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Productivity, quality and nutrient balance in spring sugarcane (*Saccharum* spp. hybrid complex) under organic and inorganic nutrition

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ABSTRACT

An experiment was conducted during spring season of 2008-09 and 2009-10 on sandy loam soil at Pusa to assess the effect of farmyard manure and fertilizer levels on sugarcane (*Saccharum* spp. hybrid complex). The experiment was laid out in factorial randomized block design and replicated thrice with two FYM viz., 0 and 20 tonnes/ha and four fertilizer levels *viz.,* F_1, 150 + 37.1 + 49.8, RDF; F_2, 150 + 43.6 + 66.4; F_3, 200 + 43.6 + 83.0 and F_4, 200 + 54.6 + 99.6 kg N + P + K/ha. Application of 20 tonnes FYM/ha to sugarcane recorded significantly higher mean growth (tillers, 1,70,200/ha; cane height, 208.9 cm; drymatter accumulation, 33.3 t/ha), yield attributes (millable canes, 1,13, 600/ha; cane diameter, 2.18 cm) and cane yield (87.5 t/ha) over no FYM. An increase of 16.2% in cane yield, 26.31% in net return, 8.5% in benefit: cost ratio and 15.6% in sugar yield was noticed with FYM over its control. FYM @ 20 tonnes/ha registered an increase of 20.9% in N uptake, 20.3% in P uptake, 20.2% in K uptake, 10.0% in available N, 23.3% in available P and 6.4% in available K over no FYM. Net gain of N (65 kg), P (6.1 kg) and K (31 kg) were also highest in FYM added plots. Crop receiving 200 + 54.6 + 99.6 kg N + P + K/ha gave significantly higher tillers (1,83,800/ha), cane height (213.8 cm), drymatter (34.5 t/ha), cane diameter (2.22 cm) and number of millable cane (1,20,800/ha) though, it was statistically at par with 200 + 43.6 + 83.0 kg N + P + K/ha. There was an increase in cane and sugar yield with each successive increase in N + P + K level from 150 + 37.1 + 49.8 kg/ha to 200 + 43.6 + 83.0 kg/ha. Increasing N + P + K levels from F_1 to F_3 significantly increased the net returns. However, further increase to F_4 level did not proved profitable option. Fertilizer application increased the N uptake from 164 to 238 kg/ha, P uptake from 14.9 to 21.9 kg/ha and K uptake from 191.3 to 277.6 kg/ha. Significant increase in available N status was recorded with an application of 200 + 43.6 + 83.0 kg N + P + K/ha. However, available P status in post harvest soil increased significantly with each successive increase in fertilizer up to highest levels *i.e.* 200 + 54.6 + 99.6 kg N + P + K/ha. Available K status was the highest (121 kg K/ha) at 200 + 54.6 + 99.6 kg N + P + K/ha though it was on par with 200 + 43.6 + 83.0 kg N + P + K/ha. Net gain of N, P and K were progressively increased with increase in N + P + K levels from 150 + 37.1 + 49.8 to 200 + 54.6 + 99.6 kg/ha.

Key words: Farmyard manure, Inorganic fertilizers, Nutrient balance, Productivity, Profitability, Quality, Sugarcane

Sustainable sugarcane production coupled with improved quality traits needs sufficient and balanced amount of plant nutrients in soil. Imbalanced and inadequate use of nutrients results in poor cane yield, deterioration of soil health and emergence of multiple nutrient deficiencies. Nitrogen, phosphorus and potassium accounts for bulk of the essential nutrients, which many soils are deficient in, and need supplementation through inorganic and organic sources. Combined application of available organic manure along with inorganic fertilizers assures high crop productivity on sustainable basis in various cropping system (Singh and Biswas, 2000; Mohammad, 2009). The recommended dose of NPK for sugarcane in Bihar is not adequate to exploit the full yield potential of the crop due to the fact that it varies with the nutrient status, type of soil, crop variety and agro-climatic condition of the region. Higher fertilizer doses coupled with farmyard manure proved to be superior in respect to growth, yield, and soil health sustainability point of view when compared with existing recommendation. Thus to make the sugarcane cultivation more remunerative there is need to refine the NPK recommendation up to the desired level. In view of this the present study was undertaken with primary objective to optimize fertilizer needs for spring sugarcane with and without farmyard manure to enhance the productivity, profitability and quality of sugarcane under north Bihar

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condition.

