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Fertilizer Management for Sugarcane-Potato Intercropping in the Old Himalayan Piedmont plain soils of Bangladesh

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ABSTRACT

An investigation was conducted in the old Himalayan piedmont plain soils in farmers field at Kanta. Dinajpur during 1992-93 and 1993-94 cropping seasons to asses effects of nutrient management in sugarcane (var. Isd 19) intercropped with potato (var. cardinal). Zn showed beneficial effects on yield of cane. Yield response of cane were more pronounced with Ca and Mg fertilization. Combined effect of NPKS Zn Ca and Mg significantly increased the potato yield and improved the growth parameters of sugarcane and finally obtained 67.2 kg additional sugarcane yield by addition of each kg of nutrients. Maximum net benefit of Tk. 96,132/ha and the highest marginal rate of return (MRR) of 180% was found owing to the use of these elements compared to sole cane. Application of N_{180} $(P_2O_5)_{120}$ $(K_2O)_{180}$ S_{40} Zn_8 Ca_{20} Mg_{20} to sugarcane with N_{150} $(P_2O_5)_{60}$ $(K_2O)_{130}$ S_{20} Zn_4 Mg_{10} kg ha^{-1} to potato respectively was found to be sufficient for sugarcane-potato intercropped situation in old Himalayan piedmont plain soils of Bangladesh.

INTRODUCTION

Substantial advantage in yield from intercropping compared with sole cropping accrues from complementary effects of different crops on each other making better use of resource when grown together (Willey, 1979). Sugarcane is a long duration crop which requires 12-14 months from planting to harvesting. Some cane growers cannot afford to keep their land engaged for such a long period for sugarcane. Intercropping of different winter crops especially potato with sugarcane has a number of advantages. Potato intercropping not only gives an additional income but also increase yield of sugarcane through the complementary effects. Yield stability due to intercropping of potato has been reported else where (Okigbo, 1974; Rao and Shetty, 1976). In Bangladesh potato occupies 15% of total area intercropped with sugarcane (Imam *et al.* 1990). The combined return of cane and potato was always higher when both the crops were planted together and received their full rates of fertilizer (Imam *et al.* 1990). Systematic information is needed on the effects of nutrient management of potato with sugarcane. Hence, an experiment was conducted to find out the most economically acceptable nutrient levels for potato intercropping with sugarcane in the Old Himalayan Piedmont plain soils of Bangladesh.

MATERIALS AND METHODS

The field experiment was conducted at farmers field in Gangachara series soils of Dinajpur district in Bangladesh during the cropping seasons 1992-93 and 1993-94 on a sandy loam soils. Initial soil samples were collected and prepared systematically for laboratory analysis. The pH was determined by glass electrode pH meter. Analysis is made for NH^4-N, Active acidity, Ca and Mg using IN KCl extraction procedure. The sample is analysed for P,K, Cu, Fe, Mn and Zn using the modified sodium bicarbonate

extraction procedure. Analysis is made for S and B using the Ca H_4 $(PO_4)_2$ extraction procedure (Hunter, 1980). Nutrient status of the initial soil is shown in the Table 1. The critical level of each element has also been shown in the table 1.

Table 1. Nutrient status of soils under study.

Location	pH	OM%	AA	Ca	Mg	K	NH_4-N	P	Mn	S	B	Cu	Fe	Zn
				meq%			(ppm)							
Dinajpur	5.3	1.25	0.8	0.9	0.16	0.08	14	35	4.2	37	1.6	2.6	139	0.9
Critical level	-	-	-	2	0.8	0.2	75	20	5.0	14	0.2	1.0	20	2

The experiment was laid down in RCB design with three replications. Individual plot size was 80 sq.m (8m x 10m). A package of N P K S Zn Ca and Mg with variable rates were practiced. For field experiment, before selecting treatment combinations soils of experimental sites were analysed for fixation studies of different nutrients and after that green house studies were also made for missing element trial. The treatments combination were as follows:

