Pak. j. sci. ind. res., vol. 37, no. 3, March 1994

EFFECT OF RATES AND METHODS OF NITROGEN APPLICATION ON THE GRAIN YIELD AND NITROGEN UPTAKE OF WETLAND RICE

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(Received August 23, 1993; revised November 14, 1993)

Two field experiments were carried out during dry and wet seasons of 1991 to study the effect of three application methods and four rates of nitrogen fertilization on yield and N nutrition of wetland rice using randomised complete block design. The test varieties were BR3 and BR11 during dry and wet seasons respectively. Regarding grain yield, urea supergranule (USG) point placement was significantly superior to prilled urea (PU) broadcasting at all the levels of applied N in both the cases of BR3 and BR11, whereas PU injection was significantly superior to PU broadcasting only at the highest N rate. Agronomic efficiency, total N uptake and apparent recovery of added N was the highest with USG point placement followed by PU injection and was lowest with PU broadcasting in both the seasons. Agronomic efficiency and apparent recovery of added N decreased gradually with increasing N rates irrespective of fertilizer application methods in both the cases of BR3 and BR11.

Key words: N application methods, Wetland rice.

Introduction

Nitrogen is the key nutrient for crop production. Most of the rice soils of Bangladesh are deficient in nitrogen. Hence, N application is essential to meet the crop demand. Generally surface broadcasting of prilled urea (PU) is practiced by the farmers. But by this method, a substantial portion of the applied nitrogen is lost through NH_3 volatilization, denitrification, runoff etc. and consequently the N use efficiency becomes lower. Generally, the efficiency of fertilizer N in wetland rice culture is about 30-40% and in many cases, even lower [1-3].

Subsurface placement of the N fertilizer into anaerobic soil zone has been proposed by many investigators as a possible mean of increasing N use efficiency [4,5]. Deep point placement of urea supergranules (USG) has shown good promise in comparison with prilled urea (PU) in many previous investigations [6-8]. Recently, Pneumatic Urea Injector, an instrument for deep placement of prilled urea, has been developed in the Netherlands. Prilled urea can be deep placed by this instrument with necessary calibration into a depth of 8-10 cms. It was assumed that N use efficiency in wetland rice culture may be increased by deep placement of prilled urea by the instrument, Pneumatic Urea Injector. Based on the assumption, the present study was undertaken to compare among surface broadcasting of PU, deep placement of PU by Pneumatic Urea Injector (PU injection) and USG point placement for N use efficiency in wetland rice culture.

Materials and Methods

Two field experiments were carried out in Grey-Terrace soil (Chhiata series) of Bangladesh Rice Research Institute (BRRI) farm, Joydebpur during 1991 dry (Dec.–Jun.) and wet (Jun.–Nov.) seasons. Amounts of rainfall recorded at the experimental site during dry and wet seasons of 1991 were 633 and 2409 mm respectively. The soil of the experimental field was texturally clay loam having pH 7.2, organic C 1.13%, total N 0.8%, available P (Olsen) 10 ppm, exhcangeable K 0.18 *me*/100g, available S 15.5 ppm, available Zn 3.3 ppm and cation exchange capacity (CEC) 18.3 *me*/100g. Analyses of the soil were done following some standard procedures [9].

The study consisted of the following treatments.

Sl. No.	Treatment	Description
T_1	N_0	Control (No nitrogen).
T_2	N_{29} PU-B	29 kg N/ha from prilled urea (PU) applied as surface broadcasting in 3 equal splits (1/3 immediately after seedling establishment + 1/3 at active tillering stage + 1/3 at 5-7 days before panicle initiation).
T_3	N_{58} PU-B	58 kg N/ha from PU applied as treatment T_2.
T_4	N_{87} PU-B	87 kg N/ha from PU applied as treatment T_2.
T_5	N_{29} PU-I	29 kg N/ha from PU applied at a time immediately after seedling establishment as soil injection into a depth of 8-10 cms by the instrument Pneumatic Urea Injector.

