

Effect of integrated nutrient management on growth, yield of crops and availability of nutrients in inceptisol under rainfed rice (*Oryza sativa*)–niger (*Guizotia abyssinica*) sequence of Asom*

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Rice (*Oryza sativa* L.) is the staple food of the people of Asom and it is mostly cultivated during the rainy (*kharif*) season. With the advantage of considerable area under rice-fallow system and retreating monsoon, niger (*Guizotia abyssinica* L.) crop fits into the system and is preferred by the farming community of Asom as a rainfed crop. Declining trend in productivity due to continuous use of chemical fertilizers alone have been observed in several long-term experiments all over India (Nambiar 1994), while integration of organic sources sustain the productivity. It is however, difficult to meet the crop nutrient requirements with bulky organic manure alone and there is a need for integrated application of different sources of nutrients including biofertilizers for sustaining the desired crop productivity.

The combined use of organic and inorganic sources of nutrients helps in maintaining yield stability through correction of nutrient deficiencies, enhancing their efficiency and by providing favourable soil physical condition (Banerjee *et al.* 2006). The integrated nutrient management (INM) practices not only sustain soil health but also increase agronomic efficiency. As location-specific information is quite meagre, the present investigation was undertaken with the aim to assess the influence of INM on growth, yield and availability of nutrients in inceptisol under rainfed rice-niger sequence.

The investigation was carried out during 2007–08 in rice-niger cropping sequence, on an Inceptisol at The Instructional-cum-Research Farm (located in latitude

26°48'N, longitude 95°50'E and altitude 86.6 m) of Asom Agricultural University (AAU), Jorhat, Asom. The field is being cropped to rice–niger system for the last 3 years. The initial soil is of sandy clay in texture with bulk density of 1.3 mg/m³, water-holding capacity of 38.3%, mean weight diameter of 0.69 mm, water stable aggregates of 46.34%, pH of 5.01, organic carbon of 0.60%, CEC of 5.2 cmol (p⁺)/kg, EC of 0.13 dS/m, base saturation of 38.01%, available N of 270 kg/ha, available P₂O₅ of 27.6 kg/ha, available K₂O of 140 kg/ha, exchangeable Ca of 1.2 cmol (p⁺)/kg, exchangeable Mg of 0.6 cmol (p⁺)/kg and available sulphur of 9.4 kg/ha. The experiment with 7 treatments (Table 1) was laid out in randomized block design and was replicated thrice with individual plot sizes of 4 m × 6 m. The recommended levels (100%) of N, P₂O₅ and K₂O (60, 20 and 40 kg/ha for rice and 20, 10 and 10 kg/ha for niger) were applied in the form of urea, single superphosphate and muriate of potash, respectively. On the basis of nitrogen content, the amount of farmyard manure as organic source needed for a particular treatment was calculated and applied except in biofertilizer-based INM package. In T₆ and T₇, recommended dose of P and K was adjusted after subtracting their contribution through farmyard manure. Biofertilizer culture, i.e. *Azospirillum* + phosphate solubilizing bacteria (PSB) dual culture developed by Biofertilizer Section of AAU, Jorhat was applied @ 3 kg/ha before transplanting of *kharif* rice following root dip treatment, and *Azotobacter* + PSB dual culture was applied at the same rate for niger crop by seed treatment for 2 hr before sowing. The biofertilizer-based INM package included application of farmyard manure @ 3 tonnes/ha, rock phosphate (RP) @ 50% of recommended dose of P₂O₅ and MOP @ 100% of recommended dose of K₂O for both the crops. Half of urea, whole of single super phosphate, rock phosphate and muriate of potash were broadcasted at the time of transplanting of *kharif* rice. The remaining urea was top dressed at the time of maximum tillering stage and panicle-initiation stage of rice crop in two

* Short note

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Table 1 Yield attributes and yields of cv 'Basundhara' rice and 'NG 1' niger as affected by integrated nutrient management in rice-niger sequence

