International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1667-1671
© 2019 IJCS
Received: 04-05-2019
Accepted: 06-06-2019

Kalaiyarasi R
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

V Kuralarasan
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Jeena George
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

NM Praveen
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

V Manikandan
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
Kalaiyarasi R
Department of Genetics and Plant Breeding, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Salinity tolerance screening in local rice varieties of Tamil Nadu and Kerala

Kalaiyarasi R, V Kuralarasan, Jeena George, NM Praveen and V Manikandan

Abstract
The response of sixteen rice varieties including local varieties collected from Tamilnadu and Kerala state along with two check varieties was studied at germination and early seedling growth stage subjected to five salinity levels at 0mM, 50mM, 100mM, 150mM, 200mM of *NaCl*. The pre-test was conducted by Agar Plate Method at salinity levels at 0, 50,100,150mM of *NaCl*. The selected varieties were tested for salinity tolerance by using Roll Towel Method at different concentration 0mM, 50mM, 100mM, 150mM, 200mM of *NaCl*. Data were analyzed statistically for final germination percentage (FGP), speed of germination (SG), germination energy percentage (GE %), plumule length, radicle length, root length and shoot length. Lower values of FGP, SG, GE % led to reduction in the shoot and root length in all varieties and the magnitude of reduction increased with increasing salinity stress. Germination was completely arrested in one variety at increased salt concentration of 200mM. Rice varieties ADT45, ADT 39, GP 16, Deepthi and Thaichunga Matta showed greater salt tolerance during germination at 200mM salinity than the values of check varieties Pokkali and Co 43. The results suggested that ADT 45, ADT 39, GP 16, Deepthi and Thaichunga Matta might be used for further study of salinity effect on growth processes and its physiological consequences at an advanced stage of growth.

Keywords: Germination, rice, salinity levels, NaCl, salt tolerance

Introduction
Rice (*Oryza sativa* L.) is a semi aquatic cereal, which is originated in the tropics. It is the primary staple food for more than two billion people in Asia, the world's most densely populated region, and for hundreds of millions of people in Africa and Latin America (IRRI, 1985). [1] Out of total arable land area (148 million hectares) 42.2 million hectares were under rice cultivation with average yield of 2.12 metric tons per hectare in 2009. Abiotic stress is the major threat to crop production worldwide, reducing average yields of major crops by more than 50%. Total area under salinity is 953 million hectares which covers 8% of the land surface (The coastal areas are particularly vulnerable to salinity due to saline water intrusion and rise in the sea level as a consequence of global warming.

According to the classification of crop tolerance to salinity, the rice crop is within the sensitive division from 0 dS m-1 to 8 dS m-1. There are two essential parameters sufficient for expressing salt tolerance. Salinity threshold level means the maximum allowable salinity without yield reduction and slope means the percent of yield reduction per unit increase in salinity beyond the threshold. The salinity threshold level of rice (*Oryza sativa* L.) is 3.0 dS m-1 with 12 % yield reduction per unit increase in ECe (dS m-1) above this level. The relative levels of ECe at which there is 50 % reduction in yield and seedling emergence are 3.6 and 18 dS m-1, respectively and reported that, rice is sensitive to salinity at the seedling stage and becomes tolerant at the vegetative stage and very susceptible at the reproductive phase in terms of grain yield. It is necessary to identify the sensitivity and tolerance level of varieties at early seedling stages for successful crop production in a saline environment. (Anbumalarmathi1 & Preeti Mehta, 2013) [2]. Therefore, the objective of this study was to find out the salt tolerance of 16 rice varieties, collected from various regions of Kerala and Tamil Nadu.

Materials and Methods
Total of sixteen rice varieties are used for testing, which includes viz., ADT 45, Gandhakasala, Valichoori, Thambakam, Thaichungamatta, Adukkan, IR 72, BPT 5204, Deepthi, Kanchana, MattaThriveni, PTB 39, GP11, GP12, ADT 39 and GP16. Local rice varieties were collected

from various regions of Tamilnadu and Kerala State during the year 2012-2013. The saline tolerance rice varieties *viz*., CO 43 and Pokkali were used as check for the experiments. Germination tests were carried out in Petri dishes with ½ MS Agar medium treated with 0, 50,100,150mM of Na Cl solutions at UG Botany Laboratory, Centre for plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. In each treatment 10 seeds were used. The treatment was replicated thrice. The rate of germination was assessed in 3, 6, and 9 days after sowing and expressed in percentage. Sixteen varieties are tested for germination. (Gregorio *et al*. 1997) [3]. Among the 16 varieties, 9 varieties which showed good response were screened and again subjected to germination test by Roll Towel Method. The salt level was increased upto 200 mM. In each treatment 10 seeds were used. The rate of germination was assessed for 9 days after sowing and expressed in percentage. (Alam *et al.*, 2002). [4] The observation on shoot length and root length were measured for all the varieties. The length from the seed to the tip of the leaf blade was taken. The average height of ten seedlings was taken and expressed in Centimeter. Speed of Germination (SG), Germination energy percentage (GE %) and Final Germination Percentage (FGP) of the varieties were calculated as per the formulas (Anbumalarmathil & Preeti Mehta, 2013**).** [2]

