Original Research Article

YIELD, QUALITY AND ECONOMICS OF VARIOUS RICE VARIETIES OF TELANGANA AS AFFECTED BY SALINE IRRIGATION WATER UNDER DIFFERENT AGRONOMIC MANAGEMENT OPTIONS

ABSTRACT:

Aim: To evaluate the impact of saline irrigation water on yield, quality and economics of various rice varieties under different agronomic management options.

Study design: The experiment was laid out in strip plot design with three replications.

Place and duration of study: At College Farm, College of Agriculture, Rajendranagar, Hyderabad, during *kharif*, 2018.

Methodology: After the preliminary layout, local variety of dhaincha was broadcasted in the experimental site with seed rate @ 40 kg ha^{-1} and incorporated during initiation of flowering in the respective treatment plots. FYM was applied @ 10 t ha^{-1} and thoroughly mixed with the soil. Four rice varieties RNR-15048, KNM-118, JGL11118 and CSR-36 were raised well in advance and transplanted in respective treatments. For enabling the leaching of salts through application of irrigation water as per the leaching requirement leaching Fraction, which was calculated. Under control treatment no agronomic management options were taken.

Results: The highest grain and straw yield was recorded by CSR 36 followed by (*fb*) RNR 15048 in combination with GM (*In situ* green manuring), Among the varieties, the highest amylose content was registered by JGL 11118 (24.16%) followed by RNR 15048 (21.9 %). The highest L/B ratio was recorded by RNR 15048 (3.33) followed by CSR 36 (3.20) and JGL 11118 (3.13). The highest head rice recovery was observed in CSR 36 which was on par with RNR 15048. *In situ green manuring* in RNR 15048 variety of Telangana received higher income.

Conclusion: GM should therefore be done under saline water irrigation in registering superior yield, quality and economics in RNR 15048 in the district of Telangana.

Keywords: Saline water, FYM, green manuring, amylose, L/B ratio, Head rice recovery, Net returns, BC ratio.

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1. INTRODUCTION:

Rice (*Oryza sativa* L.) is the principal food crop for billions of people throughout the world. It is a means of livelihood for millions of rural households and plays a vital role in our national food security, hence, the slogan 'Rice is Life' is most appropriate. Irrigating saline water can also result in salt accumulation in soil, leading to the decrease in yield and deterioration of soil resources (Ahmed 2007 and feizi 2010). Rice is sensitive to salinity and the negative effect on growth and yield leads to the decrease in potential profits. For this reason, salinity has been considered as one of the important factors of irrigation water (Beltran *et al.,* 1999). Yield is a very complex character which comprise of many components and these yield components are related to final grain yield which are also severely affected by salinity (Shereen *et al*., 2005). Salinity adversely affects the productivity and grain quality of rice, the ratio of length to width (grain dimensions) and amylose content was significantly reduced in the tolerant genotype even at low electrical conductivity (4 dSm^{-1}) (Rao *et al.,* 2013). Rice yields are often decreased with increasing salinity especially when experienced in the early development stages (Grattan *et al.,* 2002 and Menete *et al.,* 2008). In Asia, India has the largest area under rice (43.4 m ha) accounting for 29.4% of the global rice area and 112.91 million tons in terms of production with an average productivity of 2153 kg ha^{-1} (Ministry of Agriculture and Farmer welfare, 2018) during 2017-18. Annually Telangana state accounts for an area of 3.29 million ha with a production of 8.37 million tons, at an average productivity of 2545 kg ha^{-1} (Agricultural Statistics, 2017). In the state of Telangana, currently 60% of the irrigated area is through groundwater (bore wells and wells) and with the upcoming irrigation projects and expansion of irrigation facilities salinity might emerge as a serious constraint for cultivation of rice and other crops. Indiscriminate use of this poor quality water in the absence of proper soil-water-crop management practices pose grave risks to soil health, environment and crop productivity (Ayers and Westcot, 1985). Thus it is important to examine the salt tolerance of rice to minimize the negative impacts on crop production and at the same time maximize the economic benefits. Hence a study is proposed to find out the impact of saline irrigation water on yield, quality and economics in various rice varieties under different agronomic management options.

