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CROP GEOMETRICAL EFFECT ON GROWTH AND YIELD UNDER DIRECT SEEDED HYBRID RICE (*ORYZA SATIVA* L.) CULTIVARS

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ABSTRACT

A field study was conducted in *kharif* season (2015), to evaluate growth and yield potential of direct seeded hybrid rice cultivars with different crop geometry. The experiment was laid out in split plot design consisting of 10 treatments, five cultivars (Arize 6444, PHB 71, PRH 10, MTU 7029 and HUR 105) in main-plots and two plant spacing's (20 × 10 and 25 × 25 cm^2) in sub-plot. Results indicated that amongst hybrid rice cultivars, Arize 6444 recorded significantly higher growth attributes *viz*. plant height, number of tillers m^{-2} and dry matter accumulation m^{-1} running row and leaf area index at 90 days after sowing. Closer plant spacing (20 × 10 cm^2) recorded higher number of tillers m^{-2}, dry matter accumulation and leaf area index in comparison to wider spacing (25 ×25 cm^2) at all the growth stages. Arize 6444 had higher yield attributing characters like panicle weight, effective tillers m^{-2}, number of grains panicle^{-1} ,test weight and grain yield in comparison to other cultivars. Significantly higher panicle length, effective tillers m^{-2}, number of grains panicle^{-1} and test weight was observed at wider spacing (25 × 25 cm^2) in comparison to narrow row spacing (20 × 10 cm^2).

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the major staple foodgrain for more than 50% of the world's population providing major source of the food energy. It is grown in 114 countries across the world on an area of 160 million hectares with annual production of 741.14 million tons (FAO, 2014). The option of intensifying the area under rice in the near future is limited. Consequently, this extra rice production needed has to come from a productivity gain. The major challenge is to achieve this gain with less water, labor and chemicals, thereby ensuring long-term sustainability. Furthermore, puddling and transplanting needs huge amount of water and labor, whereas both of these are becoming scarce and expensive, resulting less profitable rice production and also to protect soil productivity and environment by checking methane gas emission from submerged water cultivation practices (Krishna *et al*., 2008) leading to cost effective rice production (Uphoff, 2007). All these factors stipulate a major shift from traditional puddled-transplanted rice production to direct seeding of rice (DSR) in irrigated areas (Pandey and Velasco, 2005). Depending on water and labor paucity, farmers are altering either their rice establishment methods from transplanting to direct seeding in unpuddled soil with adopting DSR, it is possible to save water (Thiyagarajan *et al*., 2002). That is why special attention should be given for increasing the yield per unit area by applying improved technology and management practices. Among the cultural technologies, planting density is one of the important components, manipulation of which is an essence for optimizing yield (Faisul-ur-Rasool *et al*., 2012). Various experiments on spacing of rice have been carried out in different parts of the world to find out the suitable spacing for obtaining maximum yield (Bozorgi *et al*., 2011). Improper spacing reduced yield up to 20-30% (IRRI, 1997). The optimum spacing ensures the plant to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients (Khan *et al*., 2005). Plant spacing directly affects the normal physiological activities through intra-specific competition. When the planting density exceed the optimum level, competition among plants for light above ground or for nutrients below the ground becomes severe and consequently the plant growth slows down and the grain yield decreases. On the other hand, wider space allows the individual plants to produce more tillers but it provides the smaller number of hills per unit area which results in low grain yield (Baloch *et al*., 2002; Kandil *et al*., 2010). The main concern was to determine the effect of spacing on the performance of different crop cultivars. Agronomic practices for rice cultivars under direct seeded conditions are different from that of traditional transplanted methods. An attempt was therefore made to test the yield potential of five cultivars of rice under direct seeded conditions with narrow and wider spacing at in Eastern region of Uttar Pradesh.

