

Yield and Nutrient Uptake of Different *Rabi* Crops in Green Manure-Basmati Rice Based Cropping Systems under Organic Mode of Cultivation

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Abstract

A field experiment was carried out from *rabi* season at 2005-2006 to *kharif* season of 2006-2007 to study the influence of different organic manures on yield, nutrient composition and uptake of different *rabi* crops in green manure basmati rice based cropping systems. The experiment was laid out in Split Plot Design with three cropping systems, viz. C₁ (*Sesbania*-basmati rice-wheat), C₂ (*Sesbania*-basmati rice-chickpea) and C₃ (*Sesbania*-basmati rice-vegetable pea) in main plots and five organic manure treatments, viz. N₁ (½ enriched compost + ½ vermicompost), N₂ (½ neem cake + ½ vermicompost), N₃ (½ farm yard manure + ½ vermicompost), N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) and N₅ (no manure application) in sub-plots replicated for three times. Application of N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) increased grain/seed/pod yield of wheat, chickpea and vegetable pea to 40.72, 18.00 and 47.57%, respectively in first year and 42.72, 15.00 and 35.23%, respectively in second year of experiment and also improved the nutrient contents (N, P, K and S) of the crops. Uptake of all the nutrients was maximum by vegetable pea and with application of ¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake.

Key words : Yield, Nutrient uptake, *Rabi* crops, Rice-based cropping systems.

In an organic farm proper functioning of the soil system requires a continuous addition of sufficient and diverse organic residue and maintenance of crop rotation that maximizes the presence of living roots throughout the year and synchronizes the nutrient availability closely with crop needs. Inclusion of pulses, vegetables and oil seeds in the system is more beneficial than cereal after cereal (1, 2). Nutrient supply to crops under organic systems is mainly dependent on the organic sources of nitrogen such as legumes, manures, compost, bio-fertilizers and crop rotations. Therefore, the present study was conducted to assess the influence of different organic manures on yield, nutrient composition and nutrient uptake of different *rabi* crops in green manure-basmati rice based cropping systems under organic mode of cultivation.

Methods

The field experiment was conducted from *rabi* season of 2005-2006 to *kharif* season of 2006-2007 in Organic Farming Block at Seed Production Center of

GB Pant University of Agriculture and Technology, Pantnagar (29°N latitude, 79°20' E longitude and 243.8 m altitude) which lies in a narrow belt under the foothills of the Shivalik range of Himalayas, known as *tarai*. The soil of experimental field was clay loam in texture and the initial sample had 0.801% organic carbon, 228 kg/ha available nitrogen, 21.5 kg/ha available phosphorus, 120 kg/ha available potassium and 24 kg/ha available sulfur. The experiment was laid out in split plot design with three cropping systems, viz. C₁ (*Sesbania* green manure- basmati rice-wheat), C₂ (*Sesbania* green manure-basmati rice-chickpea) and C₃ (*Sesbania* green manure-basmati rice-vegetable pea) in main plots and five organic manure treatments, viz. N₁ (½ enriched compost + ½ vermicompost), N₂ (½ neem cake + ½ vermicompost), N₃ (½ farm yard manure + ½ vermicompost), N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) and N₅ (no manure application) in sub-plots, replicated for three times. Organic manures were applied only to *rabi* crops in the rotation and basmati rice was grown solely depending on *Sesbania* green

Table 1. Yield of different *rabi* crops as influenced by organic manure treatments. N₁ : ½ Enriched compost + ½ Vermicompost ; N₂ : ½ Neem cake + ½ Vermicompost ; N₃ : ½ FYM + ½ Vermicompost ; N₄ : ¼ Enriched compost + ¼ Vermicompost + ¼ FYM + ¼ neem cake, N₅ : No manure application.

