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Research Article

EFFECT OF AGE OF SEEDLINGS AT TRANSPLANTING, SPACING AND LEVELS OF FERTILIZER ON YIELD, NUTRIENT CONTENT AND UPTAKE OF HYBRID RICE (*ORYZA SATIVA* L.)

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Abstract: The field experiment was conducted at Agronomy farm of Dr B.S.K.K.V., Dapoli to study the effect of age of seedlings at transplanting, spacing and levels of fertilizer on yield, nutrient content and uptake of the hybrid rice during kharif seasons of year 2015 and 2016. Transplanting of 15 days old seedlings recorded significantly higher grain and straw yield, as well as N, P and K content and their uptake. Significantly higher grain and straw yield obtained by 15 cm×15 cm spacing. The N, P and K content both in the grain and straw were not influenced significantly due to different levels of spacing. However, significantly higher uptake of N, P and K in the grain and straw of the hybrid rice recorded with 15 cm×15 cm. Application of 125% RDF recorded significantly higher grain and straw yield as well as N, P and K content and their uptake.

Keywords: *Age of seedlings, Spacing, Fertilizer, Hybrid Rice*

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Introduction

Rice *(Oryza sativa* L.) is the staple food, feeding more than half of the world's population every day. In Asia, it has a special significance, where about 90% of the rice is produced and consumed as a staple food. In India, rice is the most important and extensively grown food crop, occupying an area of 44.11 million hectares with production of 105.48 million tonnes [1]. Rice is also an important cereal food crop of Maharashtra state, which contributes 3.6% of area and 2.8% of production of rice at national level. Among the different rice growing states of India, there are regional imbalances with regard to average yield. Rice is the main food crop grown in Konkan region, which occupies an area of 3.79 lakh hectares with production 9.94 lakh tones and productivity of 2.61 tonnes ha^{-1}[2]. The main reasons of low productivity and profitability are mainly viz., vagaries of nature, low fertilizer use efficiency, poor crop management and adherence of farmers to traditional crop management practices. The yield of high yielding varieties of rice is plateauing; it is rather difficult to achieve this target with the present-day inbred varieties. Hybrid rice technology has been identified as one of the alternative means to meet the challenge of food security for the increasing population [3]. The success of hybrid rice cultivation depends on the exploitation of the full heterotic potential of the hybrids with improved package of practices such as suitable genotype, optimum plant population and optimum nutrition. As the production potential and nitrogen use efficiency of hybrid rice is high. The nutrient requirement of the hybrid varieties may be different. It is, therefore, very essential to work out the nutrient management package for hybrid rice under different agroeco-system, so as to increase the nutrient use efficiency for maximization of rice yield. Seedling age at transplanting is an important factor for uniform rice stands which regulates potential agronomic traits, i.e. tillering, panicle number and grain yield per unit land area leading to sustained rice production [4]. Thus, to improve yield and quality of rice, optimum age of seedling for transplanting needs investigations. Plant density required for maximum grain yield need to be standardized, as the seed of hybrid rice is very costly. It is, therefore, necessary to determine the optimum plant spacing for obtaining high yield of hybrid rice.

