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Yield and Nutrient Budgeting as Influenced by Organic Sources of Nutrients and Weed Management in Rice-Potato-Frenchbean Cropping System

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Abstract: A field experiment was conducted during 2015-16 and 2016-17 under different organic sources of nutrients and weed management in rice (*Oryza sativa* L.) - potato (*Solanum tuberosum* L.)-frenchbean (*Phaseolus vulgaris*) cropping system with six sources of nutrients as main-plot treatments and four weed management practices as sub-plot treatments. Among the organic sources of nutrients, application of 100% organics (100% recommended N through different organic sources each equivalent to 1/3 of recommended N i.e. FYM+ vermicompost + non-edible oil cake) + VAM recorded significantly maximum individual crop yield and rice equivalent yield (REY). The highest apparent balance of nitrogen and phosphorus was recorded with the application of 100 % recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer and 50 % recommended N through vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB. Whereas, the balance of available potassium in soil was negative with the application of different sources of nutrients. Application of mustard seed meal @ 5 t/ha registered significantly higher yield of crops, REYand apparent balance of nitrogen. However, the balance of available phosphorous and potassium in soil was recorded highest with the application of rice bran @ 4 t/ha.

Keywords: Cropping system, Mustard seed meal, Nutrient budgeting, Organic sources of nutrients, Rice bran and Rice equivalent yield

In the Indian subcontinent, rice–wheat and rice–rice are the major rice-based cropping systems. However, the production potential of these systems has become fatigued and is plateauing and income has started to show a declining trend (Ray et al 2012). Because of high productivity, stability and less risk factor, the wide adoption of this system will still has to play a major role in future planning to sustain self-sufficiency of food grains in the years to come (Singh et al 2012). But now the productivity of both the crops has stagnated and factor productivity is declining year after year. The farmers realize much of their food security from this cropping system but its declining productivity needs urgent attention, which jeopardizes the farmer's economic security to a considerable extent. To strengthen the economic security, it is imperative to intensify and diversify the existing rice-wheat system with some other high value crops *viz.* potato and frenchbean having greater economic worth using organic agriculture as a practice towards crop production. In present context, general the rice-wheat crop is largely grown by applying high input using inorganic fertilizer. It can be ascertained by the fact that as far fertilizer consumption is concerned India ranks second next to China (Sharma and Thaker 2011). This practice of high input agriculture no doubt has led to self-sufficiency in food-grains but it has posed several new challenges. The productivity of most of the crops is declining. With wide application of chemical fertilizers, pesticides and herbicides, large-scale utilization of water resources and implementation of genetic engineering, the global per capita food production has been increased significantly. However, these efforts have also resulted in some negative impacts on environment and biodiversity and thus present potential threat to the sustainability. Balancing productivity, profitability and environmental health is a key challenge for agricultural sustainability facing today. Therefore, the use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetically compounded agro-chemicals appears to be one of the probable options to sustain the agricultural productivity. Keeping this in view, a field experiment was undertaken to study the effect of different sources of organic nutrients and weed management on crop yield and nutrient budgeting in rice-potato-frenchbean cropping system.

MATERIAL AND METHODS

A field experiment was conducted during 2015-16 and 2016-17 on organic sources of nutrient and weed management in rice-potato-frenchbean system under irrigated condition at Sher-e-Kashmir University of

Agricultural Sciences and Technology of Jammu. The soil of the experimental site was clay loam in texture having *p*H 8.04, organic carbon 0.55%, available N, P and K of 220.40, 13.25 and 118 kg/ha, respectively. The experiment was laid out in split plot design replicated thrice with six sources of nutrients in main-plot and four weed management treatments in sub-plot (Table 1). In case of organic nutrient management, all manures were applied before final land preparation for transplanting of rice and at planting of potato and frenchbean in furrows. The inorganic sources used were urea, single super phosphate and muriate of potash to supply N, P and K, respectively. The recommended doses of fertilizers for rice, potato and frenchbean were 30:20:10; 120:60:60 and 50:100:50 NPK (kg/ha), respectively. In case of inorganic nutrient management, full quantity of P and K were applied as basal in all the crops and N was applied in split doses. In rice, 25% of N was applied as basal, 50% top dressed at tillering and rest 25% was applied at panicle initiation stage. In potato and frenchbean 50% of N was applied as basal and rest N was applied in 2 equal splits at 25 and 45 days after planting. The test varieties for rice, potato and frenchbean were 'Pusa 1121', 'Kufri Sindhuri' and 'Contender', respectively. In case of weed management, mustard seed meal and rice bran were applied as pre-plant incorporation (PPI) ten days before transplanting/planting of rice, potato and frenchbean. Standard agronomic management practices were followed for all crops. Crop yields were recorded at the end of each season and rice equivalent yield (REY) was computed at the end of each cropping cycle. Treatment wise apparent balances of nitrogen, phosphorus and potassium was worked out by calculating the levels of nutrients (nitrogen, phosphorus and potassium) present in the soil before transplanting/planting/sowing and after harvesting of the crops, and the amount of nutrients added through fertilizers and removed by the crop and weeds. Apparent balance of nutrients was calculated individually as per the standard formula given by Yadav et al (2002). Least significant difference (LSD) values at a 5% level of significance were used to determine the significance of differences between treatment means by using OPSTAT software.

