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Studies on nitrogen extracting ability with and without fertilizer nitrogen of ten rice (*Oryza sativa* L) genotypes under rainfed lowland ecosystem of the Red and Laterite Zone of West Bengal

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ABSTRACT

A field experiment was conducted for two consecutive years in the Red and Laterite Zone of West Bengal to evaluate the performance in extracting nitrogen from inherent soil pool with and without application of recommended doses of fertilizer nitrogen. Application of fertilizer nitrogen improved the performance of all the tested varieties but to different degrees. Jogen (CN-505), among the 10 tested varieties, was the best performer under both, with and without fertilizer nitrogen application, followed by those of Swarna (IET-5656), Biraj (CNM-539) and Masuri, respectively. These four varieties may be recommended for cultivation by the farmers under both the resource situations, in the rainfed lowlands of this zone.

Key Words : Rainfed lowlands, Red and Laterite zone, Rice, Nitrogen

Red and Laterite zone of West Bengal, spreading over 85 development blocks and lying between $22^0 20^/$ N to $22^0 25^/$ N latitude and 87^0E to $87^0 05^/$ E longitudes, occupies 28% of the total geographical area of the state. Rice is the main crop and cultivated in 3 out of 4 agro-ecological situations of the zone during *kharif* (wet-rainy) season. Majorities (87%) of the farmers of the zone have marginal to small holding and are extremely poor and can hardly afford to use chemical fertilizers. Because of several biotic and abiotic stresses, the yields of local varieties of rice are very low. Cultivars differ in their nitrogen acquisition and physiological N use efficiency (Triol-Padre *et al*., 1996; Ladha *et al*., 1998) because of the differences in critical growth, biomass accumulation, organ formation and ability to translocate, distribute and remobilize the absorbed N in various organs (Ladha *et al*., 1993). So, varietal specificity according to season is imperative for the maximization of yield and N use efficiency (De Datta and Broadbent, 1998). The present investigation was undertaken to study the performance of some promising high yielding rice varieties in extracting N from inherent N pool with and without fertilizer N application in the rainfed lowland ecosystem.

MATERIALS AND METHODS

An investigation was conducted during *kharif* (wet-rainy) season of 2000 and 2001 in the Sub Divisional Adoptive Research Farm (SARF), Jhargram, Paschim Medinipur, West Bengal, India having a hot and humid climate and 1300-1500 mm rainfall annually. The experiment was conducted in a typic haplustalf soil having sandy loam texture (Sand-77.2%, Silt-8.0%, Clay-14.8%), CEC of 9.40 c mol (p^+) kg^{-1}, near neutral soil reaction (pH-6.9), medium low organic carbon (0.45%), medium low available P (31.5 $kgha^{-1}$ Olsen P) and medium low available K (222 kg K_2O ha^{-1}). Growth, yield and nitrogen extracting ability of 10 different genotypes of rice viz., (1) Sabita (NC-492), (2) Jogen (CN-505), (3) Suresh (CN-540), (4) Biraj (CNM- 539), (5) Prakash (IET-2254), (6) Sasyashri (IET-2815), (7) Kunti (IET-6141), (8) IR-42, (9) Masuri and (10) Swarna (IER-5656), were evaluated under two levels of fertilizer N viz., (i) No fertilizer N (N_0) and (ii) Fertilizer N @ 60 $kgha^{-1}$(N_{60}). Fertilizer N in the form of urea was applied in 2 equal splits, each at final land preparation stage and at maximum tillering stage (35 days after transplanting of seedlings) and fertilizer P @ 30kgP_2O_5 ha^{-1}in the form of Single Super Phosphate and potassium @ 30kg K_2O ha^{-1}in the form of Muriate of Potash was applied as basal dressing during final land preparation. Twenty one day old healthy rice seedlings @3-4 seedlings $hill^{-1}$were transplanted at 20 cm x 10 cm spacing in 5 m x 3 m plots. The crop was grown to maturity and different growth and yield parameters including grain yield were recorded.

The experiment was laid out in a Randomized Complete Block design with three replications. The generated data were analyzed following standard statistical methods.

RESULTS AND DISCUSSION

Two years' pooled mean data for different attributes are presented in table (1 and 2). Statistical

analyses of the data revealed significant effect of variety, n levels and their interaction for different attributes studied.

