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PERFORMANCE OF RICE CROP AS INFLUENCED BY VARIOUS PLANTING METHODS, VARIETIES AND DATES OF TRANS PLANTING

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ABSTRACT

Field experiments were conducted at Punjab Agricultural University, Ludhiana (Punjab) to study the effect of planting methods on yield and yield contributing characteristics of rice crop during *kharif* 2012 and 2013. The experiments comprise of three dates of transplanting (15th June, 30th June and 15th July), two rice varieties (PR-118 and PR-116) and two planting methods (bed and conventional). The experiment was laid out in the factorial split plot design. Seedlings were transplanted at a spacing of 20 cm x 15 cm in conventional method and 30 cm x 10 cm on the middle of beds. The results showed that significant reduction in grain yield was observed with delay in transplanting from 15th June onwards. Significantly higher grain yield (43.77q/h) was recorded in variety PR-118 as compared to variety PR-116 (33.19q/h). The yield contributing characteristics were also significantly higher in 15th June transplanted crop (variety PR-118), under bed planting as compared to conventional planting. The crop transplanted in beds gave significantly higher grain yield (43.7q/ha) as compared to conventional (flat) planting (33.3q/ha).

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INTRODUCTION

Rice is the main cereal crop of north-western India including Punjab. In Punjab, rice cultivation has increased considerably with the availability of high yielding varieties, irrigation facilities and support price. Rice currently occupies an area of 28.45 lakh hectare with production of 113.74 lakh tons and productivity of 39.98 q ha^{-1} in Punjab (Anonymous, 2014). On an average, more than 4000 litres of the water is consumed to produce one kilogram of rice (Anonymous, 1992). To meet the demands of ever increasing population and maintenance of self sufficiency, the present production level needs to be increased up to 120 million tonnes by the year 2020 (Sujathamma *et al*., 2015). The production can be increased vertically without expansion of area under rice. Punjab is currently facing the problems of declining ground water table in most of its areas, increased energy cost for pumping of underground water and deterioration of ground water quality. Transplanting in puddled field is the common method which results in formation of a hard pan and deteriorates the soil structure. The traditional practice of continuous ponding of water also results in considerable deep percolation losses and over irrigation than the crop requirements. Hence, other practices for rice growing need to be explored to solve this problem such as transplanting in beds without puddling the soil which requires less water. In this method, the seedlings are transplanted in between the beds and water is applied only in between the beds, which results in 30-35 per cent saving of water. Bed planting has shown improved water use efficiency and fertilizer use efficiency, reduced crop lodging and reduced seed rate without sacrificing yield (Hobbs *et al.,* 2000). Transplanting rice on sides of freshly constructed beds saves 15% irrigation water as compared to puddle flat (Sandhu *et al*., 2012).Optimum plant spacing ensures plants to grow properly both in their above and underground parts through different utilization of solar radiation and nutrients (Singh *et al*., 2015). So, there is an urgent need to improve the water productivity of rice crop in Punjab to prevent economic loss and ecological degradation. Keeping this in view, the field experiments were conducted to study the effect of planting methods on yield and yield contributing characteristics of rice.

MATERIALS AND METHODS

Field experiments were conducted during *kharif* season of 2012 and 2013 at the Research Farm, School of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana. It is situated at 30°54′N latitude and 75°48′E longitude and is 247 m above mean sea level. The area experiences an average annual rainfall of 759.3 mm. Two rice varieties, PR-118 (V_1) and PR-116 (V_2) were transplanted under bed planting method (M_1) and conventional (Flat) method

(M_2) on three different dates *viz*. 15th June (D_1), 30th June (D_2) and 15th July (D_3) during both the crop seasons. Fresh beds were prepared with the help of wheat bed planter. The 30 days old seedlings were transplanted at a spacing of 20 cm x 15 cm in conventional method and 30 cm x 10 cm on the middle of the beds. The experiment was laid out in the factorial split plot design with four replications. The recommended doses of fertilizers were applied at the rate of 110 kg N/acre in the form of Urea, 27 kg P_2O_5/acre in the form of DAP and 20 kg K_2O in the form of MOP as per the recommendations by Punjab Agricultural University, Ludhiana. Yield contributing characteristics *viz*. number of grains per plant, number of effective tillers per plant, 1000-grain weight, grain yield and straw yield were recorded at harvesting. The meteorological data was recorded at the Agro meteorological Observatory located 100m away from the experimental site.