2. MATERIAL AND METHODS

The experiment was carried out during (*kharif*) 2018 at College Farm, College of Agriculture, Rajendranagar, Hyderabad which is located at $17^0$19' 19.2" N Latitude and $78^0$24' 39.2'' E Longitude. The soil was sandy loam in texture with neutral reaction (pH 7.4), electrical conductivity was 1.5 dSm^{-1} and

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organic carbon was medium (0.41 %). It was low in available nitrogen (260.1 kg ha^{-1}), medium in available phosphorus (37.01 kg ha^{-1}), high in available potassium (340.9 kg ha^{-1}).The water used for irrigation was analyzed for different water quality parameters by following standard methods (Dhyan Singh *et al*., 2005). The experiment was laid out in strip plot design with three replications. **Main treatments: (Agronomic management options – 4) -** M_1- Application of 10 t ha^{-1} FYM , M_2- *In situ* Green manuring of dhaincha @ 40 kg ha^{-1} before transplanting, M_3- Leaching of salts through application of irrigation water as per the leaching requirement, M_4- Check (No agronomic management practices). **Sub treatments: (Four rice varieties – 3 popular varieties of Telangana & 1 saline tolerant National check variety)**, V_1: RNR 15048 (Telangana Sona), V_2: KNM 118 (Kunaram sannalu), V_3: JGL 11118 (Anjana), V_4: CSR 36 (Check Variety). After the preliminary layout, local variety of dhaincha was broadcasted in the experimental site with seed rate @ 40 kg ha^{-1} and incorporated during initiation of flowering in the respective treatment plots. FYM was applied @ 10 t ha^{-1} and thoroughly mixed with the soil. For enabling the leaching of salts through application of irrigation water as per the leaching requirement we need to know the leaching Fraction, which was calculated using the formula given by Rhoades *et al.*(1974) and Rhoades and Merrill. (1976) *i.e.,* **LR= Ec_w /5(Ec_e) - Ec_w**. where., LR = the minimum leaching requirement needed to control salts within the tolerance (ECe) of the crop with ordinary surface methods of irrigation, ECw = salinity of the applied irrigation water in dSm^{-1} , ECe = average soil salinity tolerated by the crop as measured on a soil saturation extract. The EC_w recorded was 4.68 dSm^{-1} which comes under C_4 class (water quality limits for classification as per USDA Hand Book on Agriculture No. 60). Keeping in view of higher EC_w values for the irrigation water, in the present study we have considered the EC_e values at 75% yield potential which was 3.4 dSm^{-1} derived from the FAO Irrigation and Drainage paper 29 (Ayers and Westcot, 1994). Leaching Fraction for 75% yield potential was calculated as detailed below:

$$LR = \frac{4.68}{5(3.40)-4.68} = 0.38$$

To irrigate the crop consistently with an EC_w of 4.68 dSm^{-1}, we need to apply 38% more water than the crop needs in order to maintain a desired level of salinity in the root zone without exceeding the critical value of 3.4 dSm^{-1}. The total annual depth of water that needs to be applied to meet both the crop demand and leaching requirement is estimated from equation, $AW = \frac{ET}{1-LR}$ where, AW = depth of applied water

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(mm/year), ET = total annual crop water demand (mm/year), LR = leaching requirement expressed as a fraction (leaching fraction). The amount of irrigation to be given was measured by using water meter.

