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Effect of Varieties and Planting Geometry on the Yield Performance of Rice (*Oryza sativa* L.) under Aerobic System of Cultivation

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A B S T R A C T

A field experiment was conducted during *Kharif* season of 2004 and 2005 at UAS, Hebbal Bengaluru, on the Performance of Varieties and Planting Geometry in Aerobic Rice Cultivation. The experiment was laid out in Factorial randomized complete block design (RCBD) with three replications. Two factors viz. – variety (3) and spacing (6).Variety consists of Jaya (V_1), Rasi (V_2) and MTU -1010 (V_3), while planting geometry consists of six spacing *Viz.*, 30 cm x 10 cm (S_1), 30 cm x 15 cm (S_2), 30 cm x 20 cm (S_3), 30 cm x 30 cm (S_4), 40 cm x 10 cm (S_5) and 40 cm x 15 cm (S_6). Significantly higher grain yield (55.95 q ha^{-1}) was obtained in Rasi, which was significantly superior over MTU-1010 (53.76 q ha^{-1}) and Jaya (50.58 q ha^{-1}) varieties. Increased yield in Rasi variety is attributed to improved growth and yield parameters. Among different plant geometry, wider and square planting at 30 cm x 30 cm obtained significantly higher grain yield (57.02 q ha^{-1}) as compared to closer spacing of 30 cm x 10 cm (50.31 q ha^{-1}) and 30 cm x 15 cm (52.94 q ha^{-1}) respectively. The result showed that Rasi variety with square planting performed better in aerobic method of cultivation.

Introduction

Rice is one of the predominant cereal crops of India and the world. More than 80 per cent of Asia's daily food requirement is derived from rice. Rice is the most important human food crop in the world. Rice production in the world during 2017 was 751.9 million tones in an area of 158 million hectares with a productivity of 3.75 tonnes per hectare. China and India are contributing more than half of the world total acreages and production of the rice crop. In 2012, nearly half of world's population – more than 3 billion people – relied on rice every day. Rice (*Oryza sativa* L.) is an important cereals crop which is grown across the world. By the end of 21st Century, the earth's climate is predicted to warm up by an average of 2-4 ^{0}C (IPCC, 2007), due to anthropogenic and natural factors (Eitzinger *et al.,* 2010). Rice cultivation is a water intensive enterprise. However, lowland rice fields have relatively high water requirements and their sustainability is threatened by increasing water shortages (Bouman and Tuong, 2001). Aerobic rice system is a new way of growing rice that needs less water than low land rice. It is grown like an upland crop in soil that is not puddled, non-flooded or saturated. It is a sustainable rice production methodology for immediate future to address water scarcity and environmental safety arising due to global warming. Most of the rice is currently grown in regions where current temperatures are already close to optimum for rice production. Yields of rice have been estimated to be reduced by 41 % by the end of the 21st Century (Ceccarelli *et al.*, 2010) But, the incidence of very variable yield and complete yield failure were observed in dry season in the Philippines (Kreye *et al.*, 2007). The optimum temperature for the normal development of rice is ranges from 27 to 32 ^{0}C (Yin *et al.,* 1996). The growing scarcity of fresh water will pose problems for rice production in future years. Karnataka is having substantial area under rainfed and dry land and has a vast scope of growing rice under aerobic conditions. There is a need for a systematic study on the leading varieties of rice under aerobic conditions. In this backdrop, the present study was undertaken with the objectives to know the performance of rice varieties under aerobic situation and to work out the optimum spacing which gives higher yield per unit area.

