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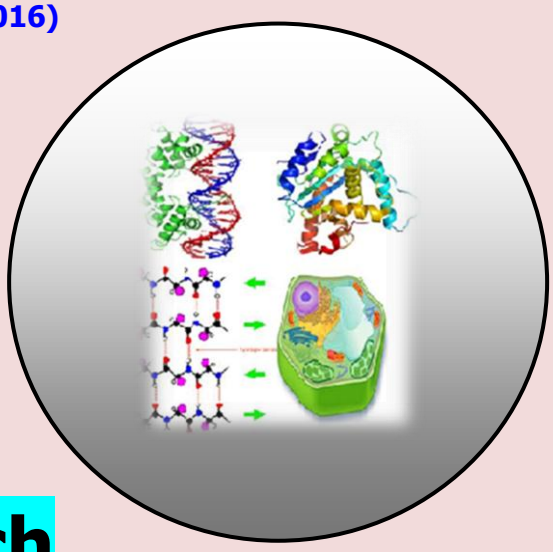

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RESEARCH PAPER

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Effects of Secondary and Micronutrients on cane weight leaf nutrient and biochemical contents in Sugarcane (*Saccharum officinarum* L.) Cultivars

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ABSTRACT

This experiment was conducted during 2008-2009 and repeated in 2014-2015 to study the impact of leaf applied secondary and micronutrient as 1% solution of zinc sulphate, magnesium sulphate, potassium nitrate, potassium sulphate, potassium metasilicate and 0.2% aqueous spray of boric acid applied at post-monsoon (180 DAP) stage of selected (five early CoS 95255, CoS 96268, CoSe 98231, CoS 8436, CoSe 01235, and late CoS 94257, CoS 767, CoS 97261, CoS 97264, CoS 99259) sugarcane varieties on cane weight, leaf nitrogen, phosphorus and potassium content, α amylase activity and reducing sugar percentages at harvest to study the impact. The results are averages of 2 trials.

The first five early sugarcane varieties (early COS 95255, CoS 96268, CoSe 98231, CoS 8436, CoSe 01235) matured one month before and therefore harvested one month earlier than the rest of varieties. It was observed that application of 1% aqueous spray of potassium sulphate (T_5) at 180 DAP significantly produced highest (48.07 % more) cane yield as compare to control sprayed with distilled water only. However the impact of this treatment was statistically equal to foliar feeding of same concentration of potassium nitrate (T_4) and sodium metasilicate (T_6) in sugarcane crop. This Increase in cane yield was directly associated with the cane weight and increased uptake of leaf nitrogen, phosphorus and potassium content. Sugarcane variety CoS 94257 (V_6) produced highest cane yield 57.22 % more than lowest yielder, followed by CoS 97261 (V_8) and CoS 97264 (V_9) due to positive association with cane weight and leaf nitrogen, phosphorus and potassium content.

As far as interaction effect were concerned best interaction was noted in potassium sulphate (T_5) X CoS 94257 (V_6), potassium nitrate (T_4) X CoS 94257 (V_6) boric acid (T_3) x CoS 94257 (V_6) followed by zinc sulphate (T_1) x CoS 97264 (V_9). These combinations were best due to superiority in cane weight and leaf nitrogen, phosphorus and potassium content at harvest.
Keywords: Secondary and micronutrient, Leaf Nutrient (NPK) Content, Leaf Amylase and reducing Sugar and Sugarcane.

