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EFFECT OF SPENT WASH AND CHEMICAL FERTILIZER ON YIELD AND NUTRIENT UPTAKE BY SUGARCANE

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ABSTRACT

A field experiment was conducted during 2007 to 2009 at Kashipur (Uttarakhand) to study the effect of spent wash and chemical fertilizer on cane yield, sugar yield and uptake of nutrients by sugarcane (Saccharum officinarum L.). Integrated use of inorganic (NPK) + effluent (100% RD NPK, 75% NPK + 25% effluent, 50% NPK + 50% effluent and 25% NPK + 75% effluent) were tested against inorganic fertilizer (NPK) laid out in randomized block design with five replications. Results revealed that the supply of nutrients to sugarcane plant through combined use of 25% NPK + 75% effluent gave the highest mean cane yield of 818 q ha^{-1}. This treatment also showed significant improvement in sugar yield (9.75 q ha^{-1}) over 100% NPK alone. The uptake of N, P, K, Ca, Mg ans S increased significantly with combined use of NPK fertilizers and effluent and maximum values were recorded with 25% NPK + 75% effluent. A significant increase in uptake of Fe, Mn, Cu, Zn and Mo in sugarcane was recorded when 25% NPK and 75% effluent were applied together compared to 100% NPK alone.

Key words: Chemical fertilizer, spent wash, yield, sugarcane, nutrient uptake

INTRODUCTION

Sugarcane, an important agro – industrial crop in the country, plays a pivotal role in national economy by contributing 1.9% to gross domestic product. However, plateauing yield level, declining factor productivity, increasing production cost, slashing sugar prices in international market and decreasing profitability in recent years indeed pose the real concerns before cane growers and mill owners. Distillery effluent is a valuable source of plant nutrients especially N, K, organic substrates and micronutrients essential for plant growth (Chhonkar *et al*. 2000). The direct use of effluent in agriculture needs adequate consideration, otherwise the existing practice of discharging effluent into water bodies may continue to pollute them. Hence, the present investigation was undertaken to study the effect of spent wash and chemical fertilizer on cane yield, sugar yield and uptake of nutrients by sugarcane (*Saccharum officinarum* L.)

MATERIALS AND METHODS

Field experiments were conducted during 2007 to 2009 at India Glycol Limited, Kashipur (Uttarakhand). The soil was sandy loam in texture having pH (1:2.5) 7.8, electrical conductivity 0.35 dS m^{-1}, organic carbon 5.5 g kg^{-1}, alkaline $KMnO_4$ extractable N 280 kg ha^{-1}, Olsen's P 17 kg ha^{-1} and 1 N ammonium acetate extractable K 380 kg ha^{-1}, S 16 kg ha^{-1}. DTPA Fe 2.4, Zn 0.58, Cu 0.18, and Mn 1.8 mg kg^{-1} .The treatments were 100% RDF, 75% RDF+25% spent wash, 50% RDF+50% spent wash and 25% RDF+75% spent wash. The experiment was laid out in a randomized block design with 5 replications. The seed before planting was treated with Emison 0.3% solution. 'CoS 767' sugarcane (1 25 000 eyebuds/ha) was sown in first week of January and crop was harvested in the last week of December during each year. Phosphorus and K was applied at cane planting as basal. Nitrogen was applied in 3 equal splits 60, 120 and 180 days after sowing. Nitrogen, P and K were applied through urea, single superphosphate and muriate of potash, respectively. Spent wash contained nitrogen, phosphorus, potassium, calcium, magnesium, sulphate, iron, zinc, copper, manganese and molybdenum 877, 157, 5840, 1235, 750, 810, 6.4, 1.2, 0.85, 5.8 and 0.25 mg/liter, respectively. The N, P and K were applied in the form of urea, single super phosphate, muriate of potash, respectively. As per treatment , 25% spent wash were applied one month before planting of sugarcane, remaining spent wash was given in three equal splits at the time of first, third and fifth irrigation. Leaf and stalk samples were collected and analyzed for major, secondary and micronutrients as per standard methods (Jackson, 1973). Sugar yield at harvesting stage was calculated as per the procedure of (Verma and Singh 1994).

RESULTS AND DISCUSSION

Millable cane and sugar yield

The millable cane and sugar yield was significantly influenced by different doses of effluent and chemical fertilizer (Table 1). Increasing dose of effluent and decreasing dose of chemical fertilizer increased the millable cane yield and sugar yield.

Highest millable cane (818 q ha^{-1}) and sugar yield (9.75 q ha^{-1}) was recorded under 25% NPK + 75% effluent treatment. However, lowest was observed under 100% NPK alone in all the years. Higher content of nutrients in plant tissues due to NPK fertilizers and effluent enabled the plant to maintain high rate of metabolic and physiological activities, increase the sink size and utilize the photosynthate at a faster rate, which laid down the foundation of higher yield. It is well established fact that the increase in cane yield, the sugar yield will increase. The significant response of the crop in terms of cane yield and sugar yield to chemical fertilizer and spent wash was due to low nutrient status of the soil and higher population of millable cane. Similar positive and significant response of sugarcane crop to nutrients has been reported by Rath *et al.* (2010) and Tyagi *et al.* (2011).