RESULTS AND DISCUSSION

Yield: The yield of individual crop (rice, potato and frenchbean) and system yield in terms of REY during the both cropping cycle were the highest with the 100% organics (100% recommended N through different organic sources each equivalent to 1/3 of recommended N i.e. FYM+ vermicompost + non-edible oil cake + VAM which was statistically at par with 100% organics + marigold for potato on border as trap crop and bottle gourd as trap crop for frenchbean and 100% recommended N through different organic sources each equivalent to 1/3 of recommended N i.e. FYM+ vermicompost + non-edible oil cake (Table 1). Combined application of FYM, vermicompost and neem cake increased the adsorptive power of soil for cations and anions particularly phosphates, nitrates and other micronutrients and their slow release during entire crop growth period led to better translocation of photosynthates to the sink reflected by higher crop yield. Favourable soil conditions and availability of micro and major nutrients through the integrated use of different organic sources led to increased leaf surface area resulting in more photosynthesis, dry matter accumulation and ultimately biomass yield (Verma et al 2011, Sharma and Subehia 2014). Rice equivalent yield was directly associated with the yield of respective crops in the sequence and so the application of 100% organics (100% recommended N through different organic sources each equivalent to 1/3 of recommended N i.e. FYM+ vermicompost + non-edible oil cake + VAM enhanced the yield potential of crops which ultimately increased the rice equivalent yield of the sequence. Among the weed management treatments, application of mustard seed meal @ 5 t/ha recorded significantly highest yield of rice, potato and frenchbean which was statistically at par with the application of rice bran @ 4 t/ha and weed free treatment. Enhancement in the growth parameters under congenial environment provided by substantial reduction in inter-generic competition due to weed suppression and better translocation of carbohydrates for higher sink realization in these treatments. Higher nutrient content of mustard seed meal led to enhanced N, P and K uptake also resulted in improvement in yield (Haramoto and Gallandt 2004, Ullah et al 2008). Increase in the yield of respective crops (potato and frenchbean) in sequence with the application of mustard seed meal which ultimately increased the rice equivalent yield.

Nutrient budgeting: Among the different sources of nutrients, the percent increase in apparent balance of nitrogen with the application of 100 % recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer was recorded to be 79.19% and 87.60% over the application of 50 % recommended N through vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB after the completion of both crop cycles (Table 2 and Table 3). The highest apparent balance of nitrogen was recorded with the application of 100 % recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer which was due to less removal of nitrogen by different crops. The lowest apparent balance of nitrogen was observed with the application of 50 % recommended N through vermicompost +

Table 1. Effect of organic sources of nutrients and weed management on crop yield (t/ha) in rice–potato–frenchbean cropping system

