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Relative performance of complex and straight chemical fertilizer in conjunction with and without organic manure in Potato-Jute crops sequence

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ABSTRACT

Field experiments were carried out during 1999-2002 in Entisol soil of nearly neutral reaction (pH 6.8), sandy clay loam in texture, of the instructional Farm of the Bidhan Chandra Krrishi Viswavidyala, West Bengal, India to evaluate the relative performance of two complex fertilizers and one straight nitrogenous fertilizer in conjunction with and without farm yard manure under potato jute crop sequential cropping system. Seven manurial treatments were applied to potato crop and two fertilizer doses given to jute crop in sequence. Altogether 14 treatment combinations replicated thrice in split plot design. Seven manurial treatments given to potato crop were in main plot and two fertilizer doses given to jute crop were in subplot. Except control treatment, all treatments of Potato crop received 150 kgN, 100 kg P_2O_5 and 100 kg K_2O ha^{-1}. Experiment was started with potato crop during 1999-2000. In potato-jute sequential cropping maximum yield of potato tuber (24.96 t ha^{-1}) and jute crop (4.63 tha^{-1}) was recorded where potato crop received IFFCO NPK (10:26:26) along with 25% N as farm yard manure and jute crop was fertilized with 40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1}. Both the crops in sequence when fertilized with same manual treatment earned maximum net return (Rs 48,578.00 per year) and return per rupee investment (Rs. 2.21). In addition to that total uptake of nitrogen, phosphorus and potassium by jute and potato crops in sequence per annum was also maximum (390.3 kg ha^{-1} $year^{-1}$) under the same treatment conditions. Addition of farm yard manure in conjunction with complex (IFFCO NPK) mineral fertilizer tested in improvement of nitrogen (10.5%), phosphorus (6.4%) and potassium (4.3%) status of soil over the initial value after fifth crop in the cropping sequence.

Key words : Organic, Inorganic, Crop sequence.

In West Bengal potato crop can very well be grown in several multiple cropping systems. It requires a high fertilizer dose and major part of phosphatic and potassic fertilizer is not being utilized by the first season crop. For better utilization of applied fertilizers to potato, the succeeding crop must be rationally chosen. Under West Bengal condition jute seems to be a good succeeding crop after potato. High basal doses of straight nitrogenous fertilizers like urea have some deleterious effect on emergence of potato. For this, complex fertilizers can very well be applied in potato for a better N economy in two sequences. For a sustainable increase in yield in a potato-jute sequence organic manure can be applied. To judge the relative efficiency of complex fertilizers in potato-jute sequence this experiment has been taken up.

MATERIALS AND METHODS

Field experiments were conducted at the Instructional farm of the Bidhan Chandra Krishi Visvidyalaya, West Bengal, India located at 22^0 56' N latitude, 88^0 32' E longitude at an elevation of 9.75 meters above sea level to study the relative performance of two complex fertilizers in conjunction with organic manure in potato-jute sequence during 1999-2000 to 2001-2002. Experiment was conducted on a sandy clay loam entisol neutral soil (pH 6.8) having 0.059% total N, 0.554% organic carbon, 21.8 kg available P_2O_5 ha^{-1} and 170.2 kg available K_2O ha^{-1}. Initially experiment was laid out with randomized Block Design having seven manurial treatments to the first potato crop (as in table-1) with three replications. After harvest of first season potato crop all the plots were sub divided into two equal halves. Two fertilizer doses (J_1=40 Kg N, 20 Kg P_2O_5 and 20 kg K_2O ha^{-1} and J_2= 40 kg N ha^{-1}) were randomly allotted to subsequent jute crop. So the data of second, third, fourth and fifth season crops were analyzed as per the split plot design considering allocation of manurial treatments to potato crops in main plot (as in table 1) and fertilizer doses to jute crop in sub plot (as in table 1). The treatments were replicated thrice. The experiments were conducted for three consecutive years on the same field without disturbing the layout. Each small unit had net plot size of 5 m × 3 m. Potato crop was fertilized with 150 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1} to all treatments except in control treatment (no fertilizer of FYM applied). The treatments in which complex fertilizers were applied as in basal dose, the fertilizer dose was balanced through straight fertilizer like urea, SSP and MOP. The treatments in which 25% was applied through FYM, the of P_2O_5 and K_2O added through it was also taken into account for calculation of inorganic fertilizers. Nutrient content of FYM used in the experiments in different years were 0.48, 0.52 and 0.50% N, 0.27, 0.24, 0.24 and 0.25% P_2O_5 and 0.46, 0.50 and 0.52% K_2O in 1999-2000, 2000-2001 ad 2001-2002, respectively. Potato crops were sown on 22.11.99, 28.11.2000 and 23.11.2001 and harvested on 24.02.2000, 20.3.2001 and 04.3.2002 and Jute crops were sown on 25.04.2000 and 14.4.2001 and harvested

