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Effect of Date of Transplanting on Growth and Productivity of Rice (*Oryza sativa* L.) Cultivars

Pardeep Kaur Mann[1], Balwinder Singh Dhillon[2]

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ABSTRACT

Background: In central Punjab, the primary cause of depleting underground water is early transplantation of long-duration rice varieties. Because of their growth in rainy days and early maturity, the cultivation of medium-duration varieties in the low evaporation period can help to migrate the over draft of underground water.

Methods: The field experiment entitled "Effect of date of transplanting on growth and productivity of the rice (*Oriza sativa* L.) cultivars" was conducted at Research Farm of University College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda to study the impact of date of transplanting on growth and productivity of the rice cultivars during *kharif* season in 2019. The trail was laid out in split plot design with three dates of transplanting (June 15, June 25 and July 5) in main plot and three rice cultivars (PR 122, PR 126 and PUSA 44) in sub plot, replicated thrice.

Result: Transplanting on 15 June crop recorded significantly higher plant height at 30, 60 DAT and at harvest *viz.* 67.4, 110.0 and 122.6 cm respectively; number of tillers at 30, 60 DAT and at harvest *viz.* 59.4, 58.2 and 46.2 respectively; leaf area index (LAI) at 60 DAT (3.1); dry matter accumulation (DMA) at 30, 60 DAT and at harvest *viz.* 8.5, 26.7 and 132.6 q/ha respectively; number of days taken to panicle initiation (57.6); number of days taken for 50 per cent flowering (64.1); effective tillers per meter row length (38.6); panicle length (26.1 cm); panicle weight (6.1 g); number of grains per panicle (177.9); 1000-grain weight (31.0g); grain yield (72.2 q/ha); straw yield (161.1 q/ha); harvest index (33.4%). The grain yield was at par with June 25. Among the cultivars, PUSA 44 recorded significantly higher plant height at 30, 60 DAT and at harvest *viz.* 70.6, 117.4 and 128.6 cm respectively; number of tillers at 30, 60 DAT and at harvest *viz.* 65.0, 60.3 and 50.4 respectively; leaf area index (LAI) at 60 DAT (3.4); dry matter accumulation (DMA) at 30, 60 DAT and at harvest *viz.* 9.5, 31.3 and 153.4 q/ha respectively; number of days taken to panicle initiation (65.2); number of days taken for 50 per cent flowering (68.7); effective tillers per meter row length (43.2); panicle length (27.5 cm); panicle weight (6.5 g); number of grains per panicle (195.7); 1000-grain weight (34.7g); grain yield (80.1 q/ha); straw yield (181.2 q/ha); harvest index (34.1%). June 15 transplanting produced significantly higher grain yield which was 1.5 and 6.4% higher than June 25 and July 5 transplanting respectively. PUSA 44 produced significantly higher grain yield which was 27.3 and 17.4% higher than PR 126 and PR 122 respectively. All the interaction effect of date of transplanting and rice cultivars recorded non-significant results.

Key words: Cultivars, Dates of transplanting, Grain yield, Rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop of India. As rice generally accounts for 32 per cent of the cropped region in Asia, the value of rice is more pronounced in Asia. In rice production, India is next to China. In India, rice is cultivated in an area of 44.6 million ha with a production of 109.5 million tons and an average productivity of 2.62 tons per ha. The slogan "Rice is Life" is best suited to India because this crop plays a vital role in our national food security and is a livelihood for millions of rural households. India's rice output goal for 2025 AD is expected to be 140 million tons, which can only be reached by growing rice production by 2 million tons per year over the current one in the next decade (Sridhar *et al.,* 2011). Rice is grown in all regions of the world because of its large potential to cope with the changing agro-climates. Rice, which is India's main important food crop, provides about 45 per cent of total production and thus holds the secret to maintaining food sustainability in India (Rai and Kushwaha, 2008). It is the main crop in *Kharif* and ranks second in area, output and productivity in Punjab, after wheat.

[1]Department of Agronomy, College of Agriculture, Guru Kashi University, Talwandi Sabo-151 302, Punjab, India.
[2]Regional Research Station, Punjab Agricultural University, Ballowal Saunkhri-144 521, SBS Nagar, Punjab, India.

