutively for three years in a coastal saline soil. Various growth and yield components (viz. plant height, number of panicle $hill^{-1}$, number of filled grains $panicle^{-1}$, weight of 100 filled grain, grain yield and duration of maturity) decreased significantly with increasing salinity. However, the number of unfilled grain $panicle^{-1}$ increased significantly with salinity. Correlation study also showed significant negative relationship between salinity and grain yield. The salinity at which yield begins to decline (threshold value) was 2.0 dSm^{-1}. The yield decrement of 10,25,50 and 75% to be expected at EC 2.4, 3.2, 4.5 and 5.8 dSm^{-1} EC 7 dSm^{-1} respectively. The expected at EC and pH of the soil at harvesting stage decreased non significantly but accumulation of salt occurred at harvest on the surface at or above EC 3 dSm^{-1}.

Keywords: Coastal saline soil; Electrical conductivity; HYV BR-16; Salinity; Sodium chloride; Zinc sulphate.

Introduction

The coastal belt of Bangladesh comprising about 2.8 million hectares of land is known as problem soil[1,2]. Most of the saline area now - a-days is protected from tidal flooding by embankments and is subjected to salinization during the dry season by the upward capillary movement of salts from brackish or saline ground water table[3,4]. This significant area is under paddy cultivation and the yield varies quite extensively from area to area[5]. For successful cultivation of this soil, Shelhevet and Kamburov[6] emphasized the need of irrigation with good quality of water. Ahmed *et al.*[7] also reported that salt tolerant rice can grow successfully with good quality of water irrigation. Moreover, soil amendments[8], selection of crops[9] and improved design of drainage system[10] could help the potential utilization of this problem soil. However, reports on response of HYV rice to salinity are scanty in literature particularly in Bangladesh. Therefore, a field experiment was designed to evaluate the impact of salinity on the growth and yield of BR-16 variety of rice in saline soil.

Materials and Method

The experiment was conducted consecutively for the three years in Aus season (March-June) at Benerpota Agricultural Research Station, Satkhira. Each plot (4m x 4 m size) was separated by a surrounding buffer zone. A basal dose of 60, 40 and 20 kg ha^{-1} of P,K and Zn respectively was applied together with one third of N (80 kg ha^{-1}). The rest of N was added in two equal splits after 30 and 50 days transplanting. 35 days old rice seedlings (3 $hill^{-1}$) of BR-16 were transplanted with a spacing of 15 cm from line to line and hill to hill. The plots were irrigated with shallow tube well water (Eciw 0.7 dSm^{-1}) periodically to maintain 4-5 cm of standing water. The specified salinity (EC 2.,3,4,5 and 6. dSm^{-1}) saline was achieved by mixing required amount of sweet water (shallow tubewell, EC

Table 1. Effect of salinity on growth and yield of BR-16 variety of rice.

Growth component	Year	Salinity (dSm^{-1}) 0.7	2.0	3.0	4.0	5.0	6.0
Plant height (cm)	1993	86a	85a	82a	41ab	0c	0c
	1994	104.1a	100.0a	96.3a	90.8a	82.8ab	75abc
	1995	83.4a	80.7a	79.8a	79.3b	79.3b	77.7b
Panicle $hill^{-1}$	1993	10.0a	8.02a	7.3a	4.3ab	0.0c	0.0c
	1994	15.0a	12.0a	10.0ab	8.6ab	7.6bc	6.0c
	1995	9.6a	9.3a	8.6a	7.6ab	6.26	6.0b
Grain $panicle^{-1}$	1993	98a	86a	70c	32d	0c	0c
		(12c)	(16bc)	(22b)	(25b)	(100a)	(100a)
	1994	118.6a	113.0a	87.3b	64.6c	52.0c	47.6c
		(12.0c)	(14.0bc)	(21.3ab)	(23.3ab)	(29.6a)	(39.0a)
	1995	90.0a	83.0a	83.0a	76.3ab	61.0c	48.6d
		(12.67)	(11.6b)	(13.3b)	(16.3b)	(18.0a)	(26.0a)
Growing period (days)	1993	139	140	142	145	0	0
	1994	142	142	142	142	147	147
	1995	136	136	136	136	137	138
Grain yield (t ha^{-1})	1993	4.05a	3.34a	2.29b	0.74c	0.0c	0.0c
	1994	5.36a	5.29a	4.66b	3.54b	2.15c	1.97c
	1995	2.70a	2.29a	1.73b	1.71b	1.33b	1.14be
Weight of 1000 grains (g)	1993	22.90a	22.50a	22.30a	17.16a	0.0b	0.0b
	1994	20.23a	20.21a	19.85a	19.12b	18.58bc	18.13c
	1995	20.35a	20.16a	19.91a	18.71b	18.26c	17.91b