on 23.08.2000 and 16.8.2001. Cultivar Kufri Jyoti and Navin (JRO 524) were used for potato and jute crops, respectively.

RESULTS AND DISCUSSION

Productivity of crops in sequence

Tuber yield of potato in the first year (1999-2000) was more in treatments where potato crop received chemical fertilizer only either in the form of IFFCO NPK (23.10 t ha^{-1}), suphala NPK (22.60 t ha^{-1}) or Urea (21.06 t ha^{-1}) as compared to that of combined use of chemical fertilizer (Table 1) and FYM (20 to 22 t ha^{-1}). The treatments in which 25% N was added through FYM during first year might have exerted morbid effect on the growth and productivity of potato, probably due to the reason of slower microbial activity for mineralization of FYM in cool winter temperature which culminated in less release of plant nutrients. The interpretation corroborates with the findings of Das and Bajernee (1994 a). But in the second (Rabi, 2000-2001) and third year (Rabi 2001-2002) the trend of result was quite reversed in case of potato. The tuber yield was higher in the treatments receiving 'chemical fertilizers also with FYM (23.91, 22.96 and 20.57 t ha^{-1} in 2000-2001 and 24.97, 23.13 and 21.35 t ha^{-1} in 2001-2002 in IFFCO NPK, Suphala NPK and Urea, respectively) during second and third years (Table 1). This result might be due to gradual mineralization of FYM added to first year crop in the sequence for a better nutrient availability in the systems and with a higher residual effect on succeeding crops. Moreover in second and third year potato crops on an average received 28.90 kg N, 2.56 kg P_2O_5 and 23.29 kg K_2O ha^{-1} through leaf fall of preceding jute crop. Chatterjee et al (1978) reported that the residual effect of FYM and other fertilizers persisted (0.2 to 2.5 t ha^{-1}) in second crop (maize/jute/moong). This effect of FYM persisted even in the 3rd crop of rice (0.4 is 0.9 t ha^{-1}). From the average of two years data it was observed that the maximum fibre yield of jute (4.36 t ha^{-1}) and tuber yield of potato (24.97 t ha^{-1}) were obtained when potato crop was manured with IFFCO NPK in conjunction with FYM and jute crop was fertilized with 40 Kg N, 20 P_2O_5 and 20 kg K_2O t ha^{-1}in sequence (Table 1). Similar results were obtained when potato was applied with a combined package of organic and inorganic form of fertilizer and jute was fertilized with inorganic form in potato jute sequence by Mukhopadhyay and Roy (2000) and Mandal and Roy (2001). A combined use of FYM with IFFCO NPK, Suphala NPK and Urea recorded an increase of 1.7, 1.3 and 0.5%, respectively over their corresponding sole chemical source.

Application of complete dose of fertilizer (40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1}) in jute crop in sequence (Table 1) helped to increase potato tuber yield by 4.6% over that of obtained by application of 40 kg N ha^{-1} dose.

