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EFFECT OF SOURCES OF NITROGEN ON GROWTH YIELD AND UPTAKE OF NUTRIENTS IN RICE

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ABSTRACT

A field experiment was conducted during rainy (Kharif) of 2010 and 2011 at Auraiya (U.P.) to study the effect of sources of nitrogen on yield, quality and uptake of nutrients in rice (Oryza sativa). Nine treatments were laid out in randomized block design with three replications. Results revealed that application of 100% N ha^{-1} (NCU) gave significantly higher tillers hill^{-1} (13.6 and 13.9), panicles hill^{-1} (12.0 and 12.5), test weight (30.7 and 30.9 g), grain yield (50.49 and 49.85 q ha^{-1}) and straw yield (83.75 and 81.00 q ha^{-1}) in first and second year, respectively lowest in control. Application of 50% N as urea + 5 t green manure ha^{-1} proved superior to most of the treatments with respect to yield attributes and yield of rice. The quality of rice grain in terms of protein content and yield improved with different sources of nitrogen and maximum values were recorded under 100 % (NCU) treatment. The lowest values of protein content and yield were recorded under control. The uptake of nutrients by rice grain and straw improved significantly with various sources of nitrogen over control. The removal of N by grain and straw increased from 27.2 to 70.1 and 14.3 to 43.5 kg ha^{-1}, P from 5.0 to 23.2 and 2.5 to 14.7 kg ha^{-1} and K from 6.4 to 29.7 and 36.6 to 153.7 kg ha^{-1}, respectively with 100% N (NCU) ha^{-1}. On the other hand, lowest uptake of N, P and K was noticed under control.

Keywords: Nitrogen, growth, yield, nutrient uptake, rice.

INTRODUCTION

Rice (Oryza sativa) is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of human population of the planet. India is the second largest producer after China and has an area of over 42.2 million ha and production of 104.32 million tones with productivity of 2.37 t/ha. The productivity of rice in India is very low, which is far below the other rice growing countries. Among the major nutrients, nitrogen application is essential to obtain the higher yields from rice. Nitrogen affects production through a number of mechanisms, viz. at cellular level, N increases the cell number and cell volume whereas at the leaf level it increases the photosynthetic rate and efficiency. Fertilizer N also increases proteins, the plants' metabolic component, as shown by increased nitrogen percentage in the plant tissues at higher N supply. The high cost of chemical nitrogen fertilizer and low purchasing power of farmers restricts its use on proper amounts, hampering crop productivity. With a view to reduce the losses and indiscriminate use of chemical fertilizers, substitution of part of the chemical fertilizer by locally available organic sources of nutrients, viz. manures, compost, green manures, crop residues, biofertilizers, neem coated urea is inevitable. In addition to supply of nutrients, organic source improves the physical condition and biological health of soil, which improves availability of applied and native nutrients. The combined use of organic and inorganic fertilizers alongwith biofertilizers has been reported not only to meet the nutrients need of the crop but also has been found to sustain large-scale productivity goals (Yadav and Meena 2014). For this purpose efficient use of nitrogen from organic and inorganic sources seems to be more appropriate. Therefore, the present investigation was undertaken to generate information for sustaining yield of rice through efficient use of nitrogen.

MATERIALS AND METHODS

A field experiment was conducted on farmer field at village Rasulpur of Auraiya district (U.P.) during Kharif season of 2010 and 2011. The soil of the experimental field was sandly loam with pH 7.8, organic carbon 3.8 g kg^{-1}, available nitrogen 165 kg ha^{-1}, phosphorus 9.0 kg ha^{-1} and potassium 190 kg ha^{-1}. The experiment was layout in randomized block design with three replications. The treatments were T_1 control, T_2 50 % N (PU) ha^{-1}, T_3, 75% N (PU) ha^{-1}, T_4 50 N (PU) + 5 t GM ha^{-1}, T_5 50 % N (PU) + 5t dry biogas slurry, T_6 975% N (PU) + 10 kg BGA ha^{-1}, T_7, 75% N (PU) + 5t FYM ha^{-1}, T_8 75% N (PU) + 5t Paddy straw ha^{-1}, and T_9 100% N (NCU). All the treatment received uniform basal dose of 60 kg P_2O_5 and 60 kg K_2O ha^{-1}. Organic sources viz. dhaincha, FYM, dry biogas slurry and paddy straw were incorporated in soil before transplanting of rice seedlings. BGA (10 kg ha^{-1}) was applied after one week of transplanting of rice seedings to water logged condition. Thirty days old seedlings of Pant-12 rice were transplanted in standing water (6cm deep) in second week of July in both the years at a spacing of 20cm between rows and 15 cm between plants. Irrigation was applied depending on the requirements. The other crop management practices were followed as per standard recommendation. The crop was harvested at the physiological maturity. Yield