Materials and methods

The experiment was conducted at Agronomy Farm, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during Kharif season of 2015 and 2016 to evaluate the effect of age of seedlings at transplanting, spacing and levels of fertilizer on yield, nutrient content and uptake of hybrid rice (*Oryza sativa* L.). The soil of experimental field was clay loam in texture, slightly acidic in reaction with high organic carbon content. Soil was medium in available nitrogen (322.51 kg ha^{-1}), low in available phosphorus (11.21 kg ha^{-1}) and high in available potassium (273.73 kg ha^{-1}). The field experiment was laid out in strip plot design comprising of 27 treatment combinations replicated thrice. The horizontal strips treatments comprised combinations of three age of seedlings at transplanting (T1- 15 days, T2- 30 days and T3- 45 days) and three levels of spacing (S1- 15 cm × 15 cm, S2- 20 cm × 15 cm and S3- 30 cm × 15 cm) while three levels of fertilizer (F1- 75% Recommended dose of NPK fertilizers (RDF), F2- 100% Recommended dose of NPK fertilizers (RDF) and F3- 125% Recommended dose of NPK fertilizers (RDF)) assigned in the vertical strips. The gross plot size was 4.2 m × 3.0 m. the hybrid rice variety "Sahyadri-3" was selected for investigation. Fertilizer application (RDF: 150:50:50 kg NPK) were done as per the treatment. full dose of P_2O_5 and K_2O and half dose of N were applied basal at the time of transplanting as per treatments and remaining 40% N was applied at maximum tillering stage and another 20% at panicle emergence stage as per the treatments. The grain and straw yield were recorded by weight of produce in plot wise. The concentration of N, P and K in plant sample were estimated by modified Microkjedahl's method, Colorimetric method and Flame photometer, respectively. Similarly, the N, P and K uptake by hybrid rice was determined by multiplying respective concentrations with grain and straw yield per hectare. The data recorded for different parameters were analysed with the help of analysis of variance (ANOVA) technique for a strip plot design. The results are presented at 5% level of significance (P=0.05)

Table-1 *Grain yield, straw yield, NPK content and NPK uptake of hybrid rice (Sahyadri-3) as influenced by the different treatments in the pooled mean of two years (2015 and 2016)*

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	N content (%)		P content (%)		K content (%)		N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
			Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Age of seedlings at transplanting														
T_1:15 days	77.70	93.19	1.123	0.549	0.220	0.113	0.329	1.129	87.29	51.26	17.10	10.54	25.55	105.28
T_2:30 days	69.26	83.32	1.105	0.538	0.215	0.104	0.318	1.124	76.59	44.86	14.89	8.66	22.02	93.71
T_3:45 days	62.81	75.78	1.082	0.529	0.211	0.093	0.306	1.118	68.08	40.17	13.24	7.03	19.24	84.78
SEm ±	0.54	0.65	0.006	0.002	0.001	0.001	0.001	0.002	0.68	0.37	0.12	0.07	0.19	0.78
C.D. at 5%	1.63	1.95	0.019	0.007	0.003	0.002	0.002	0.006	2.03	1.09	0.37	0.22	0.58	2.34
Spacing														
S_1:15 cm × 15 cm	72.37	87.19	1.094	0.534	0.213	0.102	0.317	1.120	79.41	46.75	15.47	8.96	23.00	97.81
S_2:20 cm × 15 cm	69.56	83.78	1.103	0.539	0.215	0.103	0.317	1.123	76.93	45.27	14.98	8.73	22.12	94.19
S_3:30 cm × 15 cm	67.84	81.32	1.112	0.543	0.217	0.104	0.319	1.128	75.63	44.27	14.78	8.54	21.69	91.78
SEm ±	0.54	0.65	0.006	0.002	0.001	0.001	0.001	0.002	0.68	0.37	0.12	0.07	0.19	0.78
C.D. at 5%	1.63	1.95	NS	NS	NS	NS	NS	NS	2.03	1.09	0.37	0.22	0.58	2.34
Fertilizer levels														
F_1:75% RDF	65.32	78.98	1.067	0.512	0.210	0.100	0.311	1.103	69.84	40.47	13.77	7.96	20.39	87.20
F_2:100% RDF	71.19	85.57	1.100	0.539	0.215	0.104	0.319	1.126	78.44	46.20	15.31	8.94	22.73	96.33
F_3:125% RDF	73.26	87.74	1.142	0.565	0.220	0.106	0.322	1.142	83.68	49.62	16.14	9.33	23.68	100.25
SEm ±	0.38	0.51	0.007	0.002	0.001	0.001	0.001	0.002	0.66	0.33	0.10	0.07	0.13	0.62
C.D. at 5%	1.50	2.01	0.028	0.009	0.004	0.002	0.003	0.008	2.59	1.30	0.38	0.27	0.51	2.45
Interaction Effect														
T × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
T × F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
F × S	SIG	SIG	NS	NS	NS	NS	NS	NS	NS	NS	SIG	NS	SIG	SIG
T × S × F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table-2 *Interaction effect of spacing and fertilizer levels on the grain yield and straw yield (q ha^{-1}) in the pooled mean*