When average fibere yield of jute of two years (Table 1) was compared among different manurial treatments applied to preceding potato, an increase of 6.1% yield was observed with the application of IFFCO NPK along with FYM over that of sole IFCO NPK. Under similar condition when potato crop received Suphala-NPK or Urea instead of IFFCO NPK increment of Jute fibere yield were 5.9% and 4.9%, respectively. The trend of results of individual years was very similar to that of mean results. Similarly application of 40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1} in jute increased the fibre yield by 5.2% over that of 40 kg N ha^{-1} only. It might be due to the reason that being a bast fibre crop its growth and consequently yield were influenced by a balanced fertilizers package. Verma et al. (1981) also observed the similar results in fibre yield of jute.

Economic evaluation of the potato-jute sequential cropping

In crop management, a farmer is interested to produce more per unit of investment in inputs and that also from easily available internal resource. So, it will be of great concern to evaluate the net profit per unit investment that was involved in potato-jute cropping sequence studied in-this experiment. The maximum net return (Rs. 48,578.00) was earned when potato crop was manured with IFFCO-NPK along with FYM and succeeding jute crop was fertilized with 40 kg N - 20 kg P_2O_5 -20 kg K_2O ha^{-1} (Table 2). Under the same treatment combination return per rupee investment was Rs. 2.21 (Table 2). Total productivity of crops in sequence and return per rupee investment were all along high where organic manure was added to the crop in conjunction with mineral fertilizers as compared to those obtained under the crops fertilized only with chemical fertilizers. This result is corroborated with the findings of Jayaram et al., (1990), Sanyal et al, (1993). The results thus confirmed that the country can ill-afford to any reductions in the recommended dose of fertilizer application to increase the crop production through the use of modern varieties, unless the efficiency of fertilizer use can be further enhanced through judicious use of organic manure/matter in conjunction with the mineral fertilizers. Return per rupee investment was increased by 2.9, 4.2 and 1.6% due to application chemical fertilizers viz. IFFCO-NPK, Suphala and urea, respectively, along with FYM as compared to that of their chemical form only (Table 2).

The nutrient uptake by Potato and Jute crops in sequence

The uptake of nutrients by jute and potato crops in sequence during different seasons were computed for three consecutive years (1999-2002). From the mean data of result (Table 2) it is apparent that the maximum uptake of nutrients (N, P and K) by jute and potato crops were recorded

(390.3 kg^{-1} ha^{-1} $year^{-1}$) under the treatment where potato crop was manured with IFFCO-NPK along with FYM and the jute crop received 40 kg N, 20 kg P_2O_5 and 20 Kg K_2O ha^{-1}. This might be due to the fact that with the application of FYM in presence of chemical fertilizers the nutrients become readily available to the crops. Biswas and Benbi (1989) reported that an application of farm yard manure along with N, P and K increased the uptake of nutrient by the crops over the N, P and K only.

Similarly uptake of nutrients were also high where FYM was used along the Urea (343.8 kg^{-1} ha^{-1}) or Urea (331.7 kg^{-1} ha^{-1}) alone (Table 2). Application of 40kg N, 20 kg P_2O_5.20 kg K_2O ha^{-1} nutrients in jute crop (338.7 kg^{-1} ha^{-1}) also showed superiority over that of nitrogen alone (320.7 kg^{-1} ha^{-1}) as regards to total uptake of nutrients.

Soil nutrients status after harvesting of fifth crop in the sequence

From the nutrient status of soil (N, P and K) after harvest of each crop in sequence. It is clearly observed (table 3) that nitrogen content improved over initial level after third crop (potato) in sequence. In all the treatment combinations but phosphorus content increased after fourth crop. Where as K content decreased gradually in all the treatment combination except in one or two cases. It is very clear that nitrogen, phosphorus and potassium content increased respectively by 10.5, 6.4 and 4.3% over initial when the potato crop received IFFCO-NPK along with farm yard manure and jute crop was fertilized with 40 kg N - 20 kg P_2O_5 -20 kg K_2O ha^{-1}. Not only that NPK status of the soil was also improved where the crops received farm yard manure along with Suphala-NPK.

