Screening of Rice [*Oryza sativa* (L.)]Genotypes under hydroponics at reproductive stage………

ABSTRACT

This study highlights the varying degrees of tolerance to salinity among different rice genotypes. It's interesting to note that despite rice being considered moderately sensitive to salinity. The phenotypic response of 20 rice genotypes with salt stress at EC=12dsm^{-1} was assessed under hydroponic condition at reproductive stage through visual scoring 5genotypes, viz MCM103,CSR27,MCM151-3-2-1-1 , MCM208-12-1-1, AC39416A demonstrated tolerant and 12 genotypes MCM 100, MCM109, MCM125 , MCM1471-1-2-1 , IR04A115, MCM153-1-1-1-1, MCM106-2-10-2-2, MCM258-8-2-1-1-1 , MCM148-2-1-1-1 , IR18T1045, IR100120-B-B-B-11 and MCM159-3-1-1-1 considered as moderately tolerant in the face of salt stress. Conversely,3 genotypes like FL478 ,BPT5204 ,PUSA44 showed susceptibility.

Keywords: *Screening; Oryza sativa , hydroponics, reproductive stage.*

1.INTRODUCTION

Rice (Oryza sativa L.), which belongs to the family Poaceae is one of the important cereal food crops extensively cultivated throughout the world.Rice (Oryza sativa L.).In the worldwide food production of agricultural commodity; rice had third place next to sugarcane and wheat (FAO, 2012).Global rice cultivated area is 167.2 million hectares with annual production of 769.6 metric tonns and productivity of 4.6 tonnsha. In India, Rice is cultivated in an area 44 million hectares and ranks second in production (168 metric tonns) with productivity of 3.84 tonns /ha (FAO, 2017).The estimated saline affected area in india around 12.94 ha in which Gujarat (5.28 lakh ha), West Bengal (5.08 lakh ha), and Andhra Pradesh (1.06 lakh ha) were identified as the top three-salinity affected coastal states in the country.(Velayutham*et al*.,1998).Coastal regions are frequently inundated by saline sea water and submerged for a prolonged period. Mangrove vegetation is common in the regions. The arable cropping is limited due to the heavy textured soil, tropical climate and poor-quality groundwater. Rice is the most suitable crop in coastal India. Other than rice, cotton, sorghum, bajra, groundnut, pulses,

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vegetables, and plantation and fruit crops grow in limited areas of favourable land, climate and water.(Mandal *et al.,* 2009 and 2018).

The coastal region of Andhra Pradesh is 1014 km long along the Coromandel coast between the Eastern Ghats and the Bay of Bengal. Presently and the coastal areas in Andhra Pradesh are confined to 15 districts, viz. Srikakulam, Vizianagaram, Visakhapatnam, Anakapalli, Kakinada, East Godavari, Konaseema, West Godavari, Krishna, Guntur, Eluru, Bapatla, Prakasam, SPSR Nellore and Tirupati. According to mandal*et al*(2023),Around 105,725 ha of saline soils are distributed within the coastal region, with 71% of the area spread within five districts, i.e. Konaseema (17.9%), Prakasam (15.8%), Bapatla (13.4%), Krishna (12.4%) and Eluru (11.2%).Several studies indicated that rice is tolerant during germination, becomes very sensitive during early seedling stage (2-3 leaf stage), gains tolerance during vegetative growth stage, again becomes sensitive during pollination and fertilization, and then becomes increasingly more tolerant at maturity (Pearson et al 1966, IRRl 1967).At reproductive stage, salinity causes an increase in sterile florets by affecting panicle initiation, spikelet formation, fertilization, and germination of pollen. Salinity also reduces panicle length, number of primary branches and spikelets per panicle, fertility and panicle weight, thus reducing grain yield (Pearson 1961,Akbar *et al*., 1972Mohammadi *et al*.,2013, Zang*et al*.,2008).

