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RESPONSE OF RICE TO SALINITY SHOCK AT VARIOUS GROWTH STAGES AND TYPE OF SALINITY IN THE ROOTING MEDIUM.

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Two separate experiments were designed, one in solution and the other in soil culture to determine the most sensitive growth stage of rice to salt stress and relative toxicity of various salts in the growth medium. Four rice varieties i.e. Basmati-370, NIAB-6, BG-402-4 and IR-1561 were used for these studies. Two salinity levels (control and EC 10 dSm^{-1}) were developed by adding NaCl to solution culture; and NaCl alone, $NaCl+CaCl_2$, Na_2CO_3 & a salt mixture ($Na_2SO_4+NaCl+CaCl_2+MgSO_4$ in the ratio of 9:5:5:1) in soil culture. Salt stress applied at the time of transplanting and at panicle initiation stage caused the maximum reduction in paddy yield while for straw yield seedling (transplanting) stage proved more crucial. With respect to type of salinity, NaCl alone was more toxic then $NaCl+CaCl_2$, Na_2CO_3 or the salt mixture. Comparative toxicity of Na^+ and Ca^{2+} is discussed.

INTRODUCTION

Plant growth is affected by salinity at all stages of development, but sensitivity varies from one growth stage to the other (Maas and Hoffman, 1977). Determination of the sensitive stage is necessary for the development of a rapid procedure for mass screening of various genotypes of a crop as the testing could then be confined to the sensitive stage only. In addition, such an information in useful for the utilization of saline water for irrigation which may be applied, if necessary, at the relatively less sensitive stage to overcome water shortage.

Screening crop cultivars for salt tolerance in nutrient culture needs salt addition. Some workers prefer to use NaCl alone (Ikehashi and Ponnamperuma, 1978) or combined with $CaCl_2$ after seedlings have established. Salt tolerance measurements at the U.S. Salinity Laboratory are done using saline irrigation water having 1:1 NaCl : $CaCl_2$salts (see Maas and Hoffman, 1977). In addition, many saline sodic soils, under rice cultivation contain measurable amounts of carbonates ions. These studies were conducted to compare growth responses of four rice varieties to salt stress at different growth stages in solution culture and to assess the relative toxicity of different salts to rice in soil culture.

MATERIALS AND METHODS

Experiment-I.

Fourteen-day old seedlings of four rice varieties (Basmati-370, NIAB-6, BG-402-4, IR-1561) were transplanted to 1 cm plugged holes in thermopal sheets floated over 15 liters of Yoshida nutrient solution (Yoshida <u>et al</u>., 1972) in plastic tubs. Three holes were used for each variety, each hole having one seeding. The nutrient solutions were changed weekly. The experiment was laid out in completely randomized design. Salt stress of 100 mol m^{-3} NaCl was applied at each particular growth stage. To avoid salinity shock salt was added in 3 increments @ 33 mol m^{-3} per day. Plants were stressed at 100 mol m^{-3} NaCl for ten days and after that they were again brought back to normal solution conditions within three days. These salinity shocks were given at the following stages:

a. Seedling stage (three days after transplanting)
b. Tillering stage (16 days after transplanting)
c. Panicle initiation stage (45 days after transplanting)

One control was also kept to compare the results. At maturity, paddy and straw yields were recorded.

Experiment-II

The experiment was conducted in July 1986 to determine the effect of NaCl alone, NaCl+$CaCl_2$ (1:1; equivalent basis), Na_2CO_3 alone and a salt mixture (commonly present in soils of Pakistan; Na_2SO_4 + NaCl + $CaCl_2$ + $MgSO_4$ @ 9:5:5:1; equivalent basis) on growth of the same four rice varieties. Glazed pots (27 cm depth, 27 cm dia.) were filled with 10 kg of medium textured soil which was air dried, homogenized and passed through a 2 mm sieve. The soil was sandy clay loam in texture having pH 7.9, cation exchange capacity 7.3 me 100 g^{-1} and 2.3% $CaCO_3$ contents. The soil was salinized with the respective salts to ECe level of 10 dSm^{-1}, and puddled before transplanting rice seedings. Untreated soil (Ece 1.1 dSm^{-1}, SAR 1.0) served as control. Adequate dose of fertilizers was also applied. The experiment was laid out in completely randomized design. Six 30-day old seedings of each variet were transplanted in each pot. One week after transplanting, thinning was done to four seedlings per pot. Soil was kept submerged by adding demineralized water daily. After one month of growth period harvesting was done to record shoot and root fresh weights.