Corresponding Author: Balwinder Singh Dhillon, Regional Research Station, Punjab Agricultural University, Ballowal Saunkhri-144 521, SBS Nagar, Punjab, India. Email: balwinderdhillon.pau@gmail.com

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Planting time is the major factor that determines the productivity of a crop. Optimum planting time for a crop is location specific. Optimum planting time worked out June 1-10 in Punjab (Gill *et al.,* 2006). Early or delay in sowing leads to lower production of rice. Gravois and Helms (1996) also showed that rice grain yields declined as seeding date was delayed. At a specific location, maximum grain yield can be achieved by planting the crop at the optimum time,

which may vary from variety to variety (Reddy and Narayana, 1984). Rice varieties exhibit wide variation in the production of high density grains which showed maximum potential for grain filling and test weight (Murty *et al.,* 1992). Timely sowing of rice results in earlier harvest and allows timely planting of the next wheat or other crops. The rice- wheat system productivity was nearly 12 tons per ha when about 25 days old rice seedlings were transplanted before end of June. The total system productivity is reduced by more than 40 percent when field were planted after August 15 (Rai and Kushwaha, 2008). The specific sowing date for the rice transplanting also plays a crucial role in optimizing its growth and increasing the yield. The sowing time of the rice crop is important for three major reasons. Firstly, it ensures that vegetative growth occurs during a period of satisfactory temperatures and high levels of solar radiations. Secondly, the optimum sowing time for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved (Farrell *et al.,* 2003). Sowing date has a direct impact on the rate of establishment of rice seedling (Tashiro *et al.,* 1999). Khalifa (2009) found that early sowing of rice recorded maximum tillering, panicle initiation, heading date, number of tillers/plant, plant height and root length at panicle initiation and heading stage, chlorophyll content, number of days to panicle initiation and heading date, leaf area index, sink capacity, spikelets/leaf area ratio, number of grains per panicle, panicle length (cm), 1000-grain weight (g), number of panicles m^{-2}, panicle weight (g) and grain yield (t/ha).

Scientists and policy-makers support delayed transplantation from a relatively higher to lower evaporative demand duration (May to late June). Likewise, rice being highly sensitive to diverse ecological conditions, adequate seedling age plays a crucial role in achieving potential yields; however, it behaves differently with the span of different cultivars. In addition, varieties differ in their seedling strength, competitiveness of the weeds, tolerance of submergence and drought, maturity, resistance lodging and productivity. In central Punjab, the primary cause of depleting underground water is early transplantation of long-duration rice varieties. Because of their growth in rainy days and early maturity, the cultivation of medium-duration varieties in the low evaporation period can help to migrate the over draft of underground water. This will certainly cause a serious problem for future sustainability. Therefore there is an immediate and urgent need to reduce the water consumption especially during the early establishment of the crop after transplanting. So there is a serious need to test the delaying of transplanting of the crop by at least 10-15 days late transplanting (from 15th June to 25th June), which is quite dry, hot and highly evaporating period. Rice, being a major *kharif* season crop of this area requires a study of growth and productivity and its association with different weather parameters. In view of above consideration the present investigation was planned to evaluate the effect of different transplanting dates on growth and productivity in different rice varieties.

MATERIALS AND METHODS

The present investigation entitled "Effect of date of transplanting on growth and productivity of rice (*Oryza sativa* L.) cultivars" was conducted at the experimental farm of the University College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda. It is located between the latitude of 29.9875°N and the longitude of 75.0903°E with an altitude of 252 meters above mean sea level. The experimental site is part of a semi-arid climate in which both summers and winters are intense. During summer, a high temperature of around 45° is not unusual, although freezing temperatures followed by frost may occur in the months of December and January. Normally, the monsoon season begins in the first week of July.

The soil was slightly alkaline (pH 7.9) with normal electrical conductivity (0.24 dSm^{-1}). The soil was medium in organic carbon content (0.29%). The available nitrogen (233.75 kg ha^{-1}) was low, whereas the available phosphorus (15.03 kg ha^{-1}) and available potassium (216.85 kg ha^{-1}) were both medium. The experiment was laid out in split plot design with three replications.

The five plants were selected randomly from each plot, then height of these plants was measured at regular intervals in centimeters with a meter scale in each plot and it was estimated from ground level to the tip of the plant. From the two rows of plot, the total number of tillers per meter of row length was counted and the average was worked out. The leaf area index as calculated by multiplying the leaf length × leaf width with correction factor K × number of leaves per plant in each treatment. Plants were cut close to the ground to record dry matter accumulation of the different dates of observations; samples were oven dried at 70°C±2°C till constant weight was achieved. Samples were weighed after drying to record the drying weight and expressed in g. The panicle bearing tillers were recorded in the same way as number of tillers per meter row length were recorded during observation period. Five panicles were sampled from the tagged hills of each plot. The length was determined from the base of the panicle to the tip of the topmost spikelet. The mean panicle length was calculated and expressed in centimeters. The grains of five panicles selected for panicle length from each plot were counted carefully and averaged to obtain the number of grains per panicle. Five panicles were selected from marked area and were weighed and averaged to record weight per panicle. One thousand grains from the net plot of each treatment were counted and their weight recorded in gram and represented as the test weight. Produce of the net plots was threshed and grains thus obtained as winnowed, cleaned and weighed. The yield was recorded in kg per plot was standardized to 14 per cent moisture and then weight was converted into q ha^{-1}. Dry weight of straw collected from the net plot was recorded after sun drying for 4-5 days and expressed in q/ha.