Treatments	Yield of crops (q/ha)											
	Wheat				Chickpea				Vegetable pea			
	Grain		Straw		Seed		Stover		Pod		Stover	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
N ₁	17.52	18.88	30.47	30.94	15.83	15.44	31.06	27.52	22.77	21.55	31.04	28.34
N ₂	17.70	18.62	28.21	29.84	15.05	14.72	29.97	29.05	19.86	18.22	30.17	27.83
N ₃	17.43	19.59	30.74	33.05	15.47	15.79	29.31	27.29	21.77	20.15	31.87	30.07
N ₄	20.25	21.78	33.98	34.54	16.65	16.09	29.51	29.25	26.52	23.18	38.28	34.36
N ₅	14.39	15.26	24.10	27.87	14.11	13.98	24.93	24.76	17.97	17.14	30.00	30.08
SE ±	0.86	0.83	2.75	3.15	0.82	0.83	3.04	2.55	2.36	1.66	2.15	2.07
CD at 5%	2.81	2.73	8.99	NS	NS	NS	NS	NS	7.71	5.42	7.03	NS

manuring. The recommended dose of farm yard manure was 20 t/ha and of vermicompost, enriched compost and neem cake 10 t/ha in wheat. For chickpea

and vegetable pea the dose was half of wheat. Sixty day old *Sesbania* crop was incorporated day before transplanting of rice. Rice (var Pusa basmati 1) was

Table 2. Nutrient contents of different *rabi* crops as influenced by organic manure treatments.

Treatments	Nutrient contents (%)											
	Wheat				Chickpea				Vegetable pea			
	Grain		Straw		Seed		Stover		Pod		Stover	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Nitrogen content (%)												
N ₁	1.630	1.653	0.886	0.866	3.390	3.370	1.173	1.223	3.690	3.720	1.373	1.403
N ₂	1.550	1.636	0.836	0.853	3.283	3.243	1.146	1.160	3.573	3.640	1.310	1.330
N ₃	1.583	1.643	0.863	0.857	3.376	3.310	1.146	1.153	3.686	3.726	1.336	1.373
N ₄	1.646	1.660	0.866	0.855	3.316	3.223	1.166	1.170	3.716	3.793	1.436	1.503
N ₅	1.566	1.626	0.816	0.843	3.356	3.293	1.133	1.138	3.540	3.590	1.330	1.363
SE ±	0.035	0.023	0.019	0.011	0.036	0.040	0.023	0.033	0.046	0.046	0.058	0.055
CD at 5%	NS	NS	0.063	NS	NS	NS	NS	NS	0.150	0.152	NS	NS
Phosphorus content (%)												
N ₁	0.393	0.377	0.038	0.036	0.303	0.300	0.230	0.241	0.420	0.423	0.160	0.182
N ₂	0.376	0.386	0.035	0.034	0.313	0.326	0.230	0.237	0.406	0.412	0.166	0.143
N ₃	0.376	0.383	0.034	0.032	0.316	0.328	0.213	0.220	0.416	0.420	0.186	0.203
N ₄	0.396	0.386	0.038	0.037	0.326	0.340	0.216	0.219	0.420	0.422	0.196	0.211
N ₅	0.363	0.365	0.034	0.033	0.300	0.295	0.200	0.214	0.390	0.413	0.155	0.133
SE ±	0.020	0.019	0.002	0.002	0.022	0.010	0.013	0.009	0.005	0.004	0.010	0.013
CD at 5%	NS	NS	NS	NS	NS	0.03	NS	NS	0.018	NS	0.033	0.044
Potassium content (%)												
N ₁	0.476	0.503	1.543	1.576	0.800	0.830	1.263	1.246	0.996	1.010	1.213	1.240
N ₂	0.466	0.480	1.520	1.546	0.816	0.843	1.270	1.283	0.976	0.986	1.233	1.250
N ₃	0.483	0.506	1.536	1.540	0.863	1.899	1.280	1.293	0.983	1.010	1.203	1.250
N ₄	0.493	0.500	1.533	1.566	0.850	0.900	1.303	1.310	1.033	1.066	1.230	1.280
N ₅	0.440	0.456	1.510	1.503	0.793	0.821	1.260	1.260	0.963	0.966	1.186	1.220
SE ±	0.014	0.012	0.035	0.028	0.029	0.024	0.027	0.040	0.016	0.027	0.057	0.059
CD at 5%	0.046	0.040	NS	NS	NS	NS	NS	NS	0.052	0.089	NS	NS

Table 2. Continued.