Table 1: Effect of spent wash and chemical fertilizers on yield of millable cane and sugar yield (q ha^{-1})

Treatments	2007 –08	2008 –09	2009 –10	Mean
Millable cane yield (q ha^{-1})				
100% RDF	625	676	652	651
75% RDF+25% effluent	686	722	702	703
50% RDF+50% effluent	746	780	765	764
25% RDF+75% effluent	802	835	818	818
CD (P=0.05)	59	53	55	56
Sugar yield (q ha^{-1})				
100% RDF	7.25	7.93	7.67	7.62
75% RDF+25% effluent	7.98	8.49	8.32	8.26
50% RDF+50% effluent	8.83	9.25	9.19	9.09
25% RDF+75% effluent	9.56	9.89	9.79	9.75
CD (P=0.05)	0.77	0.65	0.71	0.71

Uptake of nutrients

Total uptake of N, P and K in sugarcane crop was significantly influenced by different doses of effluent and NPK fertilizer (Table 2). Increasing dose of effluent and decreasing dose of NPK fertilizer at 100% NPK, 75% NPK + 25% effluent, 50% NPK + 50% effluent and 25% NPK + 75% effluent increases the uptake of nitrogen (88 – 130 kg ha^{-1}), phosphorus (30 – 59 kg ha^{-1}) and potassium (106 – 150 kg ha^{-1}) by sugarcane. Highest uptake of N, P and K (130, 59 and 150 kg ha^{-1}) was recorded under 25% NPK + 75% effluent treatment. However, lowest was observed under 100% NPK fertlizer. The higher uptake may be due to increased yield and nutrient content. These results are in accordance with the findings of Kavitha *et al.* (2008) and Rath *et al.* (2010).

Table 2: Effect of spent wash and chemical fertilizers on uptake of primary and secondary nutrients (kg ha^{-1}) by sugarcane

Treatments	N	P	K	Ca	Mg	S
100% RDF	88	37	106	47	26	18
75% RDF+25% effluent	104	43	125	51	30	20
50% RDF+50% effluent	120	51	140	54	33	22
25% RDF+75% effluent	130	59	150	58	35	24
CD (P=0.05)	14.2	7.1	14.6	3.7	3.0	2.0

Uptake of secondary nutrients (Ca, Mg and S) by sugarcane crop was significantly influenced by different doses of effluent and NPK fertilizer (Table 2). Application of 25% NPK + 75% effluent increased the uptake of Ca, Mg and S by crop from 47 – 58, 26 – 35 and 18 – 24 kg ha^{-1}, .respectively. Highest uptake of Ca, Mg and S by crop was recorded under 25% NPK fertilizer + 75% effluent treatment. The addition of Ca, Mg and S through effluents in soil increased the availability of Ca, Mg and S in soil ultimately reflected the uptake of these nutrients. The results corroborate to the findings of Chandraju *et al.* (2010). Total uptake of micro–nutrients (Fe, Zn, Cu, Mn and Mo) by sugarcane crop was significantly influenced by different doses of effluent and NPK fertilizer (Table 3). The uptake of Fe (413 – 656 g ha^{-1}), Zn (51 – 59 g ha^{-1}), Cu (21 - 35 g ha^{-1}), Mn (56 – 96 g ha^{-1}) and Mo (17 – 25 g ha^{-1}) increased significantly with increasing doses of effluent and lower doses of NPK fertilizers.. Highest Fe, Zn, Cu, Mn and Mo uptake by crop was recorded under 25% NPK fertilizer + 75% effluent treatment. However, lowest was observed under 100% NPK fertilizer treatment. This may be due to the presence of good amount of Fe, Zn, Cu, Mn and Mo in effluent which ultimately increased the uptake of Fe, Zn, Cu, Mn and Mo in sugarcane crop. The results corroborate the findings of Chandraju *et al.* (2010) and Das and Kumar (2009).

Table 3: Effect of spent wash and chemical fertilizers on uptake of Fe, Zn, Cu, Mn and Mo (g ha^{-1}) by sugarcane

Treatments	Fe	Zn	Cu	Mn	Mo
100% RDF	413	51	21	56	17
75% RDF+25% effluent	487	63	26	69	20
50% RDF+50% effluent	584	75	30	83	22
25% RDF+75% effluent	656	89	35	96	25
CD (P=0.05)	81	12.6	4.6	13.3	2.4

The results of experiment showed that the highest cane yield, sugar yield and nutrient uptake were recorded at 25% NPK fertilizer + 75% effluent.

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