Table 1 : Production of potato tuber and jute fibre as influenced by manurial treatments in potato-jute sequence during 1999-2002.

Manurial treatments to potato crops		Rabi 1999 - 2000	Rabi 2000-2001			Rabi 2001-2002			Mean of 2000-2001 & 2001-2002		
			Fertilizer doses to jute crop (kg ha^{-1})								
			J_1	J_2	Mean	J_1	J_2	Mean	J_1	J_2	Mean
1. Yield of potato tubers t ha^{-1}											
P_1=Control		12.67	09.70	8.62	9.16	10.00	9.56	9.78	9.85	9.09	9.47
P_2=10:26:26 (IFFCO NPK)		23.10	22.83	22.06	22.44	23.12	22.95	23.04	22.98	22.51	22.75
P_3=10:26:26+ FYM		22.42	24.73	23.10	23.91	25.19	24.75	24.97	24.96	23.93	24.45
P_4=15:15:15 (Suphola NPK)		22.60	22.31	21.70	22.01	23.31	22.69	23.00	22.96	22.20	22.58
P_5=15:15:15:+ FYM		22.21	22.98	22.93	22.96	23.25	23.00	23.13	22.73	22.97	22.85
P_6=Urea+SSP+MOP		21.06	20.10	18.50	19.31	21.65	19.91	20.78	20.83	19.21	20.02
P_7=Urea+SSP+ MOP+FYM		20.01	20.86	20.28	20.57	21.75	20.95	21.35	21.31	20.62	20.97
Mean		20.58	20.50	19.60		21.18	20.54		20.80	20.08	
SEm±	P	0.368		0.590			0.671			0.631	
	J			0.290			0.301			0.296	
	P×J			0.771			0.812			0.792	
CD (*P*=0.05)	P	1.135		1.817			2.013			1.861	
	J			NS			NS			NS	
	P×J			NS			NS			NS	

2 Yield of jute fibre (t ha^{-1})	Kharif 2000			Kharif 2001			Mean of two years		
	J_1	J_2	Mean	J_1	J_2	Mean	J_1	J_2	Mean
P_1=Control	3.32	3.16	3.24	3.38	3.33	3.36	3.35	3.25	3.30
P_2=10:26:26 (IFFCO NPK)	4.16	3.59	3.88	4.01	3.85	3.93	4.09	3.72	3.91
P_3=10:26:26+ FYM	4.40	3.86	4.13	4.32	4.00	4.16	4.36	3.93	4.15
P_4=15:15:15 (Suphola NPK)	3.69	3.46	3.59	3.85	3.72	3.79	3.77	3.61	3.69
P_5=15:15:15:+ FYM	3.93	3.77	3.85	3.99	3.94	3.97	3.96	3.86	3.91
P_6=Urea+SSP+MOP	3.49	3.42	3.46	3.52	3.45	3.49	3.51	3.44	3.48
P_7=Urea+SSP+ MOP+FYM	3.57	3.53	3.55	3.81	3.68	3.75	3.69	3.61	3.65
Mean	3.79	3.55		3.84	3.71		3.82	3.63	

Effect of	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
P	0.135	0.414	0.047	0.145	0.091	0.273
J	0.065	NS	0.033	NS	0.049	NS
P×J	0.171	NS	0.088	Ns	0.129	NS

Table 2 : Total uptake of nutrients (N, P and K), net return and return per rupee investment in potato-jute sequence (Mean of two years)

