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Integrated nutrient management in potato (*Solanum tuberosum*)–vegetable cropping sequence under rainfed conditions in hilly areas of Meghalaya

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ABSTRACT

A field trial was conducted during the summer season (March–July) and autumn season (August–December) of 1997–99 at Central Potato Research Station, Shillong, to study the economic feasibility of integrated nutrient management in potato (*Solanum tuberosum* L.)–vegetable cropping system under rianfed conditions in hilly areas of Meghalaya. Potato–radish (*Raphanus sativus* L.) cropping system gave the highest productivity as well as net return over potato–cabbage [*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *botrytis* L.] cropping system. Recommended dose of fertilizer NPK to both the crops in sequence remained most productive and profitable than other nutrient treatments tried, as it gave significantly higher potato equivalent yield (PEY), better plant stand and also had significantly higher residual effect. The net monetary return as well as available NPK status of soil from different fertilizer schedule followed the same pattern as that of PEY. The treatment receiving recommended dose of NPK to potato and only recommended N to autumn crop was inferior to treatment receiving recommended N and half PK to both the crops. Positive balance of NPK in soil was observed at higher levels of NPK application.

Key words: Potato, Vegetable, Cropping system, INM

Multiple cropping is one of the most important steps towards increasing crop production. Potato being a short-duration crop, finds its place in a variety of cropping systems followed in different parts of country as it fits well in the multiple cropping system. Many crop sequenes involving potato as a base crop in summer season and cabbage, radish, cauliflower, carrots etc. in autumn season are grown by cultivators in rainfed hilly areas of Meghalaya. In the past, fertilizer, recommendations were made based on the nutrient requirement of the individual crops. Very often in such type of recommendations, the residual effect of previous crops on the succeeding crop is ignored.

Though research work has been done in determining nutrient requirement of potato, cabbage, radish, cauliflower etc. crops grown individually, studies on working out economically viable crop sequences involving these crops along with optimization of their fertilizer requirment did not receive serious attention. Therefore, the present investigation was carried out to study the comparative economics of potato-based crop sequences besides working out their optimium fertilizer requirement in the sequence.

MATERIALS AND METHODS

The experiment was conducted during the summer seasons (March–July) and autumn seasons (August–December) of 1997, 1998 and 1999 at Central Potato Research Station, Shillong (25.8° N and 91.8°E with an elevation of 1,790 m). The soil was sandy clay loam in texture with pH of 5.2. The soil tested medium in available N and K and low in available P. The experiment comprising 8 treatment combinations replicated 4 times was laid out in split-plot design with 2 crop sequences allocated to main plots and 4 manuring schedules to sub-plots. The crop sequences were potato-cabbage (C_1) and potato-radish (C_2). The manuring schedules comprised recommended NPK to potato + recommended NPK to autumn crop (M_1), recommended NPK to potato + recommended N and half of the recommended P and K to autumn crop (M_2), recommended NPK to potato + recommended N to autumn crop (M_3), recommended N and half of the recommended P and K to potato + recommended N and half of the recommended P and K to autumn crop (M_4). Potato crop was planted during the summer season and after potato crop individual plots without changing the layout were

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prepared for autumn crop. The experiment was repeated on the fixed site during all the 3 years without changing the layout. Recommended varieties and agronomic practices were followed. Need-based cultural operations and plant-protection measures were followed. The weather conditions remained favourable for growing the summer and autumn crops during all the 3 years. The yields of crops were converted into potato-equivalent yield for comparisons. Economics for each treatment was worked out based on market rate of inputs and outputs. After harvesting of all the crops, soil samples were analysed following standard procedure to see the change in fertility status.

RESULTS AND DISCUSSION

Yield

Manuring schedules M_1, M_2 and M_3 which received recommended dose of NPK for potato crop gave significantly higher potato yield than manuring schedule M_4 which received only half of PK and full N for potato crop. The difference in potato yield due to manuring schedules M_1, M_2 and M_3 were not significant, indicating uniformity of the experimental site. The data indicated that none of the crops after potato had adverse effect on yield of subsequent potato crop. Radish crop was better than cabbage in terms of yield (Please check). Manuring schedule M1, where recommended dose of NPK for radish was applied, recorded highest radish yield (Table 1), while manuring schedule M_3, where only recommended dose of N was applied lowest yield. Similar results were obtained with cabbage in these manuring schedules during all the 3 years. Manuring schedule M_2 which received full recommended dose of NPK for potato and full N + half P and half K to autumn crop (cabbage and radish) gave higher yield of autumn crop than manuring schedule M_4 which received full N + half P and half K to potato and full N + half P and K to autumn crop.

Potato equivalent yield

Adoptionof the potato–raddish cropping system gave significantly higher potato–equivalent yield over potato–cabbage cropping system (Table 2). Among different manuring schedules, M_1 recorded significantly higher potato-equivalent yield than rest of the manuring schedules. The lowest poato-equivalent yield was received in manuring schedule M_3 that received recommended NPK to potato and only recommended N for autumn crop. Manuring schedule M_2, where recommended dose of NPK for potato and full N + half P and half K of recommended dose for autumn crop (cabbage or radish) was applied produced significantly higher potato-equivalent yield compared to manuring shceudle M_4, which received recommended dose of N and half P and half K fro potato crop and full N + half P and half K of recommendation for autumn crops.