RESULTS AND DISCUSSION

Weather during 2012 and 2013 crop seasons

The maximum temperature during crop season was ranged between 28.7- 43.7ºC in 2012 and 24.7 - 44.1ºC in 2013 crop season. The minimum temperature was ranged between 17.6- 29.2ºC in 2012 and 11.9 – 29.1ºC in 2013 crop season (Figure 1). The minimum temperature during 2013 was higher from 39th to 43rd SMW as compared to 2012.The sunshine hours were in the range of 3.3- 11.1 hrs in 2012 and 2.1- 10.0 hrs in 2013 crop season (Figure 2).From 38th to 43rd SMW, the sunshine hours were higher during 2012 compared to 2013. Total rainfall received during 2012 crop season was 422.0 mm as compared to 723.1mm in 2013 (Figure 2). During 2012 the rainfall was very low and it was drought year.

Biometric parameters

Growth and yield contributing characteristics viz. plant height and dry matter per plant were significantly higher in 15th June transplanted crop as compared to 30th June and 15th July transplanted crop (Table 1) during both the crop seasons. Significantly higher plant height was recorded in bed planting method (82.5 cm) as compared to conventional method (75.6 cm). Bhuyan *et al*. (2012) also observed that plant height of rice was higher in bed planted crop as compared to conventional planting. Better growth of rice in bed planting method might be due to higher availability of photosynthetically active radiation (PAR) and amount of light available for photosynthesis which ultimately improved the development through proper carbohydrates metabolism and respiration resulting better growth of rice. Crop transplanted on 15th June recorded the highest dry matter per plant (44.6 gm) as compared to 30th June (38.7 gm) and 15th July (31.1 gm) transplanted crop. Dhaliwal *et al*. (2011) also observed that 10th June transplanted crop produced higher dry matter as compared to early and late transplanted crop. Significant interaction effect of different dates of transplanting and varieties was observed for dry matter per plant during both the years

Table 1: Effect of different treatments on growth and yield attributes of rice (Pooled data of 2 years)

TreatmentsTransplanting Dates	Plant ht. at harvest(cm)	No. of effective tillers/pl.	1000 grain wt. (gm)	No. of grains/pl.	Biological mass (q/ha)	Yield (q/ha)	Harvest index (%)
15th June(D_1)	83.0	18.5	22.4	404.2	100.1	43.6	47.2
30th June(D_2)	79.4	14.2	20.6	381.8	88.8	40.6	42.2
15th July (D_3)	75.0	10.4	19.2	308.4	81.8	31.1	41.2
CD (P=0.05)	1.9	1.6	0.68	28.2	9.1	2.8	3.1
Varieties							
PR-118 (V_1)	81.4	17.4	22.8	380.3	98.3	43.8	37.9
PR-116 (V_2)	76.8	11.4	18.8	349.2	82.3	33.2	32.2
CD (P=0.05)	1.6	1.3	0.5	23.0	0.74	2.3	2.6
Transplanting Methods							
Bed Planting (M_1)	82.5	16.8	22.4	411.6	95.7	43.7	38.5
Conventional Planting (M_2)	75.8	12.0	19.1	317.9	84.9	33.3	31.7
CD (P=0.05)	2.3	0.89	0.6	18.3	7.04	3.5	2.3

Table 2: Interactive effect of different dates of sowing and varieties on dry weight per plant (gm) at harvest

	2012				2013				Pooled			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
V_1	58.3	48.1	39.6	48.7	46.8	37.0	30.4	38.1	52.6	42.6	35.0	43.4
V_2	42.3	41.4	30.9	38.2	31.7	30.5	23.3	28.5	36.5	34.7	27.1	32.8
Mean	50.3	44.8	35.3	-39.2	33.9	26.9	-	44.6	38.7	31.1	-	
CD				4.5				3.2				4.1

Table 3: Interactive effect of different planting methods and varieties on dry weight per plant (gm) at harvest

	2012			2013			Pooled		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
V_1	56.9	40.5	48.7	45.4	30.8	38.1	51.2	35.6	43.4
V_2	40.1	36.3	38.2	30.9	26.0	28.5	34.9	30.6	32.8
Mean	48.5	38.4	-	38.2	28.4	-	43.1	33.1	-
CD			3.5			2.8			2.5

Table 4: Interactive effect of different dates of sowing and varieties on effective tillers/plant of rice

	2012				2013				Pooled			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
V_1	24.5	19.0	12.3	18.6	21.5	15.0	11.8	16.1	23.0	17.0	12.1	17.4
V_2	14.6	12.9	8.9	12.1	13.5	9.8	8.8	10.7	14.1	11.8	8.8	11.6
Mean	19.6	15.9	10.6	-	17.5	12.4	10.3	-	18.6	14.4	10.4	-
CD				3.1				1.8				2.2

Table 5: Interactive effect of different planting methods and varieties on effective tillers/plant of rice