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attributes and yield of grain and straw were recorded at harvest. The N content in grain and straw was analysed by micro Kjeldahl method. Phosphorus in diacid digest was determined by Vanado molybdophosphoric acid yellow colour method and potassium by flame photometer (Jackson 1973). Nutrient uptake in grain and straw was calculated by multiplying the yield with nutrient concentration.

RESULTS AND DISCUSSION

Yield and yield attributes

Rice plant grew with imposition of nitrogen alone and alongwith organic manures recorded significantly higher number of tillers than the plants under control (Subha Lakshi *et al.* 2014). Application of 100 % N (NCU) recorded significantly more number of panicles and test weight over control and most of the treatments. Application of inorganic nitrogen alone and in combination with organic sources i.e. green manure, dry biogas slurry, BGA, FYM, paddy straw and NCU significantly increased the grain yield over control during both the years of experimentation. The highest grain yield was produced at 100 % N (NCU), followed by 50% N + 5t dhaincha ha^{-1}, showing the values of 50.49, and 46.50 qha^{-1}, respectively during first year. Similar results were also obtained in second year. The highest grain yields of 50.49 and 49.85 q ha^{-1} at 100% N (NCU) were recorded 58.5 and 60.3% higher than the lowest grain yield on 20.91 and 22.25 q ha^{-1} at control during 2010 and 2011, respectively. These results are in close conformity with the findings of Kumar *et al.* (1996) and Singh *et al.* (1999). This might be due to more tillers, panicle hil^{-1} and test weight. Higher values of yield attributes i.e. tillers, panicle $hill^{-1}$ and test weight were found to be promoted by the application of nitrogen, green manure, dry biogas slurry, BGA, FYM, paddy straw and NCU. Average better tillers (13.60 and 13.94 $hill^{-1}$), panicle (11.97 and 12.50 $hill^{-1}$) test weight (30.70 and 30.93 g.) were recorded with 100 % N (NCU) during 2010 and 2011, respectively. Similar results were reported by Bulble *et al.* (1996) and Gangaiah and Prasad (1999).

Table 1: Yield and yield attributing characters of rice as affected by various treatments

Treatment	Grain yield (qha^{-1})		Straw yield (q ha^{-1})		Tillers $hill^{-1}$		Panicle $hill^{-1}$		Test weight (g)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_1 Control	20.91	20.25	33.21	33.95	8.4	4.4	7.4	7.3	18.1	18.9
T_2 50% RDN	31.5	28.91	48.58	48.65	11.3	10.7	10.3	10.2	19.7	19.8
T_3 75% RDN	37.4	36.10	58.70	58.69	11.7	11.9	10.5	11.2	27.4	27.7
T_4 50% N + 5t GM ha^{-1}	46.50	42.20	69.68	67.86	12.8	12.0	11.6	11.8	29.1	29.9
T_5 50% N +5t DBS ha^{-1}	35.20	32.80	51.56	51.37	10.3	10.8	10.4	10.2	20.8	21.7
T_6 75% N + 10kg BGA ha^{-1}	38.70	37.25	60.81	60.74	11.5	11.8	11.3	11.6	30.6	28.3
T_7 75% N + 5tFYM ha^{-1}	37.20	34.57	57.00	55.61	10.05	11.5	11.6	10.7	23.7	23.1
T_8 75% N + 5t Paddy straw ha^{-1}	36.55	33.96	55.31	54.97	10.6	10.9	11.5	10.7	23.9	25.0
T_9 100% NCU	50.49	49.85	83.75	81.00	13.6	13.9	12.0	12.5	30.7	30.9
C.D. (0.05)	1.68	2.89	2.46	2.85	0.66	1.24	1.15	1.17	0.56	1.17

