Performance of Different Rice (*Oryza sativa* L.) Cultivars under Aerobic Conditions

S. Neelima[*] and K. Ashok Kumar

Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Nandyal, Andhra Pradesh (518 502), India

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Correspondence to

[*]*E-mail*: neelima3633@rediffmail.com

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Abstract

Low land rice, the traditional rice growing practice, requires high water input and is being under threat due to increasing scarcity of fresh water under wet land eco-system that warrants new water saving rice cultivation. Aerobic rice cultivation offers an opportunity to produce rice with less water. In aerobic rice system, fields remain un-flooded throughout the season like an upland crop and is grown in un-puddled, aerobic soils under irrigation and high external inputs. Hence, there is a need to evaluate the existing rice varieties that are suitable for aerobic cultivation. Twelve rice entries were evaluated along with three checks in direct sown, un-puddled irrigated conditions in the scarce rainfall zone of Andhra Pradesh. Among the different rice cultivars tested, MTU 4870 recorded higher grain yield (4.8 t ha^{-1}) over all other cultivars but was on par with RDR 1010 (4 t ha^{-1}), RDR 977 (3.9 t ha^{-1}) and RDR 996 (3.8 t ha^{-1}).

1. Introduction

Rice is the most important staple food in Asia and provides 35-80% of total food calorie uptake (Anonymous, 1997). Irrigated low land rice is the most prominent agricultural eco-system and the present and future food security of the burgeoning population depends on it. Further, permanent flooded conditions during the cultural cycle provide a continuous and adequate supply of water, non-aquatic weeds control, facilitate the use of granular insecticides and herbicides, reduce losses of ammonium fertilizer and enhance the availability of nutrients following reduction of the soil due to the exclusion of oxygen by the flood water (Shapiro, 1958; Ponnamperuma, 1965; Patrick et al., 1985). However, the water used for wetland preparation and the large losses by seepage, percolation and evaporation when the soil is submerged, the production of low land rice requires much water (Bowman and Tuong, 2001). The conventional flooding technique is very high water consuming and 48% (570 mm) of the applied irrigation water (1,180 mm) is lost through evapotranspiration (ET) (Brown et al., 1978). The remainder is lost due to runoff and infiltration. Water represents a major and necessary production cost for rice growers. But water is becoming scarce day by day and share of agriculture for water is coming down due to increasing demand from other sectors. Hence, there is a need to search an alternative which can economize the water use without hampering the yield. As an alternative to flooded rice, aerobic rice is a water-saving rice production system in which potentially high yielding, fertilizer responsive adapted rice varieties are grown in fertile aerobic soils that are un-puddled and have no standing water. Supplementary irrigation, however, can be supplied in the same way as to any other upland cereal crop (Wang et al., 2002; Bouman et al., 2005). Upland yields of more than 7 t ha^{-1} have been recorded, indicating that rice does not require flooded conditions for high yields (De Datta, 1975). The objective of the present study was to evaluate the response of several rice cultivars under aerobic rice production system.

2. Materials and Methods

A field experiment was carried out during *kharif* 2008 at Regional Agricultural Research Station, Nandyal, Andhra Pradesh, India. Twelve rice cultivars (NDLR 7, 21, 25, 38, 145; RDR 977, 982, 989, 996, 1004, 1010, 1013) were evaluated with three check varieties (NDLR 8, BPT 5204 and MTU 4870). The soil was clay loam, slightly alkaline with a pH of 8.2, low in nitrogen (210 kg ha^{-1}), medium in available phosphorus (24 kg P_2O_5 ha^{-1}), and rich in available potassium (360 kg K_2O ha^{-1}). The experiment was laid out in a randomized block design and replicated thrice. The plots measuring 2.4 m x 3.0 m were separated by 1 m channel. A spacing of 22.5 cm between the rows was adopted. Rice varieties were drill-seeded on 27th August, 2008 at 2 cm depth. The total amount of rainfall received during the crop growth period was 424 mm. Irrigation was given as and when hair line cracks appeared on the soil surface. A total of eight irrigations were given during the crop period, and the amount of irrigated water was measured with a water meter, and water use efficiency (WUE) was calculated as 8240 $m^3 ha^{-1}$. 160 kg of Nitrogen (⅓ as basal, ⅓ at tillering and ⅓ at panicle initiation stage), 80 kg of P_2O_5 (as basal) and 80 kg of K_2O (half as basal and half at panicle initiation stage) were applied in the form of urea, single super phosphate and muriate of potash, respectively. Weeds were controlled by taking up inter-cultivation at 30 DAS (days after sowing) followed by two hand weeding at 50 and 70 DAS. Observations were recorded on eight quantitative traits, viz. plant height (cm), days to 50% flowering, days to maturity, number of panicles m^{-2}, test weight (g), number of filled grains, grain yield (t ha^{-1}) and straw yield (t ha^{-1}). Also harvest index and WUE were calculated.