INTRODUCTION

Foliar feeding of crops has assumed great importance these days because of the cheap availability of highly soluble agro-chemicals, efficient machinery for spraying' quick response of applied nutrients and relatively far less requirement of the fertilizer per unit area of land in comparison to that of soil feeding. In addition, it does not add to the cost of crop production as these are mixed with the pesticides sprayed routinely for proper crop husbandry. The basic fact that nutrients are absorbed not only through the roots but also through the foliage has been known for long but progress of work on foliar feeding has remained restricted to plants threatened with deficiency diseases. Ever since the discovery of radio-isotopes' which have made possible the accurate measurement of uptake transport and metabolism of the applied nutrients by the roots from the soil and those absorbed by the leaves from nutrients sprays, however, much headway has been made in this direction. Burr et. al. (1956) has claimed that high percentage of required nutrients can be supplied to the plant by foliage sprays, and these may be absorbed several times more efficiently than conventional soil application (Srivastava et al., 1999 and Ravindra Babu and Bhopal Rao, 2004). Keeping in view the aims and objectives, five early and five late maturing (five early CoS 95255, CoS 96268, CoSe 98231, CoS 8436, CoSe 01235, and late CoS 94257, CoS 767, CoS 97261, CoS 97264, CoS 99259) sugarcane varieties were selected to observe the impact of secondary and micronutrients sprays 1% solution of zinc sulphate, magnesium sulphate, potassium nitrate, potassium sulphate, potassium metasilicate and 0.2% aqueous spray of boric acid applied at post-monsoon (180 DAP) stage on cane weight, leaf nitrogen, phosphorus and potassium content, biochemical contents in sugarcane (*Saccharum officinarum* L) cultivars.

MATERIAL AND METHODS

This experiment was conducted during 2008-09 (spring planting) at Agricultural farm of G.F. College, Shahjahanpur, U. P., India and repeated in 2014-2015. The results are averages of both the trials. The soil was sandy lome pH 7.20, EC 0.62, Organic carbon 0.3, calcium carbonate nill and WHC 47.00. The aim of the experiment was to find out of 1% foliarly applied aqueous solution of secondary and micronutrients (zinc sulphate, magnesium sulphate potassium nitrate, potassium sulphate, and potassium metasilicate) and 0.2% aqueous boric acid spray at post-monsoon 180 DAP) stage as compound to foliarly applied distilled water (control) in ten sugarcane varieties (five early CoS 95255, CoS 96268, CoSe 98231, CoS 8436, CoSe 01235, and late CoS 94257, CoS 767, CoS 97261, CoS 97264, CoS 99259) on cane weight as well as leaf NPK content, leaf α amylase and reducing sugar content at harvest. The experiment was based on a factorial randomized design.

Secondary and micronutrients selected for the treatments were supplied in the form of 1% concentration of the solution separately but it was 0.2% in the case of boric acid at post monsoon (180 DAP) stage. The whole plants were completely manually sprayed with the respective agro-chemical aqueous solution by a hand sprayer during evening to avoid foliar drift (wind problem).

A uniform basal dose of 150 kg N, 60 kg P and 80 kg Wha was applied to each pot (taking into account 1 hectare contain = 2 million kg soil) before sowing. Nitrogen was given in (1/ 3 + 1/3 + 1/3) split dose as top dressing, monocalcium single superphosphate and muriate of potash were used as perspective sources.

The single budded setts were used with three sets in each pot at the time of planting. Single plant was maintained in each pot after three leaf stage. Each treatment was replicated thrice. Six experimental pots were maintained in each replicate. Weeding was done when required during the course of growth of plants. Agronomical practices were employed according to crop needs. The nitrogen was estimated according to (Lindner, 1944), phosphorus content by Fiske and Subba Row, 1925 and potassium flame photometrically. The amylase activity was carried out according to Paleg, 1960 and reducing sugar was estimated by Nelson 1944.

RESULTS AND DISCUSSION

This experiment was conducted during 2008-2009 and repeated in 2014-2015 to study the impact of leaf applied secondary and micronutrient as 1% solution of zinc sulphate, magnesium sulphate, potassium nitrate, potassium sulphate, potassium metasilicate and 0.2% aqueous spray of boric acid applied at post-monsoon (180 DAP) stage of selected (five early CoS 95255, CoS 96268, CoSe 98231, CoS 8436, CoSe 01235, and late CoS 94257, CoS 767, CoS 97261, CoS 97264, CoS 99259) sugarcane varieties on cane weight, leaf nitrogen, phosphorus and potassium content, α amylase activity and reducing sugar percentages at harvest to study the impact. The results are averages of 2 trials.

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Sugarcane variety CoS 94257 (V_6) produced highest cane yield 57.22 % more than lowest yielder, followed by CoS 97261 (V_8) and CoS 97264 (V_9) due to positive association with cane weight and leaf nitrogen, phosphorus and potassium content.