Treatment	For sugarcane (kg/ha)								For potato (kg/ha)						
	N	P_2O_5	K_2O	S	Zn	Ca	Mg	CD	N	P_2O_5	K_2O	S	Zn	Mg	CD
T_1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2	160	100	150	40	4	-	-	-	120	50	120	20	-	-	-
T_3	180	120	180	40	-	20	20	-	150	60	150	20	-	-	-
T_4	180	120	180	40	8	20	20	-	150	60	150	20	4	10	-
T_5	180	120	180	40	-	20	20	5000	150	60	150	20	-	-	3000
T_6	180	120	180	40	-	20	20	-	(sole cane)		-	-	-	-	-

*CD means cowdung.

After the final land preparation, 30 d old soil bed settlings (var. Isd 19) were transplanted in late December at 1.0m between row spacing. Simultaneously the potato (Var. cardinal) were planted in rows between the vacant space of two rows of sugarcane in November. Each crop in each treatments received fertilizers as shown in above table. After land preparation full dose of P_2O_5 (as TSP), S (as gypsum), Zn (as zinc sulphate), Mg (as magnesium oxide), Ca (as calcium oxide), Cowdung (CD) and half of K_2O (as MP) were applied in the trenches for cane as basal dose. One third of N (as urea) was applied as top dressing after 20 d of transplanting. Rest of N and K_2O were applied in two equal installments within 100 d and 150 d after cane plantation.

For intercrop potato, half of the total N and full dose of P_2O_5, K_2O, S, Mg, Zn and cowdung were applied between the vacant space of two cane rows. Remaining N was applied after 30-40 d of potato plantation. The recommended crop management practices were adopted for cane as well as intercrop (Potato).

RESULTS AND DISCUSSION

Laboratory studies

The analytical results of initial soil of the experimental plot indicates (Table 1) that the soils of Gangachara series was deficient in N, Zn, Ca, Mg and exchangeable K. Available P, S, B, Cu and Fe of the soils were above critical level. Mn content was very close to optimum level in the soils.

Yield and yield attributes of cane

Significant differences in tiller, number of millable cane and yield were obtained in different treatments in sugarcane + Potato intercropping pattern in both the years (Table 2). Pooled data for 2 years indicated that the highest number of effective tiller (161.2 x 10^3 ha^{-1}), millable cane (110. 8x 10^3 ha^{-1}) and cane yield (85.2 t ha^{-1}) was produced by cane + potato with the treatment T_4. Similar results were found by Rathi and Singh (1979) and Agarwal (1973) who reported that crops like potato, radish and spinach have exert positive influence on the production of number of millable cane and yield. Marked significant response of yield and yield attributes of cane in both the years are observed with the treatment T_4 when Zn, Mg and Ca were added with NPKS. Zinc application increased yield of cane by 8% over the treatment T_3 where Zn was not used. Rahman *et al.* (1992) also obtained the individual application of Zn @ 8 Kg ha^{-1} increased 8.7% cane yield compared to control. Addition of Mg and Ca increased yield of cane by about 31% over treatment T_2 where Ca & Mg are not applied. All the treatment showed marked improvement of both the cane and tuber yield over control. It is assumed that sugarcane is likely to be benefited from combined effect of Zn, Mg and Ca with higher rates of NPKS nutrient application. Nutrient applied to potato and management practices ultimately induced greater yield of cane. On the other hand, treatment T_4, where all types of nutrient was applied both in cane and potato produced 13.3% higher cane yield than that of purestand cane. Higher yield of cane under such combination was also reported by Rathi and Singh (1980). There were significant differences in the recoverable sucrose percentage under different treatments in the first year where the highest recovery was found with T_4. However, it appeared insignificant in the second year. It may be clear that potato intercropped with sugarcane did not have any adverse effects on growth and yield of cane, rather it produced synergistics effects on cane yield. It is also assumed that sugarcane being a long duration nature which captalized on the residual resources left by potato. The results agreed with the findings of Verma and Yadav (1988).