Fertilizer levels	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	Spacing			Spacing		
	S_1	S_2	S_3	S_1	S_2	S_3
F_1	66.98	64.05	64.93	80.97	77.62	78.36
F_2	74.56	71.15	67.85	89.76	85.77	81.17
F_3	75.59	73.47	70.73	90.84	87.95	84.43
Mean	72.38	69.56	67.84	87.19	83.78	81.32
SEm±	0.66			0.89		
C.D. at 5%	1.91			2.55		

Table-3 *Interaction effect of spacing and fertilizer levels on the phosphorus uptake by grain and potassium uptake by grain and straw (kg ha^{-1}) of the hybrid rice in the pooled mean*

Fertilizer levels	*Phosphorus uptake* (kg ha^{-1})			*Potassium uptake* (kg ha^{-1})					
	Grain			Grain			Straw		
	Spacing			Spacing			Spacing		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
F_1	13.99	13.46	13.87	20.92	19.86	20.40	89.08	85.53	86.98
F_2	15.90	15.27	14.77	23.72	22.71	21.76	100.78	96.53	91.69
F_3	16.52	16.20	15.69	24.35	23.80	22.90	103.58	100.50	96.66
Mean	15.47	14.98	14.78	23.00	22.12	21.69	97.81	94.19	91.78
SEm±	0.17			0.23			1.08		
C.D. at 5%	0.48			0.65			3.11		

Results and discussion

Effect of age of seedlings at transplanting on yield, nutrient content and uptake of hybrid rice

The data presented in [Table-1] showed that, the transplanting of 15 days old seedlings recorded significantly higher grain and straw yield in the pooled data as compared to rest of the age of seedlings at transplanting followed by the transplanting of 30 days and 45 days old seedlings in the descending order of significance. The mean increase in the yield due to transplanting of 15 days old seedlings over 30 days and 45 days old seedlings was to the tune of 12.19 and 23.71 percent in grain yield and 11.85 and 22.97 percent in straw yield, respectively. This might be due to increased morphological characters viz., plant height, number of leaves hill^{-1}, number of tillers hill^{-1} and dry matter production hill^{-1} observed under transplanting of 15 days old seedlings. This result corroborates the findings of Singh and Singh (1998) [5] who revealed that significantly highest straw yield was recorded with 25 days old seedling age, when compared with 35and45 days old seedlings. The nitrogen, phosphorus and potassium content both in the grain as well as in the straw were increased significantly due to transplanting of 15 days old seedlings compared to rest of the age of seedlings at transplanting in the pooled mean of the two years. However, in case of nitrogen content in grain and potassium content in straw, transplanting of 30 days old seedlings recorded higher value and was at par with the transplanting of 15 days old seedlings in the pooled mean. Transplanting of 15 days old seedlings significantly increased the uptake of nitrogen, phosphorus and potassium by the grain and straw of the hybrid rice in the pooled mean followed by 30 days and 45 days old seedlings in the descending order of significance. In fact, the significant variations in NPK concentrations in the grain and straw and their respective grain and straw yields have caused a significant difference in N, P and K uptake by the different age of seedlings. This might be due to vigorous and healthy growth of the plant which developed more productive tillers and stronger root system and insure greater resource utilization and uptake of nutrients. The present findings are in close agreement with those reported by Aggarwal and Singh (2015) [6] and Chaudhari, *et al*., (2015) [7].