Means followed same letter (s) are not significantly different by LSD* at 1% level. Figure in the parenthesis represents unfilled grain.

Table 2. Changes in soil pH and salinity at harvest.

Year	pH	Initial EC (dSm^{-1})	EC (dSm^{-1}) 0.7	2.0	3.0	4.0	5.0	6.0
1993	7.8	5.85	1.85f	1.90c	3.30b	4.20c	4.90b	5.40a
			(7.7)	(7.7)	(7.8)a	(7.9)	(8.0)	(7.9)
1994	7.4	2.70	2.65c	3.60ab	3.96c	4.15a	4.20a	4.50a
			(7.5)	(7.6)	(7.8)	(7.8)	(7.9)	(7.8)
1995	7.6	2.95	1.50ab	1.90ab	2.50ab	2.96a	3.72a	4.25a
			(7.5)	(7.6)	(7.8)	(7.8)	(7.8)	(7.9)

Legends same as Table 1.

0.7 dSm^{-1}) with saline irrigation water. Five salinity levels together with a control (EC iw 0.7 dSm^{-1}) in triplicate, were arranged in a randomized block design. Weeds were removed as they appeared. Changes in EC and pH were determined from soil extract (soil: water ratio being 1:2). Rainfall data was collected from automatic rain gauge. Various growth parameters and yield components were recorded. The response of plant yield to salinity

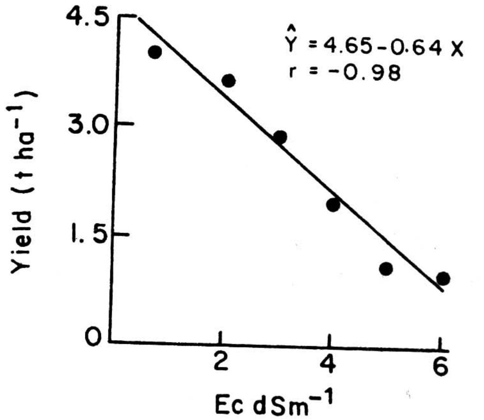

Fig-1 : Grain yield of rice (Av.3 years) as influenced by salinity of irrigation water.

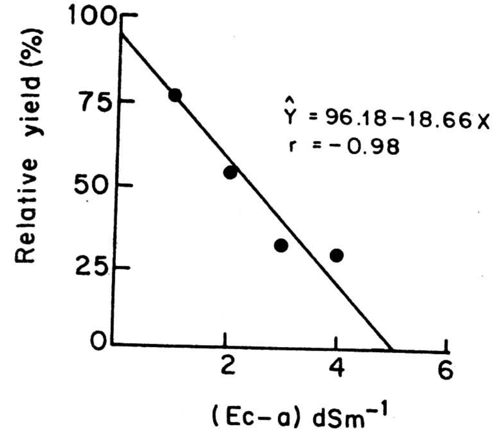

Fig-2 : Relative yield (Av.3 years) decrement of rice as influenced by salinity of irrigation water.

was calculated following the equation of Mass and Hoffman ; y = 100 -(Ec-a) b where a = the salinity at which yield begins to decline (threshold value), b = the rate of yield decline with increased salinity; y = relative yield (%) and EC mean water salinity expressed as dSm^{-1}