3. Results and Discussion

The entries were found to be significantly distinct from each other for all parameters except for number of filled grains $panicle^{-1}$. The variety MTU 4870 recorded significantly higher grain yield (4.8 t ha^{-1}) than all other cultivars barring RDR 1010 (4 t ha^{-1}) and RDR 977 (3.9 t ha^{-1}). These results were in agreement with the findings of James Martin et al. (2007) and Bouman et al. (2002). Further, test weight recorded with MTU 4870 (18.4 g) was also significant over all other varieties and was on par with RDR 1010 (17.8 g) and RDR 977 (17.2 g). The higher number of panicles m^{-2} and test weight contributed to higher grain yield in MTU 4870, RDR 1010, RDR 977 and RDR 996. Significantly more plant height was noticed with MTU 4870 (72.1 cm) over NDLR 25, NDLR 145, RDR 982, RDR 996, NDLR 8 and BPT 5204. The number of days required for 50% flowering in RDR 1010 (93 days) and RDR 977 (94 days) was significantly less compared to all other cultivars. Significantly higher straw yield was noticed with NDLR 21 (4.1 t ha^{-1}) over all other cultivars but was on par with NDLR 8 (3.5 t ha^{-1}) (table 1).

Table 1: Performance of 15 rice genotypes under aerobic, un-flooded cultivation

Entries	1	2	3	4	5	6	7	8	9	10	11
NDLR 7	29	56.3	114	144	196	10.6	211	3.1	2.2	0.58	3.8
NDLR 21	38	68.7	128	158	162	16.3	75	2.2	4.1	0.35	2.7
NDLR 25	41	58.3	128	158	230	11.8	128	1.3	3.0	0.30	1.6
NDLR 38	32	64.7	116	146	182	14.2	141	2.9	3.3	0.47	3.5
NDLR 145	46	50.9	120	150	174	10.9	97	1.4	2.8	0.33	1.7
RDR 977	36	65.7	94	124	137	19.2	135	3.9	2.5	0.61	4.7
RDR 982	40	62.1	113	143	187	15.8	160	2.9	3.3	0.47	3.5
RDR 989	39	70.0	111	141	171	12.7	126	2.7	3.2	0.46	3.3
RDR 996	41	53.5	130	160	136	13.4	119	3.8	2.8	0.58	4.6
RDR 1004	41	73.3	133	163	147	13.3	135	2.9	2.7	0.52	3.5
RDR 1010	34	63.6	93	123	118	17.8	136	4.0	2.7	0.60	4.9
RDR 1013	30	52.8	113	143	147	12.0	137	3.3	3.0	0.52	4.0
NDLR 8	37	58.5	117	147	190	13.5	146	3.1	3.5	0.47	3.8
BPT 5204	39	53.5	121	151	136	12.9	147	1.3	2.8	0.32	1.6
MTU 4870	42	72.1	117	147	148	18.4	201	4.8	3.2	0.60	5.8
SEm±	4.1	3.6	0.7	0.7	19	0.6	37	0.4	0.3		
CD (p=0.05)	NS	10.4	2.1	2.1	55	1.9	NS	1.3	0.7		

1: Plant population m^{-2}; 2: Plant height at harvest (cm); 3: Days to 50% flowering (DAS); 4: Days to maturity (DAS); 5: Number of panicles m^{-2}; 6: Test weight (g); 7: Number of filled grains $panicle^{-1}$; 8: Grain yield (t ha^{-1}); 9: Straw yield (t ha^{-1}); 10: Harvest index (%); 11: WUE (kg ha^{-1} mm)

RDR 977 recorded higher harvest index value (0.61) and the least was noticed with NDLR 25 (0.30). Also, higher WUE was observed with MTU 4870 (5.8) and least was noticed with NDLR 25 (1.6).

4. Conclusion

Aerobic system of rice production is feasible in scarce rainfall zone of Andhra Pradesh and MTU 4870 (4.8 t ha^{-1}), RDR

1010 (4 t ha^{-1}), RDR 977 (3.9 t ha^{-1}) and RDR 996 (3.8 t ha^{-1}) resulted in significantly higher grain yield over all other tested cultivars.

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