Potato yield

Gradual improvement of yield was conspicuous with the addition of different nutrient elements (Table 2). The mean of two years yield record showed the highest production with T_5 where organic matter was added along with chemical fertilizers and the results were statistically significant. Such yield improvement may be attributed due to the use of organic matter. Improvement of potato yield due to application of organic matter was also noticed by Singh and Singh (1978).

Nutrient use efficiency

While considering the nutrient use efficiency in sugarcane-potato intercrop combination, it is revealed from the yield data that T_4 out yielded the other treatments. In this treatment around 67.2 kg sugarcane yield was obtained by addition of each kg of nutrients. Gradual yield improvement was noticed with the increase of rate of nutrients and addition of new elements which reached the maximum at T_4 and started to decline beyond that (Figure 1). The highest adjusted yield of cane (potato yield converted into

cane yield on the basis of market price) was also received in the same treatment. This indicated the better utilization of nutrient applied to cane and accrued through the utilization of residual nutrient left after harvest of potato. Such yield advantage and better utilization of nutrient in intercropped (Mixed cropped) was also reported by Willey (1979) and Hossain (1984). According to them the intercrops may draw nutrient from larger volume of soil than single crop stand because of some degrees of mutual avoidance of root systems and perhaps more root soil contact in the same volume of soil.

Table 2. Yield and yield attributes of cane and potato at different levels of Nutrients.

Treat	Tiller ($X10^{-2}$ ha^{-1})			Millable cane ($X10^{-1}$ ha^{-1})			Recovery %		Cane yield ($t\ ha^{-1}$)			Potato yield ($t\ ha^{-1}$)		
ment	1992 -93	1993 -94	Pooled	1992 -93	1993 -94	Pooled	1992 -93	1993 -94	1992 -93	1993 -94	Pooled	1992 -93	1993 -94	Pooled
T_1	110.7b	82.2b	96.5	53.6c	60.1c	56.8	8.0b	9.7a	40.5d	45.9d	43.2	3.1b	4.5c	3.8
T_2	160.8a	135.9a	148.4	90.9b	96.5b	93.7	8.2b	9.3a	67.7c	61.8c	64.8	4.0b	7.0b	5.5
T_3	166.1a	138.1a	152.1	102.4ab	106.6ab	104.5	8.6ab	9.7a	78.9ab	77.6b	5.3a	7.0b	5.3a	6.1
T_4	179.1a	143.3a	161.2	105.6a	116.0a	110.8	9.1a	8.7a	84.3a	86.0a	85.2	5.2a	7.2b	6.2
T_5	171.2a	134.6a	152.9	102.7ab	113.1ab	107.9	8.7ab	9.1a	72.5bc	78.9b	75.2	5.0a	8.8a	6.9
T_6	172.2a	124.2a	148.2	94.2ab	103.3ab	98.7	8.1b	9.0a	74.5bc	75.8b	75.2	-	-	-

Values within a column followed by the same do not differ significantly at the 0.05 level as per DNMR test.