Results and Discussion

Effect of *Nacl* on speed of germination of rice varieties (by Agar Plate Method)

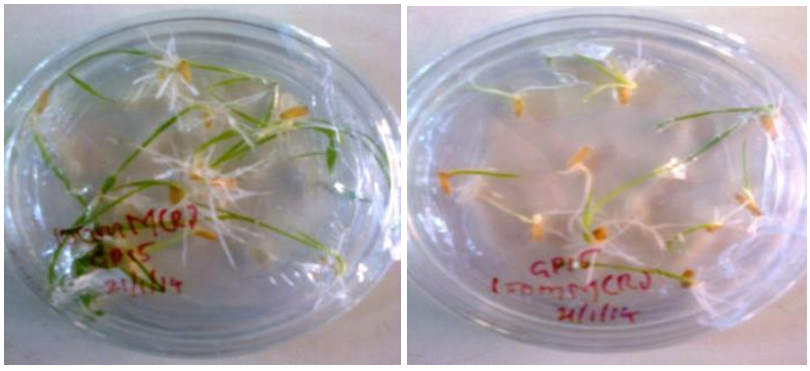
In this study the germination percentage was found to be lower when there is an increase in the level of salt concentration. Germination of seeds involves the activation of enzyme systems as well as mobilisation of reserve foods and these processes are adversely affected by NaCl (Levitt, 1980). [5] Reduction was occurred in the speed of germination while increasing salinity. At 150Mm, the maximum SG was shown by ADT 45 and minimum in Gandhakasala, Deepthi and IR 72, while Matta Thriveni and PTB 39 didn't show any response (Table 1). The trend was also observed by Datta and Pradhan (1981), [6] Krishnamoorthy *et al* (1987), [7] Sundar Daniel Paulas and SreeRangasamy (1991) [8] and Gupta (1993). [9]

Table 1: Effect of *Na Cl* on speed of germination of rice varieties (by Agar Plate Method)

Rice Varieties	Control 0 mM *NaCl*	50mM *NaCl*	100mM *NaCl*	150mM *NaCl*
ADT 39	80	70	68	61
VALICHOORI	90	67	63	44
GANDHAKASALA	55	23	16	8
THAICHUNGA MATTA	95	90	87	60
DEEPTHI	98	90	85	20
THAMBAKAM	70	60	53	36
KANCHANA	70	46	40	33
MATTATHRIVENI	0	0	0	0
PTB 39	0	0	0	0
ADUKKAN	80	69	57.4	42
GP11	90	72	66.7	57.8
GP12	55	39.7	31.14	25.57
IR 72	100	65	65	20
BPT 5204	96	90	87	60
ADT 45	100	96	90	88
GP16	98	70	70	40

Effect of *NaCl* on germination energy percent 4 DAS of rice varieties (by Agar Plate Method)

Germination energy percentage was also found to be decreased with increase in salinity levels. It was minimum in Deepthi, Kanchana, Adukkan and Thambakam at 150 mM and maximum (90%) in the variety ADT 45 (Plate 1.) (Table 2).While PTB 39 and MattaThriveni did not show any response at 50 mM,100 mM,150mM salinity level respectively. At 50 mM and 100 mM, the varieties Thaichung matta, Deepthi and ADT 45 showed maximum response comparing to others. (Table 2). The deleterious effects of salts on germination were observed in terms of decreased germination percentage in Gandhakasala, Kanchana and Thambakam. (Table 2).



At 100 mM At 150 mM

Plate 1: Maximum Germination Percentage observed rice variety ADT 45 at 9 DAS(days after sowing) at different levels of salinity (100 mM and 150 mM NaCl)

Table 2: Effect of *NaCl* on germination energy percent 4 DAS of rice varieties (by Agar Plate Method)

Rice Varieties	Control 0 mM *NaCl*	50mM *NaCl*	100mM *NaCl*	150mM *NaCl*
ADT39	80	70	66	63
VALICHOORI	90	66	63	26
GANDHAKASALA	40	23	6	0
ADUKKAN	70	66	56	23
GP11	70	70	56	46
GP12	40	30	20	0
PTB 39	10	0	0	0
MATTATHRIVENI	0	0	0	0
KANCHANA	45	30	26	20
THAMBAKAM	55	46	46	23
THAICHUNGA MATTA	95	90	80	40
DEEPTHI	100	90	70	10
IR 72	75	65	40	0
BPT 5204	80	75	65	60
ADT 45	100	95	95	90
GP16	95	65	65	35

Effect of *NaCl* on germination energy percent 9 DAS of rice varieties (by Agar Plate Method)

Higher final germination percentage was shown by ADT 45, Thaichunga Matta and Deepthi. At 150mM maximum final germination percentage was given by ADT 45 and minimum by IR 72 and Gandhakasala (Table 3).

