



Diurnal variations in the mineral composition of coconut leaves

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Foliar analysis is by far the most reliable method for determining the nutrient status of the perennial crops. It has proved to be an excellent tool for diagnosing the deficiencies and excesses of various nutrient elements. The reliability of the results of tissue analysis depends on sampling of representative index tissues at proper stage and time, as its value depends on the knowledge of the change in chemical composition of leaves with respect to season, position, time of sampling and crop intensity (Bould, 1966). The literature of changes in the leaf mineral content over the course of the day is few and a particular time of leaf sampling is not standardized for coconut. Keeping this fact in view, the present study was carried out to estimate the diurnal variations in the leaf mineral content and to find out a suitable time for leaf sampling in coconut, variety "Sakhigopal Local" under coastal littoral sandy soils of Orissa.

Twenty-five palms of uniform age and receiving uniform general recommended package of practices of Sakhigopal Local (Tall) coconut in the Coconut Research Station, Govt. of Orissa, Konark, a potential coconut growing area of Orissa, were selected for this study. The palms were in the age group of 35-40 years and spaced at 8 m x 8 m. The soil of the experimental field is typically littoral sand containing approximately 90% sand. The chemical analysis of the soil revealed that the soil was very low in organic matter and nitrogen content, high in phosphorus and medium in potash content.

In order to define the diurnal variation on leaf nutrient content, the 14th leaf starting from the first fully opened mature leaf (Chapman, 1964) was chosen for the study. The leaf samples were taken at 2 hourly intervals starting from 0700 hours till 1700 hours. The sample was analyzed following the procedure described by Lim *et al.* (1999) and Korikanthimath *et al.* (2003) with befitting statistical procedure of mean, range, coefficient of

variations and CRD design (Panse and Sukhatme, 1989). The leaf samples were collected from the leaf rank of the coconut by cutting 4-5 leaflets from the middle of the frond on both the sides (Chapman, 1964). The collected materials were wiped out with moist tissue to remove any residual soil or dust and then oven dried at 65°C for 72 hours and powdered and subjected to analysis. Care was taken to exclude damaged, insect-ridden, or diseased leaflets, and dead tissue while collecting the samples. Leaf nitrogen content was estimated by Kjeldahl method (Singh *et al.*, 1999), P by colorimetric method (Jackson, 1973), K by Flame Photometry method (Jackson, 1973), Ca and Mg by Versenate Titration method (Jackson, 1973), S by following the procedure described by Chesnin and Yein (1950), and the micronutrients (Fe, Mn, Cu and Zn) were determined by the procedure described by Lindsay and Norvell (1978). The N, P, K, Ca, Mg and S content was expressed as percentage and the micronutrient content was expressed in ppm.

Variations in N, P and K content

The data on the diurnal variation in N, P and K content have been analyzed and presented in Table 1 and illustrated in Figure 1.

The mean nitrogen content varied from 1.411 per cent in the afternoon (1300 hours) to 1.544 per cent during morning (0700 hours). There was no significant difference between the nitrogen content when estimated at 0900, 1100, 1300 and 1700 hrs. The coefficient of variation during different hours ranged between 8.19 and 8.62 per cent at 1100 and 1700 hours, respectively. The lowest coefficient of variation (8.19 %) was recorded at 1100 hrs. The mean phosphorus content ranged between 0.116 to 0.130 per cent during 1300 hours and 0700 hours of the day. The coefficient of variation was lowest (7.10 per cent) at 0700 hours. The stability (0.124 %) as observed from the Figure 1 was obtained between 0900

and 1100 hours for the leaf phosphorus content. The phosphorus content analysed at 0900, 1100 and 1500 hrs has remained at par. The potassium content in the index leaf varied from 1.052 per cent at 1500 hours to 1.163 per cent at 1700 hours. The lowest coefficient of variation (12.04 per cent) was observed at 0700 hours. It was also observed that there was no significant difference between the potassium content of the index leaf when analysed at different hours of the day. It was evident from the study that there were fluctuations in the levels of macronutrients in coconut leaf at different hours of a day. The phosphorus content was relatively higher in the morning while potassium content was higher in the evening. Similar trend for phosphorus and potassium was also reported by Scheidecker and Prevot (1954) in oil palm.

per cent (0700 hours). The magnesium content of the index leaf during 0900, 1100 and 1700 hrs has remained at par. The coefficient of variation varied from 11.64 per cent at 1100 hours to 15.32 per cent at 1700 hours. During 0900-1100hrs magnesium content remained stable (0.259-0.257 %) as observed from the Figure 1.

There was little diurnal variation in the sulphur content of the leaves (Table 2), which varied from 0.122 per cent (0700 hours) to 0.131 per cent (1500 hours). Stability in case of mean sulphur content (0.125 per cent) was observed between 0900 and 1100 hours of the day. The lowest coefficient of variation (12.02 per cent) was also obtained at 1100 hours of the day.

