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Effect of Organic Source and Nitrogen Levels on Soil Microbial Biomass Nitrogen in Rice under Rice-wheat Cropping System

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Abstract : A field experiment was conducted at Govind Ballav Pant Univerisity of Agriculture & Technology, Pantnagar during 2000-01 and 2001-02 to evaluate the effect of four organic sources *viz. Sesbania aculeata, Crotalaria juncea, Vigna unguiculata* and wheat straw along with 4 levels of N to rice (*Oryza sativa L.*) and 3 levels of N to wheat (*Triticum aestivum L.* Enerd. Fiori & Paol, L.) on soil microbial biomass nitrogen during rice growth under rice-wheat cropping, system. Soil microbial biomass (SMB) N values gradually declined with time and reached minimum at rice harvest during both the years except in 2000-01 the treatment in which rice was grown after incorporation of *Crotalaria* green manure and wheat straw where SMB values increased at 60 days after transplanting (DAT) as compared to 30 DAT. Variation in organic sources applied to rice brought significant differences in SMB N values at all the stages of rice growth in both the years. Interaction between organic sources and nitrogen level applied to rice were found significant at all stages of growth in both the years except at 60 DAT during 2000-2001.

Key words : Organic source, Soil microbial biomass (SMB), Nitrogen (N), Cropping system.

Introduction

Rice-wheat cropping system is the predominant cropping system in India which is ensuring food security presently, Both rice and wheat crops are heavily fertilized with N, because the system removes 250 kg N/ha. There is a renewed interest in organic manures, such as farmyard manures, composts, green manures and recycling of crop residues, as source of plant nutrient to sustain reasonable productivity. The more readily available green manures constitute a valuable source of both N and organic matter (Ladha *et al*., 1996). Since crop residues and green manures cannot meet the total nutrient needs of modern agriculture, integrated use of nutrients from fertilizers and organic sources seems to be the need of the time (Ramamoorthy *et al*.2001).

The soil microbial biomass (SMB) N serve as a potential source of mineralizable N which can be used by plant. Cropping practices and fertilization of soil affect microbial growth and activity. There was a very large and rapid increase in the amount of microbial biomass N following straw incorporation (Ocio *et al*., 1991). *Sesbania* green manure (Azam *et al*., 1985) and fertilizer N application (Goyal *et al*., 1992). Ocio *et al*. (1991) found that field incorporation of 10t straw ha^{-1} to a silty clay loam soil increased the amount of biomass 1.5 fold, from about 76 to 118 kg biomass N ha^{-1}, within 7 days. Therefore, proper understanding

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of N dynamics of native as well as applied N in rice-wheat system in essential for better scheduling of fertilizer N and sustainability in the productivity of these soils. The present investigation was undertaken to study the contribution of *Sesbania, Crotalaria* and *Vigna* green manure, wheat straw incorporation in rice and fertilizer N application to both rice and wheat towards soil microbial biomass N content at different stages of rice crop growth.