Rice was grown by transplanting method under present investigation. Hence, seedlings of four rice varieties RNR-15048, KNM-118, JGL11118 and CSR-36 were raised well in advance before transplanting. The recommended dose of fertilizer @ 120:60:40 N, P_2O_5 and K_2O kg ha^{-1} was applied to rice through straight fertilizers urea, single super phosphate and murate of potash, respectively. Half of the recommended dose of N, entire dose of P and K were applied as basal application. The rest of the N was applied in two splits *i.e.,* at maximum tillering (45 DAT) and panicle initiation (60 DAT) of the crop. For the plots in which *In situ* green manuring was done and in plots where FYM was applied 75% of recommended dose of fertilizer was applied in order to equate the nutrient doses. Amylose content was analyzed in the whole rice flour by Colorimetric Iodine Method (Juliano, 1979). Length and width of 10 unbroken grains of each genotype were measured with a Dial Caliper (Ogawa Seiki Co. Ltd, Tokyo, Japan). Head rice recovery is the quantity of unbroken rice recovered after shelling of rough rice and milling expressed as percentage of rough rice. Sample of clean rough rice was passed through a shelling machine (Satake Rice Dehulling Machine, Satake Co., Hiroshima, Japan) to remove the husk from the grains. The de-hulled or brown rice was then milled in a McGill Miller no 2 (Rapsco, Brookshire, TX, USA) for 2 min to remove the bran and embryo. The milled rice was separated into broken and unbroken grains with a manual sieving device. The proportion of whole grains thus recovered was weighed. All the methods used for determining rice grain quality were as described by Juliano (1979). Grain yield, straw yield were observed, Economics were also calculated to ascertain economic viability of the treatments. All the data were statistically analyzed to draw a valid conclusion.

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3. RESULTS AND DISCUSSION :

3.1 Grain yield (t ha^{-1}): With all the management practices CSR 36 recorded higher grain yield. *In situ* green manuring, in combination with CSR 36 variety recorded highest grain yield (5.80 t ha^{-1}) and was on par with application of FYM (5.63 t ha^{-1}) and leaching of salts with irrigation water (5.40 t ha^{-1}) and significantly superior over control (5.06 t ha^{-1}). Among the popular varieties of Telangana, RNR 15048 out

yielded (5.27 t ha^{-1}) compared to KNM 118 (4.75 t ha^{-1}) & JGL 11118 (4.15 t ha^{-1}) with *In situ* green manuring (Table 1).

3.2 Straw yield t ha^{-1}

CSR-36 with *In situ* green manuring (7.42 t ha^{-1}) observed higher straw yield and which was on par with CSR 36 with application of FYM (7.38 t ha^{-1}) and CSR 36 with leaching of salts with irrigation water (7.18 t ha^{-1}) and significantly higher than all other interactions. Among the Telangana varieties RNR 15048 with *In situ* green manuring (6.72 t ha^{-1}) noticed higher straw yield and was on par with RNR 15048 with application of FYM (6.38 t ha^{-1}).The lowest straw yield was noticed in JGL 11118 under no management practices adopted (2.98 t ha^{-1}).

Saline irrigation water caused significant reduction in grain and straw yields in rice under control. This could be due to the reduced number of tillers, number of panicles, number of grains per panicle and test weight, The similar observations were also found by Zeng, *et al*. (2001), Shereen *et al.* (2002) and Aref and Rad (2012) in rice.

The grain yield in leaching treated plot was lesser than other management practices. It might be due to the continental monsoonal climate, concentration of rains in a short span of 2-3 months is the most uncontrolled factor causing non steady state conditions. Under such situations, salt tolerance at critical stages of crop change with patterns of salinization and initial distribution of salinity in soils caused by irrigation water. It could be due to the irrigation water which was consumed by the crop might have left the remaining soil water more concentrated with salts (Minhas and Gupta 1993). The similar results were reported by El-Haddad and Noaman (2001).

The positive effect of GM on the plant physiology could be due to the development of elaborate root system, which provided growth regulator substances and modifying soil physiological behaviours leading to higher grain yield which was in accordance with the Baig and Zia (2006).

