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Effect of planting methods and varieties on growth and yield of paddy under rainfed conditions

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Abstract
A field experiment was carried out using split plot design with three replications during Kharif 2017 to evaluate the effect of planting methods and varieties on growth and yield of paddy under rainfed conditions. The study comprised of five planting methods as main plots and two varieties as sub plots replicated thrice. Significantly superior plant height, number of effective tillers plant^{-1}, number of panicles plant-1 and number of grains panicle^{-1} were observed with PKV SRI method transplanted at 25 cm x 25 cm over rest of the treatments. While drilling at 20 cm and farmers practice were at par with respect to all yield attributes and yield of paddy. Plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1} and number of grains panicle^{-1} were not influenced due to varieties. Maximum grain yield (27.96 q ha^{-1}) and straw yield (42.93 q ha^{-1}) were obtained with the method of PKV SRI transplanting at 25 cm x 25 cm which was significantly superior over other methods. The PKV SRI transplanting at 20 cm x 20 cm was found to be at par with drilling at 25 cm; drilling at 20 cm and farmers practice.

Keywords: Paddy, planting methods, varieties, growth, yield

Introduction
Rice (*Oryza sativa* L.) is an important staple food crop of India, contributing 45% to the total food grain production. It is extensively grown in Eastern, Northern and Southern states of the country. In India, rice is grown under diverse agro-ecological condition such as irrigated (19.6 million ha.), rainfed upland (7.1 million ha.), lowland (16.0 million ha.) and deep water (1.5 million ha.). It is widely grown in South-Eastern part of the country covering an area of 56.08 million ha. With an annual production of 92.6 million tonnes. India rank first in respect of area 44.50 million ha., second in production 102.75 million tonne, only after China, but the productivity of rice is very low only 2.20 tonne ha^{-1} which is quite low as compared to other rice growing countries like Japan (6.8 t ha^{-1}), Korea (6.1 t ha^{-1}), China (5.9 t ha^{-1}) and Indonesia (4.3 t ha^{-1}). Among the different agronomic practices, planting methods and choice of variety play a vital role in achieving higher yield levels of rice. It is because of the proper distributions of crop plant unit^{-1} area and efficient utilization of available resources as well as environment. Rice is grown under direct seeding either dry broadcast after receiving first flush of shower or wet seeding of sprouted seeds in the puddle soil, which severely suffers from weeds resulting in very low yields. However, direct seeding of rice have several advantages i.e. saves labours, faster and easier planting, timely sowing, less drudgery, early crop maturity by 7–10 days, less water requirement, high tolerance to water deficit often high yield, low production cost and more profit, better soil physical condition for succeeding crops and less methane emission. Further looking on the intensification in limited field, the System of Rice Intensification (SRI) has been highly emphasized to maximize the production of rice. Careful transplanting of young seedlings at a wider spacing under SRI cultivation ensures more number of tillers, more root growth and panicle length. Through appropriate water management strategies under SRI the field is kept moist and not flooded ensuring lesser water requirement for crop. System of Rice Intensification (SRI) is an alternative practice to solve the water crisis and as a methodology for increasing the productivity of irrigated rice by changing the management of plant, soil, water and nutrients. Keeping these in view, the research was carried out to know the suitable planting methods and variety for higher yield of rice under rainfed conditions.