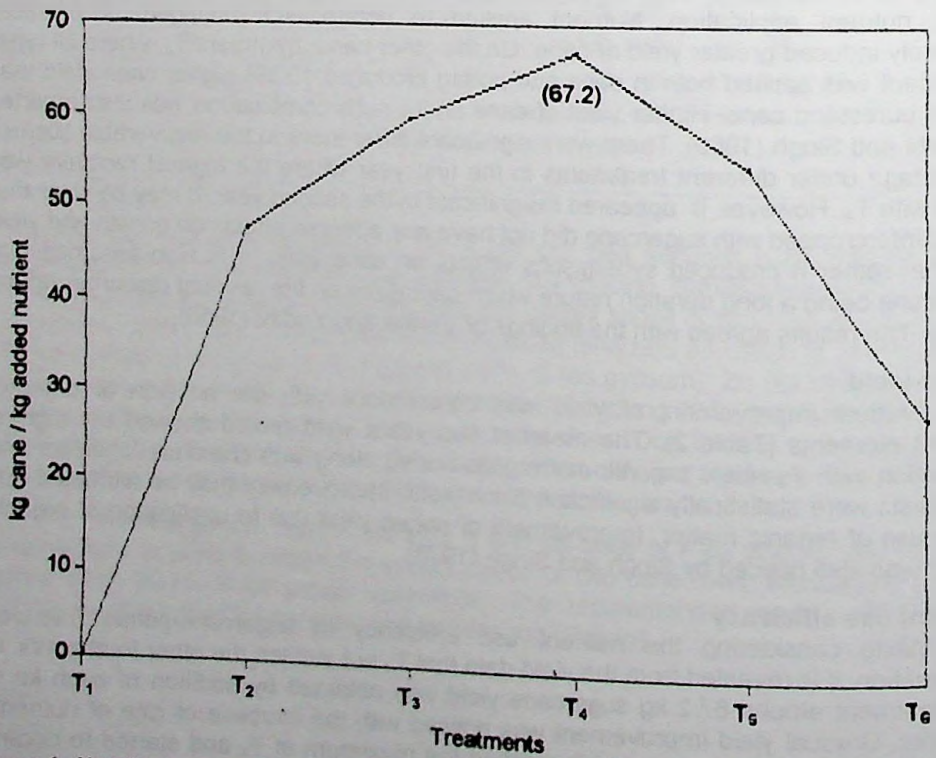

Figure 1. Nutrient use efficiency by cane.

Economics of fertilizer use

Partial budget analysis and marginal analysis (Rechard *et al.* 1979) on the total product from field experiments have been provided in the Table 3a and 3b.

Table 3a. Partial budget analysis for fertilizer use in different treatments from cane intercropped with Potato (Average of two years)

Treat-ment	Yield (t-ha^{-1})		Gross field profit (Tk. ha^{-1})			Variable money cost (Fertilizer Tk.ha^{-1})	Variable opportu-nity cost (Tk.ha^{-1})	Total variable cost (Tk. ha^{-1})	Net benefit (Tk.ha^{-1})
	Cane	Potato	Cane	Potato	Total				
T_1	43.2	3.8	43,372	19.,000	62,372	-	-	-	62,372
T_2	64.8	5.5	65.059	27,500	92,559	10.980	250	11,230	81,329
T_3	78.3	6.1	78,613	30,500	1,09.113	17,518	250	17,768	91,345
T_4	85.2	6.2	85,540	31,000	1,16.540	20,158	250	20,408	96,132
T_5	75.7	6.9	76,002	34,500	1,10,502	21,518	290	21,808	88,694
T_6	75.2	-	75,500	-	75,500	12,396	200	12,596	62,904

Table 3b. Marginal analysis of the undominated fertilizer response data.

Net benefit (Tk. ha^{-1})	Treatment	Variable cost (Tk. ha^{-1})	Change from the next highest benefit		
			Marginal increase in net benefit	Marginal increase in variable cost	Marginal rate of return (MRR)
96,132	T_4	23.408	4,787	2640	1.8
91,345	T_5	17,768	17,768	6538	1.5
81,329	T_2	11,230	18,425	11,230	1.6
62,372	T_1	-	-	-	-

Price of fertilizer (Tk. Kg^{-1}) Urea, 5.50; TSP; 9.00; MP; 7.00' Gypsum, 3.50; Zinc, 30.00; Ca0, 60.00; Mg0, 100.00; Cowdung 0.50. Price of sugarcane Tk. 1004.00 per ton; Potato Tk. 5000.00 per ton.

Maximum net benefit (for two crops) of Tk. 96,132/- ha^{-1} was obtained in T_4 which was followed by Tk. 91,345/- ha^{-1} in T_3. The marginal analysis of the undominated response data (Table 3b) indicated that the highest marginal rate of return (MRR) of 180% was obtained in T_4 followed by 150% in T_3 and 160% in T_2. Therefore, it is suggested that treatment T_4 is the economically acceptable treatment in this soil condition.

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