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Integrated Nutrient Management on the productivity and nutrient uptake of crops in rice-lathyrus (as *utera*)-sesame cropping system under rainfed lowland eco-system

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Abstract

A field experiment was conducted during 2003 and 2004 in farmer's field of West Bengal in entisol soil of neutral reaction having 0.068% total N, 26.8 and 195 kg/ha available P and K, respectively to study the effect of Integrated Nutrient Management on the productivity of the crops in rice-lathyrus - (as *utera*)-sesame cropping system under rainfed condition. The results revealed that the yield of crops differed significantly with different nutrient management with organic and inorganic sources in rice-lathyrus (as *utera*)-sesame cropping system. The highest grain yield of rice (4912.7 kg/ha) was recorded in the treatment receiving 75% RD of NPK to rice and sesame only + *in situ* green manuring to rice with dhaincha (*Sesbania aculeata*)+ FYM @ 10t/ha to rice (T_{11}), which was as good as the yield of the crops recorded in the treatments receiving 100% RD of NPK to rice and sesame only + FYM @ 10 t/ha to rice (T_6), 150% of RD to rice only (T_4) and 100 % RD of NPK to rice and sesame only + *in situ* green manuring of rice with *dhaincha* (T_8). In rice, applying higher dose of fertilizer (150% of RD to rice only) increased the grain yield of rice but this treatment was not consistent in increasing the yield of the other crops in sequence. The highest seed yield of *lathyrus* (1096.1 kg/ha) and sesame (659.5 kg/ha) was recorded under the treatment, T_{11}, followed by that obtained under T_6 and T_8 treatments. Higher yields of the crops were also obtained with the application of reduced rate of fertilizer (75% RD of NPK to rice and sesame) in conjunction with FYM@ 10 t/ha to rice (T_5) or *in situ* green manuring of rice with dhaincha (T_7) or application of crop residues (T_{10}). The lowest yields of the crops were recorded by imbalanced application of nutrients (Farmers practice). Plant nutrient uptake of all the crops in sequence was also favourably influenced by integrated nutrient management in rice-lathyrus (as *utera*)-sesame cropping system by application of reduced dose of inorganic fertilizers to rice and sesame when used in combination with FYM application and *in situ* green manuring with *dhaincha* to rice crop.

Intensive cultivation has led to the imbalance in soil fertility, resulting in decline in yield of crops. Farmer has to use more and more fertilizers year after year to obtain the optimum yield as a result of decline in soil fertility (Hobbs *et al.*, 1990). Continuous use of inorganic fertilizers may have some ill effects on the soil properties also in the long run. Pollution of ground water owing to leaching of nitrates is new concern in the country. Research has been conducted to generate soil management technologies including INM to overcome the declining rate of increase in crop productivity. Many trials showed that organic fertilizer application in combination with mineral fertilizers can sustain high yield significantly (Adiningsih *et al.*, 1997). Organic sources of fertilizer releases nutrient slowly and increase nutrient use efficiency. Therefore a field experiment was planned to study the effect of Integrated Nutrient Management on the productivity of the crops in rice-lathyrus - (as *utera*)-sesame cropping system under rainfed condition.

MATERIALS AND METHODS

Field experiment was conducted in farmer's field of West Bengal during 2003

and 2004 on entisol soil of neutral reaction having 0.068% total N, 26.8 and 195 kg/ha available P and K, respectively. The experiment comprised 11 treatments, replicated thrice was tested in Randomized Block design and the treatments were: T_1: Fertilizer management as per farmer's practice (40:20:20 N: P_2O_5: K_2O kg/ha to rice and 10 kg N/ha only each to sesame and lathyrus) i.e., control; T_2: 75% of the Recommended Dose of NPK (RD of NPK) to rice and sesame only; T_3: 100% of the RD of NPK to rice and sesame only; T_4: 150% RD of NPK to rice only; T_5: 75% RD of NPK to rice and sesame only + 10 t ha^{-1} FYM to rice; T_6: 100% RD of NPK to rice and sesame only + 10 t ha^{-1} FYM to rice; T_7: *In situ* Green manuring to rice with *Dhaincha* (*Sesbania aculeata*) + 75% RD of NPK to rice and sesame only; T_8: *In situ* Green manuring to rice with *Dhaincha* + 100% RD of NPK to rice and sesame only; T_9: 100% RD of NPK to all the crops i.e. rice, lathyrus and sesame; T_{10}: 75% RD of NPK to rice and sesame only + addition of crop residues after harvest of the crops; T_{11}: 75% RD of NPK to rice and sesame only + *In situ* Green manuring to rice with *Dhaincha* +10 t ha^{-1} FYM to rice. *Utera* crop (*lathyrus*) was grown with residual fertility in all treatments except 'T_9'. Recommended dose of NPK for rice, lathyrus and sesame was 60: 30: 30, 10:20:10 and 40:20:20 kg N: P_2O_5: K_2O/ha respectively. The green manure, *Dhaincha* was incorporated in the soil, *in situ,* prior to transplanting of rice when it reached a age of 40-45 days.