MATERIALS AND METHODS

The experiment was conducted during *kharif* season of 2015 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, situated in the South Eastern part of Varanasi city at 25°18' N latitude, 83°03' E longitude and at an altitude of 81.71 meters above the mean sea level in the Northern- Gangetic alluvial plains having characteristics of sub-tropical climate (Shukla *et al.*, 2014).The soil of experimental plot was sandy clay loam and having 206.0 kg/ha alkaline permanganate oxidizable N (Subbiah and Asija, 1956), 24.4 kg/ha available P (Olsen *et al.*, 1954), 220.5 kg/ha 1 N ammonium acetate exchangeable K (Stanford and English, 1949) and 0.81% organic carbon (Jackson, 1973).The investigation was laid out in split-plot design replicated thrice. The treatments comprised of five cultivars (Arize 6444, PHB 71, PRH 10, MTU 7029 and HUR 105) as assigned to main plots. All five cultivars have their own specialty, like Arize 6444, launched in 2001 reported consistently 25-30 % higher yield Some important characteristics of this hybrid are medium duration (135-140 days), medium slender grain, high productive tillers per plant (13-15), more grains per panicle (250-300 grains panicle^{-1}), wider adaptability, more than 70% milling.PHB 71 was developed by Pioneer Overseas corporation, Hyderabad in 1997. Some important characteristics of this hybrid are medium duration (130-135 days), tall (130 cm) non-Shattering, long slender grains with intermediate amylase (23%), low Alkali spreading value (2.4), high milling (71%) and Head rice recovery (59%). Tolerant to Bacterial blight, Blast, Brown plant hopper, and gall midge. PRH 10 Pusa Rice Hybrid-10 (PRH-10) is a superfine aromatic rice Hybrid with basmati quality developed at IARI, New Delhi, in 1998 from the cross of Pusa 6A × PRR-78. The grains are medium long and fine with a 1000-grain weight of 20–22 g. It possesses an attractive aroma. This hybrid was released in July 2001 for commercial cultivation in Uttaranchal, western U.P., Delhi and Haryana. MTU 7029 is a cross of Vasista × Mahsuri released in 1982 from Acharya N G Ranga Agricultural University, Andhra Pradesh, India. It is a dwarf cultivar having medium slender grain, which matures in 140 days. It is resistant to Bacterial leaf blight and tolerant to many diseases. The yield potential of this cultivar is 55-60 q ha^{-1}. HUR 105 is a mutant variety of MPR 7-2 released in 2009 from Banaras Hindu University, Varanasi, Uttar Pradesh, India. It is a semi dwarf variety having plant height of 100-102 cm. It matures in 130-135 days having long slender grain. It is tolerant to leaf and neck blast. The yield potential of this cultivar is 58-60 q ha^{-1}.

Each main plot was further divided into two sub-plots to accommodate two crop geometry treatments *i.e.* 20 × 10 and 25 × 25 cm^2. Herbicide mixture of bispyribac sodium @ 25 g ha^{-1} and Azimsulphuron @30 g ha^{-1} was also applied at 18 DAS to control weed flora. Plant height, number of tillers m^{-2} and dry matter accumulation m^{-1} running row, leaf area index among crop growth characters, yield attributing characters like panicle length, panicle weight, number of effective tillers m^{-2}, number of grains panicle^{-1} and test weight. Also yield, net return, benefit cost ratio, production efficiency were recorded. All the data obtained from the experiment was statistically analyzed using the F-test (Gomez and Gomez, 1984). Critical difference (CD) values at P = 0.05 were used for determine the significance of differences between mean values of treatments.

RESULTS AND DISCUSSION

Cultivars

The differences in plant height (cm), number of tillers m^{-2}, dry matter accumulation m^{-1} running row, leaf area index at 90 days after sowing were observed. The maximum plant height and number of tillers m^{-2} was recorded in Arize 6444 and it had also significantly higher dry matter accumulation m^{-1} running row and leaf area index than PHB 71, PRH 10, MTU 7029 and HUR 105. At 90 DAS, plant height of PRH 10 was statistically at par with Arize 6444 and in case of number of tillers m^{-2} Arize 6444 became statistically similar with PRH 10 and MTU 7029. In contrast, HUR 105 recorded lesser growth attributing characters like number of tillers m^{-2}, dry matter accumulation m^{-1} running row and leaf area index, whereas leaf area index was statistically at par with PRH 10. However, the minimum plant height was observed in MTU 7029. Yield attributing characters like panicle weight, number of effective tillers m^{-2}, number of grains panicle^{-1} and test weight of Arize 6444 was significantly higher than other cultivars which resulted maximum grain yield in Arize 6444 than rest of cultivars. Similar to growth attributes, yield attributes in HUR 105 was lesser in most of the characters like panicle length, panicle weight, number of effective tillers m^{-2} and number of grains panicle^{-1} than rest of the cultivars. In case of test weight minimum weight was recorded in MTU 7029. Consequently Arize 6444 recorded highest grain yield. The taller plant in

