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Performance of rice (*Oryza sativa* L.) - rapeseed (*Brassica campestris* L.) cropping sequence under system based nutrient management

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ABSTRACT

System based nutrient management practice for rice– rapeseed cropping sequence was studied in a field experiment during 2003-04 and 2004-05. Application of FYM at 2.5 t ha^{-1} + Eupatorium at 2.5 t ha^{-1} recorded maximum grain yield of rice (3.63 t ha^{-1}), productivity (4.68 t ha^{-1}) and economics (Rs.12,621 ha^{-1}) of the system. The highest residual effect of organics on rapeseed seed yield was noticed with FYM at 5 t ha^{-1}. Application of 100% recommended dose of fertilizer (RDF: NPK 60:60:40) to rice followed by 50% RDF to rapeseed recorded highest rice grain yield as well as system productivity (4.64 t ha^{-1}). However, no significant difference was observed in seed yield of rapeseed among the inorganic treatments. The maximum gross return, net return and benefit cost ratio was registered with 100% RDF to rice + 50% RDF to rapeseed.

Key words: *Rice, rapeseed, Eupatorium, Alnus, system productivity, net return, benefit: cost ratio*

Rice– rapeseed is the most prevalent cropping sequence adopted by the farmers in the northeastern hill region of India. This system is followed in the mid hill areas without proper nutrient management leading to fast depletion of soil fertility and crop productivity. The rising prices and lack of availability of inorganic fertilizers at right time to the farmers due to poor transport facility necessitates some alternative ways of nutrients supply. Integration of locally available organics and on-farm inputs like obnoxious weeds, green tree leaves and farm yard manure as supplementary source of nutrient may meet the nutrient requirement of the system. The beneficial effects of integrated plant nutrient supply (IPNS) in rice - based cropping system has well been reported by many workers (Bhandari *et.al.*, 1992 and Kumar *et.al.*, 2000). Further, organic sources of nutrient supply to the preceding crop benefit the succeeding crop to a great extend (Hegde and Dwivedi, 1992) and make the system sustainable. Hence, an attempt was made to develop a system based nutrient management practice for rice-rapeseed cropping sequence using locally available organics and on-farm inputs along with inorganic fertilizers in mid hills of Meghalaya

MATERIALS AND METHODS

The field experiment was conducted during 2003-04 and 2004-05 in factorial randomized block design with three replications, having sixteen treatment combinations including five organic sources viz., FYM at 5 t ha^{-1}, *Eupatorium* at 5 t ha^{-1}, *Alnus* at 5 t ha^{-1}, FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} and FYM at 2.5 t ha^{-1} + *Alnus* at 2.5 t ha^{-1} and three inorganic fertilizers levels viz., 50 % recommended dose of fertilizer (RDF NPK 60:60:40) to rice + 75% RDF NPK 50:30:20 to rapeseed, 100 % RDF to rice + 50% RDF to rapeseed and 150 % RDF to rice + 25% RDF to rapeseed. The soil of the experimental site was alfisol, acidic in nature (pH 5.2), high in organic carbon (0.83%), medium in available N (450 kg ha^{-1}), low in available P (6.23 kg ha^{-1}) and high in available K (303.8 kg ha^{-1}). The Siam weed (*Eupatorium odoratum)* and Alder (*Alnus nephalensis)* were analyzed for NPK content and found to have 2.27 and 2.41% N, 0.80 and 0.90% P and 1.22 and 1.20 % K, respectively on dry weight basis. Rice (cv. Bhalum 1) and rapeseed (cv. M 27) were sown on 5th June 2003 and 9th June 2004, 16th October 2003 and 23rd October 2004, respectively.

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Organic sources of nutrients viz., FYM, fresh chopped *Eupatorium* and *Alnus* were applied two weeks before sowing of rice crops. Half of nitrogen and full dose of phosphorus and potassium were applied as basal and rest of the nitrogen was applied in two equal splits, each at maximum tillering and panicle initiation stage of rice. The fertilizers were applied to rapeseed at the time of sowing as per the treatments. Yield of both the crops were recorded after harvesting and pooled. System productivity in terms of rice equivalent yield (REY), net return and B: C ratios were calculated.