Material and Methods

A field experiment was conducted during Kharif season of 2017 at Agronomy Farm, College of Agriculture (Dr. PDKV), Nagpur, Maharashtra under rainfed conditions. The soil of the experiment field was sandy clay loam in texture with pH 7.8, organic carbon 0.616% and available N, P_2O_5 and K_20 as 275.9, 24.09 and 379.0 kg ha^{-1} respectively. The total rainfall received during Kharif 2017 (1stJuly to 30th October) was 951.4 mm in 40 rainy days. The experiment was conducted in split plot design replicated thrice with 10 treatment combinations comprising five different drilling and transplanting methods viz., drilling at 20 cm (P_1), drilling at 25 cm (P_2), PKV SRI method transplanting at 20 cm x 20 cm (P_3), PKV SRI method transplanting at 25 cm x 25 cm (P_4), and farmers practice (random transplanting) (P_5) as main plots and two varieties Sye-1 (V_1) and Skl-6 (V_2) as sub plots. For SRI method, 20 cm x 20 cm & 25 cm x 25 cm markers were used for transplanting 18 days old seedlings and for farmers practice 25 days old seedlings were used for transplanting. FYM was incorporated one week before transplanting. Organic manures i.e FYM @ 5 t ha^{-1} were applied one week before planting. 1/3rd nitrogen, total phosphorus and potassium were applied as basal at the time of drilling and puddling operations. 1/3rdN was applied at maximum tillering stage and remaining 1/3rdN was applied at panicle initiation stage. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash respectively. The crop was sown on 28th June 2017 (nursery & drilling) and transplanted on 17th July 2017. In SRI method, conoweeder was operated for 2 times for control of weeds. Plant protection measures and agronomical practices were followed as per need. The observations on plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1}, number of grains panicle^{-1}, grain yield and straw yield plot^{-1} were recorded at harvest. Data were collected and analyzed statistically.

Result and Discussion

Data regarding plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1}, number of grains panicle^{-1}, grain yield and straw yield (q ha^{-1}) at harvest are presented in table 1.

Table 1: Growth and yield attributes of paddy as influenced by different planting methods and varieties.

Treatments	Plant height (cm)	No. of effective tillers hill^{-1}	No. of panicles plant^{-1}	No. of grains panicle^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Planting methods						
P_1 Drilling at 20 cm	65.89	8.51	6.16	139.10	20.76	31.76
P_2 Drilling at 25 cm	70.48	10.49	8.34	150.02	23.90	36.00
P_3 PKV SRI 20 cm x 20 cm	72.54	11.77	8.93	152.51	24.77	37.20
P_4 PKV SRI 25 cm x 25 cm	77.13	13.82	10.69	159.52	27.96	42.93
P_5 Farmers practice	67.93	9.49	7.01	141.85	21.97	33.84
SE (m) ±	0.82	0.32	0.28	1.31	0.53	0.67
CD at 5%	2.66	1.04	0.90	4.29	1.73	2.18
Varieties						
V1 SYE-1	70.03	10.66	8.07	147.17	23.42	35.84
V2 SKL-6	71.55	10.97	8.38	150.03	24.33	36.85
SE (m) ±	0.30	0.14	0.11	0.98	0.30	0.35
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Interaction						
SE (m) ±	0.67	0.31	0.24	2.19	0.66	0.79
CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Planting methods

Plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1}, number of grains panicle^{-1} at harvest were significantly influenced due to different methods of planting. Significantly superior plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1}, number of grains panicle^{-1} were observed with PKV SRI method transplanted at 25 cm x 25 cm over rest of the treatments. The treatment PKV SRI 20 cm x 20 cm was found to be at par with the treatment drilling at 25 cm in terms of plant height, number of panicles plant^{-1}, number of grains panicle^{-1}. While the treatment drilling at 20 cm and farmers practice was at par with respect to all yield attributes. These findings are in agreement with those obtained by Aslam *et al*. (2008) [3] and Prasad *et al*. (2001) [14] who reported that, transplantation of rice increased all the growth and yield attributes of rice over direct seeding.

