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Effect of planting methods, source and level of nitrogen on the growth and yield of rice (*Oryza sativa*) and on succeeding wheat (*Triticum aestivum*)

V.P. JAISWAL[1] AND G.R. SINGH[2]

Narendra Deva University of Agriculture and Technology, Faizabad, Uttar Pradesh 224 001

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) and winter (*rabi*) seasons of 1996–97 and 1997–98 to study the effect of source and level of nitrogen on growth and yield of rice (*Oryza sativa* L.) under different planting methods and its residual effect on wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Transplanting methods proved best for maximum grain yield (45.35 q/ha), recording significantly higher yield than broadcasting and direct-seeding methods. Urea supergranule (USG) exhibited its superiority by recording significantly higher value of all the yield-contributing characters, nitrogen uptake and consistently resulted in significantly higher grain yield than prilled urea (PU), the increase being 12.0 and 10.2% during 1996 and 1997 respectively. The increased level of N improved the yield and yield attributes. Maximum values of yield attributes and the grain yield were recorded with the highest level of nitrogen (120 kg/ha). The grain yield increased with 120 kg N was 29.7 and 23.7% over the 60 kg N/ha in 1996 and 1997 respectively.

Key words : Rice, Planting methods, N source, N level, Residual effect, Wheat

Transplanting method persists as the major system of planting rice under puddled condition. Often the farmers fail to transplant the seedlings in time because of delayed monsoon resulting in lower grain yields. Under these circumstances the direct-seeding method appears to be the alternate practice. In lowland situation, N-use efficiency has been estimated to be about 30–50% (Talukdar *et al.*, 1996) and in many cases even less (Sarvana *et al.*, 1988). Low recovery of applied N in rice result in losses through denitrification, ammonia volatilization, runoff and

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Present address : [1]Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh 226 002

immobilization. The low nitrogen efficiency has attracted the attention to design better nitrogen-management practices although little effort has been made in transplanted rice only. Therefore the present investigation was undertaken to assess comparative efficiency of N sources at different levels on growth and yield of rice under different planting methods and its residual effect on wheat crop.

MATERIALS AND METHODS

A field experiment was conducted during the rainy (*kharif*) and winter (*rabi*) seasons of 1996–97 and 1997–98 at Agronomy farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, on silty loam soil, with pH 7.8. The soil was low in organic carbon (0.32%), available nitrogen (200 kg/ha), available phosphorus (16.0 kg/ha) and available potash (257.0 kg/ha). The treatments were set out in split-plot design, keeping 3 planting methods, viz. transplanting, broadcasting of sprouted seed under puddled conditions and direct seeding in main plots, combination of 2 sources (urea supergranules and prilled urea) with 2 nitrogen levels (60 and 120 kg N/ha) along with control (0 kg/ha) in subplots with 4 replications. Full dose of P_2O_5 (60 kg/ha), K_2O (60 kg/ha) and 25 kg zinc sulphate were applied basal at the time of direct seeding, broadcasting under puddled condition and transplanting. Nitrogen application through prilled urea (PU) was applied in 3 splits, i.e 1/3 as basal, 1/3 at tillering and rest 1/3 at the time of panicle initiation. Nitrogen through urea supergranule (USG) was applied as total quantity in point placement method by placing each ball of 1 g weight through USG applicator in the centre of 4 hills at 5 cm depth, 8 days after transplanting. In direct-seeding method, urea supergranules were applied in alternate rows by maintaining ball-to-ball spacing at 20 cm as on same date of application in transplanting method. Under broadcasting method, USG were applied by maintaining ball-to-ball spacing at 40 cm × 20 cm. Dry seeds of 'Sarjoo 52' were sown in rows at 20 cm apart @ 100 kg/ha under direct-seeding method. Sprouted seeds of rice (100 kg/ha) were broadcast uniformly under puddled condition. In transplanting method, the 20-day-old seedlings were transplanted at the spacing of 20 cm × 10 cm using 2 seedlings/hills. 'HD 2285' wheat was grown following the recommended agronomic practices and operations. Only half dose (30 kg) of 50% recommended N (60 kg) and full dose of P_2O_5 (60 kg/ha) and K_2O (60 kg/ha) were applied basal at the time of sowing wheat. Remaining nitrogen (30 kg) was top-dressed in 2 equal splits, at tillering (30–35 DAS) and panicle-initiation (60–65 DAS) stages of wheat crop through urea. Plant samples of rice crop were collected at different stages and analysed for nitrogen content.