(Continued...)

T_6	N_{58} PU-I	58 kg N/ha from PU applied as treatment T_5.
T_7	N_{87} PU-1	87 kg N/ha from PU applied as treatment T_5.
T_8	N_{29} USG	29 kg N/ha from urea supergranule (USG) applied at a time immediately after seedling establishement as point placement by hand into a depth of 8-10 cms.
T_9	N_{58} USG	58 kg N/ha from USG applied as treatment T_8.
T_{10}	N_{87} USG	87 kg N/ha from USG applied as treatment T_8.

Instead of 30, 60 and 90 kg N/ha 29, 58 and 87 kg N/ha were applied because the later doses were convenient for USG point placement in 20 x 20 cm spacing of rice. The treatments and the plot size were the same for both dry and wet seasons. Unit plot size was 4 x 4m. The experiments were laid out in randomized complete block design with 3 replications. Blanket doses of P, K and S @ 25, 35 and 20 kg/ha from triple super phosphate, muriate of potash and gypsum respectively were applied before transplanting at final land preparation in both the seasons.

In dry season 50-day-old seedling of BR3 (a modern rice variety) were transplanted with a spacing of 20 x 20 cm on the 3rd Feb., 1991. Necessary intercultural operations were done and irrigation was provided as and when required. Rice crop was harvested at maturity on the 5th Jun., 1991 for grain and straw yields. During wet season, 30-day-old seedlings of BR11 (a modern rice variety) were transplanted with a spacing of 20 x 20 cm on the 22nd Jul., 1991 in the same plot where dry season experiment was conducted. Necessary intercultural operations were done and supplementary irrigation was provided as and when required. Rice crop was harvested on the 20th Nov. 1991 for grain and straw yields. Grain yield was adjusted at 14% moisture content and straw yield was recorded as oven dry basis in both the seasons. Grain and straw samples were analyzed for total N concentration by micro-Kjeldahl digestion followed by steam distillation and estimation of N titrimetrically [10]. Data were analyzed as per standard statistical procedures.

Results and Discussion

Grain yields increased significantly over control irrespective of methods and rates of N fertilizer application in both the seasons (Table 1). During dry season, grain yield of BR3 ranged from 2.7 to 4.8 t/ha while in wet season, grain yield of BR11 ranged from 2.7 to 3.8 t/ha. In both the seasons, USG point placement was significantly superior to conventional PU broadcasting method irrespective of N rates, whereas PU injection was significantly superior to PU broadcasting only at the highest N rate (87 kg/ha). In most of the cases difference between PU injection and USG point placement was not significant. Grain yield increased gradually with increasing N rates irrespective of application methods in both dry and wet seasons. Agronomic efficiency (kg grain/kg added N) ranged from 14.9 to 37.9 in case of BR3 while 8.1 to 20.7 in case of BR11. Agronomic efficiency was the highest with USG point placement followed by PU injection and lowest with conventional PU broadcasting in both the seasons. Agronomic efficiency decreased with increasing N rates in both the cases of BR3 and BR11. The superiority of USG point placement over PU broadcasting regarding grain yield and agronomic efficiency is in agreement with some previous findings [11-13].

Like grain yields, straw yields also increased gradually with increasing N rates in both the seasons (Table 1). During dry season, USG point placement and PU injection were sig-

TABLE 1. EFFECT OF METHODS AND RATES OF NITROGEN FERTILIZER APPLICATION ON THE YIELD PERFORMANCE OF BR3 AND BR11.