Materials and Methods

The experiment was carried out at Crop Research Centre of Govind Ballav Pant University of Agriculture and Technology, Pantnagar, during 2000-01 and 2001-02. The soil of the experimental fields was silty clay loam with pH 7.3 and 7.2, organic carbon 1.066 and 0.783 per cent, available N 227 and 205 kg/ha, available P 20.5 and 18.5 kg/ha and available K 149 and 124 kg/ha in 0-20cm and 20-40 cm depth respectively. Four organic sources of nutrients *viz.*, green manuring with *Sesbania aculeata, Crotalaria juncea, Vigna unguiculata* and wheat straw incorporation beside summer fallow with 4 levels of N *viz.*,. 0, 60, 120 and 180kg/ha were applied to rice; wheat was grown after rice and received 3 levels of N *viz.* 0, 75 and 150kg/ ha. The trial was laid out in a split-split plot design, keeping organic sources in main plot, N levels to rice in subplots and N levels to wheat in sub-sub plot, with 3 replications. The layout remain unchanged in the 2 years. Green manure crops were sown in beginning of May and were incorporated at 8 weeks stage. Chopped wheat straw (4-5cm) @ 10.0t ha^{-1} was incorporated during puddling. The plot size was 15m × 11m for main plot, 7m × 5m for subplot and 5m × 2m for sub-subplots. Nitrogen was applied in 3 splits to rice-50% at planting, 25% at tillering and 25% at panicle initiation and in 2 splits to wheat 50% at sowing and 50% after first irrigation. P_2O_5 @ 60kg/ ha to both the crops and K_2O @ 40kg/ ha to rice only as basal dose was applied. Twenty five days old rice seedlings of variety "Pant Dhan 4" were transplanted at a spacing of 20cm × 15cm on 2 July and 29 June during 2000 and 2001, respectively." UP-2338" wheat was sown on 24 and 17 November in 2000-01 and 2001-02, respectively at 23cm row spacing using 100kg seeds/ha.

Measurements on SMB were done on 30, 60 and 90 (days after transplanting) DAT and at harvest stage of rice. About 100g of field moist soil from each plot was taken and divided into tow equal parts. One half (approximately 40g oven dry weight basis) was extracted immediately, without fumigation, by shaking with 0.5m K_2SO_4 (160ml) for 30 minutes and another half was fumigated with chloroform for 24h as desired by (Brookes *et al.*, 1985). Following fumigation the soil samples were extracted with 0.5m K_2SO_4 as above. The extracted soils were then filtered using Whatman No.42 filter paper. The total N in the filtrate was determined. Remaining 20g soil was kept for determination of moisture content.

Biomass N = 1.85 EN (Brookes *et al.*, 1985) where EN is the difference between N extracted from the fumigated and non fumigated treatments.

Results

Soil microbial biomass nitrogen (SMB N), the amount of nitrogen made 0.5 m K_2SO_4 extractable with fumigation is given in Table 1 & Table 2. SMB N values gradually declined with time and reached minimum at rice harvest during both the years except in 2000-2001 the treatments in which rice was grown after in corporation *Crotalaria* green manure and wheat straw where SMB N values increased at 90 DAT as compared to 60 DAT and at 60 DAT as compared to 30 DAT, respectively.

Table-1 : Soil microbial biomass nitrogen (kg ha^{-1}) at different stages of rice as influenced by integrated nitrogen management.

Treatments	Days after transplanting							
	2000-2001				2001-2002			
	30	60	90	At harvest	30	60	90	At harvest
Organic sources								
Fallow	19.4	16.6	15.2	13.7	19.5	17.3	13.7	14.3
Wheat straw	27.5	28.7	24.2	20.8	29.6	30.4	23.5	21.8
Vigna	44.1	41.9	40.2	37.5	67.7	61.2	53.7	43.3
Crotalaria	51.5	47.6	51.1	45.9	70.3	63.4	57.5	52.3
Sesbania	62.5	55.9	52.3	47.6	70.8	65.4	61.2	54.7
SEm±	0.8	0.8	0.8	0.7	0.9	1	0.9	0.8
CD (0.05)	2.7	2.5	2.8	2.3	3	3.2	3.1	2.6
N levels (kg ha^{-1})								
0	33.9	32.4	30.3	28.1	42.5	40.5	34.6	31.8
60	37.6	34.8	33.7	30.2	47.4	43.4	38.6	34
120	43.9	40.5	39.2	35.1	55.4	50.2	44.8	39.4
180	48.5	45	43.3	39	60.9	56.1	49.8	43.9
SEm±	0.8	0.7	0.7	0.6	0.9	0.8	0.8	0.7
CD (0.05)	**2.3**	**2**	**2**	**1.8**	**2.7**	**2.5**	**2.4**	**2**