MATERIALS AND METHODS

Field experiment was conducted during spring season of 2008-09 and 2009-10 at Sugarcane Research Institute, Rajendra Agricultural University, Pusa, Bihar. The farm is situated at 25°59°N latitude, 85°40'E longitude and at an altitude of 52.1 m above mean sea level. The sandy loam soil of the experimental field had 1.48 g/cc bulk density and 29.8% free $CaCO_3$, with 8.3 pH. It was low in organic carbon (0.44 %), available N (193 kg/ha), available P (6.6 kg/ha) and available K (85 kg/ha). The experiment was conducted in a factorial randomized block design with three replications. The treatments comprised two level of FYM, viz., 0 and 20 t/ha and four N + P + K levels (kg/ha) viz., F_1 (RDF, 150 + 37.1 + 49.8), F_2 (150 + 43.6 + 66.4), F_3 (200 + 43.6 + 83.0) and F_4 (200 + 54.6 + 99.6). The required quantity of FYM (0.50 + 0.14 + 0.31 % N + P + K) was applied at the time of last ploughing and mixed well in the soil as per the treatment. Urea, diammonium phosphate and muriate of potash were taken as fertilizer sources for N, P and K, respectively. FYM and fertilizers were calculated and applied as per treatment. Full dose of FYM, P and K and half dose of N were applied as basal. Remaining N was top dressed in two equal splits after the first irrigation and at the time of earthing up (early July). An early maturing variety of sugarcane 'CoP 9301' was planted on 26 and 27 February 2008 and 2009, respectively, on leveled soil by opening 15 cm deep furrow at 90 cm row spacing. During 2009-10, the experiment was conducted in the site adjacent to the experimental plot of 2008-09. The total rainfall received during the crop season was 1521 mm in 2008-09 and 914.8 mm in 2009-10. All recommended agronomic practices were followed throughout the cropping period. Crop was harvested on 7th and 8th February, 2009 and 2010, respectively. Whole cane samples were taken at the time of harvest and analyzed for quality parameters through prescribed laboratory procedures. The economics of experiment was worked out on the basis of cost of cultivation and cane yield at prevailing market prices of the treatments. The per tonne rates were ₹1,270 and 2,050 for sugarcane during 2008-09 and 2009-10, respectively.

The net returns was calculated by deducting the total cost of cultivation from the gross realization for each treatment and expressed as ₹/ha on the basis of cost of inputs and prices of outputs in experimentation year. The benefit: cost ratio (BCR) was calculated as ratio of gross realization to cost of cultivation. The concentration of N, P and K in soil and plant were analyzed using standard procedures. Total uptake by sugarcane plant was calculated by multiplying the concentration with their respective dry matter accumulation (q/ha). To work out the N, P and K balance, initial status of soil, nutrients added through farmyard manure and inorganic fertilizers, plant uptake and available soil N, P and K after sugarcane was taken in the account.Cane juice was extracted with power crusher and juice quality was estimated as per method given by Spencer and Meade (1955). Sugar yield was calculated as; sugar yield (t/ha) = [S - 0.4 (B - S) x 0.73] x cane yield (t/ha) / 100; Where S and B are sucrose and brix percent in cane juice respectively.

RESULTS AND DISCUSSION

Growth and yield attributes

Farmyard manure had positive and significant influence on growth and yield attributes of sugarcane (Table 1). Application of FYM @ 20 t/ha recorded significantly higher values of tillers and cane height and drymatter partitioning by 17.3, 11.7 and 15.6% respectively over no FYM. The improvement in growth parameters was due to beneficial effect of FYM in improving soil environment, which in turn encourages the nutrient and water holding capacity of soil for longer period which resulted in better growth of sugarcane. The results are in agreement with the findings of Patel *et al.* (2010) and Gangwar *et al.* (2003). Significant improvement in cane diameter and number of millable cane was observed under FYM added plot. This agrees with findings of Srivastava *et al.* (2008).