The harvest index was calculated by dividing the economic yield by the biological yield and multiplying by 100.

RESULTS AND DISCUSSION

Growth parameters of rice

The data indicated that the rice planted on June 15 produced significantly taller plants as compared to the crop planted on June 25 and July 5 (Table 1). June 15 planting recorded 3.9 and 17.4 cm higher plant height than June 25 and July 5 planting, respectively. The late planting had shorter growing period due to photoperiod response and June planting was attributed favourable environmental conditions which enabled the plant to improve its growth and development as compared to July planting. These findings were in close agreement with those of Verma *et al*., (2004) and Choudhary *et al*., (2011). The tallest plants were recorded in PUSA 44 variety and it was significantly higher than PR 126 and PR 122. PUSA 44 recorded 21.3 and 18 cm higher plant height than PR126 and PR122 rice cultivars respectively when observed. Rice planted on June 15 produced significantly higher number of tillers per meter row length as compared to the crop planted on June 25 and July 5 (Table 1). June 15 planting recorded 4.1 and 6 higher number of tillers per meter row length than June 25 and July 5 planting when observed respectively. The higher value of tillers might be due to availability of more time for growth period with optimum photoperiod as well as optimum temperature for the growth of crop plant which may result in more nutrient absorption by the roots for the synthesis of protoplasm responsible for rapid cell division which may increase the number of tillers. Similar results were also reported by Singh *et al.,* (1996), Singh *et al.,* (1997) and Mahajan *et al.,* (2009). The maximum number of tillers was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. PUSA 44 recorded 13.7 and 9.1 higher number of tillers per meter row length than PR 126 and PR 122 rice cultivars, respectively. It is cleared from the data that rice planted on June 15 produced significantly higher leaf area index (LAI) as compared to the crop planted on June 25 and July 5 (Table 1). June 15 planting recorded 6.8 and 14.8 per cent higher LAI than June 25 and July 5 planting when observed.

The higher LAI might be due to more number of leaves and size which were accumulation of food material through photosynthesis during growth period of the crop and then distributed towards the root and shoot. The more LAI in early planting crop have also been reported by Samdhia (1996), Verma *et al.,* (2004). The significantly higher LAI was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. PUSA 44 recorded 41.6 and 17.2 percent higher LAI than PR 126 and PR 122 rice cultivars when observed. The rice planted on June 15 produced significantly higher dry matter accumulation (DMA) as compared to the crop planted on June 25 and July 5 (Table 1). June 15 planting recorded 16.8 and 24.7 per cent higher DMA than June 25 and July 5 planting when observed respectively. The tallest plants and higher number of tillers might be due to the better development of early form tillers up to the stage of maximum tillering due to better photosynthesis activities of the plant in the optimum photoperiod at optimum temperature to supply energy in term of photosynthate for their proper development which may ultimately led to higher dry matter accumulation. Similar results were also reported by Patel *et al.,* (1999). The maximum DMA was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. PUSA 44 recorded 86.3 and 31.44 per cent higher DMA than PR 126 and PR 122 rice cultivars respectively.

Yield attributes of rice

The rice planted on June 15 produced significantly higher number of effective tillers as compared to the crop planted on June 25 and July 5 (Table 2). June 15 planting recorded 3.2 and 5.0 higher number of effective tillers than June 25 and July 5 plantings, respectively at maturity. Late planting on July 5 might have exposed the crop to relatively more adverse environmental condition in terms of water stagnation during initially establishment and at tillering phase, low temperature at the reproductive phase which might have pulled down the number of effective tillers as compared to

Table1: Effect of different date of transplanting and rice cultivars on growth parameters of rice.

Treatments	Plant height (cm)	Number of tillers per meter row length	Leaf area index (%)	Dry matter accumulation (q/ha)
Dates of transplanting				
June 15	122.6	46.2	3.1	132.6
June 25	118.7	42.1	2.9	113.5
July 5	105.2	40.2	2.7	106.3
LSD (P=0.05)	1.3	0.7	0.08	8.7
Cultivars				
PR 122	110.6	41.3	2.9	116.7
PR 126	107.3	36.7	2.4	82.3
PUSA 44	128.6	50.4	3.4	153.4
LSD (P=0.05)	0.7	1.0	0.06	8.3
Interaction	NS	NS	NS	NS

Table 2: Effect of different date of transplanting and rice cultivars on yield attributes of rice.