Effect of organic sources

Variation in organic sources applied to rice brought significant differences in SMB N values at all the stages of rice growth in both the years. Rice grown with *Sesbania* green manure plots being at par with *Crotalaria* green manured rice plots recorded significantly higher SMB N as compared to remaining organic sources at all the stages of rice growth except at 30 and 60 DAT in 2000-2001 ad at 90 DAT in 2001-2002 in which the difference between *Sesabania* and *Crotalaria* green manured rice plots for SMB N values were significant. The rice plots with no green manuring showed the minimum SMB N values due to *Vigna* and *Crotalaria* green manured rice plots at 30 and 60 DAT only during 2001-2002 wee found non-significant.

Effect of N levels to rice

SMB N increase significantly with increasing each level of nitrogen applied to rice even up to 180 kg N ha1 at all stages of rice growth during both the years.

Effect of Interaction between Organic sources and nitrogen levels to rice

Interaction between organic sources and nitrogen level of nitrogen applied to rice were found significant at all the stages of crop growth in both the years except at 60 DAT during 2000-2001 (Table-2). SMB N increased significantly by increasing each level of Nitrogen applied to rice even up to 180 kg N with *Sesbania* and V*igna* green green manure at various stages of growth during both the years. The differences in SMB N values between 0 and 60, 60 and 120 and 120 and 180 kg N ha^{-1} with *Crotalaria*, wheat straw and fallow plots were not significant at all the growth stages during both the years except in *Crotalaria*, the differences between 60 and 120kg N ha^{-1} for SMB N values were significant. At any level of nitrogen application *Sesbania* green manure showed significant superiority in EN values over any of the organic

Table-2. Infection effect of treatments on soil microbial biomass nitrogen (kgha^{-1}) at different stages of rice.

Treatments	Nitrogen level (kg ha^{-1}), 2000-2001											
	30DAT				90DAT				At harvest			
	0	60	120	180	0	60	120	180	0	60	120	180
Fallow	17.5	16.7	21.1	22.3	13.7	13.1	16.5	17.5	11.1	11	15.5	17.3
Wheat Straw	23.3	25.8	28.2	32.8	20.5	22.7	24.8	28.8	17.7	19.3	21.3	24.9
Vigna	36.5	41.8	44.8	53.4	33.2	38.2	40.9	48.7	31.8	34.8	37.9	45.3
Crotolaria	42.6	46.1	57.4	59.8	42.3	45.9	57	59.3	40.1	41.3	50.2	52.2
Sesbania	49.8	57.5	68.3	74.5	41.7	48.9	56.6	62.2	39.9	44.5	50.5	55.5

	N Levels (Kg ha^{-1}), 2001-2002															
	30DAT				90DAT				At harvest				Harvest			
	0	60	120	180	0	60	120	180	0	60	120	180	0	60	120	180
Fallow	17.6	16.8	21.1	22.3	14	13.8	19.5	21.8	12.4	11.8	14.9	16	11.6	11.4	16.1	18
Wheat Straw	25.1	27.8	30.4	35.2	25.8	28.3	31.1	36.4	20.2	22.3	23.7	27.9	18.6	20.3	22.3	26.2
Vigna	55.9	64.1	68.7	82	52	56.9	61.8	74.1	45	50.3	53.8	65.2	37.2	40.1	43.6	52.1
Crotolaria	57.6	62.5	80.1	80.9	55.4	57	69.3	72.1	47.1	51.9	64.4	66.8	45.7	47.1	57.1	59.4
Sesbania	56.2	65.9	76.7	84.3	55.2	61.1	69.3	76.1	48.3	56.4	67	73.1	46.1	51.1	58	63.6

