

Salt Tolerance Potential of Some Selected Fine Rice Cultivars

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Abstract: Performance of newly evolved fine rice cultivars Shaheen Basmati and Bas. PB.95 were compared with the approved varieties; Bas.385 and Super Basmati in saline ($EC = 1, 3, 5 \& 7 \text{ dSm}^{-1}$) and saline sodic soils ($EC 5.1-5.7 \text{ dSm}^{-1}$, SAR 19-24 and pH 8.8-9.3) in pot and field experiments respectively. Shaheen Basmati & Bas PB-95 indicated significantly more plant height; 1000-grain weight and grain yield plant^{-1} in the pot experiment. Field study was conducted for three consecutive years. Shaheen Basmati & Bas PB-95 gave higher yields than the standard varieties Bas-385 and Super Bas. at five sites in Hafizabad (Pindi Bhattian and Karyala), Sheikhpura (Mirza Virkan and Shahkot) and Gujranwala (Eminabad) districts.

Key words: Salt tolerance potential, rice varieties, salt affected soil

Introduction

Pakistan is among the four major rice exporting countries of the world but produces only 4.3 m tons compared to 21.1, 16.6 & 88.5 m tons by Vietnam, Thailand & India which are the other three exporters. Demand of rice, the largest staple food, is increasing with the increasing population of the world. It is expected that consumption of rice will increase from 560 m tons in 1995 to 780 m tones by 2020 for meeting the requirements of the population explosion (Anonymous, 1994). Pakistan has been endowed by nature with vast potentialities for growing rice on large scale; the relatively leveled terrain, heavy soils with good water holding capacity, good sunny days, congenial climatic conditions and abundant supplies of farm labour. But scarcity of irrigation water and salinity of soil as well as ground water are the major limiting factors. A vast rice growing area of the Punjab (Sheikhpura, Gujranwala and Hafizabad districts) is under the influence of marginal to severe salinity. Qureshi and Lennard (1998) reported that 6.3 m ha of arable lands of Pakistan are affected by salinity. Research must find ways and means for utilization of saline lands and brackish water by exploiting genetic resources and improved agronomic practices.

Rangaswamy *et al.* (1999) released CORH2, a rice hybrid with an average yield of 5.1 t ha^{-1} on high salinity soils. The yield was 23% higher than existing salt tolerant line CO 43. Mandal *et al.* (1999) found pokkali as the best rice cultivars performing in saline soils. Pramanik and Mandal (2000) studied the performance of nine salt tolerant, semi dwarf somaclones of "Pokkali" and "Taichung Sen Yu" under saline soils. The experiment was conducted to select the most suitable rice cultivars from the existing & newly evolved fine rice cultivars for obtaining optimum yield in salt affected soils.

Materials and Methods

The studies being reported were undertaken in pots as well as field for two years. Pot experiment was conducted at the campus of Soil Salinity Research Institute, Pindi Bhattian (Punjab) and Pakistan while field studies were carried out on five sites at farmer's field in Hafizabad, Sheikhpura and Gujranwala districts.

Pot study (1997-98): Four varieties/lines of rice namely Super Bas, Bas-385, Bas PB-95 & Shaheen Bas. were raised in pots each containing 12 Kg soil. Four levels of salinity ($1, 3, 5$ and 7 dSm^{-1}) were artificially developed according USDA Salinity laboratory method (1954). Standard agronomic practices were followed. Pots were arranged in CRD layout and three plants pot^{-1} were maintained from transplanting to maturity. Data

regarding plant height, tillering, 1000-grain weight, panicle sterility and paddy yield were recorded and subjected to statistical analysis according to Steel and Torrie (1980).

Field studies (1997-99)

Field trials were conducted at following five locations on farmer's field during 1997-99 for three consecutive years.

Siddiqueabad, Pindi Bhattian district Hafizabad

Karyala, district Hafizabad

Mirza Virkan, district Sheikhpura

Shah Kot, district Sheikhpura

Eminabad, district Gujranwala.