The calcium and sulphur content of the index leaf did not show any significant difference when analysed at different hours of the day.

Table 1. Macronutrient content (%) at different hours of a day in the index leaf of coconut palm

Time (hrs)	Nitrogen			Phosphorus			Potassium		
	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)
0700	1.36-1.78	1.544	8.58	0.115-0.146	0.130	7.10	0.85-1.32	1.091	12.04
0900	1.32-1.68	1.466	8.20	0.110-0.150	0.124	10.11	0.82-1.35	1.132	13.46
1100	1.28-1.66	1.430	8.19	0.110-0.150	0.124	10.13	0.80-1.34	1.113	13.70
1300	1.24-1.61	1.411	8.25	0.100-0.140	0.116	10.90	0.82-1.40	1.149	14.24
1500	1.30-1.72	1.487	8.44	0.100-0.145	0.126	7.82	0.78-1.28	1.052	13.36
1700	1.28-1.70	1.450	8.62	0.100-0.140	0.118	9.51	0.84-1.38	1.163	12.99
Se.D		0.0348			0.0032			
C.D. (0.05)		0.069			0.0064			NS	

Table 2. Secondary nutrient content (%) at different hours of a day in the index leaf of coconut palm

Time (hrs)	Calcium			Magnesium			Sulphur		
	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)
0700	0.30-0.61	0.397	21.10	0.25-0.37	0.283	12.72	0.094-0.150	0.122	12.78
0900	0.27-0.58	0.368	21.68	0.21-0.33	0.259	11.66	0.098-0.153	0.125	12.26
1100	0.29-0.60	0.393	20.28	0.21-0.33	0.257	11.64	0.100-0.152	0.125	12.02
1300	0.27-0.58	0.373	20.54	0.20-0.30	0.238	12.13	0.098-0.153	0.124	12.63
1500	0.22-0.57	0.344	25.00	0.20-0.31	0.244	11.70	0.105-0.159	0.131	12.07
1700	0.21-0.61	0.360	25.44	0.20-0.35	0.266	15.32	0.100-0.155	0.125	12.54
Se.D		—			0.0093			—	
C.D. (0.05)		NS			0.018			NS	

Variation in Ca, Mg and S content

The Ca, Mg and S contents of the index leaf of coconut palm are presented in Table 2. The mean calcium content varied from 0.344 per cent at 1500 hours to 0.397 per cent at 0700 hours. The coefficient of variation for different hours has exceeded 20 per cent but the lowest coefficient of variation (20.28 %) was found at 1100 hours. The mean magnesium content in the index leaf ranged between 0.238 per cent (1300 hours) and 0.283

Variation in the micronutrient contents

The micronutrient (Fe, Mn, Cu and Zn) contents estimated during different hours of the day in the index leaf of the palms have been summarized and presented in Table 3 and illustrated in Figure 1.

The mean iron content in the leaves varied from 286.6 ppm at 0700 hours to 314.3 ppm at 1700 hours. The coefficient of variation with respect to the iron content in the palms ranged between 18.12 and 20.00 per cent at

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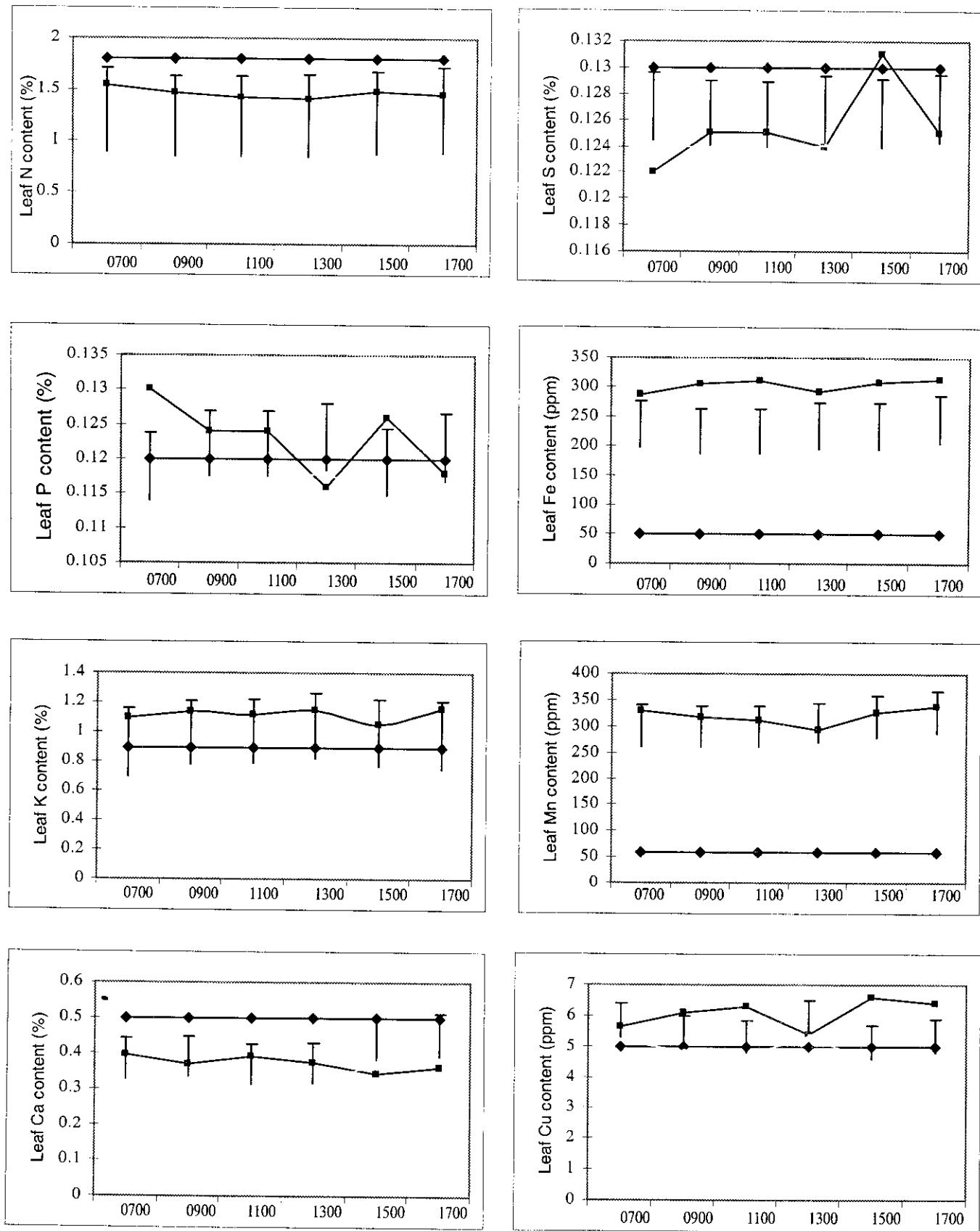


