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Evaluation of Drought Tolerant Rice Varieties under Various Methods of Crop Establishment under Rainfed Condition of Bihar

Rajeev Singh

Krishi Vigyan Kendra, Aurangabad, Bihar Agricultural University, Sabour Bhagalpur (Bihar)

ABSTRACT

A field experiment was conducted at KrishiVigyan Kendra, Aurangabad and at farmers' field during rainy seasons of 2014 and 2015, to evaluate drought tolerant rice varieties under various methods of crop establishment under rainfed drought-prone condition of Bihar. The experiment was laid out in a split-plot design with 3 methods of establishment i.e. direct seeded rice (DSR), unpuddled transplanted rice (UPTR) and transplanted rice (TPR) with three varieties viz., Sahbhagiedhan, SushkeSamrat and Abhishek in a total of nine replications including four at KVK, Aurangabad and five at farmers' field during both the years. The direct seeding of rice (DSR) produced significantly higher plant height, number of tillers/m2, panicles/m2, grains/panicle, filled grains/panicle and 1000-grain weight as compared to TPR and UPTR. Direct seed produced 7.8 and 13.94 per cent more yield in 2014 and 4.64 and 8.52 per cent more in 2015 over unpuddled and puddled transplanted rice, respectively. Net return and benefit-cost ratio were also significantly higher in direct seeded rice than puddled and unpuddled transplanting of rice. Amongst the varieties of rice, SushkSamrat produced significantly higher yield attributes viz., tillers/m2, panicles/m2, grains/panicle, filled grains/panicle and 1000-grain weight, and subsequently produced grain yield higher by 10.29 and 9.94 per cent in 2014 and by 4.48 and 7.80 per cent in 2015 over Sahbhagiedhan and Abhishek. The net return and benefit-cost ratio were also recorded significantly higher with SushkSamrat than Sahbhagiedhan and Abhishek.

Key words: Crop establishment, Direct seeded rice, Unpuddled, Rainfed, Drought tolerant, Rice, Variety, Economics.

INTRODUCTION

India has to increase its rice productivity by 3 per cent per annum to sustain present food self -sufficiency and to meet future food requirement. The growing of more food with the same production cost or even reduced cost, and sustaining the quality of natural resources-base are the major concern (Kumar and Ladha, 2011). Rice is grown under diverse ecologies ranging from irrigated to rainfed upland, lowland and deep water. Traditional crop-establishment method of rice such as puddling and transplanting requires large amount of water, energy and labour, which are becoming increasingly scarce and expensive (Mishra and Singh, 2012a), making rice production less profitable. Therefore, the direct-seeding of upland rice is becoming more popular as an alternative to transplanted rice, as is more remunerative if the crop is managed properly (Sharma *et al,* 2007). As the direct-seeding of rice facilitates timely sowing of subsequent wheat, even if a slight loss in rice productivity is compensated by increased wheat yields, implying no loss in system productivity (Mishra and Singh, 2012b). The manual transplanting in standing water after puddling is the dominant method of rice establishment in the rice-wheat growing areas of the Indo-Gangetic Plain. Repeated puddling damages the soil-structure and health (Kukal and Aggrawal, 2003), which adversely affects the soil productivity (Singh *et al,* 2005). Transplanting is labor-intensive and shortage of labor at the time of transplanting is of major concern. This calls for a change in rice

Corresponding Author's Email: singhrajeev79@gmail.com

establishment methods to improve productivity, economics and long-term sustainability. Direct-seeded rice is a cost-effective option that gives yield similar to transplanting under good weed and water management practices. The major forces driving the shift from transplanting to direct seeding are availability of chemicals method of weed control, the increasing scarcity and rising cost of water, and less availability of farm labor and rise in wages, particularly during peak transplanting season.