	2012			2013			Pooled		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
V_1	22.0	15.2	18.6	19.3	12.9	16.1	20.6	13.3	16.9
V_2	13.8	10.5	12.1	12.2	9.4	10.8	14.1	9.9	12.0
Mean	17.9	12.8	-	15.7	11.2	-	17.4	11.6	-
CD			1.4			1.3			1.2

Table 6: Interactive effect of dates of transplanting and varieties on grain yield (q/ha) of rice

	2012				2013				Pooled			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
V_1	58.3	46.	38.4	47.6	52.7	39.4	30.9	41.0	53.0	43.6	34.6	43.7
V_2	41.9	36.7	32.1	36.9	33.4	31.4	23.0	29.4	37.7	34.4	27.5	33.2
Mean	47.5	44.0	35.2	-	43.1	35.6	26.9	-	43.6	40.6	31.1	-
CD				4.0				6.8				3.9

Table 7: Interactive effect of different planting methods and varieties on grain yield (q/ha) of rice

	2012			2013			Pooled		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
V1	56.2	41.4	48.8	49.0	31.5	40.3	51.5	35.9	43.7
V2	39.0	32.5	35.8	33.1	27.3	30.2	36.0	30.5	33.3
Mean	47.6	37.0	-	41.0	29.4	-	43.8	33.2	-
CD			4.9			8.1			4.9

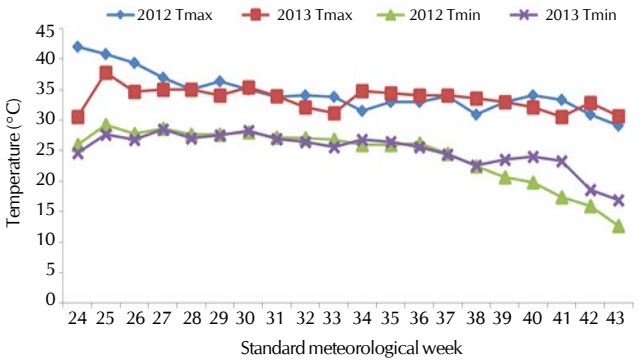

Figure 1: Meteorological parameters maximum and minimum temperature (ºC), during 2012 and 2013

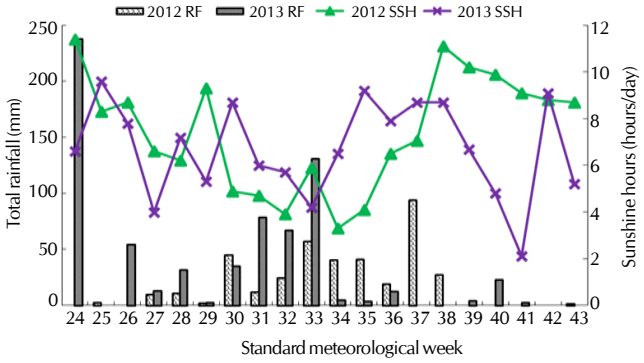

Figure 2: Meteorological parameters total rainfall (mm) and sunshine hours (hrs) during 2012 and 2013

(Table 2). Variety PR-118 transplanted on 15th June recorded significantly higher dry matter per plant (52.6 gm) as compared to all other combinations. Similarly significant interaction was also observed between different planting methods and varieties (Table 3). Bed planting method produced significantly higher dry matter per plant (51.2 gm) in variety PR-118 as compared to all other combinations. Crop transplanted on 15th June produced maximum biological yield (10.0 t/ha) followed by 30th June (8.9 t/ha) and 15th July (8.2 t/ha) transplanting respectively. The highest biological yield (9.57 t/ha) was recorded in bed planting method as compared to conventional method (8.49 t/ha) (Table 1). These results corroborate to the findings of Dhaliwal *et al.* (2006). Patel (1999) also reported significantly higher biomass in early transplanted crop (15th June) as compared to delayed transplanting (30th June and 30th July).

Effective tillers

The time of transplanting influenced the number of effective tillers per plant (at harvest) in both the varieties and significant differences were observed in varieties under different dates of transplanting during both the crop seasons (Table 1). The crop transplanted on 15th June produced significantly higher

number of effective tillers per plant (18.5) as compared to 30th June (14.2) and 15th July (10.4) transplanted crop. Similar results were also reported by Om *et al*. (1997). Gill *et al*. (2006) also observed that maximum productive tillers were obtained when transplanting was done on 10th June. The low temperature prevailed at the pollen development stage of late transplanted crop may cause a sharp decline in fertile or filled spikelets particularly in the photosensitive cultivars. The variety PR-118 produced significantly higher number of effective tillers per plant (17.3) as compared to variety PR-116 (11.4) during both the crop seasons.

