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Site Specific Nutrient Management for Sugarcane-potato And Sugarcane-onion in Intercropping Systems

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Abstract: Four field experiments were conducted under different Agro-ecological zones (AEZs) of Bangladesh at Ishurdi (AEZ 11), Jamalpur (AEZ 9), Rajshahi (AEZ 11) and Thakurgaon (AEZ 1) in 2001-2002 cropping season. The main aims of the studies were to determine the fertilizer requirements on productivity of cane and intercrops (potato and onion) and their economics under sugarcane based cropping systems. Cane yield was enhanced when it was intercropped with potato and onion for the residual effect of applied fertilizer to intercrops. Net economic return was greater in cane intercropped with potato and onion over sole crop for all the experiments. Intercropping potato with sugarcane using FRG'97 rates of fertilizer for cane (130 kg N, 35 kg P, 60 kg K, 20 kg S and 3 kg Zn ha^{-1}) and potato (50 kg N, 10 kg P and 20 kg K ha^{-1}) gave higher economic benefit at Ishurdi site. In Jamalpur site, sugarcane intercropped with potato following fertilizer rates based on BSRI'98 for cane (150 kg N, 42 kg P, 100 kg K, 30 kg S and 2 kg Zn ha^{-1}) and potato (50 kg N, 10 kg P and 40 kg K ha^{-1}) gave the highest net profit. But, the treatment received fertilizers as per FRG'97 showed higher economic benefit from sugarcane-onion intercropping systems both at Rajshahi and Thakurgaon sites.

Key words: Sugarcane, Potato, onion, site-specific, nutrient management

INTRODUCTION

Usually sugarcane is planted in widely spaced (1.0 m) rows in Bangladesh. Sugarcane plants have large lateral spread when fully-grown but initial rate of increase in horizontal spread is slow. Plant sugarcane canopy does not close until 3.5-5.0 months, depending mainly on variety and growing period. During this period, the inter-row space remains unoccupied and the young cane does not make much demand on growth resources, especially light and water, available in the inter-rows. Hence there is an ample scope to grow fast-growing intercrops in the vacant space between the cane rows. Sugarcane intercropping helps increasing both the yields of intercrops and cane. This is due to the complementary effects of different short duration crops and sugarcane which is an added advantage over sole cane that was reported by several workers (Imam *et al.*, 1990 and Bokhtiar *et al.*, 1995). The sugarcane crop depletes a considerable amount of nutrients from soil. As a consequence, soils are loosing its inherent ability to supply nutrients for sustainable production. Yadav *et al.* (1987) reported that the organic matter content of sugarcane soil increased due to companion cropping of pulses. The combined return of cane and potato was always higher when both the crops were planted together and received their full rates of fertilizer (Bokhtiar *et al.*, 2002). Yield potentiality and nutrient requirement of cane and intercrops under sugarcane based intercropping systems varied from place to place due to prevailing climatic conditions and edaphic factors. Hence a study has been made to determine the fertilizer requirement of sugarcane as well as intercrops potato and onion at different Agro-ecological zones (AEZs) of Bangladesh.

MATERIALS AND METHODS

Four field experiments were conducted in 2001-2002 cropping season in different AEZs at Ishurdi, Jamalpur, Rajshahi and Thakurgaon sites of Bangladesh. Experiments were laid out in randomized complete block design with four replications. The unit plot size was 8×6m. The tested varieties of sugarcane were Isd 20, Isd 28 and Isd 29. Cardinal and Taherpuri variety were used as tested material for potato and onion, respectively. All the recommended cultural management practices were followed for sugarcane and intercrops when required. Full amount of TSP, gypsum, zinc sulphate, one third of urea and MP were applied as basal in the trenches and mixed thoroughly with soil. Rest amount of urea and MP were top dressed in two equal splits at 120 day after plantation (DAP) and at 180 DAP i.e. at tiller completion stage. For intercrops, half of urea and MP, full amounts of TSP and gypsum were applied as basal doses. Remaining half of urea and MP were top-dressed after 45 DAP. Sunhemp as

green manure crop was raised and incorporated *in situ* after 40±5 days of seed sowing. The incorporated green manure contained 1.65% N. Necessary data were recorded and analyzed using the least significant differences test (LSD) at P=0.05. Sugarcane crop was harvested 13 months after planting.

The treatments deployed are as follows:

For sugarcane-potato intercropping systems

T_1 - Recommended fertilizer dose for sole sugarcane following FRG'97 for MYG

T_2 - Fertilizer dose for sole sugarcane based on soil test value for HYG

T_3 - Fertilizer dose for sole cane as per BSRI recommendation' 98 for HYG

T_4 - Fertilizer dose for sugarcane + potato following FRG'97

T_5 - Fertilizer dose for sugarcane + potato following BSRI recommendation' 98

T_6 - Fertilizer dose for sugarcane + potato following BSRI'98+ Sunhemp

For sugarcane-onion intercropping systems: This experiment also comprised of six treatments and received fertilizer similar to sugarcane-potato only the difference is intercrop, onion.