Fig 1. Mean leaf nutrient content at different hours with C.V. as error bar

N.B. The straight line refers to the critical value of the respective elements (Thampan, 1982; Ravi Savery *et al.*, 1994)

0900 and 1700 hours, respectively. However, the mean iron content remained quite stable at 0900-1100 hrs. The mean manganese content of the leaves ranged between

be considered as the most suitable time for leaf sampling in coconut in littoral sandy soils of Orissa, and which allows the samples to be processed in the afternoon.

Table 3. Nutrient (Fe, Mn, Cu and Zn) content (ppm) different hours in coconut palm

Time (hrs)	Iron			Manganese			Copper			Zinc		
	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)	Range	Mean	C.V. (%)
700	229-426	286.6	19.17	185-560	328.6	25.60	2.0-9.3	5.62	36.99	18.6-22.0	19.51	7.75
900	245-438	304.9	18.12	178-532	316.7	25.52	2.5-9.8	6.10	34.54	17.8-22.8	20.20	7.31
1100	245-442	309.3	18.24	175-521	310.2	25.49	2.7-10.1	6.28	33.57	18.4-23.4	20.78	7.28
1300	228-426	292.4	19.02	166-501	293.8	26.24	2.0-9.1	5.37	38.27	16.5-21.8	19.24	7.85
1500	232-442	306.8	18.85	186-574	327.2	27.38	3.1-10.5	6.62	32.06	19.5-25.0	22.20	6.76
1700	238-452	314.3	20.00	191-589	336.9	28.23	3.2-10.3	6.42	33.39	18.9-23.8	21.42	6.18
Se.D			0.417		
C.D. (0.05)	NS			NS			NS			0.828		

293.8 ppm to 336.9 ppm at 1300 and 1700 hours, respectively, and the lowest coefficient of variation (25.49 per cent) was observed at 1100 hours.

The mean copper content ranged between 5.37 ppm and 6.62 ppm at 1300 and 1500 hours, respectively. The lowest coefficient of variation (32.06 per cent) for copper was obtained at 1500 hours. There was no significant difference between the content of these three micronutrients when the index leaf was analysed at different hours of the day.

The zinc content of the index leaf ranged between 19.24 ppm (1300 hours) and 22.20 ppm (1500 hours) (Fig. 1). The lowest coefficient of variation (6.18 per cent) with regard to zinc concentration was observed when the leaves were sampled at 1700 hours. However, the zinc content of the index leaf has remained at par when analysed during 0900 and 1100 hrs of the day.

The results suggest that the lowest coefficient of variation for N, Ca, Mg, S and Mn content of the index leaf was observed at 1100 hours, where as for iron, the lowest coefficient of variation was observed at 0900 hrs. Phosphorus, magnesium and sulphur content of the index leaf was stable between 0900-1100 hrs. Apart from the elements like N, P, Mg and Zn, there was no significant difference between the nutrient content when analysed at different hours of the day. However, the nutrient content for those four elements remained at par during 0900-1100 hrs. Hence, the period 0900-1100 hours might

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