Fertility levels had significant impact on growth and yield attributes, viz., tillers, cane height, drymatter accumulation, cane diameter and number of millable canes (Table 1). Significantly more number of tillers at 125 DAP (pre monsoon) was obtained due to the plots receiving 200 + 54.6 + 99.6 kg/ha N + P + K, though it was on par with 200 + 43.6 + 83.0 kg/ha N + P + K. The increase in the rate of biosynthesis of various plant metabolites and physiological process in the plant system leading to increased rate of tiller formation. N + P + K level brought significant improvement in cane height.

The better nutritional environment for plant growth at active vegetative stages as a result of improvement in root growth, cell multiplication and elongation in the plant body, which ultimately increased the cane height. Shukla (2007) also reported similar results. Fertilizers levels resulted in significant improvement in drymatter accumulation upto 200 + 43.6 + 83.0 kg N + P + K/ha beyond which 200 + 54.6 + 99.6 kg N + P + K/ha there was no significant variation. 200 + 43.6 + 83.0 and 200 + 54.6 + 99.6 kg N + P + K/ha was accumulated 33.3 and 34.5 t/ha drymatter, respectively at 270 days after planting. Significantly higher cane thickness and number of millable cane with higher level of N + P + K was primarily due to the improved fertility status of soil created congenial environ-

Table 1. Effect of farmyard manure and fertilizer levels on growth, yield, quality and economics of spring sugarcane (Pooled data of two years)

Treatment	Tillers at 125DAP ($\times10^3$/ha)	Cane height (cm)	Dry matter (t/ha)	Cane diameter (cm)	Millable cane ($\times10^3$/ha)	Cane yield (t/ha)	Brix (%)	Pol %	Purity %	Sugar yield (t/ha)	Cost of cultivation ($\times10^3$₹/ha)	Net returns ($\times10^3$₹/ha)	Benefit : cost ratio
FYM (t/ha)													
0	145.1	187.1	28.8	2.04	102.0	75.3	20.69	18.36	88.96	9.6	63.51	62.41	1.99
20	170.2	208.9	33.3	2.18	113.6	87.5	20.67	18.32	89.14	11.1	67.71	78.83	2.16
SEm+	4.5	5.7	0.8	0.04	4.1	2.1	0.13	0.50	0.38	0.1	-	3.40	0.05
CD (P=0.05)	13.4	17.2	2.5	0.12	NS	6.4	NS	NS	NS	0.4	-	10.31	0.16
Fertilizer levels (kg N+P+K/ha)													
$N_{150}+P_{37.1}+K_{49.8,}$ (RDF)	126.7	174.8	26.5	1.93	96.8	69.2	20.50	18.28	89.09	8.8	64.77	50.78	1.79
$N_{150}+P_{43.6}+K_{66.4}$	150.9	194.1	29.9	2.09	105.1	78.3	20.90	18.42	89.39	10.0	65.21	65.82	2.01
$N_{200}+P_{43.6}+K_{83.0}$	177.3	209.4	33.3	2.19	118.8	87.6	20.40	18.23	89.39	11.1	65.94	80.66	2.23
$N_{200}+P_{54.6}+K_{99.6}$	183.8	213.8	34.5	2.22	120.8	90.7	20.90	18.45	88.34	11.6	66.54	85.23	2.28
SEm±	6.3	8.0	1.2	0.06	5.8	3.0	0.18	0.13	0.49	0.2	-	4.81	0.08
CD (P=0.05)	19.0	24.3	3.5	0.16	17.5	9.0	NS	NS	NS	0.5	-	14.58	0.23

RD: Recommended dose

ment for better growth and development of sugarcane plant and thus improved the cane diameter and count of millable canes. The positive response with N + P + K on millable cane count was also reported by Shukla (2007).

