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Effect of salinity on germination and Seedling characters of different varieties of *Oriza sativa* L (Rice)

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Abstract
Salinity is an hindrance to the sustainable agricultural production. It adversely affects the crop productivity and is an abiotic stress. Due to increasing salinity, the germination, height, growth and total leaf area of rice from vegetative to generative stages are inhibited. In the present Research, the effect of salinity with measurable concentrations on germination and early seedling growth of six different germplasms of rice were tested, to indicate salinity level. A Petridish experiment and a Pot culture experiment with NaCl concentrations of 0, 50, 100, 150 and 200 mM, were conducted. The results of vigour index in petridish experiment, germination %,shoot length and root length were recorded. The six rice varieties were tested and positively affected by increase of NaCl concentrations on percentage of germination and vigour index. CSR23 (Dhanrasi) rice variety recorded highest Shoot Height of 18.7 cm at lowest concentration of 25.0mM. The shoot height of 12.5 cm was recorded, at highest concentration of 200mM,in comparison with other rice varieties.

Keywords: Rice, oryza sativa, L, sodium chloride (NaCl), salt effect, salinity effect, germination, seedling growth, salt stress

Introduction
Rice is a staple food in large part of the world's population especially in the East, South, Southeast Asia, tropical Latin America and West Indies. Rice (*Oryza sativa*) belongs to the family Poaceaecomprises of two main types: *indica* and *japonica* in Asia. Salt stress reduces the crop productivity (Yasseen *et al*. 2010; Joseph and Jini 2010). Salt Stress causes a reduced water potential, ionic imbalances and toxicity and sometimes severe salt stress may even threaten survival (Joseph and Jini 2011). Rice is one of Asia's largest food demand, which is consumed and grown in about 90% of Asian countries. The stock is still inadequate to fullfil people's demand. Rice crop is generally exposed to salinity immediately after planting in saline soils or irrigated with saline water. Salinity results indecrease in the rate of seed germination and seedling viability for most of the agricultural crops (Karim *et al*., 1992) [10]. Salinity affects the seed germination in two ways:, eitherby decreasing the absorbption of water, osmotically orby facilitating the uptake of ions in excess amount to be toxic for the embryonic activity (Ayers *et al*., 1952). The ability of seed germination of a rice crop under salt stress conditions is an indication of salt tolerance, at least, at the early stage of growth. Yoshida (1981) [13] revealed that rice is more sensitive to salinity during early seedling growth and flowering than other growth stages. As a result of salinity, Rice cultivars show a great variation in germination. (Afroze, 1996) [1].
Salt stress has adverse effects on rice growth and yield, which depend on crop stages, stress severity and duration. The seedling stage is one of the most sensitive to salt in rice (Reddy, *et al*., 2017) [7].
According to Lutts *et al*., 1996, rice becomes very sensitive at the young seedling stage, which impacts the quantitative measure, in salt affected fields. It is necessary to identify the sensitivity of a variety at early seedling stages for successful crop production in a saline environment. The salt composition is evenly distributed over the water. As a result, rice seed germination measures are an appropriate way to assess the plant response to salt stress. High salinity delays and reduces the germination percentage of plants. Salinity decreases the germination percentage, root length, shoot length and seedling growth (Agnihotri, *et al*., 2006) [2].

Materials and Methods
Rice Seeds of six varieties *viz*.,1) RNR 15048 (Telangana Sona), 2) KNM-118 (Kunaram Sannalu), 3) JGL11118 (Anjana), 4) NLR 34449 (Nellore mahsur), 5) RNR 10754 (Tellahamsa) and 6) CSR23 (Dhanrasi) were placed for germination and the seedlings were allowed to grow for nine days at NaCl concentrations of 0, 50, 100, 150 and 200 mM (Micro Molarity). Ten seeds from each cultivar in each treatment were placed for germination on filter paper in 10 cm diameter Petri dish. The petridishes were kept under laboratory conditions where the temperatures fluctuated between 25 C and 33 C. The seeds in each Petri dish were soaked in an equal amount of the respective Sodium Chloride (NaCl) concentrated solutions. The number of germinated seeds were recorded

at a 24 h interval for 9 days. Seeds were considered germinated when both plumule and radical extended to more than 2 mm length.