Treat- ments	Wheat				Chickpea				Vegetable pea			
	Grain		Straw		Seed		Stover		Pod		Stover	
	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07
Sulphur content (%)												
N ₁	0.150	0.154	0.124	0.129	0.318	0.323	0.226	0.232	0.363	0.368	0.253	0.265
N ₂	0.146	0.148	0.126	0.122	0.318	0.323	0.234	0.240	0.375	0.378	0.262	0.260
N ₃	0.149	0.150	0.120	0.124	0.322	0.326	0.226	0.230	0.366	0.368	0.255	0.258
N ₄	0.147	0.151	0.124	0.128	0.326	0.331	0.227	0.234	0.371	0.368	0.259	0.260
N ₅	0.143	0.146	0.119	0.123	0.316	0.322	0.222	0.228	0.361	0.358	0.248	0.256
SE ±	0.005	0.005	0.004	0.006	0.004	0.003	0.004	0.002	0.007	0.007	0.007	0.004
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.022	0.013

raised in nursery following recommended practices and one month old, 2–3 seedlings were transplanted in 20 × 15 cm spacing. After harvest of rice, wheat (var PBW 343), chickpea (ICCV 96029, ICRISAT, line received from PAU, Ludhiana) and vegetable pea (var Arkel) were sown in different main plots with an inter-row spacing of 22.5 cm for wheat and 30 cm for chickpea and vegetable pea. Grain/seed/pod yield and straw/stover yields of all the crops were recorded from net plot area and multiplied with N, P, K and S contents of grain/seed/pod and straw/stover of respec-

tive crops to work out the removal of the nutrients by them. Plant samples were collected from net plot area and analyzed for different nutrients following standard procedures. Data collected for various observations were subjected to the analysis of variance appropriate to the design as given by Gomez and Gomez (3). Test of significance of the treatment differences was done on the basis of *F* test. The significant difference between treatment means was compared with the help of critical difference at 5% level of probability.

Table 3. Uptake of nitrogen and phosphorus by different *rabi* crops as influenced by organic manure application. C₁: *Sesbania*-basmati rice-wheat; C₂: *Sesbania*-basmati rice-chickpea; C₃: *Sesbania*-basmati rice-vegetable pea N₁: ½ Enriched compost + ½ Vermicompost; N₂: ½ Neem cake + ½ Vermicompost; N₃: ½ FYM + ½ Vermicompost; N₄: ¼ Enriched compost + ¼ Vermicompost + ¼ FYM + ¼ Neem cake, N₅: No manure application.

Treat- ments	Uptake of nitrogen (kg/ha)						Uptake of phosphorus (kg/ha)					
	Grain/seed/pod		Straw/stover		Total		Grain/seed/pod		Straw/stover		Total	
	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07	2005- 06	2006- 07
Cropping Systems												
C ₁	27.94	30.97	25.27	26.80	53.21	57.77	6.68	7.15	1.07	1.08	7.76	8.24
C ₂	53.18	51.15	33.48	32.33	86.66	83.49	4.83	4.80	6.37	6.27	11.20	11.07
C ₃	79.49	74.43	43.98	42.14	123.47	116.57	8.98	8.40	5.62	5.32	14.60	13.72
SE ±	2.81	4.95	1.09	1.17	2.85	4.69	0.37	0.63	0.26	0.18	0.33	0.66
CD at 5%	11.01	19.38	4.27	4.60	11.16	18.34	1.47	2.47	1.03	0.72	1.29	2.59
Organic Manure Treatments												
N ₁	55.80	54.68	35.41	33.49	91.22	88.17	7.09	6.96	4.41	4.31	11.51	11.27
N ₂	49.95	48.65	32.57	32.09	82.53	80.74	6.50	6.51	4.36	4.00	10.87	10.52
N ₃	53.92	53.09	34.30	33.65	88.33	86.74	6.85	6.99	4.43	4.40	11.29	11.40
N ₄	63.37	60.07	39.65	38.57	103.02	98.64	8.21	7.90	5.07	4.98	13.28	12.88
N ₅	44.62	44.42	29.28	30.99	73.91	75.42	5.50	5.57	3.49	3.42	8.99	8.99
SE ±	3.10	2.27	1.95	1.84	3.61	2.97	0.42	0.29	0.36	0.32	0.49	0.46
CD at 5%	9.05	6.63	5.70	3.68	10.55	8.66	1.24	0.86	1.04	0.91	1.45	1.33

Table 4. Uptake of potassium and sulfur by different *rabi* crops as influenced by organic manure application. C₁ : *Sesbania*-basmati rice-wheat ; C₂ *Sesbania*-basmati rice-chickpea ; C₃ : *Sesbania*-basmati rice-vegetable pea N₁ : ½ Enriched compost + ½ Vermicompost ; N₂ : ½ Neem cake + ½ Vermicompost ; N₃ : ½ FYM + ½ Vermicompost ; N₄ : ¼ Enriched compost + ¼ Vermicompost + ¼ FYM + ¼ Neem cake, N₅ : No manure application.