As far as interaction effect were concerned best interaction was noted in potassium sulphate (T_5) X CoS 94257 (V_6), potassium nitrate (T_4) X CoS 94257 (V_6) boric acid (T_3) x CoS 94257 (V_6) followed by zinc sulphate (T_1) x CoS 97264 (V_9). These combinations were best due to superiority in cane weight and leaf nitrogen, phosphorus and potassium content at harvest.

The increased cane production to the tune of 37 percent (table 1) due to potassium sulphate spray which mitigated the drought during hot summer.

Table 1. Effect of secondary and micronutrients on cane weight (gm) at harvest in sugarcane (*Saccharum officinarum* L.) cultivars.
(Mean of two trials).

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	685.00	890.00	990.00	990.00	880.00	835.00	665.00	847.86
CoS 96268 (V_2)	570.00	690.00	570.00	835.00	940.00	580.00	490.00	667.86
CoSe 98231 (V_3)	970.00	870.00	830.00	835.00	880.00	830.00	480.00	813.57
CoS 8436 (V_4)	880.00	885.00	880.00	980.00	970.00	980.00	580.00	879.29
CoSe 01235 (V_5)	860.00	790.00	740.00	1070.00	980.00	895.00	650.00	855.00
CoS 94257 (V_6)	1050.00	890.00	985.00	1310.00	755.00	1610.00	572.00	1024.57
CoS 767 (V_7)	735.00	730.00	920.00	895.00	780.00	910.00	790.00	822.86
CoS 97261 (V_8)	1055.00	1010.00	1011.00	1410.00	1155.00	1195.00	901.00	1105.29
CoS 97264 (V_9)	1299.00	899.00	1355.00	999.00	995.00	1350.00	680.00	1082.43
CoS 99259 (V_{10})	850.00	730.00	910.00	1215.00	1125.00	1310.00	575.00	959.29
Mean	895.40	838.40	919.10	1053.90	946.00	1.49.50	638.30	
			C.D. at 5%			F-value		
Treatment			15.92			*		
Varieties			19.03			*		
Treatment X Varieties			50.36			*		

*** = Significant**

It is evident that potash increases succulence and helps to retain more moisture in cane crop. It indirectly reduces transpiration losses. As a result more number of canes survived in these spraying treatments (Jayabal et. al. 1991). The indication of beneficial effect of late application of K most affected by foliar spray has also been reported by Ali et al. (1986).

According to Laxshmikantham (1973) who reported that initially K was absorbed at a very rapid rate but stopped shortly in the middle of the growth period. The loss of K in the aerial portion at this stage was due to its back mobility to soil. Thus, if at the growth stage K is applied it may augment the growth of the crop. The beneficial effect of K was noted by Rama Rao and Sekhon (1985) also in bajra as it regulated transpiration by increased stomatal resistance and sustaining of growth and development.

Table 2. Effect of secondary and micronutrients on leaf nitrogen content (%) at harvest in sugarcane (*Saccharum officinarum* L.) cultivars.
(Mean of two trials)

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	1.46	1.42	1.40	1.48	1.48	1.45	1.40	1.44
CoS 96268 (V_2)	1.40	1.44	1.46	1.46	1.48	1.44	1.38	1.44
CoSe 98231 (V_3)	1.46	1.45	1.42	1.42	1.40	1.46	1.42	1.43
CoS 8436 (V_4)	1.49	1.45	1.42	1.42	1.49	1.48	1.46	1.46
CoSe 01235 (V_5)	1.53	1.50	1.52	1.52	1.52	1.50	1.48	1.51
CoS 94257 (V_6)	1.46	1.48	1.46	1.46	1.48	1.45	1.44	1.46
CoS 767 (V_7)	1.49	1.52	1.58	1.58	1.55	1.52	1.48	1.53
CoS 97261 (V_8)	1.57	1.56	1.52	1.52	1.52	1.50	1.46	1.52
CoS 97264 (V_9)	1.52	1.50	1.49	1.49	1.48	1.44	1.38	1.47
CoS 99259 (V_{10})	1.56	1.54	1.56	1.56	1.58	1.54	1.48	1.55
Mean	1.49	1.49	1.48	1.49	1.50	1.48	1.44	
			C.D. at 5%			F-value		
Treatment			0.044			*		
Varieties			0.053			*		
Treatment X Varieties			0.142			*		