RESULTS AND DISCUSSION

Growth, yield attributes and yield

Maximum plant height was recorded with broadcasting of sprouted seeds under puddled condition, which was at par with transplanting method but significantly superior to direct-seeding method. Planting methods had significant impact on leaf-area

index (LAI) at all the stages of growth. The LAI increased up to 100 days after sowing (DAS), thereafter declined at harvest due to leaf senescence. Transplanting method recorded higher LAI, followed by broadcasting method. This might be due to increased number of green leaves and more number of shoots per unit area resulted from better utilization of moisture and nutrients. Similar findings were reported by Reddy *et al.* (1987).

Transplanting values of panicles/m^2, grains/panicle and panicle length, resulting higher grain yield of rice (Tables 1,2). The highest grain yield was recorded under the transplanting method, followed by broadcasting of sprouted seed in puddled condition and direct-seeding method during 1996–97 and 1997–98 respectively, On an average, transplanting method increased the grain yield significantly by 8.9 and 16.4% over the broadcasting and direct-seeding method respectively. The higher yield under transplanting method may be owing to better performance of growth and yield attributes through optimum utilization of resources which had direct bearing on the production of higher grain yield. Overcrowding in broadcasting and direct seeding methods might have increased the inter- and intra-plant competition for resources. These findings support those of Saikia *et al.* (1992).

At all the growth stages, significantly higher LAI and maximum plant height were recorded under USG-treated plot than PU. Application of 120 kg N/ha recorded significantly higher LAI and height than 60 kg N/ha. Our results confirm the finding of Lin and Lin (1985).

The USG resulted in significantly higher values of panicles/m^2, panicle length, grains/panicle and test weight which ultimately resulted in higher grain and straw yields of rice. The increase in grain yield owing to USG over PU was 12.0 and 10.2% in 1996–97 and 1997–98 respectively. Deep placement of USG possibly reduced volatilization and denitrification losses compared with broadcasting of PU, and more nitrogen was made available to plant which ultimately increased the yield. These findings are in agreement with those of Saha and Mitra (1988). Application of 120 kg N/ha significantly increased the grain yield by 29.7 and 13.7% over 60 kg N/ha in 1996–97 and 1997–98 respectively. Significantly higher values of yield attributes were noticed under higher level of nitrogen (120 kg/ha) (Tables 1,2). Increasing level of N might be helpful to well development of source and sink capacity which ultimately resulted in increasing all the yield-attributing characters at higher fertility levels.

Nitrogen uptake

Transplanting method recorded significantly higher nitrogen uptake in grain and straw compared with other planting methods (Table 2). The increase in total N-uptake was 11.9 and 19.7% over broadcasting and 7.6 and 17.4% over direct seeding during the first and second year respectively. It might be due to higher grain and straw yields under transplanting, though the N content did not vary with planting methods. On an average, USG-treated plot recorded significantly higher

Table 1. Yield attributes of rice as affected by planting methods, N source and level

Treatment	Plant height (cm)		Panicles/ m^2		Filled grains/ panicle		Panicle length (cm)		1,000-grain weight (g)	
	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98
Planting method										
Transplanting	90.0	82.6	288.2	272.8	135.6	122.0	22.54	21.40	22.21	22.45
Broadcasting	92.0	83.9	271.0	253.2	127.8	116.8	21.82	21.14	22.50	22.53
Direct seeding	86.2	80.4	250.0	234.2	111.9	111.0	21.73	20.94	23.02	22.80
LSD (P=0.05)	3.73	1.69	6.20	3.48	1.94	2.61	0.62	0.33	0.25	NS
Nitrogen source										
PU	91.5	84.2	276.2	262.8	128.1	119.9	22.48	21.53	22.61	23.03
USG	95.0	85.5	294.5	273.3	138.3	127.7	22.78	21.85	23.05	23.30
LSD (P=0.05)	1.70	NS	3.31	2.72	3.03	2.02	NS	0.29	0.26	0.239
Nitrogen (kg/ha)										
0*	74.0	68.0	207.3	195.3	92.6	88.7	19.62	19.00	21.40	20.30
60	89.8	82.2	268.0	241.6	126.2	113.6	22.35	21.35	21.57	22.95
120	96.8	87.4	302.7	294.5	140.2	133.6	22.92	22.03	23.09	23.38
LSD (P=0.05)	1.70	1.51	3.31	2.72	3.03	2.02	0.41	0.29	0.26	0.236