Hence, a pot culture experiment was conducted to screen the rice cultures for salt tolerance at reproductive stage through visual scoring. The pot culture experiment was conducted randomized design with 20 genotypes (treatments) and two replications.

2. MATERIALS AND METHODS

The method involves sowing pre-germinated seeds in perforated plastic pots filled with fertilized soil (50 N, 25P and 25 K mg kg^{-1} soil), which are kept in concrete tanks filled with water. Two plants per plot are allowed to grow initially, thinned later to one plant per pot. A water level of 3 cm below the soil surface of the perforated pots is maintained in the tanks. All plants are grown under control conditions ($EC < 2$ dSm^{-1}) until the flag leaf appears when salt stress is applied at the same growth stage for all genotypes. In the first appearance of the flag-leaf, individual pots are transferred to saline conditions with 12EC and are maintained under these saline conditions for 15–20 days. Plants that were grown under similar conditions without salinization serve as controls. Clipping of leaf was done at the first appearance of the flag leaf, and that was used to

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Comment [a18]: you must mention the place of work and the climatic conditions of the place accelerate salt accumulation in the flag leaf. Consequently, only the flag leaf and penultimate leaf were left for salt accumulation and translocation to the reproductive organs. This accelerates, after 2 or 3 days, the effects of stress treatment and its effect on yield components as compared to that of control plants where all leaves are left untrimmed. Subsequently, all plants were transferred back to non-saline conditions. Scoring for salt tolerance,Yield and yield components were recorded (RkSinghet *al*., 2021, Chattopadhyay *et al*.,2018) from the individual plants.).However, progress in phenotyping has been slow due to time consuming and laborious protocols for the reproductivestage screening as compared with the relatively easy phenotyping protocols for the seedling stage (Jena and Mackill 2008;Calapit-Palao 2010). Screening for reproductive-stage tolerance in micro-plots filled with soil irrigated with saline water or soil preparations in pots or in natural field conditions have been proposed (Mishra 1996; Singh and Mishra 2004; Singh*et al.* 2008).

3. RESULTS AND DISCUSSION

Twenty genotypes designated and coded as CPST1 to CPST20 (MCM100,MCM 103,MCM 109, MCM 125, PUSA 44,FL478,BPT 5204,CSR27,MCM1471-1-2-1,IR04115,MCM153,-1-1-1,MCM100-2,MCM258-8-2-1-1-1,MCM148-2-1-1-1,MCM151-3-2-1-1,IR18T1045,MCM208-12-1-1,IR100120-B-B-B-11,MCM159-3-1-1-1 and AC39416A at reproductive stage under pot culture conditions. The genotypes were screened as per the stage standard evaluation score (SES) (IRRI 2013; Singh et al. 2010)

Table:1 Standard evaluation score (SES) for visual salt injury as per IRRI protocol.

Score	Observation	Tolerance
1	Normal growth, no leaf symptoms	Highly tolerant
3	Nearly normal growth, but leaf tips or few leaves whitish and rolled	Tolerant
5	Growth severely retarded, most leaves rolled, only a few are elongating	Moderately tolerant
7	Complete cessation of growth, most leaves dry, some plants drying	Susceptible

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9	Almost all plants dead or dying	Highly susceptible

Table:2 Relative salt tolerance of different growth stages of rice

Kind of salt stress	Growth stage	Low	Moderate	High
Salinity—EC e (dS m^{-1})	Seedling	< 6	6–10	> 10
	Reproductive	< 6	6–8	> 8
Sodicity (pH 1:2)	Seedling	< 9.2	9.2–9.8	> 9.8
	Reproductive	< 9.2	9.2–9.6	> 9.6

In the Table2 show the electrical conductivity of a saturated soil paste and the pH of a 1:2 soil water paste that define different levels of tolerance (low, moderate and high) to salinity and sodicityHere, ECe is the electrical conductivity of a saturated soil paste; and pH 1:2 is the pH of a stirred mixture of 1 part of soil and 2 parts of distilled water.