RESULTS AND DISCUSSION

Different sources of organic nutrients showed significant variation in all the yield and yield attributing characters. Highest plant height (84.7 cm), grains panicle^{-1} (142.5), grain yield (3.63 t ha^{-1}) and straw yield (8.47 t ha^{-1}) of rice was recorded with application of FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} which was at par with fresh chopped *Eupatorium* at 5 t ha^{-1} (Table 1). Increase in rice grain yield owing to green leaf manure and FYM incorporation may be attributed to release of nutrients to soil slowly for longer duration after decomposition resulting in better plant growth and yield attributing characters. Patra *et.al.*,2000 and Das *et.al.*, 2001 reported similar effects of organic matter incorporation in rice. Among the inorganic nutrient sources, significant difference was also noticed in all the growth and yield attributes of rice. Highest plant height (83.1 cm), grains panicle^{-1} (144.9), test weight (29.3 g) and grain yield (3.52 t ha^{-1}) was registered with 100% RDF to rice (Table 1). However, though the straw yield (8.56 t ha^{-1}) increased marginally with 150% RDF but could not proved its superiority statistically over 100% RDF. Harvest index of rice did not differ significantly with fertilizer levels.

The application of organics and/or inorganics to rice and their residual effect and direct effect of fertilizers to rapeseed significantly increased all the growth and yield attributing characters of rapeseed over control. The per cent increase in plant height, number of branches plant^{-1}, number of siliqua plant^{-1}, seed yield, straw yield and harvest index by 64.10, 100.88, 81.92, 168.82, 110.43 and 19.05%, respectively over control. The various organic sources of nutrients had significant effect on plant height, number of branches plant^{-1}, number of siliqua plant^{-1}, seed yield and harvest index except straw yield of rapeseed. Significantly highest plant height (79.9 cm), number of branches plant^{-1} (5.5), number of siliqua plant^{-1} (88.2), seed yield (0.66 t ha^{-1}) and harvest index (0.28), respectively was recorded in plots where FYM at 5 t ha^{-1} was applied to rice. It was

Table 1. Effect of Integrated plant nutrient supply treatments on growth, yield attributes and yield of rice (Pooled for 2 years)

Treatments	Plant height (cm)	Grains panicle^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index
Organic nutrients						
FYM at 5t ha^{-1}	78.3	132.3	28.8	3.26	7.80	0.29
Eupatorium at 5t ha^{-1}	84.5	139.5	29.2	3.58	8.46	0.30
Alnus at 5t ha^{-1}	77.0	125.2	28.1	3.20	7.73	0.29
FYM at 2.5t ha^{-1} + *Eupatorium* at 2.5t ha^{-1}	84.7	142.5	28.8	3.63	8.47	0.31
FYM at 2.5t ha^{-1} + *Alnus* at 2.5t ha^{-1}	78.7	132.3	28.7	3.31	7.84	0.30
CD (P=0.05)	2.9	4.2	NS	2.5	3.2	NS
Inorganic nutrients						
50% RDF (rice) + 75%RDF (rapeseed)	77.2	124.5	27.8	3.18	7.21	0.31
100%RDF (rice) + 50%RDF (rapeseed)	83.1	144.9	29.3	3.52	8.41	0.30
150%RDF (rice) + 25%RDF (rapeseed)	81.6	133.8	29.1	3.49	8.56	0.29
CD (P=0.05)	2.3	3.3	1.0	1.9	2.5	NS
Control vs. Rest						
Control	73.3	98.6	26.4	1.90	5.41	0.26
Treatment	80.6	134.4	28.7	3.40	8.06	0.30
CD (P=0.05)	3.7	5.4	1.7	3.1	4.1	0.02

at par with FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} treatments plots (Table 2). However, no significant difference was observed for straw yield of rapeseed among the organic nutrient sources tried. This increase of growth and yield components may be due to carry-over effect of applied nutrients to the preceding rice crop and higher availability of macro and micronutrients with the addition of FYM, *Eupatorium* etc. This is in conformity with the findings of Ahmed and Thakur, (1998). Application of inorganic nutrient sources did not influence significantly the growth and yield attributing characters of rapeseed, which proved that the residual effect of nutrient supply to rice compensated the direct effect of fertilizers on rapeseed seed yield. The highest plant height (76.2 cm), number of branches $plant^{-1}$ (4.9), number of siliqua $plant^{-1}$ (83.7) and straw yield (1.53 t ha^{-1}), respectively, were recorded with 50% RDF to rice and 75% RDF to rapeseed. However, the highest seed yield (0.52 t ha^{-1}) was recorded with 100% RDF to rice and 50% RDF to rapeseed (Table 2). The productivity of rice-rapeseed cropping system was positively influenced by IPNS treatments. The rice equivalent yield (REY) was increased by 94.3% over control. The REY of rice - rapeseed cropping sequence also varied significantly with different organic nutrient treatments (Table 3). Highest REY of 4.68 t ha^{-1} was recorded with FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} that was at par with FYM at 5 t ha^{-1} and *Eupatorium* at 5 t ha^{-1} alone but significantly higher compared to rest of the treatments under rice - rapeseed cropping sequence. Significant difference was also observed among the inorganic fertilizers treatments for rice equivalent yield of the system. The IPNS treatments either organics and/or inorganics registered higher net returns (Rs.11,506/-ha^{-1}), benefit: cost ratio (1.79) compared to Rs.3,969/- and 1.45, respectively in control (Table 3). The highest net return (Rs. 12,621/-ha^{-1}) as well as benefit cost ratio (1.93) was registered with FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} followed by *Eupatorium* at 5 t ha^{-1} (Rs. 11,807/- ha^{-1} and 1.86, respectively) among the various organic sources of nutrients which may be due to higher productivity of crops. However, the maximum net return (Rs.12,013/-ha^{-1}) and benefit cost ratio (1.86) was observed with 100% RDF to rice and 50% RDF to rapeseed because of higher productivity. This result confirm with the findings of Munda and Islam, (2006).