In Pot culture experiment, homogeneous seeds from six varieties of above rice were selected and sowed in sterilized sand, germinated, and grown in the laboratory premises. The 21 days old healthy and similarly grown seeds were selected and moved into two plastics pots with different size containing soil medium, and were grown in the glasshouse between various concentration of 0) 0mM (control), 1) 25 mM, 2) 50 mM, 3) 75 mM, 4) 100 mM, 5) 150 mM, and 6) 200 mM (Micro Molarity). The growth response was then observed by measuring the shoot height, root length and electrophysiology by measuring potential differences (PD's) of leaves on a weekly basis on two different stages. After completion of pot culture experiment, leaf samples from each treatment were collected and processed for further chemical analysis of Chlorophyll contents (A & B), Total Nitrogen content and crude protein contents using standard analytical methods laid out by (Subbaiah and Asija,1954; Murthy and Majumder (1962) and A.O.A.C. (1963 &1991) respectively.

The germination percentage, germination index and germination rate, was calculated by the following formula:

No. of germinated seeds X 100

Germination Percentage (GP) =Total no. of seeds The germination index was calculated after final germination by the following equation (Karim *et al*., 1992 [10].

The germination index was calculated after final germination with the following equation:

Germination Index (GI) = Germination % in each treatment X 100

Germination % in the control.

Results and Discussion

Results of Petridish Experiment

Lowest germination % was recorded by JGL11118 (Anjana) cultivar at 200 mM conc. of 51.25 % and CSR23 (Dhanrasi) rice variety recorded highest germination % of 81.75% at 200 mM. Control treatment recorded highest germination % in all the cultivars tested from 95.50 to 98.25 % with a mean of 95.17%. The germination % of six rice varieties was significantly affected by the increase of NaCl conc. showed significant differences in germination % at 25, 50, 75, 100, 150, and 200 mM NaCl (Table 1).

Table 1: Performance of six rice cultivars at different salt concentrations on Germination % (GP) and Germination Index (GI)

Name of Rice Variety tested	Salt concentrations in mM (Micro Molars)											
	0.0 mM		25 mM		50mM		100mM		150mM		200mM	
	GP	GI	GP	GI	GP	GI	GP	GI	GP	GI	GP	GI
RNR 15048 (Telangana Sona)	95.5	88.5	84.5	78.8	75.3	78.8	72.5	75.9	67.50	70.7	54.5	57.1
KNM-118 (Kunaram Sannalu)	94.5	86.2	81.5	77.0	72.8	77.0	70.5	74.6	68.25	72.2	52.3	55.3
JGL11118 (Anjana)	96.5	91.7	88.5	79.3	76.5	79.3	71.5	74.1	61.50	67.9	51.3	53.1
NLR3444 (Nelloremahsur)	93.5	86.9	81.25	74.1	69.3	74.1	65.3	69.8	65.25	65.5	42.5	45.5
RNR1075 (Tellahamsa)	92.8	85.4	79.3	82.5	76.5	82.5	70.5	76.0	64.50	69.5	41.5	44.7
CSR23(Dhanrasi)	98.3	92.1	90.5	89.8	88.3	89.8	86.5	88.0	81.75	83.2	67.8	69.0
MEAN	95.2	88.5	84.3	80.2	76.4	80.2	72.8	76.4	68.1	71.5	51.6	54.1
STANDARD DEV.	1.51	2.6	3.6	5.0	3.1	5.0	2.9	5.6	2.8	5.6	6.0	8.1
AVERAGE DEV.	1.58	2.3	3.6	3.9	4.0	3.9	4.6	3.9	4.6	4.1	6.5	6.3

GP = Germination Percentage, GI = Germination Index

Lowest germination Index (GI) recorded by JGL11118 (Anjana) cultivar at 200 mM conc. of 53.11 % and CSR23 (Dhanrasi) rice variety recorded highest germination Index of 68.96% at 200 mM conc. (Table 2). Significant differences in germination Index at 25, 50, 75, 100, 150, and 200 mM NaCl.