Table 3: Effect of *NaCl* on germination energy percent 9 DAS of rice varieties (by Agar Plate Method)

Rice Varieties	Control 0mM *NaCl*	100mM *NaCl*	150mM *NaCl*	200mM *NaCl*
ADT 39	80	76	73	70
VALICHOORI	90	73	73	56
GANDHAKASALA	55	36	26	20
ADUKKAN	70	70	60	43
GP11	80	80	73	63
GP12	60	50	40	40
PTB 39	10	0	0	0
MATTATHRIVENI	0	0	0	0
KANCHANA	75	46	33	30
THAMBAKAM	70	60	53	36
THAICHUNGA MATTA	95	95	95	85
DEEPTHI	100	100	100	50
IR 72	100	95	80	20
BPT 5204	90	90	85	75
ADT 45	100	100	100	90
GP16	100	90	90	45

Effect of *NaCl* on germination percent of rice varieties (By Roll Towel Method)

While increasing salinity, gradual reduction in germination percentage was observed in the check varieties. Similar trend was seen in the varieties studied. At 100 mM concentration of NaCl, the rice varieties GP 11, BPT 5204, 1R72, ADT 45, GP16, Deepthi and Thaichunga Matta showed higher higher germination percentage than Pokkali and Co 43. (Table 4). The trend was also observed by Datta and Pradhan (1981). [6] At the maximum 200 mM of NaCl, Pokkali and Co43 showed the germination of 77% and 82%. Comparing the result with the rice varieties studied, the germination was higher in ADT45 (90%) at the similar concentration of 200 mM NaCl (Table 4) which shows that ADT 45 has good salt tolerant capacity (Plate 1).

Table 4: Effect of *NaCl* on germination percent of rice varieties (By Roll Towel Method)

Rice Varieties	Control 0 mM *NaCl*	50mM *NaCl*	100mM *NaCl*	150mM *NaCl*
Thaichunga Matta	90	90	80	70
Deepthi	100	90	80	80
Adukkan	100	80	70	60
GP11	90	90	90	70
BPT 5204	100	90	60	20
IR 72	90	90	90	40
ADT 45	100	100	90	90
GP16	90	90	70	70
ADT 39	100	80	80	80
Check varieties				
POKKALI	87	80	79	77
CO 43	95	86	85	82

Effect of *Na Cl* on shoot length and root length of rice varieties (by Roll Towel Method)

Shoot Length

Generally, shoot length got increased when the salt concentration is increased. The plumule length was maximum in Thaichunga Matta, IR 72 and minimum in BPT 5204 at control (Table 5). By increasing salinity level to 100 mM, Deepthi and Adukkan have higher plumule length. But while increasing the salinity level to 150 mM and 200 mM plumule length of ADT 45 was found to be higher than all varieties. The minimum is observed for GP11 at 200 mM (Table5). A similar result of reduction in shoot length was observed in IR20, IR50 (Pushpam, (1994), [10] Hakim *et al*., (2010). [11] At maximum level 200 mM of NaCl, shoot length of salt tolerant check varieties like Pokkali and Co43 was found to be 2.64 cm and 1.58 cm respectively (Table 5). In the same concentration, the varieties like ADT 45 (3 cm) and ADT 39 (2.5 cm), showed higher shoot length than the tolerant check varieties (Table 5). The varieties studied also showed a similar trend in the reduction of shoot length as salinity increased. Similar result also observed by Datta and Pradhan (1981), Krishnamoorthy et.al (1987), Sundar Daniel Paulas and SreeRangasamy (1991) and Gupta (1993). [6, 7, 8 & 9]

Table 5: Effect of *NaCl* on shoot length and root length of rice varieties (Roll Towel Method)