Table 1: Effect of cultivars and spacing on growth, yield attributing characters and yield in direct seeded rice at 90 DAS

Treatment Cultivar	Plant height (cm)	Dry matter m^{-1} running row	Number of tillers m^{-2}	Leaf area index (LAI)	Panicle length (cm)	Panicle weight (g)	Effective tillers m^{-2}	No of grains panicle^{-1}	Test weight (g)	Yield (Kg ha^{-1})
Arize 6444	106.98	85.2	492.16	4.07	25.66	7.34	337.98	189.33	25.21	5614.9
PHB 71	104.26	71.61	477.33	3.69	27.66	6.18	280.27	176.5	23.6	5361.3
PRH 10	86.98	78.96	461.5	3.38	30	6.28	260.14	181.83	24.57	5102.5
MTU 7029	64.65	73.49	486.83	3.75	22.16	6.03	288.13	154.17	18.38	5123.4
HUR 105	83.61	64.02	456.16	3.4	20.83	5.61	238.24	145.83	20.96	4267.9
SEm±	0.89	1.93	5.9	0.07	0.47	0.25	2.96	2.96	0.21	77.19
CD	2.93	6.3	19.25	0.22	1.55	0.82	9.67	9.68	0.7	251.72
Spacing(cm^2)										
20 × 10	89.4	79.27	465.46	3.92	24.8	6.54	275.99	156.86	22.08	4978.69
25 × 25	89.2	70.04	484.13	3.39	25.73	6	285.91	173.2	23	5209.29
SEm±	0.37	0.6	19.25	0.04	0.11	0.16	2.65	1.66	0.18	43.21
CD	NS	1.91	18.33	0.14	0.36	0.53	8.37	5.24	0.57	133

SEm± = Error mean sum of square, CD = Critical difference cultivar Arize 6444 might be due to better utilization of available growth resources like light and temperature which may result in more nitrogen absorption for the synthesis of protoplasm responsible for rapid cell division consequently increasing the plant in shape and size or may be due to hybrid vigour of the cultivar. Similar findings have also been reported by Sowmyalatha *et al.* (2012). The higher number of total tillers m^{-2} in cultivar Arize 6444 might be due to ability of effective utilization of plant growth resources *viz*. photoperiod, dry matter production and increase in tillers with advancement of life cycle. The findings have also been supported parallely by Dass and Chandra (2015). The higher LAI recorded in cultivar Arize 6444 might be due to more number of leaves m^{-2}. Jat *et al*. (2015) have also been found similar result. The differential growth behavior of crop cultivars could be attributed to the genetical characters of the cultivar (Adhikari *et al.*, 2004). Significantly higher grain yield was recorded in Arize 6444 rice hybrid which might be due to synchronization of tillers that help in early emergence of productive panicles and panicle weight possibly due to better utilization capacity of available nutrients which helped in determining the relatively more yield (Sowmyalatha *et al.*,2012).

Spacing

As per data in table square spacing (25 × 25 cm^2) recorded more plant height, dry matter accumulation, number of tillers m^{-2} and leaf area index in comparison to 20 × 10 cm^2 . Differences in plant height at both spacing were statistically at par. However, significantly higher dry matter accumulation m^{-1} running row, number of tillers m^{-2} and leaf area index were recorded in square spacing (25 × 25 cm^2) as compared to plant spacing (20 × 10 cm^2). In case of yield attributing characters like panicle length, effective tillers m^{-2}, number of grains $panicle^{-1}$ and test weight was significantly higher at wider plant spacing (25 × 25 cm^2) as compared to narrow spacing (20 × 10 cm^2). As a result grain yield was significantly higher in wider plant spacing (25 × 25 cm^2) as compared to narrow spacing (20 × 10 cm^2). Trivedi and Kwatra (1983) and Singh *et al. (2015)* have also been found similar result. The improvement in the yield attributing characters and yield might be the result of better utilization of space, light and other inputs mainly due to the reduced inter- and intra-plant competition which ultimately favored development of higher number of effective tillers m^{-2} and bolder grains at wider spacing transforming into grain yield. (Krishan *et al.*, 1994, Sihag *et al.*, 2015)

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