In pooled analysis, bed planting method produced more number of effective tillers (16.8) as compared to conventional planting (12.0) (Table1). It might be due to the reason that each individual tiller has uniform supply of nutrients, more light and aeration and also the advantage of less severe competition amongst germinated seeds/seedlings, which resulted in more number of panicle-bearing tillers per unit area in bed planting method. The results were in conformity with Gupta *et al*. (2002). Gupta and Hobbs (2002) also observed that when rice crop was transplanted on the raised beds the crop gets escaped from losses due to temporary water logging. The interaction between different dates of transplanting and different varieties showed significantly higher number of effective tillers per plant (23.0) with the combination of 15th June transplanting in variety PR-118 (Table.4). Significant interactions were also observed between different planting methods and different varieties

Grain yield

Grain yield is a function of growth and yield attributing parameters. The highest grain yield was obtained in 15th June transplanted crop (43.7 q/ha) followed by 30th June (40.7 q/ha) and 15th July (31.1 q/ha) transplanting during both the crop seasons. The perusal of data indicated that with each delay in transplanting of rice, there was significant reduction in grain yield during both the crop seasons. Dhaliwal *et al*. (2006) and Mahajan *et al*. (2009) also reported that crop transplanted on 10th June gave higher yield. Bali *et al*. (1995) observed that June was the optimum planting time for obtaining higher yield of rice in northwest India. Similarly Oteng *et al*. (2013) also reported that transplanting date can have a dramatic effect on crop development and yield of rice crop. The variety PR-118 recorded significantly higher grain yield (43.8 q/ha) as compared to variety PR-116 (33.2 q/ha) during both the crop seasons.

Grain yield was significantly higher (43.7 q/ha) in bed planting as compared to conventional planting method (33.3 q/ha) during both the crop seasons. The higher grain yield recorded in bed planting method was attributed to good crop conditions, efficient utilization of natural resources (soil, light, water, air *etc*.) which resulted in higher number of tillers per plant, number of effective tillers and number of grains per plant than conventional method. Grain yield of rice transplanted on bed was as higher compared with the recommended flat planting method reported as Atta *et al*. (2006), Khettak *et al*. (2006), Mishra and Saha (2007) and Kaur *et al*. (2007). Similar results were also reported by Singh (2003), Singh *et al* (2002), Bhuyan *et al*. (2012), Singh *et al*. (2008) and Thawait *et al*. (2014). Pandey *et al* (2012) revealed that yield of rice transplanted on FIRB (bed irrigated raised beds) is comparable with traditional rice cultivation with as much as 25 per cent to 50 per cent saving in irrigation water. Significant interactions were found on the effect of yield between dates of transplanting and varieties. Similarly interactions were also found between different varieties and planting methods (Tables 6 and 7). Interaction between different dates of transplanting and different varieties showed that significantly higher yield (53.0 q/ha) was recorded with the combination of 15th June transplanting (D_1) in variety PR-118 in comparison to all other combinations. The interaction between different planting methods and varieties showed significantly higher yield in variety PR-118 (51.5 q/ha) under bed planting method as compared to all other combinations of dates and varieties.
The yield contributing characteristics *viz*. 1000-grain weight, number of grains per plant and harvest index differed significantly in all the treatments (Table.1). Among the different dates of transplanting, rice transplanted on 15th June (D_1) had maximum 1000-grain weight (22.45 gm), number of grains per plant (404.16) and harvest index (47.20 %) as compared to 30th June and 15th July transplanting during both the crop seasons. This may be due to availability of favourable temperature during panicle and grain development period in 15th June (D_1) transplanted crop. These findings were also supported by Soomro *et al*. (2001) and Sharma *et al*. (2011) who observed significant reduction in yield and yield contributing characteristics with delay in transplanting. Variety PR-118 had more 1000-grain weight (22.76 gm), number of grains per plant (380.33) and harvest index (43.8 %) during both the crop seasons. The planting method had a significant effect on yield contributing characteristics. The bed planting method had more 1000-grain weight (22.42 gm), number of grains per plant (411.63) and harvest index (38.48 %) as compared to conventional method (19.14 gm, 317.91 and 31.68 %) during both the crop seasons. The maximum number of grains in bed transplanted crop might be due to production of maximum number of tillers per unit area on account of higher availability of solar radiation.

In general the yield and yield contributing characteristics were comparatively lesser in 2013 crop season than 2012 because of high minimum and maximum temperature prevailed during the crop growing season. The high temperature might have affected initial growth of the crop, thereby resulting in reduced grain yield during 2013 crop season. Total rainfall during 2013 crop season was higher (695.7 mm) as compared to 2012 (381.8 mm). During booting stage 252.1 mm rainfall was received which resulted in lower yield due to washing of pollens.

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