3.3 Amylose content

The effect of main treatments was found to be non significant. It was found that at all the management practices like GM (green manuring), FYM (Farm yard manure) and leaching recorded highest amylose content than the control (Table 2). The highest amylose content was observed with *In situ* green manuring (22.5 %) followed by application of FYM (22.39%).

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Among the varieties the highest amylose content was recorded in JGL 11118 (24.16%) which was significant over all others. There was no significant difference observed in amylose content among the varieties RNR 15048 (21.9%), KNM 118 (21.34%), and CSR 36 (21.05%). When compared to the JGL 11118 the amylose content was decreased by 9.35%, 11.6%, 12.8% in the varieties of RNR 15048, KNM 118 and CSR 36. The difference in amylose content in the varieties might be due to the varietal characters (genetically controlled). The interaction effect was found to be non significant for the amylose content and it ranged from 20.81 to 24.71%.

3.4 L/B ratio

The effect of management practices was found to be non significant (Table 2). The highest L/B ratio was observed by *In situ* green manuring (3.22) which was followed by the application of FYM @10 t ha^{-1} (3.18). The lowest L/B ratio was observed with control (3.14) where no management practices were adopted. It was noticed that there was an increase of 2.5%, 1.2%, 0.9% increase in L/B ratio compared to the control.

Among varieties, the highest L/B ratio was recorded by RNR 15048 (3.33) which was significantly higher than all other varieties. It was followed by CSR 36 (3.20) which was significantly higher than JGL 11118 (3.13) KNM 118 (3.04) and which were on par with each other. The interaction effect was found to be non significant on L/B ratio and it ranged from 3.02 to 3.42.

3.5 Head rice recovery

It was noticed that all the management practices recorded significantly higher head rice recovery than control (60.87%). There was an increase of 6.7%, 5.2%, 3.8% in head rice recovery to that of control (Table 2). The head rice recovery was significantly affected by the varieties, The highest head rice recovery was observed in CSR 36 (65.35%) which was on par with RNR 15048 (64.95%). Both these varieties recorded significantly higher head rice recovery than KNM 118 (61.81%) and JGL 11118 (61.01%). The head rice recovery was reduced in control which might be due to adverse affects of salt concentration. Direct osmotic effect of salts causes nutritional imbalance and reduces availability of nutrients, which in turn affects the nutritional value and quality as a whole of rice grain (Rao *et al*., 2013).

3.6 Gross returns

The highest gross returns (95020 □. ha^{-1}) were obtained with *In Situ* green manuring in combination with the variety RNR 15048 and was on par with application FYM in RNR 15048 (89676 □. ha-

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^{1}), It was followed by *In Situ* green manuring in CSR 36 (84308 □. ha^{-1}). Among the varieties of Telangana assessed the highest gross returns were realized in RNR 15048 grown with *In Situ* green manuring which was due to the higher grain and straw yield in the respective treatments. Lower gross returns were obtained in JGL 11118 grown under control conditions.

3.7 Net returns (□. ha^{-1})

The higher net returns was found with *In Situ* green manuring in combination with RNR 15048 (51721 □. ha^{-1}) and was superior over other interactions. GM with all the varietal combinations was found significant than other management practices. While in JGL 11118 (-295 □. ha^{-1}) loss was incurred when grown under control conditions.

3.8 BC ratio

In Situ green manuring in RNR 15048 (2.19) registered higher BC ratio and was found superior to other interactions. This was due to reduction in the cost of cultivation coupled with realization of higher yields. The *In Situ* green manuring in combination with RNR 15048 followed by CSR 36 was observed best economically due to higher Gross returns, net returns and BC ratio. The similar results were obtained by Khan *et al*. (2010).