Wat= week after transplanting

Nutrient uptake

Uptake of nutrients depends upon crop yield and their concentration. The values of nutrient uptake followed the patterns of yield obtained in different treatments. The prolonged and spatial availability of nitrogen from slow release fertilizer (NCU) seem to supply and supplement smaller amount of nitrogen from coated urea nitrogen top dressed in limited quantities at tillering and panicle initiation stages. Maximum uptake was recorded at 100 % N (NCU) showing the N, P and K uptake of 70.1, 23.2, 29.2 kg ha^{-1} in grain and 43.5, 14.7, 153.7 kg ha^{-1} in straw, respectively which was significantly higher than all the treatments. These results are supported by the findings of Bacon (1990). The higher N, P and K uptake by grain and straw of rice were recorded with

Table 2: Effect of nitrogen sources on uptake of nutrients (kg ha^{-1}) rice mean of 2 years

Treatments	Grain			Straw		
	N	P	K	N	P	K
T_1 Control	27.2	5.0	6.4	14.3	2.5	36.6
T_2 50% RDN	42.6	8.0	11.0	22.9	3.8	54.1
T_3 75% RDN	51.3	13.4	17.2	29.0	8.3	90.4
T_4 50% N + 5t GM ha^{-1}	64.3	148.7	25.5	35.8	11.2	117.0
T_5 50% N + DBS ha^{-1}	47.9	9.5	13.0	29.9	5.4	62.5
T_6 75% N + 10kg BGA ha^{-1}	53.5	14.7	18.5	30.2	9.1	100.2
T_7 75% N +5t FYM ha^{-1}	50.8	12.9	15.6	28.1	6.8	81.5
T_8 75% N + 5t Paddy straw ha^{-1}	50.1	11.6	15.0	26.7	6.1	77.4
T_9 100%N (NCU)	70.1	23.2	29.7	43.5	14.7	153.7
C D (P=0.05)	1.60	1.12	0.94	1.98	0.73	5.58

treatment enriched by organi manure and green manure. This might be due to continuous release of nutrients from the soil treated with FYM and green manure, blue green algae dried biogas slurry or paddy straw. These results are in conformity with the finding of Singh *et al.* (2013), Yadav and Meena (2014). Ahmad *et al.* (2014) and Subha Lakshmi *et al.* (2014) also reported higher nutrient uptake with the application of NPK alongwith organic manures.

Protein Content and Yield

The data on protein content n grain and straw are presented in Table 3. Increasing levels of nitrogen significantly increased the protein content in rice, grain and straw from 8.14 to 8.66 and 2.70 to 2.35%, respectively with 100% N (NCU). The increase in protein content owing to nitrogen addition might be attributed to its involvement in N metabolism. Addition of organic sources of nitrogen alongwith FYM, BGA, paddy straw and dried biogass slury also improved the protein content significantly over nitrogen levels alone and control. Among these organic, combined application of 75% N + 5 t FYM ha^{-1} proved superior to other organic sources of nitrogen in respect of protein content in rice. This increase in protein yield due to N application may be attributed to increased protein content and grain yield of rice.

Table 3: Effect of inorganic and organic sources on protein content (%) in rice grain

Treatments	Protein content in grain	Protein content in straw	Protein Yield (kg ha^{-1})
T_1 Control	8.14	2.70	167.5
T_2 50% RDN	8.52	2.91	257.3
T_3 75% RDN	8.58	3.09	315.3
T_4 50% N + 5t GM ha^{-1}	8.64	3.15	383.1
T_5 50% N + DBS ha-^{1}	8.52	3.01	289.6
T_6 75% N + 10kg BGA ha^{-1}	8.64	3.11	328.0
T_7 75% N +5t FYM ha^{-1}	8.54	3.08	306.3
T_8 75% N + 5t Paddy straw ha^{-1}	8.52	3.01	300.3
T_9 100%N (NCU)	8.64	3.25	428.9
CD (P=0.05)	0.28	0.03	19.5

Application of nitrogen up to the level of 100% N (NCU) increased the yield of protein which ranged from 167.5 to 428.9 kg ha^{-1}. It may be concluded that application of 100% N (NCU) and 75% N + 5 t FYM ha^{-1} improved yield and nutrient uptake in rice under the prevailing agro-climatic condition.

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