FRG'97-Fertilizer Recommendation Guide'1997; BSRI'98-Bangladesh Sugarcane Research Institute'1998; MYG-Moderate Yield Goal (80±10 t ha^{-1}): HYG- High Yield Goal (100±10 t ha^{-1})

RESULTS AND DISCUSSION

Yield attributes and yield: At Ishurdi site, significantly lowest number of tillers (200.36×10^3 ha^{-1}), millable cane stalks (129.53×10^3 ha^{-1}) and yield (90.93 t ha^{-1}) of cane were obtained from the T_1 treatment while the highest number of tillers (247.65×10^3 ha^{-1}), millable cane stalks (149.06×10^3 ha^{-1}) and yield (121.14 t ha^{-1}) were obtained from T_5 treatment combination which received BSRI' 98 fertilizer rates both for cane and potato (Table 1). Results of the study also indicated that raising of intercrops influenced cane yield significantly. Application of recommended fertilizers for cane and potato produced higher yields of 126.4, 121.14 and 118.90 t ha^{-1} in T_4, T_5 and T_6, respectively. This might be due to complementary effects of growing intercrops and residual effects of plant nutrients on sugarcane crop that ultimately enhanced more cane yield compared to sole cane.

At Jamalpur site, data on tillers, millable cane stalks and yield of potato significantly varied due to different fertilizer management practices. The increase of cane yield was 7.3 and 5.2% in T_5 and T_6 with intercrops over sole cane (T_1). The results indicate that cultivation of the intercrop with sugarcane caused no adverse effects on cane yield rather significantly increased its yield compared to sole cane. It is presumed that residual effect of applied fertilizers as well as additional cultural management for the intercrop resulted more yields. At both the locations, maximum potato yield of 6.41 and 6.38 t ha^{-1} as intercrop was found in T_6 treatment received fertilizers based on BSRI'98 at Ishurdi and Jamalpur, respectively.

At Rajshahi, the highest number of tillers of 176.87×10^3 ha^{-1} was produced in T_4 treatment followed by T_5 treatment while the lowest number of tillers (148.95×10^3 ha^{-1}) was produced in T_1 treatment. The highest number of millable cane stalks (136.81×10^3 ha^{-1}) and the highest cane yield of 114.79 t ha^{-1} were obtained from T_6 treatment that received fertilizer based on BSRI'98 followed with sunhemp (Table 2).

At Thakurgaon there was insignificant differences were observed in respect of tillers, millable cane stalks and cane yield among the treatments but an increasing trend was observed. The highest cane yield of 72.44 t ha^{-1} was found in T_4 treatment received with the fertilizer following FRG'97 which was closely followed by T_5 and T_6 treatments. For both the locations the yield increase was noticed in those treatments where, onion raised as companion crop. It is assumed that residual effect of applied fertilizers as well as additional cultural management for intercrop, i.e. beneficial association of intercropping with sugarcane, resulted to more yields. Brix per cent was significantly different among the treatments and it was the highest (18.80%) in T_6. The maximum yield of intercrop onion was obtained 7.81 in T_5 at Rajshahi and 4.42 t ha^{-1} in T_6 at Thakurgaon, respectively.

Economics of fertilizer use: The economic analyses of different fertilizer packages were done considering the total variable cost and return for all the treatments (Table 3 and 4). At different sites the highest net benefit and BCR was varied, as it was associated with the yield production as well as fertilizer requirement of the treatments. In sugarcane-potato intercropping systems at Ishurdi the highest BCR of 3.54 was obtained in T_4 treatment followed by 3.50 in T_5 treatment. At Jamalpur all though the highest BCR of 3.32 was found in T_2 treatment but the treatment T_5 gave the highest net profit with BCR 3.20. In case of sugarcane-onion intercropping systems, at Rajshahi the highest BCR of 4.14 was obtained in T_4 which was closely associated with BCR of 4.02 in T_5. At

Table 1: Yield and yield contributing parameters of sugarcane as affected by different fertilizer management packages at Ishurdi and Jamalpur sites