Thus, the IPNS treatments of FYM at 2.5 t ha^{-1} + *Eupatorium* at 2.5 t ha^{-1} in combinations or

Table 2. Effect of Integrated Plant Nutrient Supply treatments on growth, yield attributes and yield of rapeseed (Pooled for 2 years)

Treatments	Plant height (cm)	Number of branches $plant^{-1}$	Number of siliqua $Plant^{-1}$	Seed yield (t ha^{-1})	Stoveryield (t ha^{-1})	Harvest Index
Organic nutrients						
FYM at 5t ha^{-1}	79.9	5.5	88.2	0.66	1.69	0.28
Eupatorium at 5t ha^{-1}	72.5	4.2	80.5	0.46	1.45	0.24
Alnus at 5t ha^{-1}	74.5	4.3	81.2	0.48	1.37	0.26
FYM at 2.5t ha^{-1} + *Eupatorium* at 2.5t ha^{-1}	76.8	5.1	82.2	0.49	1.37	0.26
FYM at 2.5t ha^{-1} + *Alnus* at 2.5t ha^{-1}	72.0	3.8	76.6	0.41	1.49	0.22
CD (P=0.05)	3.0	0.6	4.0	0.8	NS	0.11
Inorganic nutrients						
50% RDF (rice) + 75%RDF (rapeseed)	76.2	4.9	83.7	0.49	1.53	0.24
100%RDF (rice) + 50%RDF (rapeseed)	74.4	4.5	81.5	0.52	1.48	0.26
150%RDF (rice) + 25%RDF (rapeseed)	74.9	4.4	79.9	0.49	1.42	0.25
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Control vs. Rest						
Control	45.8	2.3	44.9	0.19	0.70	0.21
Treatment	75.2	4.6	81.7	0.50	1.47	0.25
CD (P=0.05)	3.8	0.7	5.1	1.0	3.2	0.01

Table 3. Effect of IPNS treatments on rice equivalent yield (REY) and economics of rice - rapeseed cropping sequence (Pooled for 2 years)

Treatments	REY (t ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit: Cost ratio
Organic nutrients				
FYM at 5t ha^{-1}	4.67	14,729	11,428	1.78
Eupatorium at 5t ha^{-1}	4.56	13,729	11,807	1.86
Alnus at 5t ha^{-1}	4.23	13,979	9,679	1.69
FYM at 2.5t ha^{-1} + *Eupatorium* at 2.5t ha^{-1}	4.68	13,604	12,621	1.93
FYM at 2.5t ha^{-1} + *Alnus* at 2.5t ha^{-1}	4.19	13,729	9,746	1.71
CD (P=0.05)	2.8	-	-	-
Inorganic nutrients				
50% RDF (rice) + 75%RDF (rapeseed)	4.22	13,219	10,407	1.79
100%RDF (rice) + 50%RDF (rapeseed)	4.64	13,954	12,013	1.86
150%RDF (rice) + 25%RDF (rapeseed)	4.54	14,690	10,745	1.73
CD (P=0.05)	2.2	-	-	-
Control vs. Rest				
Control	2.30	8,900	3,969	1.45
Treatment	4.47	13,954	11,056	1.79
CD (P=0.05)	3.6	-	-	-

Eupatorium at 5 t ha^{-1} with or without 100 % RDF to rice + 50 % RDF to rapeseed found to be beneficial in terms of ice equivalant field gross income, net returns and benefit cost ratio for rice-rapeseed cropping sequence at mid hills (800-930 m MSL) dry terraces of Meghalaya.

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