*** = Significant, NS = Non Significant**

Chandra, (2005) while working on sugarcane at Buralikson (Assam) observed the response of muriate of potash and potassium nitrate sprays (I % and 2 %) on foliage at 120 and 150 days after stubbles emergence. Muriate of potash and potassium nitrate (2 %) proved beneficial in exploiting the yield potential of sugarcane (table 1). However, Singh and Shrinath, (1974) failed to show any additional beneficial effects on sugarcane yield and juice quality by foliar application of potash and phosphorus over nitrogen.

Table 3. Effect of secondary and micronutrients on leaf phosphorus content (%) at harvest in sugarcane (*Saccharum officinarum* L.) cultivars.
(Mean of two trials)

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	0.130	0.134	0.140	0.138	0.136	0.130	0.126	0.133
CoS 96268 (V_2)	0.132	0.133	0.130	0.132	0.138	0.132	0.128	0.132
CoSe 98231 (V_3)	0.138	0.138	0.138	0.140	0.138	0.136	0.128	0.137
CoS 8436 (V_4)	0.138	0.138	0.140	0.140	0.136	0.134	0.130	0.137
CoSe 01235 (V_5)	0.136	0.140	0.144	0.149	0.142	0.14	0.133	0.141
CoS 94257 (V_6)	0.140	0.144	0.142	0.146	0.144	0.142	0.130	0.141
CoS 767 (V_7)	0.134	0.134	0.136	0.136	0.136	0.136	0.134	0.135
CoS 97261 (V_8)	0.140	0.144	0.146	0.148	0.144	0.148	0.132	0.143
CoS 97264 (V_9)	0.149	0.144	0.146	0.148	0.148	0.144	0.130	0.144
CoS 99259 (V_{10})	0.146	0.144	0.146	0.144	0.144	0.138	0.130	0.142
Mean	0.138	0.139	0.141	0.142	0.141	0.138	0.130	
			C.D. at 5%			F-value		
Treatment			0.0040			*		
Varieties			0.0047			*		
Treatment X Varieties			0.0127			NS		

*** = Significant, NS = Non Significant**

Similarly, according to Ali et. al. (1996) growth and development of crop plants is dependent on the amount of nutrients absorbed and utilized in tissue development. The higher leaf nutrients (NPK) Concentration due to agro-chemicals (secondary and micro nutrients tables 2-4) is well understandable as leaf nutrients are closely related with cane Yield (Perumal 1996). The increase in cane weight is associated with foliar application of nutrients was found to be related by a stimulation of the roots of nutrition in the aerial organs (Perumal, 1996).

Table 4. Effect of secondary and micronutrients on leaf potassium content (%) at harvest in sugarcane (*Saccharum officinarum* L.) cultivars.
(Mean of two trials)

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	2.00	2.04	2.00	2.12	2.10	2.05	1.92	2.03
CoS 96268 (V_2)	1.98	2.00	2.10	2.00	1.98	1.99	1.86	1.99
CoSe 98231 (V_3)	1.98	2.00	2.10	2.05	1.98	1.98	1.90	2.00
CoS 8436 (V_4)	1.90	1.90	1.92	1.90	1.89	1.98	1.90	1.91
CoSe 01235 (V_5)	1.82	1.80	1.88	1.86	1.84	1.96	1.88	1.86
CoS 94257 (V_6)	2.24	2.26	2.34	2.32	2.22	2.16	2.10	2.23
CoS 767 (V_7)	2.20	2.20	2.22	2.28	2.26	2.22	2.14	2.22
CoS 97261 (V_8)	2.22	2.26	2.24	2.26	2.24	2.20	2.10	2.22
CoS 97264 (V_9)	2.40	2.26	2.20	2.32	2.32	2.20	2.12	2.26
CoS 99259 (V_{10})	2.22	2.20	2.20	2.18	2.16	2.22	2.00	2.17
Mean	2.10	2.09	2.12	2.13	2.10	2.10	1.99	
			C.D. at 5%			F-value		
Treatment			0.084			*		
Varieties			0.100			*		
Treatment X Varieties			0.265			NS		