Yield and quality

Application of FYM @ 20 t/ha significantly increased the cane yield by 16.2% over no FYM application (Table 1). It showed that FYM had stimulatory effect on efficacy of chemical fertilizers and mitigates micronutrient deficiency besides supplying major nutrients and improving the biological and physico-chemical properties of the soil. Singh *et al.* (2007) also reported enhanced yield of cane due to organic nutrition. Application of FYM did not cause significant influence on quality constraints viz., brix, pol and purity per cent in juice, however, FYM brought significant impact on sugar yield (Table 1). The highest sugar yield of 11.1 t/ha was recorded at 20 t FYM/ha and minimum 9.6 t/ha when no FYM was applied. The higher drymatter accumulation in FYM added plots was primarily responsible for higher sugar yield. The positive effect of FYM on sugar yield has also been reported by Virdia and Patel (2010).

Fertility levels cause significant impact on cane yield (Table 1). Significantly higher cane yield was obtained with each successive increase in N + P + K level up to 200 + 43.6 + 83.0 kg/ha. The increase in cane yield by 200 + 54.6 + 99.6, 200 + 43.6 + 83.0 and 150 + 43.6 + 66.4 kg N + P + K/ha over 150 + 37.1 + 49.8 kg N + P + K/ha was 31.1, 26.6 and 13.2% respectively. Vashishtha and Sinha (2000) reported increase in cane yield with corresponding increase in levels of fertilizer.

Fertility level did not cause significant variation in brix, pol and purity % juice. The results are in accordance with the findings of Singh *et al.* (2008). The effect of N + P + K fertilization on sugar yield was significant, though 200 + 43.6 + 83.0 and 200 + 54.6 + 99.6 kg N + P + K/ha were statistically on par, significantly superior to 150 + 37.1 + 49.8 and 150 + 43.6 + 66.4 kg N + P + K/ha. The percentage increase in sugar yield by 200 + 54.6 + 99.6, 200 + 43.6 + 83.0 and 150 + 43.6 + 66.4 kg N + P + K/ha over 150 + 37.1 + 49.8 kg N + P + K/ha was 31.8, 26.1 and 13.6% respectively.

Economics

Application of FYM @ 20 t/ha significantly increased the net return and benefit: cost ratio (Table 1). The increase in net return and benefit: cost ratio due to FYM over control was 26.3 and 8.5% respectively. This was due to less cost incurred on FYM application and significant difference in cane yield was observed.

There was marked improvement in net return with each successive increase in fertilizer level from 150 + 37.1 + 49.8 kg N + P + K/ha (RDF) to 200 + 43.6 + 83.0 kg N + P + K/ha (Table 1). The mean increase in net return by 200 + 54.6 + 99.6, 200 + 43.6 + 83.0 and 150 + 43.6 + 66.4 kg/ha over 150 + 37.1 + 49.8 kg/ha (RDF) was 67.8, 58.8 and 29.6 % respectively. However, crop did not significantly responded beyond 200 + 43.6 + 83.0 kg N + P + K/ ha. The rate of increase of net return was very less by application of 200 + 54.6 + 99.6 kg N + P + K/ha, indicating the non-responsiveness for higher doses. The highest benefit: cost ratio (2.28) was noticed with the application of 200 + 54.6 + 99.6 kg N + P + K/ha though, it was on par with 200 + 43.6 + 83.0 kg N + P + K/ha (2.23).

Nutrient uptake

Nitrogen, phosphorus and potassium uptake was significantly influenced by the application of FYM (Table 2, 3 and 4). A dose of 20 t FYM/ha recorded significantly higher N (226 kg/ha), P (20.7 kg/ha) and K uptake (263.4 kg/ha) over no FYM. This resulted in an increase in uptake of 39 kg N, 3.5 kg P and 44.3 kg K/ha over no FYM. The increase in nutrient uptake with FYM was due to increased availability of nutrients to the plants. It also improved the soil environment, which encouraged proliferous root system resulting in better absorption of moisture and nutrients and thus resulting in higher biomass production. Earlier reports also confirmed the significant increase in N, P and K uptake of sugarcane due to organic manure application (Srivastava *et al.* 2008). Application of fertilizer up to 200 + 43.6 + 83.0 kg N + P + K/ ha significantly increased the N and P uptake, being on par with that of 200 + 54.6 + 99.6 kg N + P + K/ha (Table 2 and 3). However, K uptake was increased with each successive increase in fertility level (Table 4). Application of 150 + 43.6 + 66.4, 200 + 43.6 + 83.0 and 200 + 54.6 + 99.6 kg N + P + K/ha respectively increased the N uptake by 20, 38 and 45%, P uptake by 22, 40 and 47% and K uptake by 20, 39 and 45% over 150 + 37.1 + 49.8 kg N + P + K/ha. It was due to the fact that added nutrients increased the N, P and K concentration in sugarcane, by providing balanced nutritional environment inside the plant and higher photosynthetic efficiency, which favoured higher dry matter accumulation, resulted in more uptakes of N, P and K by sugarcane. Muralidharudu and Tandon (2010) also noticed that application of optimum N + P + K fertilizer resulted in 111, 173 and 51 % increase in N, P and K uptake respectively as compared to unfertilized plot.

