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Standardization of leaf sampling technique for mineral composition of coconut cv. Sakhigopal Local

G.C. Acharya*, D.P. Ray and G.H. Santara**
Department of Horticulture, Orissa University of Agriculture and Technology, Bhubeneswar 751 003

ABSTRACT

A study was undertaken to find out the index leaf position to be sampled under littoral sandy soils of Orissa for the coconut variety 'Sakhigopal Local'. The variations in the leaf nutrient concentrations of ten elements according to leaf position revealed that the N, P, and K content gradually decreased as the leaf ages, while Ca and Mg content increased as the leaf ages. The linearity for N, P, K, Mg and Fe was observed between 11th and 14th leaf positions. Again, the linearity for Ca, Mn, Cu and Zn was observed between 14th and 16th leaf positions. In case of sulphur, stability was observed between 14th and 16th leaf positions. The lowest coefficient of variation for P, K, Ca, Mg and Fe was recorded in the 14th leaf positions. Hence, 14th leaf starting from the uppermost fully opened leaf could be considered as the best leaf for sampling study in littoral sand.

Key words: Coconut, leaf sampling, littoral sandy soil.

INTRODUCTION

Over the past century, the focus of analytical diagnosis has shifted from soil analysis to plant/ leaf analysis. In general, the nutritional status of a plant is better reflected in the mineral element content of the leaves than in that of other plant organs. Leaf analysis for diagnostic purpose has been particularly useful for perennial crops which are relatively slow growing, can provide easily defined and standard leaf material for analysis. Nutrient content in the dry matter may differ considerably between different leaves. Next to the mineral nutrient supply, the physiological age of a plant or plant part is the most important factor affecting mineral nutrient content in the plant dry matter. The generally accepted sampling leaf has been the 14th, since this appears to be most sensitive (Fremond *et. al.*, 5). Several workers have, however, considered other leaves as being more appropriate (Green, 9; Smith, 20). In standardizing leaf sampling for foliar diagnostic purpose, particular attention should be paid to possible variability in respect of different elements between the selected leaves and provisions made for selecting a standard leaf rank. In the present study, an attempt was made to find out the index leaf position to be sampled under littoral sandy soils of Orissa for the variety 'Sakhigopal Local'.

MATERIALS AND METHODS

The study was conducted at the Coconut Research Station, Govt. of Orissa, Konark during 2001-2004. Coconut palms of uniform age (35 years) were selected randomly for the study. The soil of the experimental plot was very low in organic matter content and medium in potassium and high in phosphorus content. To study the impact of different leaf positions on the mineral content, the leaves were selected according to phyllotaxy of the palm. Based on the phyllotaxy of the coconut palm, 1st, 6th, 11th, 16th and 21st leaf positions were selected for the study. Leaf No. 1 is the youngest fully expanded leaf. The horizontal section through the crown of the tree shows that there are five whorls of leaves, so that leaf number of an individual whorl increases in fives; leaves 6, 11, 16 and 21 were, therefore, in the same whorl. However, 14th leaf position was included owing to the importance of this leaf position with the nutrient status of the palm. The study was analyzed following the procedure described by Lim *et al.* (12) and Korikanthimath *et al.* (11) with befitting statistical procedure of mean, range, coefficient of variations. 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, 1). The collected materials were wiped out to remove any residual soil or dust and then oven dried at 65°C for 72 h and powdered and subjected to analysis. It is important that neither damaged, insect-ridden, or diseased leaflets, nor dead tissue were included while collecting the samples. Leaf nitrogen content was estimated by Kjeldahal method (Singh *et al.,* 19), P by colometric method (Jackson, 10), K by diacid digestion method (Jackson, 10), Ca and Mg by EDTA complexiometric method (Jackson, 10), S by following the procedure described by Chesnin and Yein (2), and

*Corresponding author's present address: Regional Station of CPCRI, Mohitnagar, Jalpaiguri, West Bengal 735 101. E-mail: gobindacharya@yahoo.co.in
**Deptt. of Soil Science, OUA&T, Bhubaneswar.

the micronutrients (Fe, Mn, Cu and Zn) were determined by the procedure described by Lindsay and Norvell (13). The N, P, K, Ca, Mg and S content were expressed as percentage and the micronutrient contents were detailed as ppm.