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Plate 1 : Symptoms showing different level of infection

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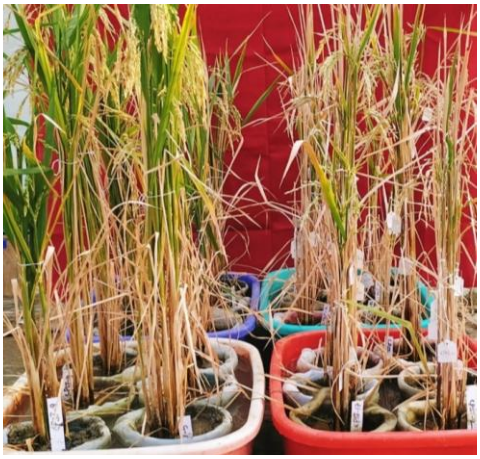

Stress Control

On the basis of the percentage of greeness of leaf area, observations concerning the severity of the disease were documented on five randomly selected plants in each genotype using the Mayee Standard evalution score (SES) 1–9 rating system. Scoring done at 14days,after salinization the severity of the salinity was observed and recorded using a 1–9 rating scale, starting with the onset of symptoms and ending with crop maturity.(Gregorio.,1997)

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Table 3:Standard evaluation score (SES) visual salt injury at reproductive stage

Disignation	Genotypes	Reproductive score
CPST1	MCM 100	5
CPST2	MCM103	3
CPST3	MCM109	5
CPST4	MCM125	5
CPST5	PUSA44	9
CPST6	FL478	7
CPST7	BPT5204	9
CPST8	CSR27	3
CPST9	MCM1471-1-2-1	5
CPST10	IR04A115	5
CPST11	MCM153-1-1-1-1	5
CPST12	MCM106-2-10-2-2	5
CPST13	MCM258-8-2-1-1-1	5
CPST14	MCM148-2-1-1-1	5
CPST15	MCM151-3-2-1-1	3
CPST16	IR18T1045	5
CPST17	MCM208-12-1-1	3

CPST18	IR100120-B-B-B-11	5
CPST19	MCM159-3-1-1-1	5
CPST20	AC39416A	3

The standard evaluation score (SES) based on visual salt injury at reproductive stage has given clear indication regarding the tolerance levels of different entries under test. The entries viz MCM103, CSR27, MCM151-3-2-1-1 , MCM208-12-1-1 and AC39416A were considered as tolerant, FL478 susceptible BPT5204 and Pusa44 as highly suscepitible and rest of the varieties as moderately tolerant to salt stress.

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Complete the results with discuss

CONCLUSION

The identification of tolerant genotypes like MCM103, CSR27, MCM151-3-2-1-1, MCM208-12-1-1, AC39416A is significant as it opens up opportunities for breeding programs aimed at enhancing salinity tolerance in rice. By using these tolerant varieties as donor parents in backcross breeding or for allele mining, researchers can potentially isolate and incorporate the genes or quantitative trait loci (QTLs) responsible for salinity tolerance into other rice varieties. This could ultimately lead to the development of improved rice varieties that can thrive in saline soils, thus bolstering food security in regions affected by salinity.

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REFERENCES

Comment [a34]: I corrected the style of reference

Akbar M, Yabuno Y, Nakao S. Breeding for saline resistant varieties of rice. I. Variability for salt tolerance among some rice varieties. Jpn. J. Breed. 1972;22:277- 284

Calapit-Palao CD, Vina CB, Gregorio GB, Singh RK A new phenotyping technique for salinity tolerance at the reproductive stage in rice. Oryza2013;50:199–207.

Chattopadhyay K, Nayak AK, Marndi BC, Poonam A, Chakraborty K. and Sarkar RK. Novel screening protocol for precise phenotyping of salt-tolerance at reproductive stage in rice. Physiology and Molecular Biology of Plants. 2018; 24(6):1047-1058.