Results and Discussion

Growth and yield of rice as influenced by different levels of salinity have been measured (Table 1 and Fig. 1). The height of the plant decreased with increasing salinity but not significantly up to EC 3 dSm^{-1} (Table 1). However, the height reduced significantly beyond salinity 3 dSm^{-1} in all the years. In 1993, the plants failed to grow at EC 5 and 6 dSm^{-1}. Person *et al.*[11] and Akbar and Yabuno[12] also reported that height of rice seedlings decreased significantly at an EC value of 5-6 dSm^{-1}. Vegetative growth of rice plant was markedly inhibited by saline irrigation before the middle growth and increasingly become more tolerant with maturation[7,13]. The average height of the plant ranged from 91.1 to 76.7 cm. The lowest height was recorded at the highest salinity. A similar trend was observed in number of panicles $hill^{-1}$ (Table 1). Development of panicles $hill^{-1}$ also showed significant variation above salinity 3 dSm^{-1}. The average number of panicles $hill^{-1}$ varied between 11.5 and 6. Increase in salinity reduced the number of panicles of rice[14,15]. Number of filled grain $panicle^{-1}$ decreased significantly with increasing salinity (Table 1). However, that of unfilled grain $panicle^{-1}$ increased significantly with salinity. The change in number of grain either filled or unfilled was significant at EC above 3 dSm^{-1} Similar views were also proposed by Akbar *et al.*[16] who reported that increase in sterility of grain was due to reduced availability of nutrients to florst at higher salinity. About 62% of the grain became sterile over the control at ED6 dSm^{-1}. The average of number of filled and unfilled grain was between 102 and 32, and 12 and 55 $panicle^{-1}$ respectively.

Total growing period for maturity of 85% seeds showed no significant difference with increasing salinity upto 6.0 dSm^{-1} in all the years (Table 1). The period of maturation ranged between 139 and 143 days on an average. Salinity decreased the weight of 1000 filled grains significantly (Table 1).

However, no significant change in weight was recorded upto EC 3 dSm^{-1} but beyond which a significant change was observed. This findings are in good agreement with Chavan and Karadge[17] who stated that decreased photosynthesis in plants due to salt stress resulted increase in sterility of the grains. Plants treated with saline water (EC 6 dSm^{-1}) caused a decrease in weight about 15% over the control.

Increase in salinity reduced the yield of grain significantly at 1% level (Table 1 and Fig. 1) beyond EC 2 dSm^{-1} during all the cropping seasons. Reduced yield at higher EC is a reflection of reduced number of panicles $hill^{-1}$ and filled grains $panicle^{-1}$. More specifically the low grain yield at higher salinity was probably a manifestation of nutritional imbalance to the plants[18]. The average grain yield reduced from 4.03 t ha^{-1} 1.03 t ha^{-1} due to increase in salinity from 0.7 to 6.0 dSm^{-1}. The highest EC decreased the yield up to 75% as compared with control. These findings are in accordance with Ahmed *et al.*[7] who reported that growth and yield of rice reduced significantly with the increase of salinity and grain yield was more affected than other agronomic parameters. Correlation study also revealed a negative correlation (r=0.98) significant at 1% level between grain yield of rice and salinity (Fig. 1).

In 1993, no grain yield was recorded from plots irrigated with water having EC 5-6 dSm^{-1} possibly due to high initial salinity of 5.8 dSm^{-1} (Table 2). At this high salinity, the seedlings died at tillering stage of growth. It was also found that EC of these plots even after harvest remained relatively high (Table 2). However, the change in pH at harvest was not significant (Table 2).

Regression analysis suggests that HYV of BR-16 rice could be grown successfully with irrigation water having conductivity of 2 dSm^{-1}. A reduction in grain yield of 10,25,50 and 75% to be expected 2.4, 3.2, 4.5 and 5.8 dSm^{-1} respectively (Fig. 2). Accumulation of salt may occur on the surface at harvest when irrigated with water containing more than 2 dSm^{-1} salinity.

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