Treatment	Rice ('Basundhara')										Niger ('NG-1')							
	Plant height (cm)	Effective tillers/m ²	Panicle length (cm)	Panicle length (cm)	Filled grains/panicle	Chaffy grains/panicle	grain per cent of chaffy grain	1000 seed weight (g)	Grain yield (tonnes/ha)	Straw yield (tonnes/ha)	Plant height (cm)	Branches/plant	Plant m ²	Capitulum/seed	1000 seed weight (g)	Seed yield (tonnes/ha)	Stover yield (tonnes/ha)	REY (tonnes/ha)
T ₁ : Control	89.8	237.0	19.8	107.6	38.0	26.1	22.07	2.5	4.1	18.1	1.8	180	3.2	19.2	3.43	0.06	0.6	0.18
T ₂ : Recommended dose of Fertilizers (RDF)	101.9	280.0	21.0	122.3	35.5	22.5	22.33	3.1	5.2	25.4	2.7	244	4.4	27.0	3.47	0.15	1.2	0.41
T ₃ : Biofertilizer based INM package	94.3	287.0	19.8	121.2	34.0	21.9	22.67	2.9	4.6	31.5	3.1	232	5.0	28.5	3.67	0.17	1.2	0.47
T ₄ : 50% RDF + 50% N (FYM)	106.6	345.8	22.3	144.9	33.2	18.7	24.50	4.1	7.1	39.6	4.7	256	8.6	33.4	3.73	0.28	2.0	0.78
T ₅ : 75% RDF + 25% N (FYM)	107.6	285.6	20.8	130.2	31.6	19.5	23.57	3.7	6.0	31.7	2.8	228	5.2	31.0	3.53	0.23	1.4	0.64
T ₆ : 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted)	107.4	308.3	22.1	135.5	35.5	19.3	23.77	3.8	6.6	34.7	4.3	204	6.7	31.5	3.70	0.23	1.5	0.64
T ₇ : 75% N (inorganic) + 25% N (FYM) + PK (inorganic and adjusted)	102.6	295.1	21.1	114.0	36.0	24.0	23.43	3.4	5.4	28.5	3.0	220	4.6	27.7	3.43	0.15	1.1	0.41
S.Ed(±)	4.06	21.01	0.59	8.95	4.32	2.55	0.35	0.29	0.62	2.89	0.31	10.14	0.70	1.76	0.05	0.01	0.08	0.04
CD (P=0.05)	8.84	45.78	1.29	19.50	1.41	5.55	0.75	0.64	1.35	6.29	0.67	22.10	1.53	3.82	0.01	0.03	0.17	0.10
CV (%)	4.90	8.83	3.45	8.76	15.60	14.63	1.82	10.74	13.62	11.81	11.68	5.56	15.90	7.59	1.69	7.86	7.40	

Table 2 Uptake and availability of nutrients and economics under rice–niger sequence as influenced by integrated nutrient management practices