*Control vs treatment, significant; PU, prilled urea: USG, urea supergranules

Table 2. Nitrogen uptake and yield of rice as influenced by planting methods, nitrogen source and levels

Treatment	Nitrogen uptake (kg/ha)						Straw yield (q/ha)		Grain yield (q/ha)	
	Grain		Straw		Total					
	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98
Planting method										
Transplanting	49.68	43.45	31.67	29.84	81.36	73.29	63.83	59.68	47.45	43.25
Broadcasting	44.20	40.00	28.53	28.10	72.74	68.11	59.92	58.25	43.02	40.25
Direct seeding	40.89	37.06	26.63	25.38	67.96	62.44	56.66	55.13	40.03	37.88
LSD (P = 0.05)	1.54	1.28	1.42	1.35	2.95	2.39	2.10	2.17	1.45	0.81
Nitrogen source										
PU	47.23	42.70	30.20	28.59	77.43	71.29	63.53	61.36	45.82	43.02
USG	54.28	48.46	34.86	34.27	89.15	89.72	68.85	66.05	51.36	47.40
LSD (P = 0.05)	1.08	1.22	1.40	1.33	2.16	2.26	1.58	2.51	0.95	1.00
Nitrogen level (kg/ha)										
0*	21.60	18.56	15.35	13.14	36.94	31.69	35.91	33.63	23.18	21.46
60	41.59	38.24	28.00	26.48	69.59	64.72	59.15	58.13	42.31	40.42
120	59.93	52.91	37.06	36.38	96.99	89.29	73.24	69.28	54.89	50.01
LSD (P = 0.05)	1.08	1.22	1.40	1.33	2.16	2.26	1.58	2.51	0.95	1.00

*Control vs treatment, significant; PU, prilled urea; USG, urea supergranules

Table 3. Residual effect of planting method, nitrogen source and level on grain yield (q/ha) and straw yield (q/ha) of wheat

Treatment	Grain yield (q/ha)		Straw yield (q/ha)	
	1996–97	1997–98	1996–97	1997–98
Planting method				
Transplanting	23.94	22.25	35.86	33.46
Broadcasting	24.25	22.44	36.12	33.74
Direct seeding	24.18	22.25	35.75	33.46
LSD (P = 0.05)	NS	NS	NS	NS
Nitrogen source				
PU	24.69	22.71	36.92	34.13
USG	24.37	22.92	36.25	34.43
LSD (P = 0.05)	NS	NS	NS	NS
Nitrogen level (kg/ha)				
0*	22.50	20.31	34.23	31.64
60	23.70	21.83	35.35	32.78
120	25.36	23.80	36.81	34.78
LSD (P = 0.05)	NS	NS	NS	NS

*Control vs treatment, significant; PU, prilled urea; USG, urea supergranules

nitrogen uptake in grain and straw over PU. The results confirm those of Shukla and Sharma (1994). Nitrogen at 120 kg/ha increased the nitrogen uptake by 41.9 and 34.8% over 60 kg/ha in grain and straw respectively. Higher uptake of N might be due to better established roots, better plant growth and yield under increased N level.

Residual effect on wheat

The grain yield of wheat was not affected significantly by various planting methods of rice crop, through it ranged from 22.25 to 24.25 q/ha. The USG and PU applied to preceding rice crop were equally effective for ears/m^2, grains/ear, test weight and grain yield (Table 3). Planting methods, sources and levels of nitrogen applied to rice did not affect the yield and yield attributes of succeeding wheat crop.

It may be concluded that higher grain yield of rice can be achieved under transplanting method with 120 kg/ha preferably through USG. Source and levels of nitrogen applied to rice did not show any residual effect on succeeding wheat crop.

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