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Integrated nutrient management for sustaining productivity and soil fertility building under potato-okra-paddy rotations.

M.CHETTRI[1], P. BANDOPADHYAY[2], U.THAPA[3] AND S.S. MONDAL[4]

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal

ABSTRACT

Field experiment was carried out during the period of 2000-01 to 2002-03 at Adisaptagram Block Seed Farm, Hooghly, West Bengal to study the effect of organic and inorganic sources of nutrient for sustaining productivity and soil fertility under potato-okra-paddy rotations. Maximum tuber yield (285.40 q ha^{-1}) of potato and grain yield (43.20 q ha^{-1}) of paddy were obtained where both potato and paddy crops were fertilized with 125 % of the recommended dose of N, P and K along with 10 t FYM ha^{-1}. Okra grown on residual fertility of previous crop was exhibited higher yield with 125 %, 100 % and 75 % of the recommended dose of N, P and K to potato in conjunction with 10 t FYM ha^{-1}. The nutrient uptake and the soil nutrient status were also improved with the combined application of organic and inorganic sources of nutrients. Application of 10 t FYM ha^{-1} to potato and paddy along with 75 % of the recommended dose of N, P and K appeared to be more remunerative than N, P and K as inorganic sources only.

The introduction of high yielding varieties and intensive cultivation with imbalance use of chemical fertilizers showed reduction in soil fertility status and crop yields. Integrated use of organic and inorganic fertilizers help in maintaining soil health and stability in crop production through correction of marginal deficiencies of secondary and micronutrients during mineralization of organic manures on one hand and soil physical and ecological condition on the other (Singh *et al*, 2000). Besides supplying nutrients to the crop, integrated use of organic. and inorganic fertilizers often leaves substantial residual effect on succeeding crop in the cropping system resulting efficient crop production (Sharma and Dua, 1995). Keeping these views, an attempt has been made to study the effect of organic and inorganic sources of nutrient for sustaining productivity and soil fertility under potato-okra-paddy rotations.

MATERIALS AND METHODS

The field experiment was conducted at Adisaptagram Block Seed Farm, Hooghly, West Bengal during the period of 2000-01 to 2002-03. The soil of the experimental site was sandy clay loam in texture having 0.064 % total N, 17.6 kg ha^{-1} available P, 235 kg ha^{-1} available K and pH of 7.3. The field experiment was laid out in randomized block design with six treatments (Table –1) and four replications. Different quantities of recommended doses of fertilizers were applied to potato (180 : 150 : 150 kg N, P and K ha^{-1}) and paddy (100 : 50 : 50 kg N, P and K ha^{-1}) and their residual effects on okra (grown without fertilizers) were studied. Nitrogen as urea was given in potato in 2 splits (1/2 at basal and 1/2 at earthing up)

and in paddy in 3 splits (1/2 at basal, 1/4 at tillering and 1/2 at panicle initiation stage) where as phosphorous (as SSP) and potassium (as MOP) were applied as basal in both potato and paddy. According to the treatment, FYM @ 10 t ha^{-1} was applied during final land preparation. The crop varieties Kufri Jyoti, Arka Abhaya and IET-4094 for potato, okra and paddy were planted/sown/transplanted in the second week of November, March and July, respectively. Irrigation for all crops in sequence were given whenever necessary. Plant samples were collected randomly before harvest of each crop and kept in oven for drying. After drying, samples were ground in grinder for chemical analysis. As per the treatment, soil samples were collected after harvesting of each crop. Total nitrogen in soil and plant samples was estimated by modified macro- Kjeldhal's method as described by Jackson (1967). Available phosphorous in soil and phosphorous content in plants were determined with the help of photoelectric colorimeter and available potassium in soil and potassium content in plants were determined by flame photometer after tri-acid digestion (Jackson , 1967)

RESULTS AND DISCUSSION

Productivity of crops : There were significant differences on productivity of crops due to different fertilizer management (Table-1). Maximum tuber yield (285.4 q ha^{-1}) of potato and grain yield (43.2 q ha^{-1}) were recorded with the application of 125 % of the recommended dose of N, P and K along with 10 t FYM ha^{-1}. Tuber yield of potato and grain yield of paddy recorded in the treatment receiving 100 % and 75 % of the recommended dose of N, P and K +10 t FYM ha^{-1} were statistically higher than the treatment receiving 125 %, 100 % and 75 % of the recommended dose of N, P and K without FYM. The increased in yield might be due to the greater availability of mineral nutrients from FYM to the crop plants. This result was supported by the findings of Minhas and Sood (1994) and Mondal and Chettri (1998). The higher yield of okra grown on residual fertility of previous crop was recorded with the application of 125 %, 100 % and 75 % of the recommended dose of N, P and K in conjunction with 10 t FYM ha^{-1}. From the results, it is evident that the residual effects of organic and inorganic nutrients applied to previous crop might have the potentiality in increasing the productivity of succeeding crop in the sequence. Taya *et al* (1994 and 1995) also observed the similar results.

Nutrient uptake : It is apparent from table-2 that the total yearly uptake of nutrients (360 kg N ha^{-1} 71 kg P ha^{-1} 415 kg K ha^{-1}, respectively) by all crops in sequence was maximum where potato and paddy crops were fertilized with 125 % of the recommended dose of N, P and K with 10 t FYM ha^{-1}. Potato and paddy crops fertilized with10 t FYM ha^{-1} along with 100 % and 75 % of the recommended dose of N, P and K also exhibited higher uptake of nutrients and the magnitude was higher than the treatment receiving only inorganic fertilizers even at higher doses. This indicates that FYM might have the power to increase the availability of nutrients. This is supported by the findings of Mondal and Roy (2001).