In recent years, emphasis is shifting towards rainfed ecology, which offers a great potential in enhancing rice productivity and production. Most of the prevalent high yielding varieties MTU-7029, RajendraMansuri, RajendraSweta, Sonam and BPT 5204 grown in the rainfed areas are meant for irrigated situations and unfortunately are drought susceptible. The International Rice Research Institute has made a landmark breakthrough by developing rice varieties with increased tolerance to submergence, drought and salt stresses. These stress tolerant varieties reduce farmers' risk and stabilize rice productivity, ultimately increasing crop intensification and diversification too. Probable cultivars are Sahbhagidhan, SushkSamrat, Abhishek and CR dhan for drought-prone environments. Therefore, testing of various drought-prone varieties under different methods of establishment was important. Keeping this in view, the present experiment was conducted to evaluate drought tolerance rice (*Oryza sativa* L.) varieties under various methods of crop establishment in rainfed drought-prone condition of Bihar.

MATERIALS AND METHODD

The field experiment was conducted at KrishiVigyan Kendra and farmers' field in Aurangabad district of Bihar during the two consecutive rainy seasons of 2014 and 2015. The experimental site is situated in South Bihar at 240.50' N, 840.70' E, and at 332'above mean sea level. The maximum temperature remained above 36.92°C and 36.04°C during 2014 and 2015, respectively. The total rainfall received was 528.75 and 579.74 mm during 2014 and 2015, respectively (Fig. 1). Most of the rainfall was received during vegetative phase from 25th (sowing time) to 39th standard meteorological week.

The soil was clay-loam having normal soil reaction (pH 7.2), low in organic carbon (0.58%) and available nitrogen (195.5 kg/ha), and medium in available phosphorus (22.4 kg/ha) and available potassium (205.5 kg/ha). The experiment was laid out in split-plot design with nine replications comprising of three crop-establishment methods in main plots and three varieties in sub-plots. In main plots, rice was established by direct-seeding with zero-till drill (ZTD–direct seeding), unpuddled transplanting and puddled transplanting. Three varieties namely Sahbhagidhan, SushkSamrat and Abhishek were kept in sub-plots. The fields were leveled with leveler to allow drill to place seeds at a uniform distance and proper depth in all the replications. The experimental plots meant for zero-till drill (ZTD) sowing were subjected to two ploughing followed by harrowing and planking before sowing with direct seeded rice machine followed by planking on 23th June, 2014 and 2015. Nursery was also sown on slightly raised seed bed on 23th June, 2014 and 2015 to get seedlings for transplanting. Twenty-one days old seedling uprooted from wet-bed nurseries were transplanted after proper field preparation (as was done in DSR) after keeping standing water in the field and transplanting done without puddling in UPTR and after puddling in PTR experimental plots using one seedling per hill and maintaining a row spacing of 20 cm and 15 cm distance between hills. After seven days of transplanting, missing hills were filled up to attain uniform plant population and growth.

In each plot, uniform plant stand was maintained and standard agronomic practices were followed for raising and maintenance of crop. The experimental field was fertilized at the rate of 80:40:20:25 kg NPK and Zn/ha. Nitrogen was applied in three splits (1/3rd each at basal stage, 30 and 60 days after transplanting), while the entire P2O5, K2O and ZnSO4 were applied as basal application.

Pendimethalin was sprayed within 2 days after sowing, by knap-sack sprayer using 500l/ha water in direct seeded rice plots, while Butachlor 1.0 kg ai/ha was applied in puddled and unpuddled transplanted plots in all replications. Post-emergence herbicides, Bispyribac sodium, was applied with knap-sack sprayer fitted with flat-fan nozzle using 500 l/ha of water at 30 days after sowing (DAS) in direct-seeded plots and 30 d after transplanting in unpuddled and puddled transplanted plots. The direct-seeded rice was kept moist for first 2 wk with light irrigation after sowing was completed and during these days one life-saving irrigation was applied 15 DAS in both years. The data on plant height, number of tillers, crop biomass and number of grains/panicles were recorded. The crop was harvested manually in the first week of November. On the basis of existing price of the inputs and outputs, variable cost of cultivation and gross returns were calculated.