Four rice cultivars i.e., Bas 385, Bas PB 95, Shaheen Bas and Super Bas were tested in saline sodic soils ranging in EC from 5.1 to 5.7 dSm^{-1} , SAR 19 to 24 and pH 8.8 to 9.3. Experimental sites were selected on the basis of pre- analysis for these parameters. Experiments were laid out in RCB design. Soil texture of the study sites varied were sandy loam to clay loam. Fertilizers NPK @ $100-75-0 \text{ Kg ha}^{-1}$ were applied. Recommended agronomic practices were followed throughout growing season. Paddy yield was recorded and analyzed described by Steel and Torrie (1980).

Results and Discussion

Pot experiment: Comparative performance of four rice cultivars at different salinity levels showed that plant height of all the cultivars were not affected significantly up to $EC-5 \text{ dSm}^{-1}$. The reason, as described by Orden (1960), may be that low concentration of salts (0.025 M) actually increased turgor pressure, cell wall synthesis, cell enlargement that resulted in faster growth. But at $EC 7 \text{ dSm}^{-1}$ (Table 1) a significant decrease was observed in Bas-385, Super Bas and Shaheen Bas where as Bas. P. B-95 was not affected (Table 1). Decrease in plant height was more pronounced in Bas.385. This may be due to genetic behaviour of different cultivars in saline media. Results are in agreement with Aslam *et al.* (1995) and Shazia *et al.* (1998) who found a negative relationship in salt stress and shoot length of rice.

Number of tillers is other growth and yield attributing character. A non-significant increase was found in tillers plant^{-1} of all the four varieties with the increasing levels of salinity (Table 1). The maximum increase was observed in Bas.PB-95 and Shaheen Bas. Increase in tillering is adopted as one of the salt tolerant mechanisms in order to dilute the negative effects of salts and these two advance lines indicated to possess this character.

Information regarding panicle sterility of rice as affected by salinity levels is depicted in Table 1. Increasing levels of

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Table 1: Yield and yield components of rice cultivars under salinity stress

Variety/line	Control	EC = 3 dSm ⁻¹	EC = 5 dSm ⁻¹	EC = 7 dSm ⁻¹
Plant height (cm)				
Bas. PB-95	107.99 ab	107.77ab	106.11 ab	105.81ab
Bas. 385	118.48 a	115.77a	112.55a	89.11c
Shaheen Bas.	118.66a	117.33a	115.99a	105.88b
Super Bas.	105.50 b	105.00 b	100.20b	90.10c
No. of tillers plant ⁻¹				
Bas. PB-95	7.44	7.78	9.99	10.33
Bas. 385	7.44	7.33	8.99	9.66
Shaheen Bas.	7.44	7.22	7.77	9.66
Super Bas.	8.20	8.22	8.77	9.33NS
Panicle sterility (%)				
Bas. PB-95	6.60d	12.17cd	13.85c	16.68c
Bas. 385	26.25b	34.32b	37.48b	74.43a
Shaheen Bas.	9.20d	9.25d	19.35c	24.67bc
Super Bas.	10.20d	10.18d	18.42c	28.42bc
1000 grain weight (grams)				
Bas. PB-95	19.35	19.11	18.63	18.24
Bas. 385	18.83	18.18	17.88	15.61
Shaheen Bas.	19.39	19.12	18.56	17.56
Super Bas.	19.40	19.20	18.20	18.40NS
Grain yield plant ⁻¹ (grams)				
Bas. PB-95	14.87a	12.66ab	11.68ab	9.09b
Bas. 385	12.90b	10.05b	9.18b	4.79c
Shaheen Bas.	16.90a	11.20ab	10.33b	8.01b
Super Bas.	15.70a	9.73b	6.02c	3.56cd

NS = Non significant

Table 2: Paddy yield of test cultivars in saline sodic soils (field study)