Soil nutrient status : The total N, available P and available K status of soil after harvest of 9^{th} crop was improved in the sequence (Table-3). The extent of increase of N (+185 kg ha^{-1}), P (+8.0 kg ha^{-1}), and K (+26 kg ha^{-1})

was maximum with the application of 125 % of the recommended dose of N, P and K in conjunction with 10 t FYM ha^{-1}. The reduction of recommended doses of inorganic fertilizers without FYM exhibited depletion of total N, available P and available K in the sequence. This is in agreement with the findings of Madhu *et al* (1997).

Net Production value (NPV) : From table – 4, it is revealed that maximum NPV (1.44) was recorded in the sequence where both potato and paddy crops were fertilized with 125 % of the recommended dose of N, P and K along with 10 t FYM ha^{-1}. It was also observed that combined application of organic and inorganic fertilizers even at lower doses (75% N, P and K) was more profitable than inorganic fertilizers only. Such view is in agreement with Mondal and Chettri (1998).

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Table 1 Productivity of crops under potato-okra-paddy sequence (3 years pooled data)

Treatments (fertilizer doses in kg N, P and K ha^{-1})	Crop yield (q ha^{-1})		
	Potato	Okra	Paddy
T_1 = 75 % RD * of N, P and K for potato and paddy	234.7	88.2	26.0
T_2 =100 % RD * of N, P and K for potato and paddy	249.1	97.1	31.0
T_3 = 125 % RD * of N, P and K for potato and paddy	260.7	102.2	33.5
T_4 = 75 % RD * of N, P and K for potato and paddy + FYM@10t ha^{-1}	267.2	109.4	37.6
T_5 = 100 % RD * of N, Pand K for potato and paddy +FYM@10t ha^{-1}	276.4	114.2	40.8
T_6= 125% RD * of N, P and K for potato and paddy +FYM@10t ha^{-1}	285.4	118.9	43.2
CD (p = 0.05)	5.95	7.10	3.48

*RD =Recommended dose

Table 2 Total uptake of nutrient by crops at different fertilizer management

Treatments (fertilizer doses in kg N, P and K ha^{-1})	Uptake of nutrients kg ha^{-1} annum^{-1}		
	Nitrogen	Phosphorous	Potassium
T_1 = 75 % RD * of N, P and K for potato and paddy	190	40	225
T_2 =100 % RD * of N, P and K for potato and paddy	272	54	310
T_3 = 125 % RD * of N, P and K for potato and paddy	277	59	335
T_4 = 75 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	325	63	380
T_5 = 100 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	355	70	410
T_6= 125 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	360	71	415
CD (p = 0.05)	4.22	6.08	3.40

*RD =Recommended dose

Table 3 Extent of increase (+) or decrease (-) of total nitrogen, available phosphorous and available potassium status in soil in kg ha^{-1} as compared to 100 % recommended dose of fertilizer, after the harvest of 9th crop in potato-okra-paddy system

Treatments (fertilizer doses in kg N, P and K ha^{-1})	Total N after paddy, 2003 (9th crop)	Available P after paddy, 2003 (9th crop)	Available K after paddy, 2003 (9th crop)
T_1 = 75 % RD * of N, P and K for potato and paddy	-100	-9.3	-28
T_2 =100 % RD * of N, P and K for potato and paddy	1480	35.2	239
T_3 = 125 % RD * of N, P and K for potato and paddy	+80	+2.8	+9
T_4 = 75 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	+100	+5.0	+11
T_5 = 100 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	+140	+6.1	+21
T_6= 125 % RD * of N, P and K for potato and paddy + FYM @ 10 t ha^{-1}	+185	+8.0	+26

*RD =Recommended dose

Initial value (2000) of soil N, available P and K were 1400, 17.6 and 235 kg ha^{-1}, respectively.

Table 4 Net production values under different fertilizer management practices in the potato-okra-paddy sequence.

Treatments (fertilizer doses in kg N, P and K ha^{-1})	Cost of manures and fertilizers (Rs ha^{-1})	Total cost of cultivation including seed and fertilizers (Rs ha^{-1})	Cost of produce (Rs ha^{-1})	Net profit (Rs ha^{-1})	Net production values (NPV)
T_1 = 75 % RD *	5,690	56,540	1,12,393	55,653	0.99
T_2 =100 % RD *	7,587	58,437	1,23,129	64,692	1.11
T_3 = 125 % RD *	9,484	60,334	1,29,893	69,559	1.15
T_4 = 75 % RD * + FYM @ 10 t ha^{-1}	6,690	57,540	1,37,232	79,692	1.38
T_5 = 100 % RD * + FYM @ 10 t ha^{-1}	8,587	59,437	1,43,812	84,375	1.42
T_6= 125 % RD * + FYM @ 10 t ha^{-1}	10,484	61,334	1,49,666	88,332	1.44

*RD = Recommended dose

Cost of manures and fertilizers (Rs)	Cost of seed (Rs q^{-1})	Cost of cultivation (Rs ha^{-1})	Cost of produce (Rs q^{-1})
1. Urea - 460.00 q^{-1}	1. Potato – 700/-	1. Potato – 20,800/-	1. Potato – 270/-
2. SSP - 300.00 q^{-1}	2. Okra - 2000/-	2. Okra - 4,600/-	2. Okra - 320/-
3.MOP - 400.00 q^{-1}	3. Paddy – 1000/-	3. Paddy – 8,890/-	3. Paddy – 800/-
4. FYM - 100.00 t^{-1}			