Results of Pot Experiment

In Pot culture experiment, shoot Height indicated that CSR23 (Dhanrasi) rice variety recorded highest of 18.7 cm at lowest concentration of 25.0mM and 12.5 cm at highest conc. of 200mM compared to other rice varieties. NLR34449 (Nellore mahsuri) variety of rice recorded lowest of 11.5 cm at lowest concentration of 25.0mdM and 6.2 cm at highest concentration of 200mM.

At the highest level of salinity (200 mM) shoot height decreased up to 6.2 cm whereas in the control the shoot height was found to be 20.7 cm. Shoot height was found 75% compared to the control at 50 mM NaCl salinity whereas the lowest shoot height 46.42% was exhibited compared to the control at the highest level of NaCl treatment of 200mM (Table 2). The decreasing tendency of shoot growth from 50 mM to 200 mM was slow. It indicated that at least 65% growth rate remained at 150 mM NaCl salinity treatment but drastic reduction was

observed at 200 mM. Reduction of shoot height is a common phenomenon of many crop plants under saline conditions as noticed earlier by several workers (Javed & Khan, 1975; Amin *et al*., 1996).

Table 2: Performance of six rice cultivars at different salt concentrations on Shoot height (SH)and Root Length (RL) in cms.

Name of Rice Variety tested	Salt concentrations in mM (Micro Molars)											
	0.0 mM		25 mM		50mM		100mM		150mM		200mM	
	SH	RL	SH	RL	SH	RL	SH	RL	SH	RL	SH	RL
RNR 15048 (Telangana Sona)	19.2	14.1	12.6	11.7	11.7	8.8	9.7	6.8	9.11	6.2	8.5	5.6
KNM-118 (KunaramSannalu)	17.9	11.8	14.6	10.4	13.2	8.3	12.5	7.6	10.4	6.5	9.2	5.3
JGL11118 (Anjana)	16.5	12.5	14.5	11.6	11.6	8.7	10.4	6.5	8.6	5.7	7.5	4.6
NLR34449 (Nelloremahsur)	17.5	11.7	11.5	9.6	10.2	8.3	8.5	6.3	7.1	5.2	6.2	4.3
RNR10754 (Tellahamsa)	18.5	14.5	16.5	12.5	15.2	10.6	13.5	9.7	10.5	8.4	8.5	5.6
CSR23 (Dhanrasi)	20.7	16.2	18.7	14.8	17.8	12.9	16.5	11.6	14.5	9.6	12.5	7.6
MEAN	18.4	13.5	14.7	11.8	13.3	9.6	11.9	8.1	10.04	6.9	8.7	5.5
Standard Dev.	1.5	1.8	2.6	1.8	2.8	1.8	2.9	2.1	2.52	1.7	2.1	1.2
Average Dev.	1.1	1.5	1.9	1.3	2.1	1.4	2.32	1.7	1.8	1.4	1.4	0.8

SH = Shoot Height in cms, RL = Root Length in cms

Root length indicated that all varieties showed inconsistency on salt tolerant over increasing salt concentration (Table 2). The results of root length indicated that CSR23 (Dhanrasi) rice variety recorded highest of 14.8 cm at lowest conc. of 25.0mdM and 7.6 cm at highest conc. of 200mM compared to other rice varieties. NLR34449 (Nellore mahsuri) variety of rice recorded lowest of 9.6 cm root length at lowest conc. of 25.0mdM and 4.3 cm at highest conc. of 200mM. At the highest level of salinity (200 mM) the root length decreased up to 4.3 cm whereas in the control the root length was found to range between 14.1 cm and 16.2 cm with a mean value of 13.47 cm in different rice varieties tested

Conclusion

Six varieties of rice tested are possible cultivars for rice salinity around 100 mM NaCl levels, but further research is needed due to the growth limitation at 150 mM NaCl in the four week duration during generative stages.

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