Plant height at harvest

Plants of fertilizer N treated plots (N_{60}) of all the varieties were significantly taller than those from the unfertilized plots (N_0) (table 1). The increase in the height, in different varieties due to fertilizer N application, ranged from 4.3% to 9.9% with a mean of 6.6%, compared to plants receiving no fertilizer N (N_0). Among the 10 varieties tested, 5 were more than 1 m tall. While the plants of the variety Sabita (NC-492) were the tallest, the plants of variety Sasyashri (IET- 2815) were the shortest irrespective of fertilizer N application.

Number of tillers

Compared to no fertilizer N, application of fertilizer N resulted in the increase in tiller number ranging from 2.7% to 19.7% with a mean value of 11.4% per hill in different varieties (table 1). In N_0 treatment, highest number of tillers per hill was observed in variety Sasyashri (IET-2815) (10.68 $hill^{-1}$) and it was the lowest in variety IR-42 (6.93 $hill^{-1}$) (table 1). Under fertilizer N application the variety Biraj (CNM-539) produced the highest number of tillers (11.0 $hill^{-1}$) and variety IR-42, the lowest (7.63 $hill^{-1}$). Irrespective of N levels, the highest number of tillers was observed in variety Sasyashri (IET-2815) followed by Biraj (CNM-539), Kunti (IET-6141) and Jogen (CN-505) and the lowest number of tillers was observed in variety IR-42 (7.28 $hill^{-1}$).

Number of panicles

Like tiller number, panicle number of plants of different rice varieties were also significantly influenced by application of fertilizer N (table 1). Compared to no fertilizer N, application of fertilizer N resulted in the increase in panicle number ranging from 3.5 % to 22.3 %with a mean value of 14.4 % per hill in different varieties (table 1). While under no fertilizer N addition (N_0), the highest number of panicles per hill was observed in variety Biraj (CNM-539) (8.82 $hill^{-1}$), under fertilizer N application (N_{60}) it was highest in variety Sasashri (IET-2815) (10.28 $hill^{-1}$). Irrespective of N level, variety Sabita (NC-492) produced the lowest number of panicles (6.01$hill^{-1}$). The variety producing the highest number of panicles irrespective of fertilizer N level was Sasyashri (IET-2815) (9.44 $hill^{-1)}$, followed by Biraj (CNM-539) (8.97 $hill^{-1}$), Kunti (IET-6141) (8.32 $hill^{-1}$) and Jogen (CN-505) (7.90 $hill^{-1}$).

Grain yield

All the varieties responded positively to fertilizer N application and with application of 60 kg fertilizer N produced the highest grain yield ranging from 22.4 % to 52.6 % with a mean value of 40.2 % compared to no fertilizer N application (table 2, Fig. 1). Irrespective of fertilizer N application, while the variety Prakash (IET-2254) produced the lowest grain yield (N_0: 2.32tha^{-1}; N_{60}: 3.48tha^{-1}), variety Jogen (CN-505) produced the highest grain yield (N_0: 3.96 tha^{-1}; N_{60}: 5.58 tha^{-1}). For organic farming without application of fertilizer N, other promising varieties were Swarna (IET-5656) (3.57 tha^{-1}), Biraj (CNM-539) (3.25 tha^{-1}) and Masuri (2.94 tha^{-1}). Under intensive agriculture with fertilizer N application, other promising varieties were Swarna (IET-5656) (4.37 tha^{-1}), IR-42 (4.29 tha^{-1}) and Biraj (CNM-539) (4.18 tha^{-1}). The overall yield accumulation (kg grains ha^{-1} day^{-1}) was highest in Jogen (CN-505) (31.54 kg grains ha^{-1} day^{-1}) followed by Kunti (IET-6141) (25.50 kg grains ha^{-1} day^{-1}), Swarna (IET-5656) (25.42 kg grains ha^{-1} day^{-1}) and Biraj (CNM-539) (24.29 kg grains ha^{-1} day^{-1}) and the lowest was in variety Sabita (NC-492).

It is interesting to note that variety Jogen (CN-505) also showed the highest response to fertilizer N application and produced 27.0 kg grains per kg fertilizer N applied. These figures for other varieties were: IR-42 (24.64), Kunti (IET-6141) (20.30), Suresh (CN-540) (20.30) and Masuri (19.60). The lowest response to added fertilizer N was seen in variety Swarna (IET-5656) (13.3 kg grains per kg fertilizer N).