Manurial treatment to potato crop	Total uptake of N, P & K in kg ha^{-1} yr^{-1}			Net return in potato-jute sequence Rs ha^{-1} yr^{-1}			Return per rupee in investment (Rs.) in potato-jute sequence		
	Fertilizer doses to jute crop (kg ha^{-1})								
	J_1	J_2	Mean	J_1	J_2	Mean	J_1	J_2	Mean
P_1=Control	174.7	162.6	168.7	16609	15324	15324	1.46	1.43	1.45
P_2=10:26:26 (IFFCO NPK)	385.8	369.4	377.6	44333	41730	43032	2.11	2.06	2.09
P_3=10:26:26+ FYM	390.3	371.0	380.7	48578	42937	45758	2.21	2.08	2.15
P_4=15:15:15 (Suphola NPK)	372.4	354.6	363.5	39620	36832	38226	1.95	1.89	1.92
P_5=15:15:15:+ FYM	371.9	352.4	362.2	41916	39255	40586	2.02	1.97	2.00
P_6=Urea+SSP+MOP	331.7	312.2	321.9	34504	32573	33539	1.86	1.83	1.85
P_7=Urea+SSP+ MOP+FYM	343.8	323.0	333.4	35988	34281		1.90	1.87	1.89
Mean	338.7	320.7		37364	34705		1.93	1.88	

J_1= 40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1} to jute crop and J_2= 40 kg N ha^{-1} to jute crop

Table 3 : Total nitrogen (%) available phosphorus and potassium (kg ha^{-1}) content of soil under potato-jute cropping sequence after harvesting of each successive crops during 1999-2002

Manurial treatment to potato crop	After 1st crop (Potato)	After 2nd crop (Jute)		After 3rd crop (Potato)		After 4th crop (Jute)		After 5th crop (Potato)	
		J_1	J_2	J_1	J_2	J_1	J_2	J_1	J_2
1. Total nitrogen content in soil (%)									
P_1=Control	0.055	0.058	0.057	0.059	0.058	0.061	0.060	0.059	0.058
P_2=10:26:26 (IFFCO NPK)	0.060	0.062	0.060	0.061	0.061	0.065	0.062	0.066	0.063
P_3=10:26:26+ FYM	0.060	0.065	0.061	0.062	0.060	0.066	0.064	0.067	0.065
P_4=15:15:15 (Suphola NPK)	0.059	0.061	0.059	0.060	0.059	0.064	0.060	0.065	0.061
P_5=15:15:15:+ FYM	0.059	0.062	0.060	0.061	0.060	0.064	0.062	0.065	0.063
P_6=Urea SSP+MOP	0.059	0.059	0.059	0.059	0.059	0.060	0.060	0.061	0.061
P_7=Urea+SSP+ MOP+FYM	0.059	0.059	0.060	0.059	0.060	0.061	0.061	0.062	0.062
Mean	0.059	0.061	0.059	0.060	0.060	0.063	0.061	0.064	0.062
2. Available phosphorus content in soil (kg ha^{-1})									
P_1=Control	20.35	20.7	20.6	19.8	19.6	21.2	20.7	21.3	20.8
P_2=10:26:26 (IFFCO NPK)	21.25	21.8	21.5	21.2	21.1	22.5	22.0	23.0	22.7
P_3=10:26:26+ FYM	21.65	22.6	22.3	21.8	21.4	23.6	22.8	23.9	22.9
P_4=15:15:15 (Suphola NPK)	21.15	21.8	21.6	21.6	21.5	22.1	21.7	22.9	22.0
P_5=15:15:15:+ FYM	21.50	22.5	22.3	22.0	22.0	23.4	22.6	23.9	22.7
P_6=Urea SSP+MOP	20.75	21.0	21.0	20.6	20.5	21.7	20.8	22.0	21.2
P_7=Urea+SSP+ MOP+FYM	21.05	21.1	21.2	20.7	20.2	21.9	21.5	22.5	21.9
Mean	21.10	21.64	21.50	21.10	20.9	22.3	21.7	22.8	22.0
3. Available potassium content in soil (kg ha^{-1})									
P_1=Control	152.9	160.3	154.5	148.3	143.2	156.7	150.1	156.7	150.1
P_2=10:26:26 (IFFCO NPK)	160.5	175.4	168.1	167.1	160.7	172.2	168.2	173.0	169.0
P_3=10:26:26+ FYM	164.8	177.2	170.3	172.8	168.3	181.7	173.5	181.9	174.0
P_4=15:15:15 (Suphola NPK)	162.5	170.5	166.2	166.3	161.5	173.5	169.2	174.0	170.1
P_5=15:15:15:+ FYM	165.8	175.7	170.8	170.4	167.2	180.1	171.7	181.0	172.0
P_6=Urea SSP+MOP	159.5	168.5	162.1	159.7	152.5	169.4	165.2	170.2	166.0
P_7=Urea+SSP+ MOP+FYM	161.0	171.3	165.7	164.8	160.7	170.5	164.3	171.3	165.1
Mean	161.0	171.3	165.4	164.2	159.2	172.0	166.0	172.6	166.6

