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SALT TOLERANCE OF RICE VARIETIES AND MUTANT STRAINS

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A pot experiment was conducted to evaluate salt tolerance of two varieties of rice (*Oryza-sativa*) Basmati-370 and IR6 and their four mutants evolved through mutation. Soil salinity levels were produced in 5 kg soil in pots by applying mixture of salts, containing 8 parts of Na_2SO_4, 6 parts of NaCl, 2 parts of $CaCl_2$, 2 parts of $MgSO_4$ and 1 part of $NaHCO_3$, at 0, 0.25, 0.50, 0.75 and 1.00% of soil (w/w), resulting in the following five levels, control (0.45), 2.85, 5.75, 7.85 and 11.40 ds/m EC of saturation extract. Under non-saline (control) conditions the grain and straw yields for varieties and mutants varied significantly. The most tolerant mutant strain (IR6-18) tolerated twice as much salinity as the most sensitive mutant strain (Bas-EF-29-2), and 50 per cent reduction in grain yield occurred in two mutant strains at EC 4.45 and 2.25 ds/m, respectively.

Key words: Salt tolerance, Rice varieties, Rice mutant strains.

INTRODUCTION

Rice is sensitive to salinity. The grain yield of many varieties is reduced to half at an electrical conductivity (EC) of 6 dS/m [1,2]. Salinity is regarded as the largest single soil toxicity problem facing rice production [3]. There is a need to develop salinity resistant varieties of rice. Mass screening of the existing varieties for natural salt resistance has been practised [4]. As natural phenotypic salt tolerance in rice is limited, the scope of improvement through mass screening is not promising. Yeo and Flower [5] have argued that resistance is conferred not by a single factor, but due to a number of physiological traits. They [5] suggest that the salt resistance of rice can be increased by selecting such traits separately and then pyramiding them. Akbar *et al.* [6] reported that selection on the basis of shoot length, Na and Ca level in the shoots, dry weight of shoots and roots, plant height and yield/plant showing predominance of additive effects and high heritability values could lead to the development of salt tolerant cultivars.

The present studies were conducted to evaluate the salt tolerance of two standard varieties of rice (*Oryza sativa* L.) and their four mutant strains evolved through mutation [7,8,9].

MATERIALS AND METHODS

Two standard varieties of rice, Basmati 370 and IR6, and their four mutant strains viz. Bas-EF-29-1, Bas-EF-29-2, IR6-EF-3 and IR-6-18, developed through mutation were tested in pot experiments for their salt tolerance.

Five kg soil was taken in pots and five salinity levels were developed by adding to the soil a salt mixture consisting of 8 parts of Na_2SO_4, 6 parts of NaCl, 2 parts of $CaCl_2$, 2 parts of $MgSO_4$, and 1 part of $NaHCO_3$ at 0, 0.25, 0.50, 0.75 and 1.00% of soil (w/w) resulting in levels of control (0.45), 2.85, 5.75, 7.85 and 11.4 dS/m EC of saturation extract. Each treatment was replicated four times and the pots were kept at field capacity moisture content for four weeks. All the treatments were fertilized with 50mg N/kg soil as urea, and 25mg P/kg soil as single superphosphate.

Nursery of rice varieties and mutant strains was grown in the field for four weeks. Five seedlings were transplanted in each pot. The pots were arranged in a split plot design, and were irrigated with distilled water and kept flooded until maturity. At maturity the plants were harvested and the grain and straw yields were recorded. The salinity levels causing 50% reduction in yields were calculated by correlation and regression analysis.

RESULTS AND DISCUSSION

The yields of grain and straw of the rice varieties and mutant strains are given in Table 1. Under non-saline conditions (control, EC_e 0.45 dS/m), the varieties and mutant strains differed significantly ($P = 0.01$) in yields of grain and straw. The grain yields varied in the order: IR6-EF-3 > IR6-18 > IR6 > Basmati 370 > Bas-Ef-29-2 > Bas-EF-29-1; and the straw yield varied in the order: Bas-EF-29-1 > Basmati 370 > Bas-EF-29-2 >

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Table 1. Effect of salinity (EC_e) on yield of grain and straw (g/pot) of different rice varieties and mutant strains.