Location	Variety	Yield t ha ⁻¹ (means of 3 replications)	Soil salinity status
Siddiqueabad	Bas.PB-95	3.363a	EC = 5.1 dSm ⁻¹
	Shaheen Bas.	3.491a	pH = 8.8
	Super Bas.	3.148b	SAR = 22
	Bas-385	3.028b	
Karyala, Hafizabad	Bas. PB-95	3.419ab	EC = 4.9 dSm ⁻¹
	Shaheen Bas.	3.618a	pH = 8.9
	Super Bas.	3.083b	SAR = 23
	Bas-385	3.33ab	
Mirza Virkan, Sheikhpura	Bas. PB-95	3.578a	EC = 5.4 Sm ⁻¹
	Shaheen Bas.	3.442ab	pH = 8.8
	Super Bas.	3.331ab	SAR = 19
	Bas-385	3.323b	
Shahkot, Sheikhpura	Bas. PB-95	3.315bc	EC 5.7 Sm ⁻¹
	Shaheen Bas.	3.602ab	pH = 9.3
	Super Bas.	3.196c	SAR = 24
	Bas-385	3.721a	
Eminabad, Gujranwala	Bas. PB-95	3.419ab	EC = 5.3 Sm ⁻¹
	Shaheen Bas.	3.554a	pH = 9.0
	Super Bas.	3.275b	SAR = 21
	Bas-385	3.431ab	

salinity registered significant increase in panicle sterility. Data indicated a positive correlation between salinity and sterility. As for as varieties are concerned, effect was more pronounced in Bas-385 than Bas. PB-95 and Shaheen Bas. Nieman and Clark (1976) suggested that photosynthesis and translocation of sugars are restricted and disturbed in salt stressed plants. Sterility of rice tillers may be a result of salt suppression or metabolic disorders. Cassman (1994) identified that number of panicles and panicle health is the most important yield-contributing factor in rice. So panicle sterility will definitely affect plant yield.

Grain weight (1000 grain) and paddy yield data are presented in Table 1. Paddy yield started negatively affecting even at EC

of 3 dSm⁻¹ in all the varieties/lines included in the study. However, a significant loss of 28.6% was only recorded in case of Super Bas at this level. Further higher levels also decreased it significantly. Only 29% yield was obtained at the highest level (7dSm⁻¹). The next sensitive variety with comparatively less salt tolerance was Bas-385. Salinity level causing significantly negative effect for this variety was 7 dSm⁻¹. Grain yield is directly related with panicle characters. As a result of sterility Bas.385 suffered the most. Results are also in line with Ayers and Westcot (1985) who stated in a review that rice gave 100% to its potential yield at EC 3 and 80% at EC 5.

Bas. PB-95 and Shaheen Bas. produced significantly higher

yields than Bas-385 and Super Bas. at the highest salinity level. The former two lines were similar to each other while the latter two varieties were also alike. Reason may be better tolerance to salinity by new genotypes i.e., Shaheen Bas. and Bas. PB-95. Results are in agreement with Marassi (2000) who released two rice cultivars "Petei" and Mocoï" suited for growing in saline soils of Buenos Aires with a yield potential of 8.5 and 10 t ha⁻¹ respectively. Shaheen Bas. and Bas. PB-95 produced higher 1000-grain weight than Bas-385 and Super Bas., which supported further to conclude that the newly evolved advance lines performed better in salt stress (Table 1).

Field studies

Table 6 presents paddy yield of rice cultivars as affected by salinity sodicity in field trials conducted at five sites (Table 2). Shaheen Bas. & Bas. PB-95 produced significantly higher yields than the approved varieties at four sites out of five in three district of the rice zone. At only one site (Shahkot, Sheikhpura) the performance of PB-95 was found to be lower. Reason for better performance of new genotypes was more tolerance to salinity. Results are in agreement with Marassi (2000). Thompson *et al.* (1998) also harvested 12.1 t ha⁻¹ of rice cultivar "Ameroo" with saline ground water in Australia. The findings of pot trial are also confirmed by field studies.

Newly evolved rice cultivars PB-95 and Shaheen Basmati proved more salt tolerant compared with the approved varieties Basmati-385 and Super Basmati. The respective yield losses of these advance lines/varieties at the highest level of salinity (7 dSm⁻¹) were; 39, 52.6, 63 and 77.3 %. Super Basmati was the most salt sensitive fine rice variety while Bas. PB-95 was the most salt tolerant. The range of EC, pH and SAR were; 4.9-5.7, 8.8-9.3 and 19-24 respectively where these cultivars were grown in the field with the yields of 60-75 % of their original potential.

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