Int.J.Curr.Microbiol.App.Sci (2018) *7*(6): 1539-1542

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 06 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.706.183

Screening of Rice (*Oryza sativa* L.) for Salinity Tolerance at Vegetative Stage under Hydroponic Condition

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Keywords

QTL: qualitative trait loci, Allele: contrasting pair of gene, EC: electrical conductivity, Hydroponic condition: soil-less culture

Article Info

Accepted:
17 May 2018
Available Online:
10 June 2018

A B S T R A C T

Rice is one of the most suitable crop for saline soils although it is usually considered moderately sensitive to salinity. In this study, the phenotypic response of ten rice genotypes with salt stress at EC = 12dsm^{-1}was assessed under hydroponic condition at seedling stage. The rice genotypes CSR-13 and CSR-30 showed highly tolerance to salinity; genotypes NDRK-5088, NUD-2, NUD-3, FL-478 and CSR-90IR-2 were recorded moderately salinity tolerance and varieties NDR-359, IR-29 and IR-28 showed susceptibility to salinity. Tolerant varieties are suggested to use as donor parents for salinity tolerance in back cross breeding and for allele mining for salinity tolerance gene/QTLs

Introduction

The plant response to salinity consists of various processes that must function in coordination to enhance both cellular hyper-osmolarity and ion disequilibrium. Salt stress adversely affects agricultural yield throughout the world affecting production.

Many species of higher plants, including most crops, are subjected to growth inhibition under high-NaCl condition. Rice is one of the most suitable crop moderately sensitive to salinity (Akbar *et al.*, 1972). It is relatively tolerant to salinity at the germination stage but its panicle initiation and pollination stage are two most salinity-sensitive growth stages which is directly related to crop yield (Heenah *et al.*, 1988, Khatun and Flower, 1995, Zeng *et al.*, 2001).

Screening of rice genotypes at seedling stage is comparatively easier than reproductive stage and also rapid. It is very difficult at the reproductive stage (Gregario *et al.*, 1997).

The typical mechanism of salinity tolerance in rice is the exclusion or reduction of Na uptake and increased absorption of K to maintain a good Na^{+}-K^{+} balance in the shoot. The visual symptoms of salt stress may still be the most appropriate for mass screening. Salt injury

starts with reduction in effective leaf area. The oldest leaves starts to roll then die, followed by the next older, and so on. Rice is very sensitive to salinity at seedling stage. Its height, root length, emergence of new roots and dry matter decreases significantly at EC 5-6 dSm^{-1} (Pearson *et al.*, 1966, Akbar and Yabuno, 1974). Salinity suppresses leaf elongation and formation of new leaves.

Photosynthetic function and chlorophyll content were inversely proportional to salinity level (Ota and Yasue, 1962). The screening technique is based on the ability of seedling to flourish in salinized nutrient solution.

Materials and Methods

Plant materials

Total ten rice genotypes were used in this study, which were NUD-2, NUD-3, NDRK-5088, NDR-359, CSR-13, CSR-30, CSR-90IR-2, FL-478, IR-28 and IR-29.

Preparation of stock solution

Proper preparation of stock solutions is essential to avoid nutrient deficiencies and mineral toxicities not attributed to salinity stress. Therefore, the amounts prepared should depend on the number of test entries screened during a two-month period. Details for preparing 1L of stock solutions are presented in Table I. For the macronutrient stock solutions, weighed the required amount of reagent (Table1) and transfer to a 1000-ml beaker and initial mixing was done with 750ml distilled water. Then mixture was transferred to 2-L volumetric flask, then added distilled water and make up volume 2 L. Shake the mixture for 15 min using a magnetic stirrer then transferred to stock solution bottle. Preparation of micronutrient stock solution is critical because most nutrient deficiencies and other toxicities could be traced to improper preparation. Each reagent of the micronutrient solution listed in Table 1 should be dissolved separately. Mixed all solutions together in distilled water using volumetric flask. Added the ferric chloride solution to the mixture just before citric acid and stirred the mixture for 15 min using a magnetic stirrer. Finally added 100 ml sulfuric acid to the mixture and maked up volume to 2.0 L. Stirred for another 10 min and stored in a dark glass bottle. The final color of this solution was yellowish brown.

Salinization of nutrient solution

Salinized the nutrient solution by adding NaCl while stirring up to the desired EC. Filled up the trays with this solution high enough to touch the nylon net bottom of the thermocol.

Results and Discussion

The rice genotypes were screened in the lab condition in Yoshida (1976) solution. The rice genotype scored for salinity tolerance at seedling stage based on Standard Evaluation System (SES), 1996 at 7, 14 and 21 days after salinization. The data revealed that all the varieties showed highly salinity tolerance to tolerance with score of 1 to 3 after 7 days of salinization. Varieties NUD-3, NDRK-5088, NUD-2, CSR-30, CSR-13 and CSR-90IR- exhibited high salinity tolerance with salinity score of 1 and NDR 359, IR 28 and IR 29 exhibited salinity tolerance with score 3. After 14 days of salinization varieties CSR- 30, CSR-13, CSR 90-IR2 and FL 478 showed tolerance to salinity; varieties Narendra Usar Dhan- 2, Narendra Usar Dhan- 3 and NDRK 5088 were recorded moderately salinity tolerance with score 5 and varieties IR 28, NDR 359 and IR 29 showed susceptibility to salinity with score 7.

Table.1 Preparation of stock solution

Element	Reagent	Preparation (g/L)
Micronutrient		
N	Amonium nitrate	91.4
P	Sodium phosphate, monobasis monohydrate	35.6
K	Potassium sulphate	71.4
Ca	Calcium chloride, dehydrate	117.35
Mg	Magnesium sulphate, 7- hydrate	324
Micronutrient		
Mn	Maganous chloride,4-hydrte	1.5
Mo	Ammonium molybdate,4-hydrate	0.074
Zn	Zinc sulphate,7-hydrate	0.035
B	Boric acid	0.934
Cu	Cupric sulphate,5-hydrate	0.031
Fe	Ferric chloride,6-hydrate	7.7
Citric acid, monohydrate	**11.9**	

Source: Yoshida *et al.*, (1976)

Table.2 Salinity score at vegetative stage in lab condition

S. No.	Varieties	Salinity score		
		7 days	**14 days**	**21 days**
1	**NUD-3**	1	5	5
2	**NDRK-5088***	1	5	5
3	**NUD-2***	1	5	5
4	**NDR-359***	3	7	9
5	**CSR-30****	1	3	5
6	**IR-29***	3	7	9
7	**CSR-13****	1	3	5
8	**IR-28****	3	7	9
9	**CSR-90-IR-2**	1	3	5
10	**FL-478**	3	3	5

After 21 days of salinization NUD-3, NDRK-5088, NUD-2, CSR-13, CSR-30, CSR-90IR-2 and FL 478 showed susceptibility response to salinity whereas, varieties NDR-359, IR-29 and IR-28 were highly susceptibe to salinity (Table 2). Gregario *et al.*, (2002) observed wide variation in for salinity tolerance in rice accessions and also reported with FL-478 and NSIC Rc222 as tolerant variant of cross Pokalli (tolerant) and IR-29 (sensitive).

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How to cite this article:

Chhavi, D. K. Dwivedi, Gaurav Kumar, Akanksha Singh and Avinash K. Singh. 2018. Screening of Rice (*Oryza sativa* L.) for Salinity Tolerance at Vegetative Stage under Hydroponic Condition. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 1539-1542.
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