Dwivedi R S and SreenivasK. .Delineation of salt-affected soils and waterlogged areas in the Indo-Gangetic plains using IRS-IC LISS-III data. Int. J. Remote Sensing 1998; 9(14): 2739–2751.

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FAO. 2012. FAOSTAT. www.fao.org/nr/water/aquastat/data/query/index.

FAO. 2017. FAOSTAT. www.fao.org/nr/water/aquastat/data/query/index.

Gregorio GB, Senadhira D. Genetic analysis of salinity tolerance in rice (Oryza sativa L.) Theor. Appl. Gen. 1997 ;86:333-338.

Comment [a35]: You have 2 referencesGregorio 1997 what is the correct

Gregorio GB, Glenn B, Gregorio S, and Mendoza D. 1997. Screening Rice for Salinity Tolerance. International Irri Rice Research Institute P.O. Box 933, Manila 1099, Philippines.

IRRI (2013) Standard evaluation system for rice (SES). 5th edition, International Rice Research Institute, Los Banos, Philippines,p 55.

IRRI(1967) International Rice Research Institute.Annual report for.Manila (Philippines): International Rice Research Institute. 308 p.

Jena KK, Mackill DJ Molecular markers and their use in marker-assisted selection in rice. Crop Sci.2008;48:1266–1276.

Mandal AK, Reddy G P O, Ravisankar T and Yadav R K. Computerized database of salt-affected soils for coastal region of India. J. Soil Salin. Water Qual., 2018;10(1): 1–13.

Mandal, U. K. et al., Trend of sea-level-rise in West Bengal coast. J. Indian Soc. Coast. Agric. Res., 2018;36(2): 64–73.

Mandal AK, Sharma R C and Singh G. Assessment of salt affected soils in India using GIS. Geocarto Int., 2009; 24(6): 437–456.

Mohammadi R, Mendioro MS, Diaz GQ, Gregorio GB, Singh RK. Mapping quantitative trait loci associated with yield and yield components under reproductive stage salinity stress in rice (Oryza sativa L.). J Genet.2013;92:433–443.

Pearson GA, Ayers SD, Eberhard DL. Relative salt tolerance of rice during germination and early seedling development. Soil Sci. 1966; 102:151-156

Singh RK, Redona ED, Refuerzo L (2010) Varietal improvement for abiotic stress tolerance in crop plants: special reference to salinity in rice. In: Pareek A, Sopory SK, Bohnert HJ (eds) Abiotic stress adaptation in plants: physiological, molecular and genomic foundation Netherland, Springer, pp 387–415.

Singh RK, Kota S and Flowers TJ. Salt tolerance in rice: seedling and reproductive stage QTL mapping come of age. Theoretical and Applied Genetics, 2021; 134: 3495-3533.

Sreenivas K, Sujatha G, Mitran T, Suresh K G J R, Ravisankar T. and Rao PN.Decadal changes in land degradation status of India. Curr. Sci.2021; 121(4): 539–550.

Uttam Kumar, M.,BikasNayak,D., Ghosh,M., Bhardwaj.AK., Ramdas,D., Bappa, Das. M. S., PrasunaRani,P., Sudipa, M., Samui, A., Mahanta, K. K., Subhasis ,M.,Raut, S and Burman, D.2023. Delineation of saline soils in coastal India using satellite remote sensing URRENT SCIENCE, VOL. 125, NO. 12, 25.

Velayutham M. Soil resource and their potentialities in coastal areas of India. J. Indian Soc. Coastal Agric. Res., 1999;17: 29–47.

Yoshida SI Forno DA, Cock JH, Gomez KA. 1976. Laboratory manual for physiological studies of rice. Manila (Philippines): International Rice Research Institute.

Zang J, Sun Y, Wang Y Dissection of genetic overlap of salt tolerance QTLs at the seedling and tillering stages using back cross introgression lines in rice. Sci China Series C- Life Sci. 2008;51:583–591.

Comment [a36]: You have 2 references Mandel 2018 what is the correct

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