Variety/ mutant strain	EC_e, dS/m					EC_e causing 50% reduction in yield, dS/m
	0.45	2.85	5.75	7.85	11.40	
Grain						
Basmati 370	27.3	11.9	4.8	–	–	3.80
Bas-EF-29-1	11.9	4.9	–	–	–	3.50
Bas-EF-29-2	21.7	2.8	–	–	–	2.25
IR6	37.1	20.3	9.1	4.2	–	4.30
IR-EF-3	47.6	16.1	5.6	–	–	3.65
IR6-18	42.7	31.5	11.9	7.0	–	4.45
Straw						
Basmati 370	106.4	79.1	33.6	–	–	4.85
Bas-EF-29-1	107.1	74.2	53.9	–	–	5.10
Bas-EF-29-2	102.9	73.3	30.8	–	–	4.40
IR6	102.2	87.5	74.2	53.9	–	7.25
IR6-EF-3	88.2	65.8	56.7	30.8	19.6	6.80
IR6-18	86.8	81.9	70.7	55.3	30.8	10.95

L.S.D.	Grain 5%	Grain 1%	Straw 5%	Straw 1%
1. Between two treatment means within the same variety.	3.395	4.501	10.283	13.650
2. Between two varieties at the same or different treatments.	3.563	4.783	10.437	13.986

IR6 > IR-EF-3 > IR6-18. The two mutant strains IR6-EF-3 and IR6-18 produced 28% and 15% more grain respectively than their parent variety IR6. Different levels of salinity reduced the yields significantly ($p = 0.01$) in all varieties and mutants. The variety IR6 produced 36 per cent more grain than Basmati 370 under non-saline conditions, and about 50% more under EC 2.85 and 5.75 dS/m salinity levels.

Salinity affected the grain yield more adversely than the straw yield in all the varieties and mutant strains. The mutant strain IR6-18 was comparatively most tolerant to salinity. Its grain yield was reduced to 50% of the control at salinity level of EC 4.45 dS/m. The least salt tolerant was mutant strain Bas-EF-29-2 producing 50% yield at a salinity level of EC 2.25 dS/m.

DISCUSSION

The response of different varieites of rice to salinity in respect of seed germination and seedling growth have been demonstrated [10]. Pearson [11], and Kaddah [12] report that the seedling stage of the rice plant is most sensitive to salinity. During the late boot stage and the subsequent flowering stages sensitivity has been debated. Some workers maintain that rice is sensitive to salt, [13,14, 15], whereas others found no evidence to support these conclusions [12,16,17,18]. Imposing salinity at bootstage did not increase sensitivity to salt as no reduction in grain yield of rice was observed [17,19].

The results of the present studies showed that salinity affected the grain formation more than the vegetative growth (straw yield). The salinity levels in the soil causes 50 percent reduction in straw yields was twice as high as that for grain yield. Our results conform with those who have observed that increased salinity at the tillering stage and the period of initiation and differentiation of panicle primordium affected straw yields much less than the grain yields which suffer drastically and almost altogether failed at higher salinity levels [11,15,16,20,21,22]. In our study the most tolerant mutant strain IR6-18 produced 50 percent straw yield at EC_e 10.95 dS/m, which is in agreement with the results of Fageria [23], who observed 50 percent reduction in yield of tops of salt tolerant rice variety at approximately EC_e 11 dS/m in his study.

Growth reduction associated with increased salinity and osmotic pressure could be due to decrease in physiological availability of water to plants and the accumulation of toxic quantities of various ions within the plant [24]. Normal growth appears to be interrupted during the period of osmotic pressure adjustment into cells in response to increases in salinity of the exterior solutions. The tolerance of plants to increases in salinity at any stage depends upon how long that growth is interrupted and the particular cells that suffer. The reduction in grain formation seems to be related to cell differentiation and development of the panicle primordium following the tillering stage. The interruption of normal cell growth and differentiation during the 3-5 weeks of panicle primordium development greatly influences the flowering, fertilization and grain formation.

It is evident from the results presented here that there are marked differences in relative salt tolerance among the varieties and mutant strains tested. Responses related to the osmotic properties of the saline medium is thought to be a complex phenomenon controlled by many genes that influence plant water relations and the osmotic properties of the plants [25]. These conclusions emphasis the importance of genetic basis for selecting plants for saline soils.

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