Post harvest N status and N balance

The highest post harvest N status of 258 kg/ha was obtained at 20 t FYM/ha (Table 2). The temporary biological immobilization and continuous mineralization of FYM on surface layer of soil was responsible for higher post harvest N availability. Choudhary and Sinha (2001) have reported improvement in N status of soil by organic manure application. The net gain over initial N status was also higher in FYM added plots, which recorded 65 kg higher N/ha than that of pre planting soil N status (193 kg/ ha). The corresponding improvement due to FYM was 59% over no FYM (Table 2). The gain in availability of N in soil due to application of FYM was due to addition of N through FYM in addition to native N of soil. Patel *et al.* (2010) opined that even under organic cultivation of sugarcane, available nutrient (N and P) status can be sustained.

Table 2. Balance sheet of N as influenced by FYM and fertilizer level in spring sugarcane (Pooled data of two years)

Treatment	Initial soil N status (kg/ha) (A)	Added N through organic and inorganic (kg/ha) (B)	N-uptake (kg/ha) (C)	Expected balance in soil {(A+B)-C} (D)	Available soil N after harvest (kg/ha) (E)	Apparent gain (E-D) or loss (D-E) (F)	Net gain (E-A) or loss (A-E) (G)
FYM (t/ha)							
0	193	175	187	181	234	53	41
20	193	275	226	242	258	16	65
SEm ±	-	-	3	-	3	-	-
CD (P=0.05)	-	-	9	-	10	-	-
Fertilizer level (kg N + P + K/ha)							
$N_{150}+P_{37.1}+K_{49.8}$	193	200	164	229	209	-20	16
$N_{150}+P_{43.6}+K_{66.4}$	193	200	196	197	241	44	48
$N_{200}+P_{43.6}+K_{83.0}$	193	250	227	216	263	47	70
$N_{200}+P_{54.6}+K_{99.6}$	193	250	238	205	270	65	77
SEm±	-	-	4	-	5	-	-
CD (P=0.05)	-	-	12	-	14	-	-

Available N status in post harvest soil increased significantly with successive rise in N + P + K levels up to 200 + 43.6 + 83.0 kg/ha (Table 2). The percentage increase in final N status of soil by 200 + 54.6 + 99.6, 200 + 43.6 + 83.0 and 150 + 43.6 + 66.4 kg N + P + K/ha over 150 + 37.1 + 49.8 kg N + P + K/ha was 29, 26 and 15%, respectively. With increase in the level of N + P + K fertilizers also assured the availability of these nutrients to the sugarcane in adequate amount and remained in soil in considerable amount after fulfilling the sugarcane needs that ultimately improved the post harvest N fertility of soil. A net gain of 77 kg N/ha was recorded under 200 + 54.6 + 99.6 kg N + P + K/ha that was only 9 % higher than 200 + 43.6 + 83.0 kg N + P + K/ha. Later was 338% higher than 150 + 37.1 + 49.8 kg (RDF) N + P + K/ha (Table 2).

Post harvest P status and P balance

Appreciable variation in post harvest P availability was observed with the application of FYM (Table 3). FYM @ 20 t/ha increased post harvest P status of soil by 23% over no FYM. This was owing to the improvement of soil health due to application of FYM which increased availability of native phosphorus. Moreover, the capacity of FYM to form a cover of sesquioxide which reduces the phosphate fixation leading to higher availability in post harvest soil. The highest gain of 6.1 kg P/ha was observed with application of 20 t FYM/ha (Table 3). Incorporation of FYM reduced the fixation of water soluble P and increased the mineralization of organic P due to microbial action leading to higher gain of P in FYM added plots.

