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Estimation of nutrient ratios in sugarcane leaf to assess the productivity of sugarcane in Visakhapatnam district of Andhra Pradesh, India

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Abstract
A survey was conducted in major sugarcane growing mandals of Visakhapatnam district and collected soil, plant samples along with the data on sugarcane yield during formative to grand growth stage of the crop. The leaf samples were analysed for all macro, secondary and micronutrients content and nutrient ratios were developed. The leaf samples analysed were classified into two categories viz., low yielding (less than 70 t ha^{-1}) and high yielding (more than 70 t ha^{-1}). Computation of nutrient ratios for sugarcane at its formative to grand growth stage implied that the mean N/P, N/K, K/P and K/N ratios 9.65, 1.21,0.78 and 7.20 respectively in the third leaf of sugarcane in the high yielding zone resulted in maximum cane yields compared to relatively higher ratios in the leaves from low sugarcane yielding zones (N/P, N/K, K/P and K/N ratios 11.02,1.25,0.85 and 9.16 respectively) which indicates that low nutrient concentrations in low yielding zone resulting in low productivity of sugarcane.

Keywords: sugarcane, nutrient rations, nitrogen, phosphorus and potassium

Introduction
Sugarcane crop is an important crop in Visakhapatnam district. Being a long duration crop and deep root system, soil test based fertilizer recommendations may not serve well for maximizing the yields. Hence, foliar analysis is usually considered to be an important tool to monitor the nutrient status of plants. Plant nutrition revealed that nutrient ratios as a better tool for diagnosing the nutrient deficiencies of crops as it takes care of nutrient interrelationships. Further, leaf analysis is widely used as an effective nutrient management technique along with interpretation of soil test results for sustainable sugarcane production McCray and Mylavarapu (2010) [4]. It is the correct method for identification of not only single plant nutrient deficiency but also concentration of particular nutrient in relation to other nutrients. Helpful in correcting the multiple nutrient deficiencies. If leaf samples are collected from farmers and analyzing for nutrients using developed DRIS indices, yield limiting nutrients from that particular fields can be identified. Therefore, the objective of this study was planned to analyze the nutrient in leaves during formative to grand growth stage in the varying yield zones of sugarcane and computation of desirable leaf nutrient ratios. Hence, the present study was undertaken to take up an assessment of leaf nutrient ratios in the low and high cane yielding zones of the district to diagnose the nutrient ratio status in leaves and also aimed in finding out that high yielding zones that resulted in maximum cane yields compared to the nutrient rations of leaves of low cane yielding zones of the Visakhapatnam district of Andhra Pradesh, India.

Materials and Methods
Study area
Visakhapatnam district is one of the North Eastern coastal districts of Andhra Pradesh and it lies between 17º – 15' and 18º – 32' Northern latitude and 18º – 54' and 83º – 30' in Eastern longitude which comprises the major sugarcane growing areas. The survey was carried out in Seven mandals namely Munagapaka, Devarapalli, Chodavaram, Payakaraopeta, Yellamanchili, Rambilli and Ravikamatham representing all the major sugarcane growing soils of the district. A total of 82 leaf samples were collected and analysed as three replications. The analysed leaf nutrient content was divided into three categories viz., low yielding (<70 t/ ha), and high yielding (> 70 t/ ha) of Visakhapatnam district during the formative to grand growth stage of the crop. Leaf sheath was used for analysis of nitrogen and the leaf samples were analysed for other macro, secondary and micro nutrients.

The collected leaf samples were washed with tap water followed by 0.1 N HCl and distilled water. These samples were dried under shade and kept in hot air oven at 60 ^{0}C. On complete drying they were ground and preserved in paper covers with proper labeling. They were analyzed for primary and secondary nutrients. Dry weights were recorded before grinding.

Nitrogen in plant sample was determined by micro kjeldahl method. Other macro, secondary and micro nutrients were analysed in acid digested extract. Phosphorus content was determined by vanadomolebdo-phosphoric acid yellow color complex method as described by Jackson (1973) [3]. An aliquot of 10 ml was taken, 10 ml of vanado-molebdate yellow reagent was added and volume was made up to 50 ml. After half hour color intensity was measured by Spectrophotometer. Potassium (K) was measured by the flame photometer (Piper 1944) [7]. The total sulphur content of the plant sample was analyzed in the diacid extract of H_2SO_4: $HClO_4$ prepared in the ratio of 9:4 by turbidimetric method Jackson (1973) [3]. Calcium (Ca), Magnesium (Mg), Copper (Cu), iron (Fe), Manganese (Mn) and Zinc (Zn) were measured by atomic absorption spectrophotometer (Cottenie *et al.*, 1979) [1].

Statistical analysis

The analytical data on plant nutrient concentrations were processed with statistical parameters viz., mean and Co - efficient of variation (C.V.) by following the methods suggested by Gomez and Gomez (1984) [2].