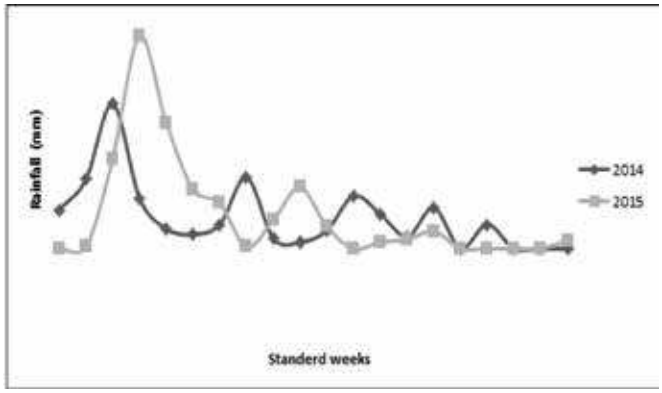

Figure 1.Rainfall status during cropping season in year 2014 and 2015

RESULTS AND DISCUSSION

Effect of planting methods

The plant height, tillers/m2, panicles/m2, panicle length, 50% flowering, grains/panicle, filled and unfilled grains/panicle and test-weight were significantly influenced by methods of rice planting. Plant height at harvest stage was recorded highest with direct seeding, but the difference was non-significant in 2014, however in 2015 it was significantly higher than unpuddled and puddled transplanted rice. Tillers/m2and panicles/m2were recorded significantly higher with DSR method as compared to unpuddled and puddled transplanting. This might be due to absence of transplanting shock in DSR methods, unlike that was experienced by the plants in unpuddled and puddled transplanted rice (Table1). Gill *et al* (2006), and Kaur and Singh (2016) also reported that direct seeded rice produced significantly higher plant height, more tillers, panicles/m2 and biomass than that with the transplanted rice, owing to more plants per unit area in DSR as compared to transplanted rice. Days taken to 50 per cent flowering was recorded lowest with DSR method over unpuddled and puddle transplanting in both years (Table 1). This might be due to uprooting shock in transplanted rice which took the plants 10-15 d to recover. Grains/panicle, filled grains/panicle and 1000-grain weight were more in direct seeded rice over unpuddled and puddled rice (Table 2) as spikelet number is the linear function of plant nitrogen concentration at panicle formation stage.

The grain yield was higher by 13.94 and 7.8 per cent in 2014 and by 8.52 & 4.64 per cent in 2015 indirect seeded rice over puddled and unpuddled transplanted rice, respectively. With direct seeded rice, straw yield was significantly higher by 12.42 and 9.75 per cent over puddled and unpuddled transplanted rice in 2014, whereas in 2015, direct seeding was at par with unpuddled transplanting, but both were superior to puddled transplanting (Table 3).

The benefit accrued was more in direct seeded rice than that in unpuddled and puddled transplanting (Table 4). The maximum benefit-cost ratio in direct seeding was due to lesser labor intensity and higher grain yield than both transplanted methods. The B-C ratio of transplanted rice was lower due to higher labor cost and lower yield than direct seeding of rice. Net return and gross return were also significantly more in direct seeded rice over unpuddled and puddle transplanted rice. The higher returns by 24.91 & 60.63 per cent in 2014 and by 25.14 & 59.23 per cent in 2015, respectively were recorded in direct seeding of rice than unpuddled and puddled transplanting rice (Table 3).

Table1. Effect of crop establishment methods and varieties on growth and yield attributes of rice.

