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PREDICTION OF IRON CHLOROSIS IN SUGARCANE FROM PLANT ANALYSIS

G. RAMANATHAN, N. NAGASUNDARAM, D AUGUSTINE SELVASEELAN, and A. BHASKAR

The technique of plant analysis, as a means of predicting Fe chlorosis in sugarcane crop has been investigated. The study revealed that in the early stages of crop growth, (less than 1 month), differentiation can be made on the basis of metabolically active Fe^{++} which declined sharply in chlorotic leaves as compared to normal leaves. At later stages, (after 5 months of crop growth), widening of P/Fe ratio predicted chlorosis better. Still later from 5 to 7 months, there was imbalance of Fe/Mn, revealing chlorosis. Decline in Mn content at 7 to 10 months of crop growth was also indicative of chlorotic condition.

Iron chlorosis is a typical deficiency symptom appearing in a number of crop plants such as sugarcane,sorghum some of the grass species, jasmine, crossandra etc. particularly when grown in soils rich in free $CaCO_3$. Yield reduction over 30 per cent is reported in many crops on account of Fe chlorosis. In sugarcane, the sympton distinctly manifests it self more in ratoon crop than in plant crop. Plant tissue analysis provides a perspective diagnostic criterion for better prediction of Fe deficiency as it is a reflection of the summation of chemical transformations taking place in the soil and is the net result of soil-water-plant interaction. Soil data suffer a set-back, as critical limits fixed to delineate deficiency areas are applicable only to one set of conditions and may not have universal application or atleast to wide ranging situation. It is in this context, that plant analysis assumes special significance. Investigations have been undertaken to explore the possibilities and to provide suitable plant indices for better prediction of iron chlorosis in sugarcane and the results are presented in this paper

MATERIALS AND METHODS

Normal and chlorotic leaf samples totalling ninety four were collected in different areas. The plant samples were drawn from canes of different age groups; only the third to sixth leaves were uniformly collected. To arrive at more precise conclusion the samples were divided into different age groups. However, leaf samples were collected from different varieties, CO 419, CO 443 and CO 6304 but the number of samples under each variety for both normal and chlorotic leves, were maintained to be equal. The leaf samples were washed with O.IN HCl and powdered after drying.

Department of Soil science Agril. Chemistry, TNAU Coimbatore.

Table 1 Metabolically active Fe2+ (MFe) Total Fe (TFe) and the ratio MFe/TFe in 3rd-6th leaves in various age grous of sugarcane crop (Chlorotic & Normal) (Mean values)

Age group	MFe		TFe		MFe/TFe	
	Chlorotic	Normal	Chlorotic	Normal	Chlorotic	Normal
1 month	27.9	92.7	250	199	0.13	0.26
3 months	92.8	102.9	346	302	0.28	0.37
3-5 months	55.4	62.1	208	154	0.32	0.41
5-7 months	84.3	89.0	110	109	0.78	0.84
7-10 months	35.3	61.5	98	119	0.44	0.45

The midrib portions of the leaves were emoved after washing with O.INHCl The undried fresh leaf samples were used for estimating the metabolically active Fe^{2+} (Katyal and Sharma, 1980). In dried and powderd samples, total Fe, P, K, Mn, Zn and Cu were estimated following the conventional procedures. The total population under each age group was divided into normal and chlorotic plants and their means were compared by using 'F test.

RESULTS AND DISCUSSION

The results presented in table 1 show a distinct trend of changes in respect of metabolically active Fe^{2+}, especially in the younger age groups. The samples collected one month before were able to differentiate chlorotic leaves from the normal leaves. While the normal leaf contained a mean value of 42 7 ppm. the chlorotic leaf contained only 27.9 ppm. the difference being statistically significant. In all other age groups too, there was a definite trend of increase in metabolically active Fe^{2+} in normal leaf over chlorotic leaf, though the differences failed to attain statistical significance. Thus the metabolically active Fe^{2+} serves as a true index in differentiating chlorotic leaf from the normal leaf and the sampling of leaves from plants less than one month old can be recommended for such distinct differentiation. A decline in values of metabolically active Fe^{2+} can also be ascribed as one of the factors causing chlorosis in sugarcane Naik (1984) indicated how physiologically inactive forms of Fe lowered the activites of associated enzymes such as carboxylase and peroxidase Further, the data showed that there was not much of such distinct differences in respect of total Fe. In fact, in some of the age groups, there was even reduction in total Fe content in normal eaves as compared to chlorotic leaves. Hence, total Fe content has no relationship with either the chlorotic condition or the normal condition and

Table 2 Total P, P/Fe, Total K and K/Fe in 3rd to 6th leaves in various age groups of sugarcane crop (Chlorotic and Normal) (Mean values)