The mean increase in the grain and straw yield with 15 cm × 15 cm spacing over 20 cm × 15 cm and 30 cm × 15 cm spacing was to the tune of 4.04, 6.68 and 4.07, 7.22 percent, respectively. An increase in the grain and straw yields under the spacing of 15 cm × 15 cm was due to the fact that less spacing provided a greater number of plants per unit area which resulted in more yield per unit area as compared to the wider spacing. On the contrary, the lower grain and straw yields under spacing of 30 cm × 15 cm was due to the less plant population which resulted in reduction of grain and straw yields. Banerjee and Pal, (2011) [8] also reported that at wider spacing number of effective tiller m-2, filled grains panicle-1 and test weight recorded higher but produced lower yield due to lesser number of plants m-2 as compared to the closer spacing. These results are in accordance with Kewat, *et al*., (2002) [9]. The nitrogen, phosphorus and potassium content in the grain as well as in the straw was not influenced significantly due to the different levels of spacing in the pooled mean of two years study. Spacing of 15 cm × 15 cm recorded significantly higher uptake of nitrogen, phosphorus and potassium in the grain and straw of the hybrid rice which was followed by 20 cm × 15 cm and 30 cm × 15 cm spacing in the descending order of significance in the pooled data. This is due to the fact that less spacing provided a greater number of plants which results in more uptake of nutrient per unit area as compared to wider spacing. This is due to the higher planting density (15 cm × 15 cm) resulted in the higher plant population per unit area and therefore significantly higher grain and straw yield which resulted into higher uptake of the above referred nutrients. These results are in conformity with that of Mahato, *et al*., (2007) [10] and Meas, *et al*., (2011). [11].

Effect of levels of fertilizer on yield, nutrient content and uptake

In the pooled mean of the two years of experimentation, significantly higher grain and straw yields were recorded with application of 125% RDF than the other fertilizer levels and it was followed by 100% and 75% RDF in the descending order of significance. The percent increase in the grain and straw yields in the application of 125% RDF was 2.91, 12.16 and 2.54, 11.09 percent over the application of 100% and 75% RDF respectively in the pooled data. The better growth and yield attributes with the application of the higher level of nutrients might have played key role in the root development, nutrient uptake, energy translocation and metabolic process through which increased translocation of photosynthates towards the sink development. The increase in NPK levels might have regulated adequate supply of nutrients to the crop over prolonged period that ultimately resulted in increased grain and straw yield as suggested by Paramasivan, *et al*., (2016) [12]. In respect of the nitrogen, phosphorus and potassium content both in the grain and straw of hybrid rice were significantly higher under application of 125% RDF followed by application of 100% RDF and 75% RDF in the descending order of significance in the pooled mean. However, in case of phosphorus content in the straw and potassium content in the grain, the application of 100% RDF remained at par with the 125% RDF in the pooled mean. Application of 125% RDF significantly increased the uptake of nitrogen, phosphorus and potassium by the grain and straw of the hybrid rice in the pooled mean followed by the application of 100% and 75% RDF in the descending order of significance. This could be ascribed to the increase in the available N, P and K contents in the soil resulting from the increasing availability of nutrients which ultimately increased nutrient content in the plant tissue and greater biomass production. Since the uptake of nutrient is a function of dry matter and nutrient content, the increased straw and grain yields together with higher NPK content resulted in greater uptake of these elements. These findings are in close conformity with the results reported by Paramasivan, *et al*., (2016) [12] and Murthy, *et al*., (2015) [13].

Interaction effects

Regarding interaction effects [Table-2], it was observed that spacing of 15 cm × 15 cm and application of 100% RDF (S1F2) produced significantly higher grain and straw yield ha^{-1} than the remaining treatment combinations. In addition to this phosphorus uptake by the grain of the hybrid rice was significantly more under spacing of 15 cm × 15 cm and application of 125% RDF (S1F3) treatment combination. Further potassium uptake in grain and straw of the hybrid rice was also higher under spacing of 15 cm × 15 cm and application of 125% RDF (S1F3) treatment combination [Table-3].

Conclusion

From the results of present investigation, it can be conclude that transplanting of 15 days old seedlings of hybrid rice variety "Sahyadri-3" at a spacing of 15 cm × 15 cm followed by application of 125% recommended dose of fertilizer may be adopted to get higher grain yield, straw yield, NPK content and its uptake by hybrid rice.

Application of research: Transplanting of seedlings at right age at optimum spacing with optimum dose of fertilizers will helps to increase crop yield.

Research Category: Crop management

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Study area / Sample Collection: Agronomy farm, College of Agriculture, Dapoli.
Cultivar / Variety / Breed name: Rice hybrid variety Sahyadri-3

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