Table 1. Yield of potato and vegetable crops in potato–vegetable cropping system as influenced by manuring schedule (pooled data of 3 years)

Treatment	Cropping system			
	Potato–cabbage		Potato–radish	
	Potato	Cabbage	Potato	Radish
M_1	12.34	22.23 (16.68)	12.30	33.22 (18.09)
M_2	12.59	18.98 (14.24)	12.81	25.21 (13.74)
M_3	12.44	11.38 (8.54)	12.33	17.56 (9.54)
M_4	10.80	15.73 (11.80)	10.72	24.44 (13.33)

Details of treatments are given in Materials and Methods
Figures in parentheses indicates equivalent yield

Table 2. Nutrient uptake in potato–cabbage and potato–radish cropping system as influenced by manuring schedule (pooled data of 3 years)

Treatment	Potato–cabbage			Potato–radish		
	N	P	K	N	P	K
M_1	110.96	17.97	132.30	11.57	14.21	141.28
M_2	105.03	16.93	123.55	98.59	12.82	124.55
M_3	85.33	12.68	98.79	84.72	11.19	104.80
M_4	91.30	14.07	107.02	91.75	11.99	115.29

Details of treatments are given in Materials and Methods
Figures in parentheses indicates equivalent yield

Economic analysis

Potato–radish cropping system gave significantly higher net return (Rs 42,962/ha/year) and benefit: cost ratio (0.78) than potato-cabbage cropping system. This might be due to higher production cost and low market price of economic produce of cabbage compared to radish. Potato–cabbage cropping system had the privilege to record higher land-use efficiency (57.81%). However, potato–radish system recorded higher production efficiency both in terms of kg/ha/day (129.24) and Rs/ha/day (218.08) (Table 3). The 3 year mean data revealed that manuring schedule M_1 resulted in the highest return (Rs 55,882/ha/year) and benefit:cost ratio (0.97), followed by schedule M_2 (Rs 44,978/ha/year) and benefit : cost ratio (0.79). The minimum net return and benefit : cost ratio was recorded in manuring schedule M_3 mainly because the yield of autumn crop was drastically reduced due to lack of phosphorus and potassium.

Nutrient uptake

The nutrient uptake in potato–cabbage and potato–radish cropping system did not varied significantly. The N and P uptake in potato–cabbage system was slightly more compared to potato–radish system due to higher content

Table 3. Potato-equivalent yield, net return, benefit: cost ratio and nutrient uptake as influenced by different treatments in potato–vegetable cropping system (pooled data of 3 years)

Treatment	Potato-equivalent yield (kg/ha)	Net return (Rs/ha)	Benefit:cost ratio	Nutrient uptake (kg/ha)		
				N	P	K
Cropping system						
C_1	24.85	36,682	0.64	98.16	15.41	115.42
C_2	25.71	42,962	0.78	96.65	12.55	121.48
CD (P=0.05)	0.21	1,467		NS	NS	NS
Manuring schedule						
M_1	29.70	55,882	0.97	111.27	16.09	136.79
M_2	26.69	44,978	0.79	101.81	14.88	124.05
M_3	21.42	245,97	0.44	85.03	11.94	101.80
M_4	23.33	33,830	0.62	91.53	13.03	111.16
CD (P=0.05)	0.61	1,678		5.43	1.79	6.09

Details of treatments are given in Materials and Methods

Table 4. Change in soil fertility as influenced by manuring schedule and cropping system

Treatment	pH	Available soil nutrient		
		N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Initial	5.2	146.7	14.5	135.7
Final value after harvest of last crop				
C_1M_1	5.2	147.2	15.7	136.2
C_1M_2	5.2	146.8	13.2	132.7
C_1M_3	5.2	141.1	11.2	121.8
C_1M_4	5.3	146.4	12.5	127.1
C_2M_1	5.2	146.9	15.3	135.8
C_2M_2	5.2	139.2	14.2	133.2
C_2M_3	5.3	141.4	11.6	121.1
C_2M_4	5.2	135.3	12.8	125.9

Details of treatments are given in Materials and Methods

of N and P in cabbage. However, K uptake was higher in potato–radish system. The nutrient uptake was influenced significantly by manuring schedule. Manuring schedule M_1 recorded significantly higher uptake of N, P and K over rest of the treatments. The lowest uptake of N, P and K was recorded in manuring schedule M_3. The higher uptake of nutrient in M_1 was mainly due to higher yield and partly due to higher nutrient composition.

Soil fertility status

Soil analysis after harvesting of the last crop of the sequence showed that there was no change in soil N under different manuring schedules. A positive balance was observed when 100% N was applied with full P and K (Table 3). This may be due to residual build up. The available P was found to decrease at lower levels of P_2O_5 as in case of manuring schedule M_2, M_4 and M_3 in that order. However, a gain was observed when higher rate of P_2O_5 was applied as in case of M_1. Similar trend in respect of available K was observed. These results are in agreement with the findings of Singh and Lal (2001).

Thus continuous cropping of potato–radish and potato–cabbage sequence over a fixed site reduced the available soil NPK year after year at lower levels of fertilizer, but same was sustained at higher levels. Such cropping system is more sustainable and will not pose a problem of nutrient deficiency in the soil if all the crops are adequately fertilized following their recommended dose.

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