P_1= Control, P_2=IFFCO NPK (10:26:26), P_3=IFFCO NPK+FYM, P_4=Sphala NPK (15:15:15), P_5=Suphala+FYM, P_6=Urea+SSP+MOP, P_7=Urea +SSP+MOP+FYM, J_1=40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1} to jute and J_2= only 40 kg N ha^{-1} to Jute Initial soil status of total N was 0.059%, available phosphorus was 21.8 kg ha^{-1} and available potassium was 120.2 kg ha^{-1}.

Das and Banerjee (1994 c) recorded the maximum net positive balance of total soil nitrogen, available phosphorus and available potassium at the end of two potato-based rotations from their initial levels with FYM treated plots. Bharaawaj *et al.* (1982) also observed the highest available potassium in FYM treated plots with recommended doses of N, P and K. Mondal et al. (1993) observed that the application of FYM or crop residues in addition to 75% of the recommended dose of NPK improved the soil fertility status after harvest of 9th crop in sequence. With inclusion of FYM in potato based sequences, soil fertility was improved with balanced fertilizer application over the initial fertility status after three years irrespective of crop rotations (Mukhopadhyay and Ray, 2000).

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- The biannual Journal entitled, **"Journal of Crop and Weed"** Volume **I no. 1 & 2,** Volume **2 no. 1&2** and **Volume 3 No.1** have already released. Journal indexing at **CABI** since its first issue.
- The West Bengal Weed Science News – 2004, The Directory of West Bengal Weed Science Society 2004-05, **Crop and Weed Science News -2006 and 2007 and a special volume of Crop and Weed Science News – 2006** have already published.
- Training programme on, "Advance weed management" on March, 2004 at FTC, BCKV, Kalyani, "Weed management in Rice, Vegetables and Oilseeds" on September, 2004 at Gayespur, Kalyani, Nadia.
- Training Progamme on, "Weed management in Onion" on November, 2004 at Balagarh, Hooghly.
- Along with RAWE programme of BCKV a demonstration on, "Important pests in NAZ region" cum farmers' day was observed at the village Rajberia of Nadia, West Bengal on June 2004.
- Training Progamme on, "Nutrient and Weed management in Agroforestry and Potato on February, 2005 at Raina, Burdwan.
- Advanced Nutrient and Pest management" at FTC, BCKV on 11th May, 2005.
- Parthenium Awarness Day on 3rd September, 2005 at Village Chandamari, Nadia and 11th September, 2006 at Goragacha, Nadia
- Training programme on, "SRI and Organic Rice Agriculture" at FTC, BCKV on 24th May, 2006.
- National Seminar on "Ecorestoration of Soil And Water Resources towards Efficient Crop Production" on June 6-7, 2007 at FTC, BCKV

Programmes to be undertaken in future

- To involve more members (Teachers/Scientists/ Students/ Farmers/ Officers etc.) from the different areas of India and Global level.
- Continuation and publication of the Biannual Journal entitled, **"**Journal of Crop and Weed" and the Annual Crop and Weed Science News.
- Training programme / Demonstrations on Global warming and its effect on agriculture, Organic agriculture, Biodiesel, Proper use of ground water, Environmentally safer pesticides including herbicides and benefits of organic farming at various villages to enrich farmers about safe use of seed, water, fertilizers, pesticides and post-harvest technology.
- Any other as resolved in the EC or GB meeting of the Society.