Treatment	Plant height (cm)		Tillers/m2		Panicles/m2		Days to 50% flowering	
	2014	2015	2014	2015	2014	2015	2014	2015
Method of establishment								
Direct seeding by drill	126.0	124.3	298	273	280	253	84	77
Unpuddled transplanting	125.7	123.1	287	261	264	240	87	81
Puddled transplanting	124.7	121.9	284	255	257	234	86	81
SEm±	0.77	0.54	1.64	1.78	3.24	1.98	0.23	0.42
LSD =0.05	NS	1.63	4.95	5.37	9.79	6.00	0.71	1.27
Varieties								
SahbhagiDhan	129.0	127.2	291	265	270	249	86	81
SushkSamrat	125.4	122.8	301	270	275	251	85	78
Abhishek	122.0	119.3	278	254	255	226	86	80
SEm±	0.64	0.48	2.17	2.12	3.00	2.25	0.29	0.46
LSD =0.05	1.82	1.35	6.18	6.04	8.56	6.42	0.83	1.32

Table 2. Effect of crop establishment methods and varieties on growth and yield attributes of rice

Treatment	Grains/panicle		Filled grains/ panicle		Unfilled grains/ Panicle		Test weight(g)	
	2014	2015	2014	2015	2014	2015	2014	2015
Method of establishment								
Direct seeding by drill	181	172	160	156	20	17	22.6	24.0
Unpuddled transplanting	167	162	151	150	16	13	22.7	23.4
Puddled transplanting	161	154	147	144	14	10	22.7	23.0
SEm±	1.62	1.74	1.51	1.79	0.55	0.42	0.1	0.144
LSD =0.05	4.89	5.26	4.57	5.41	1.65	1.27	NS	0.435
Varieties								
SahbhagiDhan	171	163	152	149	18	14	22.1	23.5
SushkSamrat	180	172	164	159	16	13	24.8	24.1
Abhishek	159	154	143	142	16	12	21.0	22.9
SEm±	1.2	1.53	1.18	1.55	0.50	0.47	0.10	0.14
LSD =0.05	3.4	4.36	3.37	4.43	1.43	1.34	0.29	0.39

Effect of Varieties

The growth and yield attributes in terms of plant height, tillers/m2, panicles/m2, 50% flowering, grains/panicle, filled grains/panicle and test-weight were significantly influenced by different varieties. Significantly higher plant height was recorded with Sahbhagidhan than SushkSamrat and Abhishek in both the years. In 2104, 3.43 and 8.27 per cent , more tillers/m2 were recorded with Sushk Samratthan over Sahbhagi dhan and Abhishek, respectively. However in 2015, maximum number of tillers/ m2were recorded with SushkSamrat,and being at par with Sahbhagidhan, both were significantly superior to Abhishek. Panicles /m2 were also recorded significantly maximum with SushkSamrat, and being at par with Sahbhagidhan, both were

Table 3. Effect of crop establishment methods and varieties on yield and economics of rice

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Method of establishment										
Direct seeding by drill	5,263	4,391	5,997	5,800	62,571	54,097	34395	25597	2.23	1.90
Unpuddled transplanting	4,879	4,196	5,464	5,652	57,910	51,805	27535	20455	1.90	1.65
Puddled transplanting	4,619	4,046	5,334	5,375	54,987	49,875	21412	16075	1.63	1.48
SEm±	24.60	37.69	32.48	78.83	263	466	263	466	0.08	0.02
LSD =0.05	74.4	114.0	98.2	238.4	796	1409	796	1409	0.023	0.045
Varieties										
SahbhagiDhan	4,752	4,191	5,584	5,643	56,672	51,739	26030	20522	1.86	1.67
SushkSamrat	5,241	4,379	5,882	5,728	62,228	53,902	31585	22685	2.05	1.73
Abhishek	4,767	4,062	5,329	5,455	56,569	50,137	25927	18920	1.86	1.61
SEm±	27.87	35.80	30.02	67.78	310	421	310	421	0.01	0.014
LSD =0.05	79.5	102.0	85.6	193.3	885	1201	885	1201	0.03	0.04