*** = Significant, NS = Non Significant**

Foliar biochemical components variations may be regarded as imitation of the concentration levels present in the stem tissues hence, the leaf biochemical analyses for various components included their status at different growth stage and their associations with growth would be highly valuable. The decreased α amylase activity in the best treatments (T_6) (table 5) and high leaf reducing sugar % (table 6) clearly indicates beneficial effect of potassium metasslicate (Shukla, 2010).

Table 5. Effect of secondary and micronutrients on leaf α amylase activity at harvest in sugarcane (*Saccharum officinarum* L.) cultivars (mg/h/mg protein). (Mean of two trials)

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	14.35	14.10	14.80	14.60	14.80	14.30	15.30	14.60
CoS 96268 (V_2)	15.20	15.40	16.40	15.40	16.30	15.20	17.20	15.87
CoSe 98231 (V_3)	16.20	16.10	16.90	17.80	16.90	16.80	18.50	17.03
CoS 8436 (V_4)	11.50	11.30	11.40	10.30	11.40	12.10	14.90	11.84
CoSe 01235 (V_5)	11.20	11.10	12.10	14.80	14.50	13.20	16.70	13.37
CoS 94257 (V_6)	18.70	18.50	18.90	19.00	19.20	18.10	18.30	18.67
CoS 767 (V_7)	19.40	18.90	19.20	19.70	19.40	19.40	19.30	19.33
CoS 97261 (V_8)	18.70	18.70	18.90	19.10	19.20	18.90	18.70	18.89
CoS 97264 (V_9)	24.10	20.10	22.30	21.40	20.30	19.30	18.50	20.86
CoS 99259 (V_{10})	17.40	17.80	17.70	18.10	18.20	17.40	17.20	17.69
Mean	16.67	16.20	16.86	17.02	17.02	16.47	17.46	
			C.D. at 5%			F-value		
Treatment			0.85			*		
Varieties			1.02			*		
Treatment X Varieties			2.70			*		

*** = Significant, NS = Non Significant**

Table 6. Effect of secondary and micronutrients on leaf reducing sugar (%)at harvest in sugarcane (*Saccharum officinarum* L.) cultivars.
(Mean of two trials)

Varieties	secondary and micronutrients sprays at 180 DAP							
	Zinc Sulphate (T_1)	Magnesium sulphate (T_2)	Boric acid (T_3)	Potassium nitrate (T_4)	Potassium sulphate (T_5)	Sodium metasilicate (T_6)	Distilled water control (T_7)	Mean
CoS 95255 (V_1)	0.125	0.095	0.270	0.040	0.125	0.090	0.075	0.117
CoS 96268 (V_2)	0.125	0.095	0.047	0.082	0.0190	0.060	0.015	0.088
CoSe 98231 (V_3)	0.040	0.150	0.125	0.142	0.011	0.090	0.045	0.086
CoS 8436 (V_4)	0.040	0.030	0.055	0.025	0.065	0.030	0.040	0.041
CoSe 01235 (V_5)	0.090	0.090	0.122	0.050	0.010	0.040	0.020	0.060
CoS 94257 (V_6)	0.095	0.080	0.040	0.055	0.045	0.040	0.060	0.059
CoS 767 (V_7)	0.080	0.060	0.090	0.120	0.175	0.085	0.045	0.094
CoS 97261 (V_8)	0.300	0.030	0.040	0.040	0.010	0.050	0.110	0.083
CoS 97264 (V_9)	0.080	0.070	0.040	0.030	0.065	0.040	0.035	0.051
CoS 99259 (V_{10})	0.145	0.120	0.060	0.070	0.100	0.080	0.050	0.089
Mean	0.112	0.082	0.089	0.065	0.080	0.061	0.050	
			C.D. at 5%			F-value		
Treatment			0.0052			*		
Varieties			0.0062			*		
Treatment X Varieties			0.0164			*		

*** = Significant, NS**

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