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Effect of Method of Establishment, Spacing and Nutrient Source on Growth and Yield of Rice

RAJINDER DHAR[1], S. KOTWAL[2], A. K. BHAT[3] AND N. K. GUPTA[1]

[1]*Water Management Research Center,* [2]*Department of Agriculture,* [3]*Department of Soil Science & Agricultural Chemistry, SK University of Agricultural Sciences—J Chatha 180009, India*

Abstract

A field experiment conducted during two *kharif* seasons of 2006 and 2007 to evaluate the effect of method of crop establishment, spacing and nutrient source on the growth and yield of rice under the agro-climatic conditions of Jammu region. Grain yield did not increase significantly over conventional method when rice was grown with SRI technique, but closer spacing of 20 × 15 cm and inorganic source of nutrient had significant influence on yield. However, conventional method significantly affected N, P and K contents of the soil, whereas wider spacing and organic source of nutrient resulted in higher N, P and K contents of the soil. SRI technique resulted in higher uptake of N, P and K in grains which was statistically higher than conventional technique and the closer spacing and inorganic source of nutrient had statistically more N, P and K compared to wider spacing and organic source respectively. Similarly, net return and B : C ratio was more with SRI technique, closer spacing of 20 × 15 cm and inorganic source of nutrient compared to conventional method of transplanting, wider spacing and organic source of nutrient.
Key words : SRI technique, Conventional technique, Organic source, Inorganic source, Nutrients.

India is the second largest rice producing country in the world but the average yield of around 2,890 kg/ha of paddy is lower than that of world average yield of 3,747 kg/ha (1). India needs to increase production by at least 2.5 million tones of milled rice every year to sustain the present level of productivity (2). Improvement in rice productivity is one of the main objectives of any agricultural and rural development program. Implementation of agricultural productivity improvement program like introduction of improved high yielding varieties, fertilizer split application, and integrated weed and pest management, use of organics was promoted on large scale to improve food security. However, economic viability of high input approach for poor farmers is still questionable especially taking into consideration that production system has hardly being able to increase yield beyond 2 tones/ha mark (3). To assure the food security in rice consuming countries of the world, those countries will have to produce 50% more rice with improved quality to meet consumers demand by 2025 (4). This additional rice will have to be produced on less land with less water, less labor and fewer chemicals. The rice production can be increased by capitalizing upon existing genetic potential by crop management practices when growing irrigated rice (5). That means by changing the management of rice plant, soil, water and nutrients to bring dramatic effect on growth and yield of rice. The present study on the management of rice using existing genotype along with establishment technique, spacing and nutrient source is an attempt in this direction.

Methods

The experiment was laid out in *kharif* of 2006 and 2007 in factorial randomized block design at research farm of SKUAST-Jammu, with 16 treatment combinations comprising two methods of establishment, conventional (25 days old seedling and 3 seedling/hill) and system of rice intensification (10—12 days old seedling and 1 seedling/hill), four spacings of 20 × 15 cm, 20 × 20 cm, 25 × 25 cm and 30 × 30 cm and two nutrient sources, inorganic fertilizer in the ratio of 160 : 60 : 30 : : N : P : K/ha through urea, DAP and MOP and organic in the form of vermicompost at 6 tones/ha whereas test variety was PR-113 during both the years of experiments. The N, P and K con-

Table 1. Effect of method of establishment, spacing and nutrient source on growth and yield attributes of rice (pooled over years).

Treatment	Plant height (cm)	Dry matter g/hill	LAI	No. of effective tillers (m^2)	Wt/ panicle (g)	Panicle of length (cm)	No. of grains/ panicle	1000- grain wt
Establishment Technique								
Conventional	98.90	36.58	4.98	194.00	6.76	24.10	176.63	23.46
SRI	101.66	42.87	5.06	201.40	6.90	24.50	182.63	23.08
SE ±	0.94	0.15	0.005	5.55	0.33	0.22	1.29	0.23
LSD (P = 0.05)	2.71	0.43	0.014	NS	NS	NS	NS	NS
Spacing (cm)								
20 × 15	103.16	42.17	5.05	256.30	7.08	24.52	197.73	24.29
20 × 20	99.69	40.50	5.03	220.30	7.01	24.50	184.75	23.70
25 × 25	99.22	38.75	5.01	181.60	6.68	24.22	173.42	23.41
30 × 30	99.07	37.50	4.99	132.50	6.63	24.04	162.55	23.14
SE ±	1.33	0.21	0.007	7.85	0.45	0.32	1.82	0.32
LSD (P = 0.05)	NS	0.59	0.018	22.64	NS	NS	5.20	0.93
Nutrient Source								
Inorganic	102.44	45.79	5.11	203.50	7.43	24.41	193.30	24.28
Organic	98.53	33.67	4.93	191.80	6.27	24.23	165.97	22.98
SE ±	0.94	0.15	0.005	5.55	0.33	0.22	1.29	0.23
LSD (P = 0.05)	2.71	0.43	0.014	NS	0.93	NS	3.72	0.65

tents of vermicompost were determined before application during both the years by standard procedures so as to satisfy the N content by the vermicompost. The soil of the experimental field was sandy loam in texture, nearly neutral in reaction, medium in available phosphorus, and potassium but low in available nitrogen. Whole of the vermicompost, P and K along with half of N was applied as a basal dose at the time of puddling based on the treatment combinations and the rest of N was split in two parts, one at tillering stage and the other at panicle initiation stage during both the years. N content of grain and straw was determined by Kjeldals method (6) and phosphorus by vandomolybedate method and potassium by flame photometer (7) and the nutrient uptake was worked by multiplying content values by respective grain and straw yield.