significantly higher than Abhishek. As compared to other varieties, Sushk Samrat took shortest time of 85 and 78 days to 50 per cent flowering in 2014 and 2015, respectively (Table1). The significantly higher grains/panicle and filled grains /panicle were recorded with SushkSamrat over Sahbhagidhan and Abhishek. This was ascribed to the reason that Sahbhagidhan and Abhishek lodged due to rain and wind, whereas SushkSamrat escaped lodging at the time of maturity. The regular rainfall also suited to SushkSamrat as the variety did not face long dry spell during its growth period. Test weight was also significantly higher with SushkSamrat than Sahbhagidhan and Abhishek (Table 2).

The yield is an important indicator to access the competitive ability of rice cultivar. The maximum grain yield was recorded with SushkSamrat over Sahbhagidhan and Abhishek. SushkSamrat produced 10.29and 9.94 per cent more yield in 2014 and 4.18 and 7.80 per cent in 2015 over Sahbhagidhan and Abhishek, respectively. In variety SushkSamrat, the straw yield was more by 5.0 & 10.37 per cent during 2014 and by 2.0 & 5.0 per cent during over Sahbhagidhan and Abhishek, respectively (Table 3). Among the rice varieties SushkSamrat earned the highest net income and benefit-cost ratio. The net income was 9.80 and 10 per cent more in 2014 and 4.18 and 7.51 per cent higher in 2015 with SushkSamrat over Sahbhagidhan and Abhishek, respectively. Higher benefit-cost ratio by 21.34 and 21.82 per cent in 2014, and by 10.54 and 19.90 per cent in 2015 was recorded with SushkSamrat over Sahbhagidhan and Abhishek, respectively (Table 3). The sale rate of produce for all cultivars were the same, thus the difference in net income was largely due to variation in yield level.

CONCLUSION

The result of our study revealed that labor-intensive and costly method of transplanting could be substituted by direct seeding with no sacrifice in productivity with best management practices. Rice can be direct seeded with zero-till drill/ direct seeding machine and conventional drill fitted with inclined plate metering device as seed metering mechanism. SushkSamrat under rainfed situation produced higher grain yield and straw yield. Sahbhagidhan and Abhishek are also other suitable options for rice cultivation in rainfed ecology.

REFERENCES

Gill M S, Kumar A and Kumar P (2006). Growth and yield of rice (Oryza sativa) cultivars under various methods and time of sowing. *Indian J Agron* **51**(2): 123–127.

Kaur Simerjeet and Surjit Singh (2016). Energetics productivity and weed control in different rice (Oryza sativa) establishment methods in North-Western Indo-Gangetic Plains. *Indian Agron* **61** (2): 179-185.

Kukal S S and Aggarwal G C (2003). Puddling depth and intensity effects in rice–wheat system on a sandy loam soil. I. Development of subsurface compaction. *Soil and Tillage Res* **72**: 1–8.

Kumar V and Ladha J K (2011). Direct seeding of rice: recent developments and future research needs. *Adv in Agron* 111: 297–413.

Mishra J S and Singh V P (2012a). Tillage and weed control effects on productivity of a dry-seeded rice-wheat system in a Vertisol in Central India. *Soil and Tillage Res* **123**: 11–20.

Mishra J S and Singh V P (2012b). Effect of tillage sequence and weed management on weed dynamics and productivity of direct-seeded rice (*Oryza sativa*)–wheat (*Triticum aestivum*) system. *Indian J Agron* **57**(1): 14–19.

Sharma R P, Pathal S K and Singh R C (2007). Effect of nitrogen and weed management in direct-seeded rice (*Oryza sativa*) under upland conditions. *Indian J Agron* **52**(2):114–19.

Singh K K, Jat A S and Sharma S K (2005). Improving productivity and profitability of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system through tillage and planting management. *Indian J Agri Sci* **75**(7): 396–399.

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