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EFFECT OF PLANTING METHODS AND VARIABLE RATES OF NITROGEN APPLICATION ON YIELD AND COMPONENTS OF YIELD OF RICE

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A field study using Basmati-385 rice *(Oryza sativa L.)* during1'_flnd 1995 seasons evaluated the effect of variable rates of N application on paddy yield, components of yield and economics of a transplanted and direct-seeded crop. Transplanted rice significantly increased paddy yield by about 15.3% than the direct-seeded rice. Further, this response was markedly higher at 100 kg N/ha. In addition, return above variable cost in the transplanted rice increased by 17.75 % over direct-seeded rice. The results suggest that under Faisalabad conditions higher paddy yield and greater economic benefits will be realized from the transplanted rice when N @ 100 kg ha' is given.

Key words: effect of nitrogen application, planting methods, rice yield

INTRODUCTION

Rice is an important cereal crop of the world. It provides the primary staple food to more than 2 billion people in Asia only. The major role played by rice as a food article is unlikely to diminish in the foreseeable future. Transplanting and direct seeding are the two usual methods used for planting rice, transplanting being widely used. Direct seeding is practised where water supply control is good. Advantages of direct seeding over transplanting include good stand establishment, higher tillering, and some times higher grain yield (Schnier *et al.,* 1990). Moreover, transplanting is more laborious, time consuming and expensive than direct seeding (Hashimoto *et al., 1976).*

Contrarily, several reports indicated that besides lower labour involvement, there is no fundamental difference between direct seeding and transplanting if good management is practised in rice culture (Prassad, 1981).

Direct-seeded rice is becoming an increasingly popular alternative to transplanting method in Asia's irrigated rice growing areas. Little information is available on specific cultural requirements of direct-seeded rice (coarse or fine) in Pakistan. Overseas studies at IRRI indicated that growth kinetics, partitioning patterns and N economy vary with planting method (Dingkuhn *et sl.,* 1990). Effects of direct-seeded rice compared to transplanting of fine rice on the yield, components of yield and economics need to be investigated. The aim of the present study was, therefore, to evaluate the effect of variable rates of N application on yield, components of yield and economics in direct-seeded and transplanted rice.

MATERIALS AND METHODS

Two field experiments werecot:lQucted at the Agronomic Research Area, University of Agriculture, Faisalabad during 1994 and 1995. The soil was sandy clay loam in texture. The cultivar 888m8ti-385, a commonly grown fine rice variety, was u~ asa test crop for experimentation. In both experiments split plot design with planting method as main~d nitrogen rate as subplots was used. The treatmeQfs comprised two planting methods viz. transplanting and direct seeding through drilling and five nitrogen rates viz. O(N_0), 25(N_1), 50(N_2), 75(N_3) and 100(N_4) kg N ha'. Plot size was 6.0 m by 2.5 m with a row spacing of 25 cm apart.

All the direct-seeded plots were sown manually with the help of a single row hand drill on 4 July 1994 and 28 June 1995, using a seed rate of 60 kg ha^{-1}. Transplanting was done manually on 4 July using 30 days old seedlings in both the years. All transplanting or direct seeding was performed on a puddled soil. Seeds for direct sowing were soaked for 24 hours prior to sowing. Nitrogen fertilizers were applied at the time of transplanting/drilling as a basal dose of respective rate and incorporated in the soil prior to planting. Phosphorus (23 kg ha^{-1}) as single superphosphate and zinc (10 kg ha^{-1}) as zinc sulphate were also applied at the time of seedbed preparation. After transplanting or sowing, irrigation water was applied and maintained until mid-ripening phase (two weeks before maturity). Weeds were controlled by hand pulling and plant protection measures followed standard recommendations.At maturity, a 5 m^2 area from each plot was harvested manually and sun dried. The straw and paddy yield were weighed and final yields were expressed in t ha^{-1}. Yield components such as number of panicles, number of productive tillers per unit area, spikelets per panicle, 1000-grain weight, etc. were calculated from 20 plants taken at random from each plot. The harvest index was calculated as the ratio of grain yield to total biomass yield.