Results and Discussion

Leaf nutrient ratios

The mean N/P, N/K, K/P and K/N ratios 9.65, 1.21,0.78 and 7.20 respectively in the third leaf of sugarcane in the high yielding zone resulted in maximum cane yields compared to relatively higher ratios in the leaves from low yielding zones (N/P, N/K, K/P and K/N ratios 11.02,1.25,0.85 and 9.16 respectively) (Table 1).

Where the nutrient ratio (N/P) of cane was high (11.02) in low yielding zones. From the analysis it was found that higher N and P uptake resulting in an N/P ratio of 9.65 when compared to that of 11.02 in the low yielding zone. Interactions between N and P in terms of yields are made in the high yielding zone, included that N induced increased root growth, enhanced root ability to absorb and translocate P and increases in P solubility as a result of decreasing soil pH which accompanies NH_4^+ absorption.

The mean Nitrogen- Potassium ratios (N/K) during the grand growth period of sugarcane was 1.21 and 1.25 in high and low yielding zones respectively (Table 1). The average N/K ratio in high yielding zone was considerably lower than that of low yielding zones. A high yielding sugarcane crop requires large amounts of these nutrients, and interactions of economic significance often accompany the correction of imbalances of N and K in sugarcane production (Miles, 2010) [5]. The favorable soil quality parameters of the high yielding zone, assessed in the study was optimum pH, non-saline nature, higher clay content and cation exchange capacity, moderate amounts of organic matter and enhanced availability of N, P, K, S and micronutrients have contributed to higher uptake of K through better biophysical environ-ment in the rhizosphere contributing to maximum concentration of nutrients in leaves.

The mean Potassium-Nitrogen (K/N) ratio in the low and high yielding zones during the grand growth period of sugarcane was 9.16 and 7.2 respectively. Muhammed sarwal *et al.* (2010) [6] reported the depletion of organic matter under continuous cane cultivation without sufficient addition of organic resources to the soil periodically results in higher K/N ratio in low cane yielding zone. Also non application of recommended doses of potassium to sugarcane crop in Visakhapatnam district resulted in higher K/N and K/P ratios in low yielding zones of sugarcane.

Table 1: Summary statistics for mango yield and leaf nutrient concentration data for low yielding (n=22) and high- yielding subpopulations (n=60) in the variable cane yielding zones of Visakhapatnam district of Andhra Pradesh

Parameters	High yielding sub-population					Low yielding sub-population				
	Mean	Med	Max	Min	Skew	Mean	Med	Max	Min	Skew
Yield (t/ha)	58.59	66.5	50	58.59	-0.14754	87.96	112	70	87.5	0.104332
Nutrients										
N	1.43	1.8	1.06	1.44	-0.06891	1.36	1.75	0.66	1.36	-0.41851
P	0.15	0.24	0.08	0.15	0.277403	0.15	0.25	0.06	0.15	0.232641
K	1.19	1.76	0.65	1.14	0.576568	1.03	1.67	0.6	1.02	0.904762
Ca	0.27	0.33	0.24	0.27	1.007436	0.28	0.35	0.22	0.27	0.565969
Mg	0.17	0.24	0.13	0.17	1.081301	0.18	0.25	0.13	0.17	0.934177
S	0.21	0.27	0.18	0.2	1.098131	0.21	0.25	0.15	0.2	-0.12616
Zn	41.78	81.33	15.58	41.77	0.623079	38.77	81.5	17.75	33.02	1.277903
Cu	7.57	18.7	4.0	6.6	1.808232	7.26	20.1	3.4	6.55	2.337563
Fe	428.89	609.11	158.4	428.89	-0.21484	432.15	617.18	191.3	418.8	-0.00047
Mn	118.13	300.5	17.8	118.13	0.633285	71.87	234	14.3	39.35	1.199638

Table 2: Computation average of N/P, N/K, K/Nand K/P ratios in the variable cane yielding zones of Visakhapatnam district of Andhra Pradesh

Nutrient ratios	High yielding population			Low yielding population		
	CV	Variance	Mean	CV	Variance	Mean
N/P	11.82	12.22091	9.65	19.85	18.94	11.02
N/K	20.25	20.94	1.21	12.94	19.24	1.25
K/N	16.36	16.76	0.78	14.26	23.14	0.85
K/P	4.914909	5.081516	7.20	14.19	13.54168	9.16

Conclusion

A total of 82 samples in three replications analyzed for nutrient ratios in the low and high yielding zones during the formative to grand growth period of sugarcane. Interactions between N and P in terms of yields in high yielding zones are primarily due to N induced increases in P absorption by the

plant. This reflects in high yielding zones where the average yield levels were maximum to 120 t ha^{-1} compared to the low yielding zones. A high yielding sugarcane crop requires large amounts N and K for cane production. In the low cane yielding zone, the crops were with deficient N concentrations and accordingly the other nutrient concentrations were below the critical level indicating the necessity for adequate supply of available N for enhancing the uptake of other nutrients by the sugarcane crop. Therefore, compared to low yielding zones the maintenance of high quality in sugarcane soils might influence crop nutrient uptake with optimum nutrient ratios and results in improved quality and high yield of sugarcane.

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