Higher values of parameters studied including grain yield, due to application of fertilizer N, were obviously due to higher availability and uptake of mineral N by the crop as many workers have reported earlier (Pandey *et al*., 1999; Singh, 1997; Singh *et al*., 2002).

This study revealed superiority of the variety Jogen (CN-505) under both traditional (applying no fertilizer N) as well as intensive method of cultivation (Fig.1) and may be recommended for cultivation under rainfed lowland ecosystem of the Red and Laterite zone of west Bengal particularly under Jhargram situation. Other varieties that may be recommended are: Swarna (IET-5656), Biraj (CNM-539) and Masuri.

Table 1 : Effects of two levels of fertilizer N on different growth parameters of ten rice genotypes

Name of Genotypes	Plant height at harvest (cm)			Number of tillers hill^{-1}			Number of panicles hill^{-1}		
	N_0	N_{60}	Mean	N_0	N_{60}	Mean	N_0	N_{60}	Mean
Sabita (NC-492)	131.4	142.6	137.0	7.52	8.23	7.87	5.55	6.47	6.04
Jogen (CN-505)	87.8	96.5	92.1	8.57	9.58	9.07	7.47	8.33	7.90
Suresh (CN-540)	123.3	132.8	128.0	7.00	8.22	7.61	5.82	6.98	6.40
Biraj (CNM-539)	113.7	119.4	116.6	9.60	11.00	10.30	8.82	9.13	8.97
Prakash (IET-2254)	77.3	81.0	79.1	8.32	8.82	8.57	7.22	7.82	7.52
Sasyashri(IET-2815)	73.2	76.4	74.8	10.68	10.97	10.82	8.60	10.28	9.44
Kunti (IET-6141)	81.0	84.5	82.7	9.40	10.25	9.82	7.90	8.75	8.32
IR-42	98.1	103.0	100.6	6.93	7.63	7.28	6.33	7.32	6.82
Masuri	119.5	124.7	122.1	7.25	8.58	7.92	6.63	8.00	7.32
Swarna (IET-5656)	95.9	102.3	99.1	7.05	8.43	7.74	6.40	7.83	7.12
Mean	100.0	106.3		8.23	9.17		7.07	8.09	
First Year	99.2	105.2	102.2	8.52	10.10	9.31	7.79	9.25	8.52
Second Year	101.0	107.4	104.2	7.94	8.25	8.09	6.35	6.93	6.64

Source	Sem	LSD (P=0.05)	Sem	LSD (P=0.05)	Sem	LSD (P=0.05)
Year	0.2785	0.55	0.0882	0.17	0.0866	0.17
Genotype	0.6227	1.24	0.1972	0.39	0.1936	0.39
N levels	0.2785	0.55	0.0882	0.17	0.0866	0.17
N x V	0.8806	1.76	0.2788	0.56	0.2738	0.55

Table 2 : Effects of two levels of fertilizer N on different yield parameters of ten rice genotypes

Name of Genotypes	Grain Yield (t ha^{-1})			Grain Productivity (kg ha^{-1} day^{-1})			Response of fertilizer N (kg grains per kg N)
	N_0	N_{60}	Mean	N_0	N_{60}	Mean	
Sabita (NC-492)	2.32	3.48	2.90	15.38	22.73	19.06	19.3
Jogen (CN-505)	3.96	5.58	4.77	28.45	34.63	31.54	27.0
Suresh (CN-540)	2.64	3.86	3.25	17.50	25.10	21.30	20.3
Biraj (CNM-539)	3.25	4.18	3.72	21.25	27.33	24.29	15.5
Prakash (IET-2254)	2.30	3.39	2.84	17.52	25.87	21.69	18.1
Sasyashri(IET-2815)	2.62	3.70	3.16	19.98	28.25	24.12	18.0
Kunti (IET-6141)	2.64	3.86	3.25	21.13	29.87	25.50	20.3
IR-42	2.81	4.29	3.55	17.62	29.35	23.48	24.6
Masuri	2.94	4.12	3.53	20.95	24.53	22.74	19.6
Swarna (IET-5656)	3.57	4.37	3.97	24.62	26.22	25.42	13.3
Mean	2.91	4.08		20.44	27.39		
First Year	3.16	4.47	3.81	22.20	29.87	26.03	
Second Year	2.65	3.69	3.17	18.68	24.90	21.79	