Treatments	Uptake by rice (kg/ha)			Uptake by niger (kg/ha)			Availability of nutrients after rice (kg/ha)			Availability of nutrients after niger (kg/ha)			Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B: C ratio
	N	P	K	N	P	K	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O			
T ₁ : Control	42.6	9.4	43.4	8.5	1.3	1.8	246.7	17.9	48.9	229.8	15.1	45.9	13 160	14 020	2.07
T ₂ : Recommended dose of Fertilizers (RDF)	59.5	14.8	82.7	18.5	3.0	3.6	297.2	21.8	58.2	252.2	20.3	52.7	16 250	18 910	2.16
T ₃ : Biofertilizer based INM package	56.7	16.9	88.2	29.3	4.7	5.2	288.5	24.9	68.4	285.7	24.7	60.6	17 350	16 370	1.94
T ₄ : 50% RDF + 50% N (FYM)	87.5	35.6	128.8	45.0	8.6	10.8	359.6	30.2	69.4	325.8	28.9	62.0	24 800	24 210	1.98
T ₅ : 75% RDF + 25% N (FYM)	75.9	28.0	107.6	38.8	5.6	8.8	316.4	26.3	60.5	288.0	24.3	57.0	20 660	22 590	2.09
T ₆ : 50% N (inorganic) + 50% N (FYM) + PK (inorganic and adjusted)	82.1	29.5	108.6	40.8	6.7	9.2	338.7	27.5	61.4	298.6	26.0	56.5	23 990	20 820	1.87
T ₇ : 75% N (inorganic) + 25% N (FYM) + PK (inorganic and adjusted)	60.9	15.8	66.9	30.0	4.1	6.4	317.8	21.1	59.2	240.3	18.6	55.7	19 450	23 540	2.21
SEm (±)	1.24	0.70	1.31	0.57	0.23	0.41	10.29	1.40	2.37	9.63	1.05	2.15			
CD (P=0.05)	3.81	2.16	4.05	1.75	0.71	1.28	31.71	4.32	7.32	29.67	3.24	6.63			
CV (%)	3.23	5.67	2.54	3.27	8.26	10.96	5.85	10.04	6.76	6.08	8.18	6.69			

equal doses. In case of niger, whole of urea, single super phosphate, rock phosphate and muriate of potash was applied as basal to the soil at the time of sowing. 'Basundhara' rice was transplanted at 20 cm × 15 cm spacing on 11 July 2007 and 'NG 1' niger on 27 November 2007 at 20 cm row spacing and maintaining plant distance of 5 cm. The crop management practices were practised as per the standard recommendation of the region. Rice was harvested on 8 November 2007 and niger on 29 March 2008, respectively.

Soil samples were collected from effective root zone depth (0–30 cm) after the harvest of *kharif* rice and *rabi* niger from each plot, air-dried, processed to pass through a 2 mm sieve and stored in polyethylene bags for analysis. Available nitrogen, phosphorus and potassium content in soil were determined by alkaline potassium permanganate method (Subbiah and Asija 1956), Bray and Kurtz No. 1 Method (Jackson 1973) and flame photometrically (Jackson 1973), respectively. Plot-wise plant samples collected at the time of harvesting were chopped, dried and ground, and digested in concentrated H₂SO₄ for determination of N content (modified kjeldahl's method) and in tri acid mixture for determination of P (yellow colour development method) and K (flame photometric method) contents (Jackson 1973). The economics and rice equivalent yield were computed at prevailing market rate during 2007–08 of different commodities. All the data were subjected to statistical analysis.

A perusal of data (Table 1) revealed that yield-attributing characteristics of rice were significantly affected by different treatments. Application of 75% recommended dose of fertilizers (RDF) + 25% N farmyard manure (FYM) produced highest plant height (107.6 cm) which was at par with 50% N (inorganic) + 50% N (farmyard manure) + PK (inorganic and adjusted) and 50% RDF + 50% N farmyard manure treatment. Substitution of 50% N with farmyard manure led to a higher increase in effective tiller numbers/m², panicle length, filled grain/panicle and test weight of seeds of rice over control compared to RDF. Similar effect was also observed in niger crop in the sequence (Table 1) with 50% RDF + 50% N through farmyard manure resulting in significant increase in plant height, branches/plant, plants/m², capitulum/plant, seeds/capitulum and test weight over recommended dose of fertilizers and control. The magnitude of increase was 118.8% in plant height, 161.1% in numbers of branches/plant, 42.2% in numbers of plants/m², 168.6% in numbers of capitulum/plant, 74.0% in numbers of seeds/capitulum and 8.8% in test weight of seeds. Such beneficial effects of integrated use of farmyard manure with chemical fertilizers are corroborative of earlier findings of Thakuria and Gogoi (1994).