RESULTS AND DISCUSSION

Response of rice to salinity shocks at various growth stages.

Different varieties showed different response to salinity at various stages of growth (Table.1). The maximum adverse effect on paddy yield was observed when salinity shock was applied at the panicle initiation stage followed by the seedling stage. In the case of straw yield, early seedling stage proved to be the most sensitive. In terms of paddy yield, NIAB-6 gave significantly higher yield than all other varieties at high salinity at all stages of growth while IR1561 clearly proved to be the most sensitive variety. BG-402-4 gave good paddy yield when the stress was imposed at seedling or tillering stages but was found as sensitive as the IR-1561 or Basmati-370 when stressed at the pancile initiation stage. Basmati-370 was salt sensitive at both seedling and panicle initiation stages.

Table. 1 *Paddy and straw yields of four rice varieties as affected by salinity shocks (100 mol m^{-3} NaCl at various stages of plant growth*

Varieties/ Lines	Control	Seedling Stage	Tillering Stage	Panicle Initiation Stage	Mean
		Paddy yield (g)			
Basmati 370	24.6 cd	13.5 fg (55)	20.7 c-f (84)	12.7 f-h (52)	17.9 B
NIAB 6	38.8 a	27.0 bc (70)	33.2 ab (86)	22.3 c-e (58)	30.3 A
BG 402-4	27.3 bc	16.8 d-g (61)	18.8 c-f (79)	6.9 gh (25)	18.3 B
IR 1561	26.8 bc	8.6 gh (32)	15.8 e-g (59)	5.0 h (19)	14.1 C
Mean	29.4 A	16.5 C	22.1 B	12.6 D	
		Straw yield (g)			
Basmati 370	54.8 a	29.6 de (54)	37.2 cd (68)	35.1 cd (64)	39.2 A
NIAB 6	53.1 ab	37.2 cd (70)	36.5 cd (69)	44.3 bc (83)	42.8 A
BG 402-4	33.1 d	14.6 f (44)	21.3 ef (64)	20.7 ef (62)	22.4 B
IR 1561	34.2 cd	13.3 f (39)	15.0 f (44)	19.0 f (56)	20.4 B
Mean	43.8 A	23.7 C	27.5 BC	29.8 B	

Means with different letters differ significantly according to Duncan's (1955) Multiple Range Test (P = 0.05). Extra letters have been omitted except first and the last ones to simplify the Table.

Values in the parenthesis ( ) represent percentages of respective controls.

Table. 2. *Effect of type of salts on the growth (g FW 4p^{-1}) of four rice varieties (EC_e 10 dS m^{-1}).*

Varieties/	Control	NaCl	NaCl+$CaCl_2$	Na_2CO_3	Salt mixture*	Mean
			Shoot			
Basmati 370	23.6 a	5.3 g-i (22)	8.8 e-g (37)	18.1 b (76)	9.6 d-f (41)	13.1 A
NIAB 6	13.2 c	5.4 g-i (419	7.8 e-h (59)	8.8 e-g (67)	8.7 e-g (66)	8.8 C
BG 402-4	17.7 b	6.6 f-i (37)	8.2 e-h (46)	12.5 cd (71)	10.4 c-e (59)	11.1 B
IR 1561	12.9 c	2.6 j (20)	3.3 ij (25)	4.9 h-j (38)	3.7 ij (28)	5.5 D
Mean	16.9 A	4.9 D (29)	7.0 C (41)	11.1 B (65)	8.1 C (48)	
			Root			
Basmati 370	23.8 a	4.8 f-h (20)	6.0 d-g (25)	16.1 b (68)	8.5 de (36)	11.9 A
NIAB 6	12.4 c	4.7 f-h (38)	5.6 e-h (45)	6.1 d-g (50)	5.7 e-h (46)	6.9 C
BG 402-4	16.7 b	5.4 eh (32)	7.2 d-f (43)	9.2 d (55)	7.4 d-f (45)	9.2 B
IR 1561	14.2 bc	1.2 i (9)	2.5 hi (18)	3.5 d-i (25)	1.5 i (11)	4.6 D
Mean	16.8 A	4.0 D (24)	5.3 CD (32)	8.7 B (52)	5.8 C (34)	

Means with different letters differ significantly according to Duncan's (1955) Multiple Range Test (P = 0.05). Extra letters have been omitted except first and the last ones to simplify the Table.

Values in the parenthesis ( ) respesent percentages of respective controls.

* Salt mixture = NaCl : Na_2SO_4 + $CaCl_2$ + $MgSO_4$

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