Treatment[1/]	Dry season, 1991 (BR3)			Wet season 1991 (BR11)		
	Grain yield (t/ha)	Agronomic efficiency (kg grain/kg added N)	Straw yield (t/ha)	Grain yield (t/ha)	Agronomic efficiency (kg grain/kg added N)	Straw yield (t/ha)
N_0	2.7	-	1.8	2.7	-	3.7
N_{29} PU-B	3.3	20.7	2.0	3.1	13.8	4.1
N_{58} PU-B	3.6	15.5	2.3	3.3	10.3	4.7
N_{87} PU-B	4.0	14.9	2.6	3.4	8.1	4.8
N_{29} PU-I	3.7	34.5	2.5	3.2	17.2	4.3
N_{58} PU-I	4.0	22.4	2.8	3.4	12.1	4.8
N_{87} PU-I	4.6	21.8	3.4	3.6	10.3	4.9
N_{29} USG	3.8	37.9	2.6	3.3	20.7	4.4
N_{58} USG	4.3	27.6	3.2	3.5	13.8	4.9
N_{87} USG	4.8	24.1	4.2	3.8	12.6	5.0
LSD (0.05)	0.42	-	0.41	0.18	-	0.26

[1/] PU-B = Prilled urea broadcasting, PU-I = Prilled urea injection, USG = Urea supergranule.

TABLE 2. EFFECT OF METHODS AND RATES OF NITROGEN FERTILIZER APPLICATION ON NITROGEN NUTRITION, UPTAKE AND RECOVERY OF ADDED N BY BR3 AND BR11.

Treatment	Dry season, 1991 (BR3)				Wet season, 1991 (BR11)			
	N content (%)		Total N uptake (kg/ha)	Apparent recovery of added N(%)	N content (%)		Total N uptake (kg/ha)	Apparent recovery of added N(%)
	Grain	Straw			Grain	Straw		
N_0	0.99	0.51	35.9	–	0.99	0.44	43.0	–
N_{29} PU-B	1.01	0.55	44.3	29	1.08	0.46	52.4	32
N_{58} PU-B	1.02	0.57	49.8	24	1.11	0.50	60.1	30
N_{87} PU-B	1.02	0.58	55.9	23	1.17	0.52	64.8	25
N_{29} PU-I	1.01	0.56	51.4	53	1.07	0.45	53.6	37
N_{58} PU-I	1.06	0.60	59.2	40	1.14	0.46	60.9	31
N_{87} PU-I	1.07	0.61	69.9	39	1.16	0.51	66.8	27
N_{29} USG	1.01	0.57	53.2	60	1.10	0.47	57.0	48
N_{58} USG	1.11	0.64	68.2	56	1.11	0.51	63.9	36
N_{87} USG	1.13	0.66	81.9	53	1.20	0.54	72.6	34
LSD (0.05)	0.08	0.07	3.3	–	0.05	0.03	5.9	–

nificantly superior to PU broadcasting regarding straw yield of BR3 at all the levels of applied N, while during wet season the treatment differences in straw yield of BR11 were not signifcant in most of the cases. It is worthwhile to mention here that there were marked differences between BR3 and BR11 regarding grain yield, straw yield and grain-straw ratio. These differences were due to seasonal and varietal difference. Varietal and seasonal difference in grain yield, straw yield and grain-straw ratio were found in some previous investigations [13,14].

Nitrogen content in grain and straw of BR3 and BR11 increased over control due to N fertilizer application and this increase occurred gradually with increasing N rates (Table 2). Treatment variations in N content were slight. However, there were considerable differences in total N uptake. This was due to differences in yield. Total N uptake increased gradually with increasing N rate. Among the application methods, total N uptake was the highest with USG point placement followed by PU injection and lowest with conventional PU broadcasting.

Apparent recovery of added N was the highest with USG point placement followed by PU injection and lowest with PU broadcasting. Higher recovery of added N by USG point placement and PU injection indicated that N fertilizer loss was less by these methods of application. Apparent N recovery decreased gradually with increasing N rates irrespective of N fertilizer application methods. This trend is in agreement with some previous findings [13,14].

The findings of the study revealed that N use efficiency can be increased by prilled urea injection into reduced soil layer by the instrument Pneumatic Urea Injector. However, compared with urea supergranule (USG) point placement, the efficiency of this method is lower.

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