Grain and straw yield (q ha^{-1}) were significantly influenced due to different planting methods. Maximum grain yield (27.96 q ha^{-1}) and straw yield (42.93 q ha^{-1}) was observed with the method of PKV SRI Method transplanting at 25 cm x 25 cm which was significantly superior over remaining methods. The treatment PKV SRI transplanting at 20 cm x 20 cm was found to be at par with treatment drilling at 25 cm, 20 cm and farmers practice. Same trend was noticed with regard to straw yield. Similar results were obtained by Muhammad *et al*. (2017) [13] who reported that the maximum rice straw was obtained by rice seedlings transplantations due to better establishment and growth of rice plants over direct seed sowing. The maximum yield of grain and straw under SRI method may be due to the maximum plant growth parameters by maximum translocation of photosynthates (Thiyagarajan, 2007; Xu Feng *et al*. 2005) [18, 21]. Larry *et al*. (2012) [9] studied planting methods, the most consistent planting method and best in almost all examined parameters under individual years was the seedling transplanting method followed by direct seed drilling method. Seedling transplanting method was not significantly different from direct drilling method in almost all parameters examined. Mehra *et al*. (2017) [12] reported that among the different tested varieties, Pro-Agro 6444 produced significantly highest grain yield than other varieties and further under SRI system found higher yield attributing characters and finally produced maximum grain yield. Bozorgi *et al*. (2011) [5] reported high grain yield in transplanting at 15 cm × 15 cm treatment as compared to 20 cm × 20 cm and 25 cm × 25 cm. The experiment conducted on the effect of spacing 20 cm × 10 cm, 15 cm × 10 cm and 10 cm × 10 cm on the grain yield of early, medium and late duration tall growing *indica* varieties showed that spacing of

10 cm × 10 cm gave higher yield in case of early maturing varieties while the spacing of 20 cm × 10 cm gave the higher yield for medium and late maturing varieties (Chandrankar and Khan, 1981) [6].

Varieties

Plant height, number of effective tillers plant^{-1}, number of panicles plant^{-1}, number of grains panicle^{-1}, grain yield and straw yield (q ha^{-1}) at harvest were not influenced due to varieties. The results were non-significant. Interaction effects were found non-significant. Rana *et al*. (2014) [15] reported the rice crop established with direct seeding of the dry and sprouted seed matured 7 days earlier than transplanting. The variety BRRI dhan-39 gave the highest yield when grown with direct seeding of sprouted seed compared to other varieties. Treatment interaction effects were found non-significant.

All these above parameters were high in transplantation because of proper spacing for good water management (Mazid *et al*. 2003) [11] photosynthetic activities and assimilate partitioning (Kundu *et al*. 1993) [8], thereby resulting in good yield in well spaced rice fields. The low paddy yields recorded in drilling and farmers practice than transplanting method could have been due to overcrowding of plants thereby competition for moisture, nutrients, space and sunlight. Lower light penetration to lower leaves increases foliar shading and produces thinner stem. All these factors collectively contribute to a decrease in photosynthesis; assimilate production and its partitioning resulting reduction in stem diameter. However, plants grown in wider spacing have more area of land around them to extract more nutrients and had more solar radiation to absorb for better photosynthetic process. The results are quite in line with Thakur (1993) [17] and Mahajan *et al*. (1995) [10] who achieved higher grain yield in transplanted technique as compared to direct sowing. Ali *et al*. (2013) [1] during the study revealed that grain yield of the different planting techniques were in the order line transplantation > conventional transplantation> direct seed dibbling> direct seed drill > pre germinated seed broadcast. Ashwini Kumar Thakur *et al*. (2017) [2] recorded significantly higher number of tillers, panicle length, grain yield, straw yield under SRI method followed by improved transplanting method. Berhanu (2017) [4] obtained higher grain yield in 50 hills m^{-2} followed by 16.7 hills m^{-2}, but it was not significantly different among density treatments. Gupta *et al*. (2003) [7] reported 10% higher yields in direct seeded rice than flooded transplanting. Sheikh (1977) [16] also reported an increase of grain yield due to the increase in the panicle number unit^{-1} ground area. Uddin *et al*. (2010, 2011) [19, 20] indicated 20.6% grain yield increments from 120 plants m^{-2} as compared to 20 plants m^{-2}.

Conclusion

Transplanting by PKV SRI method at 25 cm x 25 cm recorded significantly superior all growth attributes and yield over rest of the treatments. Transplanting by PKV SRI at 20 cm x 20 cm was found to be at par with the treatment drilling at 25 cm. The varieties were found non-influenced in terms of growth and yield parameters by different planting methods.

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