Source	SEm	LSD (P=0.05)	SEm	LSD (P=0.05)
Year	0.0653	0.13	0.5651	1.13
Genotype		0.1459	0.29	1.2635 2.52
N levels	0.0653	0.13	0.5651	1.13
N x V	0.2063	0.41	1.7869	NS

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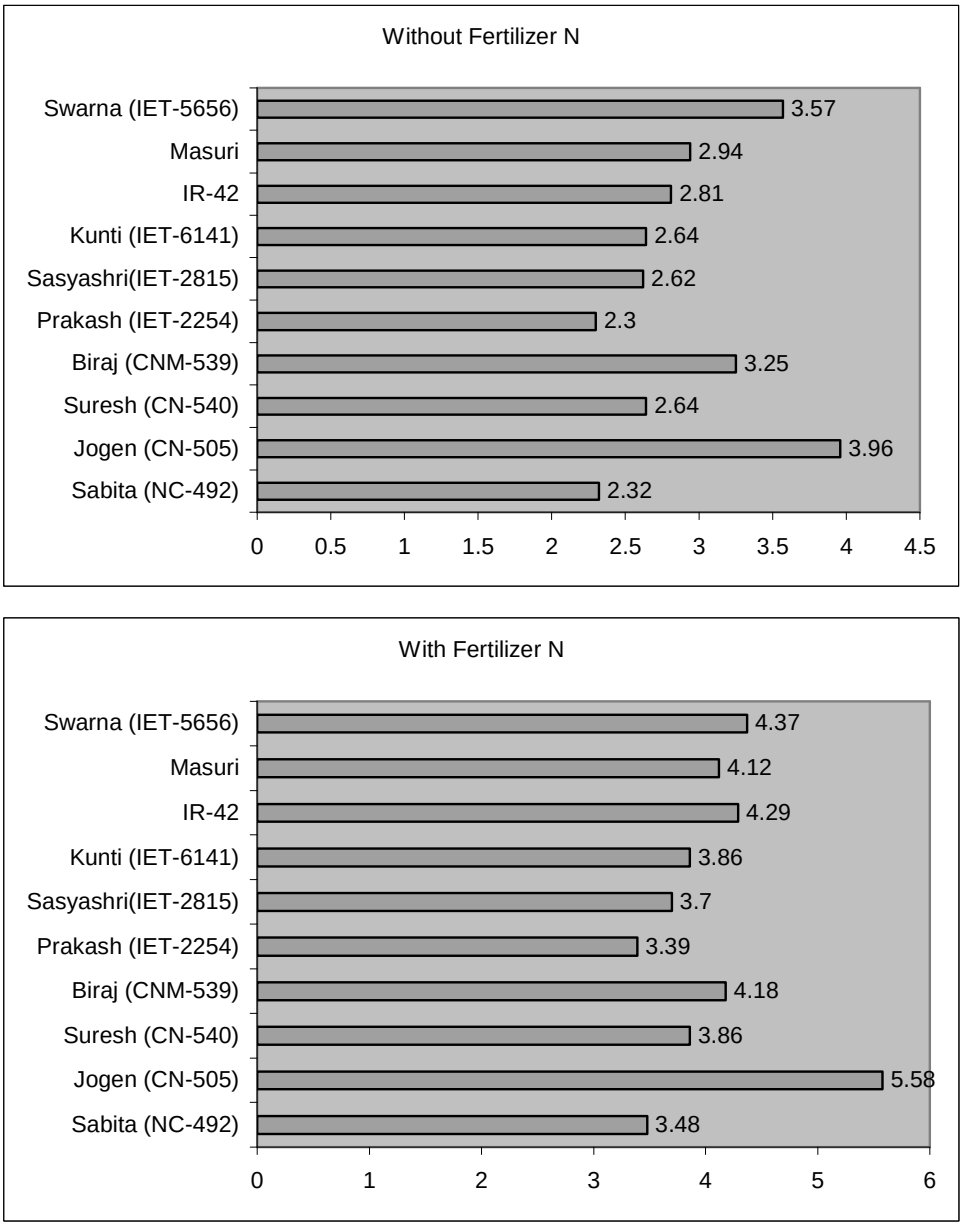

Fig. 1 : Comparative efficiency of rice genotypes in extracting N from soil pool (in terms of grain yield) with and without application of fertilizer N.