Grain and straw yield of rice varied from 2.5 to 4.1 and 4.1 to 7.1 tonnes/ha, respectively (Table 1). A significant increase in grain and straw yields of *kharif* rice in integrated nutrient management over treatments recommended NPK

dose and control was observed. This could be attributed to a steady decomposition of farmyard manure and release of nutrients throughout the crop growth period coupled with better assimilation of nutrients (Kumar *et al.* 2008). In case of *rabi* niger also similar trend was recorded. Thus, confirming the findings reported earlier by Baishya and Thakur (1997) from Asom. In general, niger yields were lower than the reported values perhaps due to late sowing of niger owing to slow drying of rice field after the harvest. Rice equivalent yields presented in Table 1 also indicated that the combined effect of 50% of RDF along with 50% N through farmyard manure significantly increased rice equivalent yield over RDF by 90.2%.

Table 2 shows that INM treatments had a significant effect on N, P and K uptake in both the crops and were promising compared to RDF. Uptake of major nutrients by rice was highest with 50% RDF + 50% N farmyard manure treatment, followed by 50% N (inorganic) + 50% N (farmyard manure) + PK (inorganic and adjusted) and 75% of RDF + 25% N (farmyard manure) treatment. In niger also uptake of N, P and K followed the similar trend. Combined application of 50% RDF + 50% N farmyard manure resulted in maximum increase in uptake of N, P and K over control (by 429.4, 561.5 and 500%, respectively) and compared to 100% RDF. This improvement in nutrient uptake in both rice and niger crop may be attributed to regulated availability of nutrients in the soil and positive interaction effects of organic and inorganic sources of nutrients (Bairwa *et al.* 2009).

It is also evident from the data on soil nutrient status (Table 2) after the crops which indicated an improvement with INM treatments over 100% RDF and control treatments. However, in general there was decline in soil available K status over the initial value in all treatments. Mismatch in the addition and removal by crops might be the possible reasons for decrease in K availability in soil. Such negative balance of K in rice–rice sequences in Jorhat district of Asom has also been reported by Basumatary and Talukdar (1999). Sharma and Bali (2001) also reported such decline in K availability in soil.

The treatment receiving 75% N (inorganic) + 25% N (farmyard manure) + PK (inorganic and adjusted) recorded the highest benefit : cost ratio (2.21), followed by RDF (2.16). However, 50% RDF + 50% N (farmyard manure) with benefit : cost ratio 1.98 was considered to be the best as compared to other treatments in terms of yield, gross and net returns (Table 2) and soil health. However, there is a need and scope to improve further the benefit : cost ratio of this treatment by reducing input cost through recycling of crop residues or composting.

SUMMARY

Results from the field study conducted during 2007–08 under the rainfed rice (*Oryza sativa* L.) – niger (*Guizotia abyssinica* L.) cropping sequence in inceptisol of Asom

revealed that application of 50% recommended dose of fertilizers (RDF) along with 50% N through farmyard manure significantly increased yield-attributing parameters, such as effective tiller numbers/m², panicle length, filled grains/panicle and test weight of seeds of rice and plant height, branches/plant, plants/m², capitulum/plant, seeds/capitulum and test weight of seeds of niger, besides maximizing the straw (7.1 tonnes/ha) and grain (4.1 tonnes/ha) yield of *kharif* rice and stover (2.0 tonnes/ha) and seed (0.28 tonnes/ha) yield of *rabi* niger as compared to RDF. Supplying 50% N through organic form (farmyard manure) along with 50% recommended dose of fertilizers also resulted in higher availability of N, P₂O₅ and K₂O in soil and nutrient uptake in both the crops. However, the benefit : cost ratio was highest (2.21) with 75% N (inorganic) + 25% N (farmyard manure) + PK (inorganic and adjusted), while 50% RDF (inorganic) substituted through 50% N farmyard manure (organic) gave higher net returns from this cropping sequence.

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