Location	Treatments	Tillers ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Yield of cane (t ha^{-1})	Brix (%)	Yield of potato (t ha^{-1})
Ishurdi	T_1	200.36d	129.53b	90.93e	18.37	-
	T_2	215.66c	144.11a	96.87d	18.32	-
	T_3	224.52bc	130.46b	104.61c	18.55	-
	T_4	235.77b	144.26a	126.40a	18.50	4.95b
	T_5	247.65a	149.06a	121.14b	17.75	5.88a
	T_6	235.20b	144.11a	118.90b	18.25	6.41a
	SE(±)	3.78	2.86	1.49	0.23	0.18
Jamalpur	T_1	179.80c	108.18c	96.61	17.98	-
	T_2	211.51b	116.25b	95.15	17.80	-
	T_3	230.15a	119.01b	98.21	17.89	-
	T_4	221.20ab	115.00b	103.12	18.28	5.78b
	T_5	228.65ab	130.57a	103.44	18.53	6.16ab
	T_6	236.61a	133.13a	101.95	17.88	6.38a
	SE(±)	5.85	2.11	2.88		0.13

Table 2: Yield and yield contributing parameters of sugarcane as affected by different fertilizer management packages at Rajshahi and Thakurgaon sites

Location	Treatments	Tillers ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Yield of cane (t ha^{-1})	Brix (%)	Yield of onion (t ha^{-1})
Rajshahi	T_1	148.95c	121.53	105.90	18.00	-
	T_2	165.27ab	122.57	107.64	17.17	-
	T_3	156.73bc	128.47	110.34	18.50	-
	T_4	176.87a	126.39	108.34	17.83	7.47b
	T_5	174.44a	124.83	108.33	18.17	7.81ab
	T_6	160.76b	136.81	114.79	18.17	7.19a
	SE(±)	3.73	4.71	2.39	0.43	0.11
Thakurgaon	T_1	94.32	66.40	46.15	17.03c	-
	T_2	103.17	69.73	51.64	19.01a	-
	T_3	104.32	70.63	49.49	18.46ab	-
	T_4	125.20	95.20	72.44	18.04b	3.90
	T_5	105.47	91.35	63.00	18.73ab	4.05
	T_6	116.51	76.56	59.44	18.80ab	4.42
	SE(±)	7.10	7.78	6.10	0.27	-

In a column the figures having similar letter do not differ significantly as per LSD at 5% level

Table 3: Economic analysis of different fertilizer management under sugarcane based intercropping systems at Ishurdi and Jamalpur site

		Yield (t ha^{-1})		Cost of production (t ha^{-1})					
Location	Treatments	Cane	Potato	Cane	Potato	Total variable cost (Tk ha^{-1})	Return (cane + potato)	Net profit (Tk ha^{-1})	BCR
Ishurdi	T_1	90.93	-	33,264.0	-	33,264.0	1,04,587.0	71,323.0	3.14
	T_2	96.87	-	33,411.0	-	33,411.0	1,11,438.0	78,027.0	3.33
	T_3	104.61	-	35,586.0	-	35,586.0	1,20,293.0	84,707.0	3.38
	T_4	126.40	4.95	33,264.0	13,253.0	48,517.0	1,72,060.0	1,23,543.0	3.54
	T_5	121.14	5.88	35,586.0	14,301.0	49,887.0	1,74,590.0	1,24,703.0	3.50
	T_6	118.90	6.41	36,786.0	14,301.0	51,087.0	1,75,195.0	1,24,108.0	3.42
Jamalpur	T_1	96.61	-	33,590.0	-	33,590.0	1,11,101.0	77,511.0	3.30
	T_2	95.15	-	32,949.0	-	32,949.0	1,09,422.0	76,473.0	3.32
	T_3	98.21	-	34,829.0	-	34,829.0	1,12,941.0	78,112.0	3.24
	T_4	103.12	5.78	33,590.0	13,792.0	47,382.0	1,53,268.0	1,05,886.0	3.23
	T_5	103.44	6.16	34,829.0	13,633.0	48,462.0	1,54,970.0	1,06,508.0	3.20
	T_6	101.95	6.38a	36,029.0	13,633.0	49,662.0	1,55,562.0	1,05,900.0	3.13

Table 4: Economic analysis of different fertilizer management under sugarcane based intercropping systems at Rajshahi and Thakurgaon site

		Yield (t ha^{-1})		Cost of production (t ha^{-1})					
Location	Treatments	Cane	Onion	Cane	Onion	Total variable cost (Tk ha^{-1})	Return (cane + potato)	Net profit (Tk ha^{-1})	BCR
Rajshahi	T_1	105.90	-	33,264.0	-	33,264.0	1,21,785.0	88,521.0	3.66
	T_2	107.64	-	34,040.0	-	34,040.0	1,23,786.0	89,746.0	3.63
	T_3	110.34	-	35,584.0	-	35,584.0	1,26,891.0	91,305.0	3.56
	T_4	108.34	7.47	33,264.0	14,832.0	48,096.0	1,99,340.0	1,51,244.0	4.14
	T_5	108.33	7.81	35,586.0	14,832.0	50,409.0	2,02,729.0	1,52,320.0	4.02
	T_6	114.79	7.19	36,786.0	14,832.0	51,609.0	2,03,208.0	1,51,599.0	3.94
Thakurgaon	T_1	46.15	-	36,483.0	-	36,483.0	53,072.0	16,589.0	1.45
	T_2	51.64	-	33,825.0	-	33,825.0	59,386.0	25,561.0	1.75
	T_3	49.49	-	36,674.0	-	36,674.0	56,913.0	20,239.0	1.55
	T_4	72.44	3.90	36,483.0	14,823.0	51,306.0	1,22,356.0	71,050.0	2.38
	T_5	63.00	4.05	36,674.0	14,823.0	51,497.0	1,11,950.0	60,453.0	2.17
	T_6	59.44	4.42	37,874.0	14,823.0	52,697.0	1,12,556.0	59,859.0	2.18