Age group	P%		P/Fe		K%		K/Fe	
	Chlorotic	Normal	Chlorotic	Normal	Chlorotic	Normal	Chlorotic	Normal
1 month	0.211	0.233	16.2	20.2	1.953	1.605	117	165
1-3 months	0.372	0.422	21 3	27.6	1.350	1,505	63	79
3-5 months	0.161	0.082	18.5	10.9	2 672	1.747	203	190
5-7 months	0.467	0.376	81.6	63.8	1.865	1.878	258	252
7-10 months	0.205	0.151	39.4	25.9	1.081	1.070	168	153

only the metabolically active fraction of the total Fe assumes greater significance. This was further corroborated by a significant difference in the ratio values of metabolically active Fe^{2+} to total Fe in samples of one month age group. The normal leaves showed a higher ratio (0.26) than chlorotic leaves (0.13).

But as the plant advanced in age, the values of metabolically active Fe^{2+} failed to show significant difference between normal and chlorotic leaves and this may be due to other factor such as nutrient inbalances and interaction.

As regards total P (Table 2) only the age group of 5-7 months showed any significant difference between chlorotic and normal leaves. Here the normal leaves contained less P (0.36%) than chlorotic leaves (0.467%) In the initial stages of crop growth, the chlorotic leaves contained numerically less amounts of P than the normal but in the later stages after five months of crop growth, the trend was reversed. The P/Fe ratio on equimolecular basis could help prediction of chlorotic condition only after five months and not before. The ratio widened in chlorotic leaves, thus indicating as excess of P over Fe in chlorotic leaves. Thus the imbalance of P and Fe, expecially after 5 months of crop growth can be recognized as yet another cause of chlorosis in sugarcane.

The data of Mn content (Table 3) did not follow a set trend as in the case of other nutrients, such as metabolically active Fe^{2+} and total P. However within each age group there was discoverable difference. For instance upto 3 months of the age, Mn content could not predict chlorosis but in age group of 5 - 7 months, the normal leaves contained less Mn (15.3ppm) than the chlorotic leaves (26.4 ppm). But the trend reversed after 7 months, when the normal leaves contained more of Mn (90.2 ppm) than the chlorotic leaves (65.8 ppm).

Table 3 Total Mn, Fe/Mn, total Zn, Fe/Zn, total Cu and Fe/Cu in 3rd to 6th leaves in various age groups of sugarcane crops (Chlorotic and Normal)

Age group	Mn (ppm)		Fe/Mn		Zn (ppm)		Fe/Zn		Cu (ppm)		Fe/Cu	
	Chlo-rotic	Normal	Chlo-rotic	Normal	Chlo-rotic	Normal	Chlo-rotic	Normal	Chlo-rotic	Normal	Chlo-rotic	Normal
1 month	36.9	37.1	6.78	6.36	33.9	32.7	8.6	7.1	5.42	6.67	49.3	34.7
1-3 months	17.0	27.1	21 9	11.35	37.5	37.0	12.0	9.6	6.00	6.50	68.8	55.3
3-5 months	37.5	36.8	5.58	4.21	37.5	42.0	7.6	4.6	6.04	5.21	42.6	33.9
5-7 months	26.4	15.3	4.54	7 92	—	—	—	—	—	—	—	—
7-10 months	65.8	90.2	1.81	1.49	18.5	20.0	6.3	7.1	12.43	10 10	10.7	15.1

Working out Fe / Mn ratio, the trend of changes gave a clear picture over the different age groups. The ratio values widened upto 3 months, indicating a relative accumulation of Fe over Mn. After 3 months, there was a steep downward decline in the ratio values, implying a relatively higher accumulation of Mn over Fe. But in the age groups of 5-7 months, the ratio was higher for normal leaves (7.92) than the chlorotic leaves (4.54). In the later stage (7-10 months), there was however not a distinct difference in ratio values between chlorotic and normal leaves though there was perceptible decline in Mn content. Thus Fe / Mn imbalance in the age groups of 5-7 months could be said to have caused chlorosis, as decrease in Mn content at the later stages could also have been a possible factor causing chlorosis in sugarcane.

In respect of other nutrients such as K, Zn and Cu, neither their contents nor their ratios showed district trend of changes and they could not serve as a reliable guide for predicting chlorosis.

The study therefore brought out that in the early stages of crop growth of less than 1 Month, sharp decline in metabolically active Fe^{2+} content differentiated chlorotic from normal leaves. At later stages, upto 5 months widening of the ratio of P/Fe predicted chlorosis better. The imbalance of nutients, Fe and Mn as shown by the ratio values of Fe/Mn in the age groups of 5 - 7 months and decrease in Mn content at later stages, (7-10 months), could also be considered as possible factors causing chlorosis.

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