Treatment	Yield (t/ha)						Rice equivalent yield (t/ha)	
	Rice		Potato		French bean			
	2015	2016	2015-16	2016-17	2016	2017	2015-16	2016-17
Sources of Nutrients								
T_1-50% recommended NPK through fertilizer + 50% N through FYM + inorganic source of micronutrients as per soil test	3.61	3.75	12.66	12.81	3.77	3.86	13.05	11.29
T_2-100% organics (100% recommended N through different organic sources each equivalent to 1/3 of recommended N *i.e.* FYM+ vermicompost + non-edible oil cake)	3.81	3.96	12.87	13.02	4.00	4.09	13.58	11.76
T_3-100% organics + marigold for potato on border as trap crop and bottle gourd as trap crop for French bean	3.88	4.03	12.97	13.12	4.05	4.14	13.75	11.91
T_4-50% recommended N through vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	3.34	3.47	12.43	12.57	3.50	3.58	12.39	10.70
T_5-100% organics+ VAM	3.94	4.10	13.03	13.18	4.11	4.20	13.89	12.04
T_6-100% recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer	3.37	3.50	12.45	12.60	3.53	3.61	12.46	10.77
CD (p=0.05)	0.15	0.17	0.19	0.20	0.16	0.16	0.39	0.37
Weed management								
W_0-Weed free	3.82	3.97	13.73	13.94	4.06	4.19	14.03	12.17
W_1-Mustard seed meal @ 5 t/ha	3.92	4.09	13.83	14.06	4.19	4.33	14.30	12.43
W_2-Rice bran @ 4 t/ha	3.86	4.02	13.75	13.97	4.11	4.25	14.12	12.26
W_3-Weedy check	3.03	3.13	9.64	9.55	2.93	2.88	10.30	8.77
CD (p=0.05)	0.11	0.13	0.14	0.15	0.14	0.15	0.30	0.28
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Apparent balance of nutrients after rice-potato-frenchbean system (2015-16) as influenced by different sources of nutrients and weed management

Treatment	N (kg/ha)				P (kg/ha)				K (kg/ha)			
	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance
Sources of nutrients												
T_1	461.30	349.23	10.85	101.22	272.77	147.90	0.15	124.72	258.77	270.89	3.17	-15.29
T_2	461.30	391.34	14.66	55.30	225.81	178.05	0.19	47.58	244.62	328.66	5.96	-90.00
T_3	461.30	393.91	18.15	49.24	225.81	179.12	0.17	46.52	244.62	332.62	6.47	-94.47
T_4	361.30	321.13	13.39	26.79	324.65	130.58	0.12	193.95	170.69	232.00	3.49	-64.80
T_5	461.30	403.36	22.84	35.10	225.81	184.78	0.13	40.90	244.62	343.92	5.32	-104.62
T_6	461.30	327.36	5.20	128.74	324.65	134.34	0.13	190.19	217.3	243.05	-2.51	-23.24
CD (p=0.05)		14.31	14.66			9.78				16.64		
Weed management												
W_0	183.33	359.10	12.08	-187.85	121.93	133.17	0.02	-11.25	132.80	271.65	2.51	-141.36
W_1	883.33	403.86	17.34	462.13	390.93	176.84	0.34	213.76	326.80	330.99	5.35	-9.55
W_2	528.53	396.89	14.86	116.78	431.53	173.03	0.19	258.31	328.00	322.11	4.02	1.88
W_3	183.33	297.69	12.44	-126.80	121.93	153.47	0.04	-31.58	132.80	242.67	2.71	-112.58
CD (p=0.05)		12.69				9.24				14.59		

See table 1 for treatment details

Table 3. Apparent balance of nutrients after rice-potato-frenchbean system as influenced by different sources of nutrients and weed management (2016-17)

Treatment	N (kg/ha)				P (kg/ha)				K (kg/ha)			
	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance	Addition	Removal	Actual change in soil after crop cycle	Apparent Balance
Sources of nutrients												
T_1	457.30	356.57	18.12	82.61	279.3	151.36	0.28	127.66	262.64	233.32	15.33	13.99
T_2	457.30	399.14	30.60	27.56	230.61	181.29	0.32	49.00	252.95	283.28	15.96	-46.30
T_3	457.30	404.20	31.36	21.74	230.61	183.05	1.30	46.26	252.95	286.73	16.00	-49.78
T_4	357.30	326.75	16.66	13.90	326.25	131.15	0.46	194.64	170.30	199.24	16.23	-45.16
T_5	457.30	412.93	35.50	8.88	230.61	190.01	1.08	39.52	252.95	296.64	16.27	-59.96
T_6	457.30	333.66	11.47	112.17	326.25	136.45	0.66	189.14	222.52	208.74	13.23	0.56
CD (p=0.05)		15.33				10.06				14.88		
Weed management												
W_0	183.33	370.59	21.85	-209.11	124.36	138.40	0.55	-14.60	133.19	235.61	14.35	-116.77
W_1	869.33	413.33	27.11	428.89	385.36	179.15	0.87	205.33	335.69	282.89	17.25	35.55
W_2	526.53	403.96	24.63	97.94	448.36	172.83	0.72	274.80	340.79	273.83	15.86	51.11
W_3	183.33	300.94	22.21	-139.82	124.36	158.49	0.58	-34.71	133.19	212.97	14.55	-94.32
CD (p=0.05)		12.82				9.64				13.27		