The data were analysed using analysis of variance **technique for split plot design.** Where F-test **indicated** statistical significance, treatment means were separated by the LSD test at 0% probability level (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Paddy Yield: Paddy yield was not significantly affected by the planting methods in 1994 and it varied from 3.20t ha^{-1} in direct-seeded rice to 3.42 t ha^{-1} in transplanted rice (Table 1). In 1995, transplanting significantly enhanced paddy yield to 4.43 t ha^{-1} as compared to direct seeding (3.58 t ha^{-1}). The transplanting method thus increased paddy yield by about 6.88 % (1994) and 23.74 % (1995) over the direct-seeded rice, especially at the higher rate of N applications. Yield response to applied nitrogen was significant up to 75 kg N ha^{-1} in both the planting methods. These results differ from those of Dingkuhn *et al.* (1992) who reported slightly higher yields in row-seeded rice compared to transplanting. However, Schnier *et al.* (1990) indicated higher paddy yield in transplanted rice than row-seeded at lower N rate. Transplanted rice enables the crop to make rapid early growth, especially with adequate supply of N, to intercept more solar radiation and thus to produce and fill many spikelets. Generally, increasing nitrogen rates significantly enhanced paddy yield over the control in both the seasons. Overall, average paddy yield varied from 3.31 t in 1994 to 4.00 t ha^{-1} in 1995, respectively (Table 1). Awan *et al.* (1989) reported paddy yields ranging from 3 to over 5 t ha^{-1} among various genotypes of rice under different environments. Maximum paddy yield was obtained in transplanted rice at higher rates of N application. Higher yield in these treatments may be due to increased growth resulting in improvement in yield. This probably helped reduce sterility and abortive kernels and led to higher grain weight (Table 1) and thus higher yield.

Total Biomass: At final harvest, the average TOM yield varied from 14.56 in direct-seeded to 19.53 t ha^{-1} in the transplanted rice and it increased upto 23.30 t ha^{-1} with increasing rates of N application (Table 1).

	Paddy yield (t ha^{-1})		Total biomass (t ha^{-1})		Harvest index (%)		No. of productive tillers hill^{-1}		No. of spikelets panicle^{-1}		1000-grain weight (g)	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Planting method												
Direct seeding	[illegible]	3.58 b	13.71 b	15.41 b	[illegible]	[illegible]	[illegible] b	[illegible]	[illegible]	144.36^{NS}	[illegible]	[illegible]^{NS}
Transplanting	3.42	[illegible]	15.34 a	[illegible]	[illegible]	18.77 b	[illegible] a	[illegible] a	149.49 b	154.75	[illegible]	19.02
Nitrogen												
Control	[illegible]	[illegible]	17.49 cd	[illegible]	[illegible].18^{NS}	21.74^{NS}	[illegible]	[illegible]	[illegible]	[illegible]	19.19 c	[illegible] b
25 kg ha^{-1}	[illegible]	[illegible] c	[illegible]	27.42 ab	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	139.48 c	[illegible]	[illegible] a
50 kg ha^{-1}	[illegible]	3.99 c	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	141.24 b	[illegible]	20.71 [illegible]	[illegible]
75 kg ha^{-1}	[illegible]	4.23 b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] a	143.99 ab	[illegible] ab	[illegible]	[illegible]
100 kg ha^{-1}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] a	11.49 a	146.91 a	[illegible]	[illegible]	[illegible]
Mean	3.31	[illegible].00	18.71	[illegible]	[illegible]	[illegible]	[illegible]	10.15	[illegible]	149.55	20.41	[illegible]

These TDM yields are slightly higher thant~:(14-16 t ha') reported in the literature (Schnier'et~j;1/., 1990; Dingkuhn *et et.,* 1992). Appliqationof50kgOt; 100 kg N ha"; to direct- seeded rice significantly increased TDM over other rates of N application,;1995, whereas in transplanting, application of 25 kg N ha"9f enhanced TDM over other rates of N application. At final harvest transplanting significantly increased TDM over direct seeding irrespective of nitrogen rate (Table 1).

Harvest Index: In 1994, no significant differences in harvest index were found between the two planting methods (Table 1). In 1995, however, transplanting method significantly reduced harvest index by 18.84 % over direct seeding (18.77 vs 23.13). The reason for having more harvest index in direct seeding may be the higher number of panicles hiU-' and shorter plants. Application of higher rates of nitrogen did not affect harvest index in both the seasons. Overall, the average values of harvest index ranged from 21.86 to 22.46% among various treatments (Table 1). Such effects are supported by Prassad (1981) who reported that biological yields and harvest index in the mid-season rice varieties were higher than in early maturing cv. Pussa-73.

Yield Components

Number of Productive Tillers: Transplanting produced significantly greater number of tillers (10.25 and 13.19) hill' than direct seeding (6.61 and 7.26) in 1994 and 1995, respectively (Table 1). Application of nitrogen also significantly but differentially increased the number of productive tillers in both the years. In 1995, the number of productive tillers was 8.21, 9.63, 10.36, 11.05 and 11.49 with N_0, N"' Nz, N_3 and N_4 treatments, respectively. Corresponding figures in 1994 were 6.56, 8.00,8.59,9.06 and 9.94 tillers hill", respectively. In general, increasing rate of nitrogen application significantly increased the number of productive tillers with transplanting compared to direct-seeded rice (Table 1). This response was substantially higher in 1995 than in 1994 season. Increasing rates of nitrogen application enhanced the number of tillers over control treatment probably by reducing competition for resources in these treatments compared to control or lower rate of nitrogen application. Similar results were reported by other workers (Santos *et el.,* 1986; Rafey *et et.,* 1989) who also reported 11.5 to 16.0 productive tillers hill" in rice under variable environments.