Treatments	Effective tillers per m row length	Panicle length (cm)	Panicle weight (g)	No. of grains per panicle	1000-grain weight	Grain yield (q/ha)	Straw yield (q/ha)
Dates of transplanting							
June 15	38.6	26.1	6.1	177.9	31.0	72.2	161.1
June 25	35.4	25.6	5.7	173.7	29.6	71.1	150.5
July 5	33.6	24.9	5.3	163.5	28.2	67.8	139.0
LSD (P=0.05)	1.4	0.3	0.3	5.8	1.1	2.1	6.5
Cultivars							
PR 122	34	25.5	5.6	168.7	28.8	68.2	147.1
PR 126	30.5	23.6	5.0	150.7	25.3	62.9	122.4
PUSA 44	43.2	27.5	6.5	195.7	34.7	80.1	181.2
LSD (P=0.05)	1.1	0.7	0.2	8.0	1.4	1.0	6.6
Interaction	NS	NS	NS	NS	NS	NS	NS

earlier planting on June 15. The results are also confirmed the findings of Gangwar and Ahmadi, (1990) and Akbar *et al.,* (2010). The maximum number of effective tillers was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. PUSA 44 recorded 12.7 and 9.2 higher number of effective tillers than PR 126 and PR 122 rice cultivars when observed at maturity respectively. The rice planted on June 15 had significantly higher panicle length as compared to the crop planted on June 25 and July 5 (Table 2). The maximum panicle length was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. Such variation in panicle length may be directly related with the growth parameters of varieties. Better in plant growth better would be the photosynthetic process there by increased accumulation of photosynthates for their translocation towards reproductive organs. The significant difference in yield attributes among the rice varieties have also been reported by Mukesh *et al.,* (2009). The transplanting of rice on June 15 significantly increased the weight of the panicle. Delay in transplanting on June 25 and July 5 caused (Table 2) significant reduction in weight panicle^{-1} as compared to June 15 which might be due to availability of longer period for better development of plant parts to allocate greater accumulation of photosynthates in early planted crop which may result in the better development of yield attribute characters *viz*. panicle weight. Similar results were also reported by Chaudhary *et al.,* (2011). The maximum panicle weight was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. The rice planted on June 15 had significantly higher number of grains per panicle as compared to the crop planted on June 25 and July 5 (Table 2). However, it was statistically at par with June 25. The maximum number of grains per panicle was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. It might be due to the better photosynthetic process which results in increased accumulation of photosynthates for their translocation towards reproductive organs. Similar results were also reported by Nayak *et al.,* (2003), Suresh *et al.* (2013). The rice planted on June 15 had significantly higher 1000-grain weight as compared to the crop planted on June 25 and July 5 (Table 2). The reduction in delayed transplanting 1000-grain weight might be due to the weather condition as delayed transplanting seedling could be unable to get longer period for better development of plant parts which may result in better development of yield attributing characters such as 1000-grain weight. Similar results were also reported by Paliwal *et al* (1996), Singh *et al*. (2004). The maximum number of grains per panicle was recorded under PUSA 44 and was significantly higher than PR 126 and PR 122. The different transplanting dates brought about significant impact upon the production of grains (Table 2). Accordingly, out of different transplanting dates, earliest June 15 planting performed best in grain production. Thus June 15 planting produced significantly 1.5 and 6.4 per cent higher grain yield than June 25 and July 5 respectively. But it was at par with June 25 transplanting. The higher grain yield in early planted crop might be due to optimum period available for growth and development resulting in more storage of photosynthates in grain observed under earlier planted crop than the later planted crop. These findings are confirmed by Kabat and Satapathy, (2013). There is significant impact of different rice cultivars upon the production of rice grains. Amongst the cultivars, PUSA 44 took a lead producing significantly 27.3 and 17.4 per cent higher grain yield than PR 126 and PR 122, respectively. The rice transplanted on June 15 significantly increased the straw yield (Table 2). Delay in transplanting on June 25 and July 5 caused significant reduction as compared to June 15. Thus June 15 planting produced significantly 7.04 and 15.8 per cent higher grain yield than June 25 and July 5, respectively. There is significant impact of different rice cultivars upon the production of rice straw yield. Amongst the cultivars, PUSA 44 took a lead producing significantly 48.0 and 23.1 per cent higher straw yield than PR 126 and PR 122 respectively. Due to marked improvement in growth and yield attributes proved instrumental in increasing straw yield under earlier planted crop. Similar results were also reported by Verma *et al.,* (2004) and Pandey *et al.,* (2008).

CONCLUSION

Among the dates of transplanting of rice, June 15 proved as the optimum date of transplanting which gives maximum growth parameters and yield attributes. Among the rice cultivars, PUSA 44 resulted as the better rice cultivar which gives maximum growth parameters and yield attributes.

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