The post harvest available P content of the soil indicated a significant and progressive increase with corresponding increase in levels of fertilizers (Table 3). The highest available P of 13.6 kg/ha was recorded at 200 + 54.6 + 99.6 kg N + P + K/ha and minimum 8.2 kg/ha when 150 + 37.1 + 49.8 kg N + P + K/ha was applied. It was due to addition of adequate amount of P through higher level of fertilizers, besides supplying proportionate amount to sugarcane, considerable amount of unutilized P left in the soil. The net gain over initial P status was slightly higher (Table 3), indicating balanced amount of nutrients is essential for soil health sustainability.

Post harvest K status and K balance

FYM had significant impact on post harvest K content in soil (Table 4). The highest values of post harvest K of 116 kg/ha was recorded at 20 t FYM/ha and minimum of 109 kg K/ha under no FYM. This may be due to some release of K from reserve pool of soil by the FYM. The expected K balance in soil was highly negative and maximum negative values (-59.4 kg) was recorded under no FYM application, indicating K mining. However, net gain of K showed positive trend and maximum gain of 31 kg K/ha was recorded under FYM added plot (Table 4).

The K availability in post harvest soil increased progressively up to the highest level of fertilizer application (Table 4). Maximum K status in post harvest soil was observed under 200 + 54.6 + 99.6 kg N + P + K/ha which was on par with 200 + 43.6 + 83.0 kg N + P + K/ha. The K status of soil after harvest observed higher over initial values including lower levels of N + P + K but expected balance had negative values in all the treatments. This results showed that K uptake exceeded the initial and added amount of K leaving a negative expected K balance of - 62 kg (Table 4). The depletion of nutrient reserves from the soil is often a hidden form of land degradation. However, net gain was positive in all the treatments and maximum values of 36 kg/ha was recorded under 200 + 54.6 + 99.6

Table 3. Balance sheet of P as influenced by FYM and fertilizer level in spring sugarcane (Pooled data of two years)

Treatment	Initial soil P status (kg/ha) (A)	Added P through organic and inorganic (kg/ha) (B)	P-uptake (kg/ha) (C)	Expected balance in soil {(A+B)-C} (D)	Available soil P after harvest (kg/ha) (E)	Apparent gain (E-D) or loss (D-E) (F)	Net gain (E-A) or loss (A-E) (G)
FYM (t/ha)							
0	6.6	44.7	17.2	34.1	10.3	-23.8	3.7
20	6.6	71.7	20.7	57.6	12.7	-44.9	6.1
SEm±	-	-	0.3	-	0.2	-	-
CD (P=0.05)	-	-	1.0	-	0.5	-	-
Fertilizer level (kg N + P + K/ha)							
$N_{150}+P_{37.1}+K_{49.8}$	6.6	50.6	14.9	42.3	8.2	-34.1	1.6
$N_{150}+P_{43.6}+K_{66.4}$	6.6	57.1	18.1	45.6	11.3	-34.3	4.7
$N_{200}+P_{43.6}+K_{83.0}$	6.6	57.1	20.8	42.9	12.8	-30.1	6.2
$N_{200}+P_{54.6}+K_{99.6}$	6.6	68.1	21.9	52.8	13.6	-39.2	7.0
SEm±	-	-	0.4	-	0.2	-	-
CD (P=0.05)	-	-	1.4	-	0.6	-	-

Table 4. Balance sheet of K as influenced by FYM and fertilizer level in spring sugarcane (Pooled data of two years)