RESULTS AND DISCUSSION

Effect on productivity of crops

Grain yield of rice

The grain yield of rice differed significantly with different nutrient management systems (Table-1). A significant increase over farmer's fertilizer management practice was recorded with other treatments with respect to grain and straw yield of rice. The highest grain yield of rice (4912.7 kg/ha) was recorded in the treatment receiving 75% RD of NPK to rice and sesame only + FYM @ 10t/ha to rice + *in situ* green manuring with dhaincha to rice (T_{11}), closely followed by the yields (4766.0, 4651.4 and 4638.5 kg/ha) recorded in the treatments receiving 100% RD of NPK to rice and sesame + FYM @ 10t/ha (T_6), 150% of RD to rice only (T_4) and 100% RD of NPK to rice and sesame + *in situ* green manuring with dhaincha to rice (T_8) respectively. In rice, applying higher dose of fertilizer (150% of RD to rice only) increased the grain yield of rice but this treatment was not consistent in increasing the yield of the other crops in sequence. Higher yields were also obtained with the application of reduced rate of fertilizer (75% RD 0f NPK to rice and sesame) in conjunction with either FYM @ 10t/ha to rice (T_5) or *in situ* green manuring with dhaincha to rice (T_7) as compared with the yield recorded in the treatment receiving 100% RD of NPK through inorganic sources only. Imbalanced application of nutrients (Farmer's practice) recorded the lowest grain yield (3193.2 kg/ha) of rice.

Seed yield of lathyrus

The seed yield of *utera* crop, lathyrus, grown after *kharif* season rice differed significantly due to different methods of plant nutrient application (Table-1). A significant increase in seed yield over farmer's fertilizer management practice was recorded with all other treatments. The highest seed yield of lathyrus (1096.1 kg/ha) was obtained where rice crop preceding lathyrus and sesame crop following the *utera* crop were supplied with inorganic fertilizer dose that was 25% less than that recommended to these crops in combination with 10 t FYM/ha and green

manuring with *dhaincha*, both of them applied to wet season rice (T_{11}). The percentage increase of seed yield over farmer's practice with this treatment was more than 200%. This treatment, with respect to these parameters, was however at par with treatments where recommended dose of inorganic fertilizer to rice and sesame was applied to rice and sesame in combination with either FYM @ 10 t/ha (T_6) or *in situ* green manuring with *dhaincha* (T_8) to rice. The treatment where previous crop residue was applied to lathyrus (T_{10}) also recorded higher seed yield of 998.I kg/ha, probably because the rice straw applied served as a good mulch. Increase in yield of *utera* crop by integrated nutrient management was also reported by Chanda *et al.*, 2004.

Seed yield of sesame

The seed yield of sesame differed significantly with different nutrient management treatments employing inorganic nutrients in various proportions either applied alone or in combination different organic sources, *viz.* FYM, green manuring or crop residues (Table-1). The results indicate that the highest seed yield of sesame (659.5 kg/ha) was obtained under the treatment where application of FYM and green manuring was done to rice and inorganic fertilizers were applied to rice and sesame at 25% reduced dosage from that recommended (T_{11}). The treatment effect of 100% RD of NPK to rice and sesame + 10 t/ha FYM to rice (T_6) and T_{11} was at par in relation to seed yield of sesame. Higher seed yield was also obtained where 100% RD of NPK was applied to rice and sesame and green manuring was applied to rice crop (T_8) and also in the treatments where either FYM application or green manuring was done to rice crop in addition to lower dose of inorganic nutrient application (T_5 and T_7). The lowest seed yield was recorded under farmer's practice and yield increase obtained with the best treatment from this treatment was 79.1%.