See table 1 for treatment details

biofertilizers for N + rock phosphate to substitute the P requirement + PSB was ascribed to the lowest addition of nitrogen under this treatment. The percent increase in apparent balance of nitrogen with the application of 50 % recommended N through vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB over the application of 100% organics + VAM was recorded to be 78.91%and 79.69% after the completion of both crop cycles (2015-16 and 2016-17).The balance of available phosphorous in soil was recorded highest with the application of 50 % recommended N through vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB followed by 100 % recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer which could be attributed to highest addition of phosphorus. The balance of available potassium in soil was negative with the application of different sources of nutrients. However, the highest negative balance of potassium was recorded with the application of 100% organics + VAM after the completion of first crop cycle (2015-16) which was due to the highest removal of potassium under this treatment. After the completion of second crop cycle (2016-17), the highest apparent balance of potassium was recorded with the application of 50% recommended NPK through fertilizer + 50% N through FYM + inorganic source of micronutrients as per soil test and the percent increase in the apparent balance of potassium was about 95.99% over the application of 100 % recommended NPK + secondary and micronutrients based on soil test through inorganic fertilizer which was due to the highest addition of potassium with the application of 50% recommended NPK through fertilizer + 50% N through FYM + inorganic source of micronutrients as per soil test. Among the weed management treatments, highest apparent balance of nitrogen was observed with the application of mustard seed meal @ 5 t/ha which was due to the highest addition of nitrogen by the application of mustard seed meal. The balance of available phosphorous in soil was recorded highest with the application of rice bran @ 4 t/ha followed by mustard seed meal @ 5 t/ha which might be due to highest addition of phosphorus with the application of rice bran. The apparent balance of available potassium in soil was higher with the application of rice bran @ 4 t/ha owing to highest addition of potassium with the application of rice bran.

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CONCLUSION

The application of 100% recommended N through different organic sources each equivalent to 1/3 of recommended N i.e. FYM+ vermicompost + non-edible oil cake+ VAM application of mustard seed meal @ 5 t/ha (organic weed management) produced significantly higher system productivity and REY besides showed improvement in apparent balance of nutrients (NPK) to considerable and sustainable levels coupled with organically weed management practice i.e. application of mustard seed meal rice bran in rice-potato-frenchbean cropping system.

REFERENCES

Haramoto ER and Gallandt ER 2004. *Brassica* cover cropping for weed management. *Renewable Agriculture and Food Systems* **19**(4): 187-98.

Ray DK, Ramankutty N, Mueller ND, West PC and Foley JA 2012. Recent patterns of crop yield growth and stagnation. *Nature Communications* **3**: 1293.

Sharma U and Subehia SK 2014. Effect of long term integrated nutrient management of rice (*Oryza sativa* L.)-wheat (*Tritium aestivum* L.) on productivity and soil properties in north-western Himalaya. *Journal of the Indian Society ofSoil Science* **62**(3): 248--254.

Sharma VP and Thaker H 2011. Demand for Fertiliser in India: Determinants and Outlook for 2020. *Research and Publications* **4**(1): 1-32.

Singh O, Kumar S and Awanish 2012. Productivity and profitability of rice (*Oryza sativa*) as influenced by high fertility levels and their residual effect on wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **57** (2): 143-47.

Ullah MS, Islam MS, Islam MA and Haque T 2008. Effect of organic manures and chemical fertilizers on the yield of brinjal and soil properties. *Journal of Bangladesh Agricultural University* **6**(2): 271-76.

Verma SK, Asati BS, Tamrakar SK, Nanda HC and Gupta CR 2011. Effect of organic components on growth, yields and economic returns in potato. *Potato Journal* **38**: 51-55.

Yadav RL, Tomar SS and Sharma UC 2002. Output: Input ratios and apparent balances of N, P and K inputs in a rice-wheat system in North-West India. *Experimental Agriculture* **38**: 457-68.