Treatments	Uptake of potassium (kg/ha)						Uptake of sulfur (kg/ha)					
	Grain/seed/pod		Straw/stover		Total		Grain/seed/pod		Straw/stover		Total	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Cropping Systems												
C ₁	8.29	9.27	45.08	48.48	53.37	57.75	2.57	2.83	3.64	3.92	6.21	6.75
C ₂	12.75	13.06	36.92	35.29	49.67	48.36	4.94	4.91	6.58	6.44	11.52	11.35
C ₃	21.69	20.37	39.22	37.74	60.92	58.12	8.03	7.40	8.23	7.87	16.26	15.27
SE ±	0.90	1.35	1.35	2.07	1.23	2.11	0.29	0.44	0.21	0.13	0.31	0.35
CD at 5%	3.52	5.26	5.29	8.09	4.83	8.27	1.16	1.74	0.83	0.54	1.22	1.39
Organic Manure Treatments												
N ₁	14.58	14.71	41.27	39.42	55.85	54.14	5.32	5.28	6.23	5.94	11.55	11.22
N ₂	13.35	13.18	39.40	39.44	52.75	52.62	4.95	4.81	6.12	5.98	11.07	10.79
N ₃	14.43	14.63	41.03	41.42	55.46	56.05	5.19	5.12	6.15	6.08	11.35	11.20
N ₄	17.17	16.77	45.82	45.67	63.01	62.44	6.10	5.73	6.95	6.82	13.06	12.56
N ₅	11.67	11.87	34.52	36.58	46.19	48.46	4.33	4.29	5.29	5.57	9.63	9.86
SE ±	0.89	0.74	2.28	2.34	2.43	2.54	0.35	0.26	0.33	0.32	0.50	0.42
CD at 5%	2.62	2.16	6.68	6.84	7.09	7.42	1.03	0.77	0.99	0.94	1.45	1.23

Results and Discussion

A significant increase in grain/pod yield of wheat and vegetable pea in both the years and in straw/stover yield in first year were observed with application of N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) as compared to no manure application (Table 1). Similarly, maximum seed and stover yield of chickpea were also recorded in the same treatment. Application of N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) increased grain/seed/pod yield of wheat, chickpea and vegetable pea to 40.72, 18.00 and 47.57%, respectively in first year and 42.72, 15.00 and 35.23%, respectively in second year. Improved nutrient supply to the crops resulted in better vegetative and reproductive growth leading to increase in yield. Earlier, several researchers reported the beneficial effects of organic manures on wheat (4), chickpea (5) and vegetable pea (6).

Application of organic manures improved N, P, K and S contents in grain/seed/pod and straw/stover of wheat, chickpea and vegetable pea during both the years over no manure application (Table 2). However, in most of the cases treatment N₄ (¼ enriched

compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake) was found to be better as compared to others. Improved nutrient composition of *rabi* crops indicated higher availability of nutrients to the crops with application of organic manures.

Data revealed that among different *rabi* crops, vegetable pea removed significantly higher amount of N and S by both pod and stover and P and K by pod only as compared to other crops during both the years (Tables 3 and 4). On the contrary, uptake of P by chickpea stover and K by wheat straw were recorded to be significantly higher as compared to other crops. Total uptake of all N, P, K and S were maximum in vegetable pea in both the years. Uptake of all the nutrients by grain/seed/pod, straw/stover and their total uptake were found to be highest with application of N₄ (¼ enriched compost + ¼ vermicompost + ¼ farm yard manure + ¼ neem cake), which was significantly superior over no manure application in all the cases and in both the years. Increase in nutrient uptake with application of organic manures could be explained by increased grain and straw yield and improvement in nutrient composition. The results are in accordance with those of earlier reports (7, 8).

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