Number of Spikelets Panicle-': The number of spikelets panicle" was significantly influenced by the planting method only in 1994. Transplanting enhanced the number of spikelets panicle" over direct-seeding by 20.68% (149.49 vs 123.87). In both planting methods were at par in respect spikelets panicle", and these ranged between 144:36 in direct~seeded to 154.75 in transplanting metfte>d,respectively (Table 1).

There~.re also significant differences in the number of sPik.~panicle' among various nitrogen levels and these~~reased almost linearly with increasing rate of N in; both the seasons. However, in both the years, N_3 and Jtyeatments were statistically at par in the numberot""lets. Overall, mean number of spikelets variedft~,about 137 in 1994 to 150 in 1995, respectivelyl~l)le 1). Many workers have reported that increasing,~Qitrogenrates increased the number of filled spikeletsi,<panicle' lRafey *et et.,* 1989).

1000-Grain Weight: The 1000-grain weight was not influenced by planting methods in 1994 and 1995 and it varied between 18.51-20.54911000 grainsin the two methods. In contrast, significant'differences were recorded in 1000-grain weight among various nitrogen rates in both the years. In 1994,the N_4 (100 kg N ha') treatment showed higher 1000-grain weight (21.38 g) as compared to N_0 (control)andN, (25 kg N ha') where it was 19.19 and 20.04g, respectively. However, Nz, N_3 and N_4 treatments were statistically at par for mean grain weight in both the years (Table 1). Singh *et al.* (1981) reported higher grain weight in transplanting than direct seeding. Barner (1985) reported that application of 132 kg N ha" increased 1OOO-grainweight. Present results are in line with those reported by Rafey *et al.* (1989).

Correlation analysis (Table 2) between paddy yield and components of yield showed that paddy yield was determined mainly by the number of tillers per unit area and average grain weight. Harvest index was correlated with the yield, suggesting that paddy yield will increase with increasing TDM unless the harvest index is changed. In this study a strong and positive correlation was noted between paddy yield and TDM production (Table 2). These significant associations are consistent with earlier findings of Awan (1989) who also reported similar relationships between yield and components of yield of Basmati-385 rice.

Economic Analysis: The data indicated higher net benefit in transplanting than direct-seeding by about 20.23% (3.41 vs 4.10t h') (Table 3). Application of

Table 2. The relationship between grain yield andyi~.d components of rice during 1994 and 1995

Character	Correlation coefficient (r)	
	1994	1995
Productive tillers hill"' vs paddy yield	0,462"	0.864"
1000-grain weight vs paddy yield	0.544"	0.564'
Harvest index vs paddy yield	-0.048^{NS}	0.571 NS
Total biomass vs paddy yield	0.900"	0.931"

*; ** _ Significant at (P «j.05); (P < 0.01) respectively; NS = Non-significant.

Table 3. Economic analysis of rice as affected by different planting methods and nitrogen rates during 1994 and 1995

Treatment	Total variable cost (Rs. ha^{-1})	Gross income (Rs. ha")'	Total expenditure (Rs. ha")'	Net income (Rs. ha")'	Benefit cost ratio
			1994		
Planting method					
Direct seeding	415.00	16800	4499.00	12301.00	2.73
Transplanting	741.25	17955	4820.75	13134.25	2.72
Nitrogen rate					
Control	0	12600	4820.75	7779.25	1.61
25 kg N ha'	255.39	15855	5076.14	10778.86	2.12
50 kg N ha'	511.36	17115	5332.11	11782.89	2.21
75 kg N ha'	766.19	18375	5586.94	12788.06	2.29
100 kg N ha'	1021.59	23047.5	5842.34	17205.16	2.94
			1995		
Planting method					
Direct seeding	433.00	19869.00	4509.50	15359.50	3,41
Transplanting	745.75	24586.50	4825.25	19761.25	4.10
Nitrogen rate					
Control	0	18093.00	4825.25	13267.75	2.74
25 kg N ha'	369.51	21367.50	5194.76	16172.72	3.11
50 kg N ha'	739.02	22144.50	5564.27	16580.,23	2.98
75 kg N ha"'	1108.54	23476.50	5933.79	17542.71	2.96
100kgNha'	1478.05	25918.50	6303.30	19615.20	3.11

different N rates markedly increased the net benefit over control (No)' Maximum net return was obtained at 100 kg N ha' by Rs. 17205/- in 1994 and Rs. 19615/- in 1995, respectively (Table 3). The results showed that under Faisalabad conditions, transplanted rice produced higher paddy yield and thus higher economic benefit. Both higher yield and economic benefits were augmented at 100 kg N application ha'.

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