	For two nitrogen levels at same level of organic source							For two organic sources at same or different levels of nitrogen						
	2000-2001			2001-2002				2000-2001			2001-2002			
	30 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
SEm±	**1.8**	**1.5**	**1.3**	**1.3**	**1.9**	**1.9**	**1.5**	**1.8**	**1.6**	**1.4**	**2**	**1.9**	**1.9**	**1.5**
CD (0.05)	**5.2**	**4.4**	**3.9**	**5.9**	**5.5**	**5.5**	**4.4**	**5.2**	**4.7**	**6**	**6**	**5.7**	**5.6**	**4.6**

sources tried in rice at all the growth stages during 2000-2001. Whereas the differences among *Sesbania, Crotalaria* and *Vigna green* manures for SMB N values were not significant at 0, 60 and 180kg N ha^{-1} of nitrogen application in 2001-2002. Green manures applied to rice recorded significantly higher values of SMB N over wheat straw and no green manuring at all the growth during both the years. However application of 180kg N ha-1 either *Sesbania* or *Crotalaria* green manured rice registered significantly greater SMB N at all the stages of rice growth in both the years. The highest SMB N value was observed with *Sesbania* green manured rice along with 180kg N^{-1} at 30 DAT during both the years.

Discussion

Sesbania, green manure incoporation maintained SMB N significantly at higher level through out the rice growth period as compared to other organic sources and fallow during both the years. However, *Crotalaria*, *Vigna* and wheat straw treatment resulted in significantly higher. SMB N over follows at all the stages of rice growth. The higher SMB N associated with wheat straw and *Sesbania* green manure might be due to slow release of N from them (Ocio *et al*., 1991; Goyal *et al*., 1992).

Increasing each successive level of N even upto 180kg N ha^{-1} to rice significantly increased the SMB N at all stages of rice growth but showed a decreasing trend as crop growth advances during both the years. The increase in SMB N with the addition of inorganic fertilizers was attributed to the formation of root exudates, musigel and sloughed off cells (Goyal *et al*., 1992).

Integrated nitrogen management with green manuring considerably enriched the SMB N at all stages of rice growth over a period of two years under rice-wheat cropping system.

Conclusion

Sesbania green manure incorporation maintained SMB N significantly at higher level through out the rice growth period as compared to other organic sources and fallow during both the years. Increasing each successive level of N even upto 180 kg N ha^{-1} to rice significantly increased the SMB N at all stages of rice growth.

Thus it may be concluded that application of 180 kg N ha^{-1} with either *Sesbania* or *Crotalaria* green manured rice registered significantly greater SMB N at all the stages of rice growth in both the years.

References

Azam F., Malik K.A. and Sajjad M. T. (1985): Transportation in soil and availability to plant of N^{15} applied as inorganic fertilizer and legume residues. *Plant and soil*, **86**, 3-13.

Brookes P.C., Londman A., Pruden G. and Jenkrison D.S. (1985): Chloroform funigation and release of soil nitrogen: a rapid direct extraction method for measuring microbial biomass nitrogen in soil. *Soil Biology and Priochemistry*, **17**, 8367-842.

Goyal S., Mishra M.M., Hooda I.S. and Raghubir S. (1992): Organic matter microbial biomass relationship in field experiments under tropical conditions. Effect of inorganic fertilization and organic amendments. *Soil biology and biochemistry*, **24**, 1081-1084.

Ladha J.K., Kundu D.K., Angelo Van Coppinolle M.G., Peoples M.B., Carangal V.R. and Dart P. J. (1996): Legume productivity and soil nitrogen dynamics in lowland rice based cropping systems. *Soil science society of American Journal*, **60**, 183-192.

Ocio J.A., Martines J. and Brookes P.C. (1991): Contribution of straw derived N to total microbial biomass N following incorporation of cereal straw to soil. *Soil Biology and biochemistry*, **23**, 655-659.

Ramamoorthy K., Thiyagarajan T.M. and Subbaiah S.V. (2001): Integrated nitrogen management through grain legumes and green manures in irrigated tropical rice based cropping system. *A review Agricultural Review*, **22(3&4)**, 141-162.