4. CONCLUSION: From the results of the present investigation the following conclusion were drawn. It was observed that CSR 36 (check variety) followed by RNR 15048 (popular rice variety of Telangana) was found to be more efficient in salt tolerance and registering yield and quality. Among the agronomic management options tested, *In situ* green manuring with dhaincha registered higher gross, net returns and BC ratio

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Table 1: Grain yield (t ha^{-1}), straw yield (t ha^{-1}) and harvest index in various rice varieties grown with saline irrigation water under different agronomic management options

	Grain yield (t ha^{-1})				**Mean**	**Straw yield (t ha^{-1})**				**Mean**
Treatments	V_1	V_2	V_3	V_4		V_1	V_2	V_3	V_4	
M_1	4.97	4.12	3.57	5.63	**4.59**	6.38	5.46	4.41	7.38	**5.91**
M_2	5.27	4.75	4.15	5.80	**4.99**	6.72	5.87	5.37	7.42	**6.34**
M_3	3.75	3.29	3.07	5.40	**3.88**	4.87	4.38	3.90	7.18	**5.08**
M_4	2.39	2.36	2.30	5.06	**3.03**	3.30	3.24	2.98	6.59	**4.02**
Mean	**4.09**	**3.63**	**3.27**	**5.49**		**5.32**	**4.74**	**4.16**	**7.14**	
	S.Em (±)	C.D (P=0.05)	CV (%)			S.Em (±)	C.D (P=0.05)	CV (%)		
M	0.08	0.31	Error a		7.7	0.07	0.24	Error a	4.6	
V	0.07	0.22	Error b		5.4	0.10	0.35	Error b	6.7	
M at same V	0.13	0.40	Error c		5.7	0.16	0.50	Error c	5.4	
V at same M	0.14	0.45				0.16	0.49			

Main treatments (Agronomic management options – 4)

M_1 : Application of FYM @ 10 t ha^{-1}

M_2 : *In Situ* Green manuring of Dhaincha @ 40 kg ha^{-1}

M_3 : Leaching of salts through application of irrigation water as per the leaching requirement

M_4 : Control (No agronomic management practice)

Sub treatments (Rice varieties -4)

V_1 : RNR 15048 (Telangana Sona)

V_2 : KNM 118 (Kunaram Sannalu)

V_3 : JGL 11118 (Anjana)

V_4 : CSR 36 (Check Variety)

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Table 2 Amylose content (%), head rice recovery (%) and L/B ratio of grains in various rice varieties grown with saline irrigation water under different agronomic management options

	Amylose content (%)				Mean	Head rice recovery (%)				Mean	L/B ratio				Mean
Treatments	V_1	V_2	V_3	V_4		V_1	V_2	V_3	V_4		V_1	V_2	V_3	V_4	
M_1	22.67	21.63	24.12	21.14	**22.39**	66.21	61.56	62.26	66.23	**64.06**	3.34	3.04	3.13	3.2	**3.18**
M_2	22.51	21.81	24.31	21.38	**22.50**	66.5	62.48	62.85	68.15	**64.99**	3.42	3.07	3.16	3.25	**3.22**
M_3	21.42	21.34	24.71	20.89	**22.09**	64.28	62.79	60.84	64.88	**63.20**	3.31	3.05	3.15	3.19	**3.17**
M_4	20.98	20.59	23.49	20.81	**21.47**	62.81	60.42	58.11	62.16	**60.87**	3.27	3.02	3.11	3.18	**3.14**
Mean	**21.90**	**21.34**	**24.16**	**21.05**		**64.95**	**61.81**	**61.01**	**65.35**		**3.33**	**3.04**	**3.13**	**3.20**	
	S.Em (±)	C.D (P=0.05)	CV (%)			S.Em (±)	C.D (P=0.05)	CV (%)			S.Em (±)	C.D (P=0.05)	CV (%)		
M	0.37	NS	Error a		7.5	0.63	2.16	Error a		8.1	0.03	NS	Error a		6.7
V	0.45	1.55	Error b		7.0	0.71	2.45	Error b		7.9	0.03	0.11	Error b		7.2
M at same V	0.56	NS	Error c		6.8	0.77	NS	Error c		8.1	0.04	NS	Error c		7.9
V at same M	0.61	NS				0.91	NS				0.05	NS			