Materials and Methods

The field experiments were conducted at Agronomy Field Unit, Main Research Station, University of Agricultural Sciences, Hebbal, Bengaluru, situated in the Eastern Dry Zone of Karnataka at 12° 58' N latitude 77° 35' E longitude with an altitude of 930 m above mean sea level. The soil of the experimental site was red sandy loam in texture. The soil of the experimental site was slightly acidic in reaction (pH 6.7), low in available nitrogen (180.4 kg ha^{-1}), medium in available phosphorus (29.4-30.1 kg ha^{-1}) and available potassium (220.42 to 231.20 kg ha^{-1}). The organic carbon content was low to medium (0.39 to 0.40 %). Field capacity was 13.52 - 13.54 per cent, permanent wilting point was 7.83-7.90 per cent, available water 1.64 -1.65 cm and bulk density was 1.56 g/cc. The experiment was laid out on a factorial randomized block design replicated three. The treatment comprised of combinations of two factors viz. – variety (3) and spacing (6).Variety consists of Jaya (V_1), Rasi (V_2) and MTU -1010 (V_3), while planting geometry consists of six spacing *Viz.*, 30 cm x 10 cm (S_1), 30 cm x 15 cm (S_2), 30 cm x 20 cm (S_3), 30 cm x 30 cm (S_4), 40 cm x 10 cm (S_5) and 40 cm x 15 cm (S_6). After land preparation, well decomposed farm yard manure (FYM) was applied and equal quantity of farm yard manure at the rate of 10 t ha^{-1} was applied to each plot three weeks prior to sowing recommended package of practices were followed for growing the crop. Overnight soaked seeds were manually dibbled at the rate of one seed per hill. Weeds were controlled by spraying Pretilochlor as pre emergent herbicide spray @ 0.75 kg per hectare. The late emerged weeds were controlled by hand weeding at regular intervals. Crop was irrigated as and when the soil developed cracks by following alternate wetting and drying cycles. Yellowing of leaves was noticed initially, as a protective measure micronutrients (Multiplex) was sprayed @ 10 ml per liter. However from flowering to grain filling stage soil was kept moist by giving irrigation at three to five days interval. The collected data on yield, plant characters and yield related attributes were analysed statistically by using “Analysis of Variance Technique” and the means were compared with the help of a statistical package programme MSTAT-C.

Results and Discussion

The growth and yield parameters on yield as influenced by different varieties and planting geometry in aerobic situation as indicated in Table 1.

Table.1 The Growth and yield parameters on grain yield as influenced by different varieties and planting geometry in aerobic method of rice cultivation

Treatment	Plant height (cm)	Leaf area (cm^2) /plant at 90 DAS	Dry matter (g) hill $^{-1}$	No. tillers hill^{-1}	No. of productive tillers hill^{-1}	Panicle length (cm)	Panicle weight (g)	No. of filled grains panicle^{-1}	No. of unfilled grains panicle^{-1}	Straw yield (q/ha) Straw yield (q/ha)	Test weight (g)	Grain yield (q ha^{-1})
Varieties (A)												
Jaya	58.31	2038.00	96.60	35.28	26.69	21.31	3.35	135.00	45.00	73.38	22.89	50.58
Rasi	64.42	2783.00	112.90	36.64	28.58	22.94	4.00	152.00	30.00	78.24	24.89	55.95
MTU-1010	59.41	2252.00	108.70	35.67	27.28	21.83	3.83	137.00	32.00	74.10	24.58	53.76
S.Em±	0.36	44.40	1.18	0.30	0.29	0.14	0.08	0.84	0.60	0.81	0.18	0.49
C.D @ 5 %	1.08	123.10	3.54	0.90	0.87	0.42	0.24	2.33	1.65	2.26	0.51	1.35
Spacing (B)												
30 cm × 10 cm	60.20	2099.00	101.00	34.00	25.89	21.44	3.10	139.00	37.00	72.52	23.50	50.31
30 cm × 15 cm	60.30	2386.00	105.10	35.11	26.17	22.28	3.76	141.00	36.00	74.78	24.22	52.94
30 cm × 20 cm	61.20	2384.00	105.90	35.00	26.94	22.17	3.64	141.00	35.00	76.95	24.00	54.34
30 cm × 30 cm	62.30	2494.00	113.40	41.11	31.78	22.56	4.17	148.00	32.00	81.91	25.22	57.02
40 cm × 10 cm	61.00	2300.00	105.60	35.28	27.17	22.22	3.79	139.00	37.00	75.47	24.08	53.31
40 cm × 15 cm	60.70	2378.00	104.40	34.56	27.17	21.50	3.40	138.00	37.00	76.19	23.90	52.66
S.Em±	0.50	62.80	1.66	0.43	0.41	0.20	0.11	1.19	0.84	1.15	0.26	0.69
C.D @ 5 %	1.50	174.01	4.98	1.29	1.23	0.60	0.33	3.29	2.34	3.19	0.73	1.91
Interaction (A x B)												
S.Em±	0.87	108.78	1.05	0.74	0.71	0.35	0.20	2.06	1.46	1.99	0.39	1.90
C.D @ 5 %	NS	NS	NS	NS	Ns	NS	NS	NS	NS	NS	NS	Ns