Results and Discussion

Growth Attributes

The growth of rice is measured in terms of plant height, dry matter accumulation and LAI. Apart from method of sowing, spacing and nutrient source also plays an important role in growth and development of plant which is ultimately reflected in high biological and economical yield of crop.

Growth characters like plant height, LAI and dry matter accumulation were significantly increased in system of rice intensification (SRI) technique over conventional method (Table 1). However, yield attributing characters like no. of effective tillers/m^2, wt of panicle, panicle length, no. of grains/panicle and 1,000-grain wt were not significantly influenced by SRI technique. The significant increase in growth characters might be due to early transplanting of young seedling and planting one seedling/ hill which could have produced more growth due to less competition for nutrients and achievement of more phyllochrons before it moved from vegetative phase to reproductive phase (8).

Closer spacing of 20 × 15 cm significantly increased LAI, dry matter, no. of effective tillers/m^2, no of grains/panicle[1] and 1,000-grain wt compared to

Table 2. Effect of method of establishment, spacing and nutrient source on yield, H I and B : C ratio of rice (pooled over years).

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Biolo-gical yield (q/ha)	H I (%)	Net profit (Rs)	B : C
Establishment Technique						
Conventional	46.54	85.45	131.99	35.26	51274.37	3.29
SRI	47.70	88.48	136.18	35.03	53415.44	3.55
SE ±	1.49	4.44	4.96	1.45	–	–
LSD (P = 0.05)	NS	NS	NS	NS	–	–
Spacing (cm)						
20 × 15	52.84	102.64	155.48	33.98	60547.53	3.92
20 × 20	48.08	100.25	148.33	32.41	53987.40	3.52
25 × 25	44.87	74.35	119.22	37.64	4907.43	3.21
30 × 30	42.69	70.63	113.32	37.67	45807.25	3.01
SE ±	2.11	6.28	4.96	2.05	–	–
LSD (P = 0.05)	6.08	18.11	20.23	NS	–	–
Nutrient Source						
Inorganic	52.15	98.36	150.51	34.65	59269.02	3.77
Organic	42.09	75.57	117.66	35.77	45420.79	3.04
SE ±	1.49	4.44	7.01	1.45	–	–
LSD (P = 0.05)	4.30	12.80	14.30	NS	–	–

wide spacing whereas plant height, wt/panicle[1] and panicle length did not bring about any significant change with different spacings (Table 1). The significant increase could be due to more leaves per land area resulting in trapping more light and oxygen for higher photosynthetic activities and creating higher sink capacity of crop associated with vigorous growth of crop plant (9, 10). However, inorganic fertilizer significantly increased all the growth and yield attributing characters except no. of effective tillers/m^2 and panicle length than organic source. This could be due to rapid and continuous availability of nutrients during grand growth stage where inorganic source was applied. Similar findings were reported by Wangshao-bua et al. (11), Zong et al. (12) and Yadav et al. (13).

Grain, straw and biological yield recorded higher values under SRI technique but were statistically at par with conventional method yielding only 2.43, 3.42 and 3.67% more grain, straw and biological yield than conventional method of planting respectively (Table 2). Similarly, closer spacing of 20 × 15 cm produced significantly 8.76, 28.29 and 36.26 q/ha more grain, straw and biological yield over 25 × 25 cm and 10.15, 32.01and 42.16 q/ha more grain, straw and biological yield over 30 × 30 cm but were at par with 20 × 20 cm spacing (Table 2). The possible reason for higher yield under narrow spacing can be attributed to higher plant density per unit area and higher yield attributes resulting in more yield per unit area. Similar findings have been reported by Salem (9), Latif et al. (14) and Bhatta and Tripathi (15).

Inorganic source of nutrient proved better source of nutrition than organic source recording significantly more yield of 10.06, 22.79 and 32.85 q/ha of grain, straw and biological yield over organic source respectively. This additional yield may be due to relatively better availability of nutrients resulting in higher nutrient uptake that might have resulted in higher grain yield along with higher yield attributes of rice. Similar findings have been reported by Salem (9) and Randriamibarisoa (16).

However, establishment technique, spacing and

Table 3. Effect of method of establishment, spacing and nutrient source on available N, P and K (kg/ha), pH and EC (dS/m) of soil (pooled over years).