Main treatments (Agronomic management options – 4)

M_1: Application of FYM @ 10 t ha^{-1}

M_2: *In Situ* Green manuring of Dhaincha @ 40 kg ha^{-1}

M_3: Leaching of salts through application of irrigation water as per the leaching requirement

M_4: Control (No agronomic management practice)

Sub treatments (Rice varieties -4)

V_1: RNR 15048 (Telangana Sona)

V_2: KNM 118 (Kunaram Sannalu)

V_3: JGL 11118 (Anjana)

V_4: CSR 36 (Check Variety)

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Table 3: Economics (gross returns and net returns) in various rice varieties grown with saline irrigation water under different agronomic management options

	Gross returns □ ha^{-1}				**Mean**
Treatments	V_1	V_2	V_3	V_4	
M_1	89676	73006	63314	82664	**77165**
M_2	95020	84163	73594	84308	**84272**
M_3	67573	58417	54457	78504	**64738**
M_4	43129	41880	40814	73566	**49847**
Mean	**73850**	**64366**	**58045**	**79761**	
	S.Em (±)	C.D (P=0.05)	CV (%)		
M	2081.03	5093.22	Error a		7.3
V	1733.45	4242.54	Error b		6.1
M at same V	3260.17	6846.37	Error c		6.0
V at same M	3410.17	7026.37			
	Net returns □ ha^{-1}				**Mean**
Treatments	V_1	V_2	V_3	V_4	
M_1	42117	25237	15545	34865	**29441**
M_2	55362	44294	33726	44409	**44448**
M_3	30014	20648	16688	40705	**27014**
M_4	5571	4111	3045	35767	**12123**
Mean	33266	23572	17251	38937	
	S.Em (±)	C.D (P=0.05)	CV (%)		
M	2081.03	5093.22	Error a	12.1	
V	1733.45	4242.54	Error b	13.1	
M at same V	3260.17	6846.37	Error c	13.2	
V at same M	3410.18	7708.37			

Main treatments (Agronomic management options – 4)

M_1 : Application of FYM @ 10 t ha^{-1}

M_2 : *In Situ* Green manuring of Dhaincha @ 40 kg ha^{-1}

M_3 : Leaching of salts through application of irrigation water as per the leaching requirement

M_4 : Control (No agronomic management practice)

Sub treatments (Rice varieties -4)

V_1 : RNR 15048 (Telangana Sona)

V_2 : KNM 118 (Kunaram Sannalu)

V_3 : JGL 11118 (Anjana)

V_4 : CSR 36 (Check Variety)

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Table 4. Economics (B:C ratio) in various rice varieties grown with saline irrigation water under different agronomic management options

	B:C ratio				Mean
Treatments	V_1	V_2	V_3	V_4	
M_1	1.88	1.52	1.32	1.72	**1.61**
M_2	2.39	2.11	1.84	2.11	**2.11**
M_3	1.79	1.54	1.44	2.07	**1.71**
M_4	1.14	1.10	1.08	1.94	**1.32**
Mean	**1.80**	**1.57**	**1.42**	**1.96**	
	S.Em (±)	C.D (P=0.05)	CV (%)		
M	0.03	0.12	Error a		7.2
V	0.03	0.10	Error b		6.2
M at same V	0.06	0.17	Error c		5.9
V at same V	0.06	0.19			

Main treatments (Agronomic management options – 4)

M_1 : Application of FYM @ 10 t ha^{-1}

M_2 : *In Situ* Green manuring of Dhaincha @ 40 kg ha^{-1}

M_3 : Leaching of salts through application of irrigation water as per the leaching requirement

M_4 : Control (No agronomic management practice)

Sub treatments (Rice varieties -4)

V_1 : RNR 15048 (Telangana Sona)

V_2 : KNM 118 (Kunaram Sannalu)

V_3 : JGL 11118 (Anjana)

V_4 : CSR 36 (Check Variety)

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Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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