Treatment	Initial soil K status (kg/ha) (A)	Added K through organic and inorganic (kg/ha) (B)	K-uptake (kg/ha) (C)	Expected balance in soil {(A+B) -C} (D)	Available soil K after harvest (kg/ha) (E)	Apparent gain (E-D) or loss (D-E) (F)	Net gain (E-A) or loss (A-E) (G)
FYM (t/ha)							
0	85	74.7	219.1	-59.4	109	168.4	24
20	85	136.7	263.4	-41.7	116	157.7	31
SEm±	-	-	2.5	-	1	-	-
CD (P=0.05)	-	-	7.7	-	3	-	-
Fertilizer level (kg N + P + K/ha)							
$N_{150}+P_{37.1}+K_{49.8}$	85	80.8	191.3	-25.5	99	124.5	14
$N_{150}+P_{43.6}+K_{66.4}$	85	97.4	230.5	-48.1	112	160.1	27
$N_{200}+P_{43.6}+K_{83.0}$	85	114.0	265.5	-66.5	118	184.5	33
$N_{200}+P_{54.6}+K_{99.6}$	85	130.6	277.6	-62.0	121	183.0	36
SEm±	-	-	3.6	-	1	-	-
CD (P=0.05)	-	-	10.9	-	4	-	-

kg N + P + K/ha. The magnitude of increase in net gain was maximum under higher level of fertilizers. It must be assumed that either K was released from the reserves held in the clay inter layer, or some other form of K (presumable non-exchangeable K) has been taken up by sugarcane.

From the two years investigation it is concluded that none of the interactions turned out to be significant, even though application of 200 + 43.6 + 83.0 kg N + P + K/ha along with 20 tonnes FYM/ha is promising over existing recommendation for exploiting higher productivity and profitability as well as for maintaining soil fertility under north Bihar condition.

REFERENCES

Choudhary, C.N. and Sinha, U.P. 2001. Dry matter production, sugar yield and nitrogen sulphur recovery by sugarcane (*Saccharum officinarum*) as influenced by concentrated organic manure, nitrogen and sulphur fertilization. *Indian Journal of Agricultural Sciences* **71**(1): 31–34.

Gangwar, K.S., Sharma, S.K. and Tomar, O.K. 2003. Integrated nutrient management in late planted sugarcane-wheat system in western Uttar Pradesh. *Indian Journal of Agronomy* **48**(1): 20–22.

Mohammad, S. 2009. Modern concepts of agricultural research : Ripples and options for conservation agriculture and resource use efficiency. *Indian Journal of Agronomy* **54**(2): 149–58.

Muralidharudu, Y. and Tandon, H.L.S. 2010. Impact of fertilizers on the yield and nutrient uptake of diverse crops. *Indian Journal of Fertilizers* **6**(3): 13–36.

Patel, V.S., Raj, V.C. and Patel, D.D. 2010. Effect of different sources and levels of organics on sugarcane. *Indian Journal of Agronomy* **55**(2): 152–56.

Shukla, S.K. 2007. Productivity and economics of high sugar genotypes of sugarcane in plant-ratoon system under various planting seasons and fertility levels. *Indian Journal of Agronomy* **52**(2): 164–67.

Singh, G.B. and Biswas, B.P. 2000. Balanced and integrated nutrient management for sustainable crop production. Limitations and future strategies. *Fertilizer News* **45**(5): 55–60.

Singh, H., Navnit Kumar and Singh, V.P. 2008. Response of sugarcane varieties to fertility levels under rainfed condition. *Rajendra Agricultural University Journal of Research* **18**(1–2): 34–36.

Singh, K.P., Srivastava, T.K., Singh, P.N. and Suman, A. 2007. Enhancing soil fertility, microbial activity and sugarcane productivity through organics in subtropical system. *Indian Journal of Agricultural Sciences* **77**(2): 84–87.

Srivastava, T.K., Singh, K.P., Lal, M., Suman, A. and Kumar, P. 2008. Productivity and profitability of sugarcane (*Saccharum* spp. hybrid complex) in relation to organic nutrition under different cropping systems. *Indian Journal of Agronomy* **53**(4): 310–13.

Spencer, G.L. and Meade, G.P. 1955. *Sugarcane Hand Book*, John Wiley and Sons, London.

Vashishtha, R.P. and Sinha, U.P. 2000. Effect of nutrient levels on germination, vigour, yield and economics of sugarcane seed crop. *Indian Journal of Sugarcane Technology* **15**(2): 39–41.

Virdia, H.M. and Patel, C.L. 2010. Integrated nutrient management for sugarcane (*Saccharum* spp. hybrid complex) plant- ratoon system. *Indian Journal of Agronomy* **55**(2): 147–51.