Selected Rice Varieties	Control		100mM		150mM		200mM	
	Root length (cm)	Shoot length (cm)	Root length (cm)	Shoot length (cm)	Root length (cm)	Shoot length (cm)	Root length (cm)	Shoot length (cm)
Thaichunga Matta	10	10.5	10	7.5	1	3.5	1	2
Deepthi	12	10	8	8.5	5	2	1	0.5
Adukkan	6	10	7	8	1.5	3	1.5	-
GP11	10	15	5	6	5	4.5	1	0.3
BPT 5204	6	4	5	4.5	4	3.5	4	2
ADT 45	12.5	8	5	6	5	6	5	3
IR 72	12	10.5	8.5	7	8.5	6.5	1	1
GP16	6.5	5	6.5	5.5	5.5	3	3	1
ADT 39	12	8	10	6	2.5	4	2	2.5
Check varieties								
POKKALI	4.0	4.9	3.1	3.2	2.0	2.8	1.38	2.64
CO 43	3.3	3.3	1.8	2.6	1.5	1.6	1.13	1.58

Root Length

Like shoot length root length was also affected by salinity. The percentage reduction was higher in GP11, IR 72, Thaichungamatta and Deepthi whereas the reduction was less in ADT 45. Similar trend was observed by Pushpam (1994), [10] Datta and Pradhan (1981), [6] Gupta (1993). [9] The percentage decrease of shoot and root length was less for ADT 45, this shows the superior salt tolerance ability of this variety. At 200 mM NaCl, in Pokkali and Co43, it was observed a root length of 1.38 cm and 1.13 cm (Table 5). The root length of varieties studied at 200mM of NaCl revealed that root length was very higher in ADT 45 (5 cm) and BPT 5204 (4 cm); the varieties like GP16 (3 cm), ADT 39 (2 cm) and Adukkan (1.5 cm) also showed increased root length than the salt tolerant check varieties at similar concentration (Table 5). The results suggested that ADT 45, ADT 39, GP 16, Deepthi and ThaichungaMatta might be used for further study of salinity effect on growth processes and its physiological consequences at an advanced stage of growth.

Conclusion

In this study the germination percentage was found to be lower when there is an increase in the level of salt concentration. Reduction was occurred in the speed of germination while increasing salinity. Higher final germination percentage was shown by ADT 45, Thaichunga Matta and Deepthi. At 150mM maximum final germination percentage was given by ADT 45 and minimum by IR 72 and Gandhakasala. At the maximum 200 mM of NaCl, Pokkali and Co43 showed the germination of 77% and 82%. Comparing the result with the rice varieties studied, the germination was higher in ADT45 (90%) at the similar concentration of 200 mM NaCl which shows that ADT 45 has good salt tolerant capacity. Like shoot length root length was also affected by salinity. The percentage decrease of shoot and root length was less for ADT 45, this showed the superior salt tolerance ability of this variety.

References

1. IRRI. 25 years of partnership. IRRI. Manila. Philippines, 1985.
2. Anbumalarmathil J, Preeti Mehta. Effect of Salt Stress on Germination of *indica* Rice Varieties. Department of Biotechnology, Stella Maris College (Autonomous), 2013.
3. Gregorio GB, Senadhira D, Mendoza RD. Screening rice for salinity tolerance. IRRI Discussion Paper Series, International Rice Research Institute, Manila, Philippines, 1997; 22:1-30.
4. Alam MZ, Stuchbury T, Naylor REL. Effect of NaCl and PEG Induced Osmotic Potentials on Germination and Early Seedling Growth of Rice Cultivars Differing in Salt Tolerance. Department of Agriculture and Forestry, Bangladesh, 2002.
5. Levitt J. Response of plants to environmental stress. Vol. 2: Water, radiation, salt, and other stresses. (2nd edition), Academic press, New York, 1980, 607p.
6. Datta SK, Pradhan SS. A mass screening method for salt tolerance of rice varieties at seedling stage. IRRN. 1981; 6(3):9-10.
7. Krishnamurthy R, Anbazhagan M, Bhagwat KA. Effect of NaCl on the inorganic ions, growth and yield of rice. Oryza. 1987; 24:66-69.
8. Sundar Daniel Paulas, SreeRangasamy SR. *In vitro* and *Invivo* behaviour of Rice genotypes for salt tolerance. M.Sc.(Agri). Thesis submitted to Tamil Nadu Agricultural University, 1991.
9. Gupta S. Comparative studies of germination and seedling growth of some tolerant selections at different salinity levels. IRRN 1993; 18(3):17.

10. Pushpam R. *In vitro* and *in vivo* selection for salt tolerance in rice; M.Sc.(Agri). Thesis submitted to Tamil Nadu Agricultural University, 1994.
11. Hakim MA, Juraimi AS, Begum M, Hanafi MM, Mohd Ismail R, Selamat C. Effect of salt stress on germination and on germination and early seedling growth of rice (*Oryza sativa* L.). African Journal of Biotechnology. 2010; 9(13):1911-1918.