It was revealed from the experiment that grain yield per hectare differed significantly due to different varieties. Rasi cultivar recorded higher grain yield (55.95 q ha^{-1}), which was significantly superior to MTU-1010 (53.76 q ha^{-1}) and Jaya (50.58 q ha^{-1}) cultivars. Among different plant geometry, wider and square planting at 30 cm x 30 cm registered significantly higher grain yield (57.02 q ha^{-1}) as compared to closer spacing of 30 cm x 10 cm (50.31 q ha^{-1}) and 30 cm x 15 cm (52.9 q ha^{-1}) respectively. Indeed, crop sown with the spacing of 30 x 15 cm and 40 cm x 10 cm was found to be on par with each other.

The average value of plant height and number of tiller $hill^{-1}$ was 91.60 cm and 17 respectively. The low aerobic rice grain yield was due to prevail of high atmospheric temperature during the study that affected almost all the growth stages of rice from emergence to ripening and harvesting. This is in agreement with findings of Yin *et al.*, (1996) and Shah *et al.*, (2011). Spikelet sterility was greatly increased at temperature higher than 35 ^{0}C (Matsui *et al.*, 1997a).

Among different plant geometry, wider and square planting at 30 cm x 30 cm registered significantly higher grain yield (57.02 q ha^{-1}) as compared to closer spacing of 30 cm x10 cm (50.31 q ha^{-1}) and 30 cm x 15 cm (52.9 q ha^{-1}) respectively. Indeed, crop sown with the spacing of 30 x 15 cm and 40 cm x 10 cm was found to be on par with each other. Significantly lower grain yield (50.31q ha^{-1}) was observed with closer spacing of 30 cm x 10cm. The variation in the yield could be explained in terms of yield attributes. Significantly more productive tillers per hill (31.78) were found at wider and square planting of 30 cm x 30cm as compared to spacing of 40 x 10 cm (27.17) and 30 cm x 15 cm (25.89). While significantly lowest number of productive tillers per hill was achieved by Jaya (21.90) with closer spacing 30 cm x 10 cm. Wider as well as square planting provided equal spacing for growth of plants as compared to rectangular spacing. There will be better availability and efficient use of nutrients, moisture and efficient harvest of solar energy by the plants in square planting. Perhaps owing to less competition, higher number of productive tillers was achieved at wider spacing of 30 cm x 30 cm. These results are in conformity with the findings of Satyavarma *et al.*, (1991), Hu-Wenhe *et al.*, (1997) and Verma *et al.*, (2002). Moreover, wider spacing gives room for profuse root and tiller growth by achieving the ‘border effect’ throughout the whole field by keeping soil moist and aerated during vegetative growth period. Under such conditions roots have access to both oxygen and water due to non hypoxic condition and non degeneration of roots during panicle initiation (Kar *et al.*, 1974). Obviously, it was due to higher grains and straw yields obtained with the Rasi variety at 30 cm x 30 cm spacing. Similar results were observed by Manjappa (2001), Aravind Kumar and Prasad (2002).

The present study concluded that Rasi rice variety grown with wider spacing of 30 cm × 30 cm recorded higher rice grain yield (50 to 58 q ha-1). Hence, growing rice variety with wider spacing is ideal for the aerobic method of rice cultivation.

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