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	pH	EC dS/m
Establishment Technique					
Conventional	220.25	13.48	158.21	7.23	0.040
SRI	214.21	12.39	150.29	7.23	0.042
SE ±	0.30	0.17	0.15	0.001	0.001
LSD (P=0.05)	0.86	0.50	0.42	NS	NS
Spacing (cm)					
20 × 15	214.75	12.07	151.75	7.23	0.044
20 × 20	216.42	12.86	153.67	7.22	0.042
25 × 25	217.83	13.12	155.33	7.22	0.040
30 × 30	219.92	13.69	156.25	7.21	0.039
SE ±	0.42	0.25	0.21	0.002	0.001
LSD (P=0.05)	1.22	0.71	0.60	NS	NS
Nutrient Source					
Inorganic	209.46	12.57	146.00	7.23	0.041
Organic	225.00	13.30	162.50	7.22	0.040
SE ±	0.30	0.17	0.15	0.001	0.001
LSD (P=0.05)	0.86	0.50	0.42	NS	NS

Table 4. Effect of method of establishment, spacing and nutrient source on uptake of N, P and K (kg/ha) in rice (pooled over years).

Treatment	Grains (kg/ha) N	P	K	Straw (kg/ha) N	P	K
Establishment Technique						
Conventional	48.69	12.55	14.15	14.37	4.37	104.76
SRI	55.43	14.56	16.00	16.60	5.94	112.42
SE ±	1.98	0.42	0.48	0.79	0.27	5.692
LSD (P=0.05)	5.72	1.20	1.37	NS	0.77	NS
Spacing (cm)						
20×15	60.76	16.02	17.77	19.34	6.84	130.21
20×20	51.59	13.98	15.50	17.87	5.86	125.41
25×25	49.54	12.59	13.96	12.93	4.22	92.29
30×30	46.36	11.64	13.07	11.80	3.60	86.43
SE ±	2.80	0.59	0.67	1.23	0.38	7.95
LSD (P=0.05)	8.09	1.71	1.94	3.25	1.10	22.97
Nutrient Source						
Inorganic	61.83	16.59	18.18	19.97	7.24	127.58
Organic	42.29	10.52	11.97	11.00	3.06	89.59
SE ±	1.98	0.42	0.48	0.79	0.27	5.62
LSD (P=0.05)	5.72	1.20	1.37	2.31	0.77	16.23

nutrient source did not effect the HI (harvest index) significantly (Table 2).

Uptake of NPK

Higher uptake of N, P and K by grain and straw was recorded with SRI technique over conventional method, the differences being significant except in N and K in straw (Table 3). This could be due to increase in dry matter production and nutrient concentration in grain and straw (data not given). Similar findings have been reported by Barison (17). Among the spacing, maximum uptake of N, P and K by grain was recorded under closer spacing of 20 × 15 cm which was superior to wider spacings and decreased with the increase in spacing, whereas maximum uptake of N, P and K by straw was also recorded with 20 × 15 cm spacing but was at par with 20 × 20 cm spacing and significantly superior over other two spacings of 25 × 25 cm and 30 × 30 cm. The possible reason could be higher dry matter production at closer spacing due to better growth and development of crop along with higher concentration of N, P and K content in both grain and straw (data not given). Similar findings were also reported by Salem (9).

Inorganic source of nutrient recorded significantly higher uptake of N, P and K by both grain and straw over organic source of vermicompost (Table 3). The higher uptake of N, P and K may be due to the availability of nutrients and subsequently higher dry matter production because nutrient uptake is a function of both dry matter production and nutrient concentration. Yadav et al. (13) and Singh (18) have also reported similar results.

Soil Properties

Available N, P and K of soil after the harvest of crops were significantly affected by establishment technique. Higher values were recorded with conventional method of 3 seedling/hill of 25 days of age which was significantly superior over early transplantation of 10 day old seedling and 1 seedling/hill of SRI technique (Table 4). This could be due to lower uptake of N, P and K by grain and straw (Table 3) though the yield was statistically at par.

Among the spacings, higher available N, P and K were recorded under wider spacing which was significantly superior over closer spacing (Table 4). It could be due to less mining of N, P and K in wider spacing resulting in less uptake of N, P and K (Table 3). Nutrient source also had significant effect on available N, P and K status of soil. Significantly higher values of available N, P and K were recorded with organic source than inorganic source (Table 4). This could be due to mineralization of N and solubilizing action of certain organic acids to hold both native P and K in available form. These findings are in line with those of Dhar and Bali (19).

Soil reaction (pH) and salt concentration (EC) were not significantly affected either by establishment technique, spacing or nutrient source (Table 4).

Economics

Highest net return of Rs 53,415.44 and B : C ratio of 3.55 of rice crop were recorded from SRI technique compared to Rs 51,274.37 and 3.29 respectively with conventional method. Among the spacing, closer spacing of 20 × 15 cm recorded highest net return and B : C ratio of Rs 60,547.53 and 3.92 respectively, whereas inorganic source of nutrient recorded higher net return of Rs 59,269.02 and B : C ratio of 3.77 than organic source (Table 2).

It may be concluded that 10—12-day old seedling and one seedling/hill sown with closer spacing of 20 × 15 cm and recommended inorganic source of nutrients in the ratio of 160 : 60 : 30 : : N : P_2O_5 : K_2O through urea, DAP and MOP gave higher grain yield, net return and B : C ratio than other treatments.

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