Fertilizer cost (Tk. kg^{-1}) ; Urea = 6.50 ; TSP =14.00 ; MP =9.50 ; Gypsum =4.00 ; Zinc sulphate = 60.00 ; MgO =40.00 ; FYM = 0.40; Sugarcane =1150 Tk t^{-1} ; Labor = Tk 70 person^{-1}day^{-1} Intercrop (Tk.kg^{-1}) ; Potato = 6.00 and Onion 10.00

Table 5: Initial and post harvest soil status under different fertilizer management at Ishurdi and Jamalpur site

Location	Treatments	pH	Organic matter (%)	Total N %	Available P (ppm)	Available K (meq%)	Available S (ppm)
Ishurdi				Initial soil			
		7.3	1.68	0.07	20.0	0.20	30.0
				Post harvest soil			
	T_1	7.5	1.45	0.065	21.0	0.19	28.0
	T_2	7.6	1.50	0.06	19.0	0.20	27.0
	T_3	7.5	1.43	0.07	19.5	0.18	28.0
	T_4	7.4	1.53	0.065	18.5	0.18	30.0
	T_5	7.4	1.50	0.065	19.0	0.19	29.0
	T_6	7.5	1.55	0.07	18.0	0.18	18.0
Jamalpur				Initial soil			
		5.5	0.78	0.07	24.0	0.17	25.0
				Post harvest soil			
	T_1	5.6	0.80	0.06	22.0	0.18	22.0
	T_2	5.5	0.75	0.06	23.0	0.09	23.0
	T_3	5.7	0.76	0.065	21.0	0.17	22.0
	T_4	5.6	0.75	0.07	22.0	0.18	24.0
	T_5	5.5	0.78	0.065	23.0	0.17	23.0
	T_6	5.5	0.80	0.07	22.0	0.18	23.0

Table 6: Initial and post harvest soil status under different fertilizer management at Rajshahi and Thakurgaon site

Location	Treatments	pH	Organic matter (%)	Total N %	Available P (ppm)	Available K (meq%)	Available S (ppm)
Rajshahi				Initial soil			
		7.2	0.78	0.06	22.0	0.18	26.0
				Post harvest soil			
	T_1	7.3	0.82	0.065	21.0	0.19	26.0
	T_2	7.2	0.80	0.06	20.0	0.20	28.0
	T_3	7.3	0.78	0.07	21.0	0.18	27.0
	T_4	7.5	0.81	0.065	22.0	0.19	26.0
	T_5	7.3	0.82	0.065	20.0	0.18	27.0
	T_6	7.3	0.83	0.07	21.0	0.19	28.0
Thakurgaon				Initial soil			
		5.4	1.70	0.07	21.0	0.14	23.0
				Post harvest soil			
	T_1	5.5	1.75	0.065	18.0	0.15	21.0
	T_2	5.5	1.73	0.07	20.0	0.16	22.0
	T_3	5.6	1.78	0.07	18.5	0.15	20.0
	T_4	5.4	1.76	0.065	19.5	0.15	20.0
	T_5	5.5	1.77	0.07	19.0	0.16	21.0
	T_6	5.6	1.78	0.075	20.0	0.15	21.0

Thakurgaon the highest BCR of 2.38 was also found in T_4 treatment that was followed by BCR of 2.18 in T_6.

Soil fertility status: The initial and post harvest soil nutrient status of soil pH, organic carbon, total N, available P, K and S for all the sites are presented in Table 5 and 6. There were considerable decreases in organic matter in soils. A little change was observed on soil pH at all sites. The changes in total N, available P, K and S were not conspicuous due to a single year practice of using different fertilizer doses in the experimental plots under study.

It is concluded that intercropping potato with sugarcane using FRG'97 rates of fertilizer for cane and potato gave higher economic benefit at Ishurdi site. Sugarcane intercropped with potato following BSRI'98 rates of fertilizer for cane and potato gave higher net profit at Jamalpur site. Application of fertilizers as per FRG'97 showed higher economic benefit from sugarcane-onion intercropping systems both at Rajshahi and Thakurgaon sites.

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