Nutrient uptake by crops

Rice

The nutrient uptake by rice plants varied significantly with different nutrient management treatments (Table-1). The nutrient uptake in the treatments receiving inorganic sources of nutrient at recommended or lower dose in combination with either FYM or green manuring was superior as compared to that receiving through inorganic sources only except that in treatment which received 150% of the recommended dose to rice alone (T_4). The highest N, P and K uptake (102.3, 33.99 and 136.8 kg/ha, respectively) was observed under treatment T_{11}, closely followed by that recorded under T_6 and T_8. Notably lower nutrient uptake was recorded in farmer's practice. Higher nutrient uptake noted in the above treatments may be attributed to higher dry matter production and also due to the fact that green manuring or FYM application along with inorganic nutrients increased the availability of nutrients in soil and its accumulation in rice over sole inorganic fertilizer application. This is in conformity with the findings of Jeyabal *et al.*, 1999.

Lathyrus

The plant nutrient uptake by lathyrus crop varied markedly due to application of different fertilizer management treatments (Table-1). The highest N, P and K uptake of 69.9, 11.9 and 54.1 kg/ha by lathyrus crop was recorded under T_{11} treatment, which was at par with T_6 treatment, wherein, recommended dose of inorganic nutrients was applied to rainy and summer season crops and FYM was applied to rainy season rice. Similar trend was also observed in case of P and K uptake also. The nutrient uptake by lathyrus was significantly reduced when a

reduction from recommended dose was done to rice and sesame, which was more conspicuous where organic sources were not supplemented to the treatments. Higher N, P and K uptake was also recorded where all the crops in sequence were applied with recommended dose of fertilizers, while minimum NPK uptake was seen in farmer's practice. Similar findings were reported by Mondal *et al.*, 2003.

Sesame

The NPK uptake of sesame varied with different nutrient management treatments (Table-1). The highest N (94.6 kg/ha), P (24.1 kg/ha) and K uptake (59.4 kg/ha) by sesame was obtained under T_{11}, closely followed by that recorded under T_6. The minimum N, P and K uptake was seen in case of treatments where imbalanced application of nutrients was done (farmer's practice).

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Table 1 Effect of Integrated nutrient management on Grain yield of rice, seed yield of linseed and sesame and nutrient uptake by the crops in rice-linseed (as *utera*)-sesame cropping system

Treatments	Grain Yield of rice (kg/ha)	Seed yield of lathyrus (kg/ha)	Seed yield of sesame (kg/ha)	Nutrient uptake by rice (kg/ha)			Nutrient uptake by lathyrus (kg/ha)			Nutrient uptake by sesame (kg/ha)		
				N uptake	P uptake	K uptake	N uptake	P uptake	K uptake	N uptake	P uptake	K uptake
T_1	3193.2	357.1	368.2	67.8	13.73	77.5	32.8	4.0	25.9	61.4	13.6	29.3
T_2	3588.6	390.5	413.6	76.1	16.00	89.9	36.8	4.6	29.7	64.4	14.2	30.9
T_3	4190.5	518.5	420.8	86.2	21.58	122.8	41.0	5.9	33.1	67.5	15.0	32.2
T_4	4651.4	830.0	405.8	95.3	27.58	135.2	45.9	7.5	37.1	61.0	12.5	29.9
T_5	4550.6	993.9	503.4	92.3	25.52	122.9	57.7	9.4	45.7	72.2	16.7	35.2
T_6	4766.0	1069.7	618.3	102.0	30.92	135.5	65.6	10.8	51.3	87.5	21.8	52.1
T_7	4464.2	974.9	495.4	92.8	26.45	120.1	52.5	8.6	41.7	69.2	15.9	34.4
T_8	4638.5	1039.1	585.4	95.2	28.43	127.1	59.6	9.7	47.0	83.7	20.8	42.1
T_9	4278.2	937.5	461.5	89.1	23.88	116.0	50.5	8.2	40.3	70.6	18.4	34.6
T_{10}	4000.8	998.3	459.1	83.1	22.84	100.4	56.0	8.6	42.2	69.7	15.7	34.6
T_{11}	4912.7	1096.1	659.5	102.3	33.99	136.8	69.9	11.9	54.1	94.6	24.1	59.4
S.Em(±)	120.5	26.4	14.7	3.0	0.93	3.8	1.8	0.6	1.3	I.8	0.9	2.8
CD (p=0.05)	**355.6**	**77.8**	**43.5**	**7.9**	**2.73**	**11.3**	**5.2**	**1.7**	**3.7**	**11.I**	**2.7**	**8.3**