RESULTS AND DISCUSSION

The N, P and K contents of the different leaf positions were analyzed and presented in Table 1 and Fig. 1. The results indicated that there exists some variation in the nitrogen concentration in different leaf positions, whereas relatively higher concentrations were found in younger leaves. The mean value for nitrogen concentrations ranged from 1.124 to 1.812 per cent in 21st and 6th leaf respectively. The linearity was observed between 11th (9.19%) and 14th leaf (9.33%). However, the nitrogen content in the 11th leaf had recorded the lowest coefficient of variation (9.19%). The data exhibited consistent increase in phosphorus content through older to younger leaves. The youngest fully opened leaf exhibited the highest concentration of phosphorus (0.192%) that gradually decreased to 0.162, 0.143, 0.130, 0.106, and 0.090 per cent in 6th, 11th, 14th, 16th and 21st leaf positions, respectively. The lowest coefficient of variation (6.70 per cent) for this nutrient element was observed in the 14th leaf. The linearity was observed between 11th (6.80%) and 14th (6.70%) leaf positions.

The highest concentration of potassium was noted in the 1st leaf position which gradually decreased as the leaves became older. The mean potassium content in the different leaf positions ranged from 0.920 to 1.604 per cent in 21st and 1st leaf, respectively. The coefficient of variation was lowest (13.90 per cent) in the leaf position 14th and the linearity was observed between this leaf position and 11th leaf positions (14.04%). The nitrogen concentration first increased from 1st leaf to 6th leaf, thereafter decreased as the leaf ages, while the phosphorus and potassium concentration decreased gradually from the 1st to 21st leaf in the experiment. This might be due to the remobilization of these three nutrient elements to newer leaves, as all these elements are highly mobile (Robson, 18). Similar trend for N, P and K was also reported by Prevot and Bachy (15), Ziller and Prevot (23), Ravi Savery *et al.* (17) in coconut. Nitrogen is a structural component of proteins, amino acids and all membranes and, therefore, should be expected to be highest in plant tissues with greater proportions of living cells (Clarkson and Hanson, 3). Elements like P do not accumulate in the mature leaves, but are transferred *via* the phloem and then xylem to the growing points (Guha and Mitchell, 8).

The Ca, Mg and S content of the leaves at different positions were analyzed and data are presented in Table 2 and Fig. 1. Both the concentrations of calcium and magnesium showed an increasing trend as the leaf ages. However, at the highest leaf position (21st) the concentration of magnesium decreased from that observed at 16th leaf position. The mean calcium content increased from 0.167 per cent in 1st leaf to 0.458 per cent in 21st leaf position. The lowest coefficient of variation (20.76%) was observed in 14th leaf position and the linearity was observed between 14th (20.76%) and 16th (20.91%) leaf positions. Similarly, the magnesium content in different leaf positions ranged from 0.148 and 0.265 per cent in 1st and 16th leaf positions, respectively. The lowest coefficient of variation (10.65%) for magnesium was also observed in 14th leaf position and the linearity was obtained between 14th and 11th (11.62%) leaf positions (Fig. 1). Elements like Ca and Mg are not freely mobile in phloem, so can not be transported but gradually accumulate in mature leaves (Guha and Mitchell, 8). Increase in calcium and magnesium content with leaf age have also been reported by Prevot and Montbreton (16) for oil palm, Prevot and Bachy (15), and Ravi Savery *et al.* (17) in coconut. Coomans (4) and Manciot *et al.* (14) observed that foliar content of Ca and Mg are depressed by high K levels and Wahid *et al.* (22) also demonstrated the antagonistic effect of Ca and Mg on K of the palms when judged through foliar analysis. The mean sulphur content of the leaves at different positions ranged between 0.077 and 0.132

Table 1. Nutrient (N, P and K) content (%) in different leaf positions in coconut palm.

Leaf	Nitrogen			Phosphorus			Potassium		
position	Range	Mean	CV (%)	Range	Mean	CV (%)	Range	Mean	CV (%)
1st	1.30-2.30	1.699	13.04	0.168-0.210	0.192	7.11	1.10-2.10	1.604	15.59
6th	1.50-2.14	1.812	10.41	0.142-0.180	0.162	7.27	1.08-1.80	1.432	14.86
11th	1.40-1.92	1.642	9.19	0.127-0.160	0.143	6.80	0.88-1.48	1.238	14.04
14th	1.25-1.75	1.515	9.33	0.113-0.145	0.130	6.70	0.80-1.40	1.171	13.90
16th	1.10-1.60	1.356	10.37	0.088-0.125	0.106	9.01	0.68-1.36	1.079	16.83
21st	0.92-1.40	1.124	10.80	0.080-0.103	0.090	6.95	0.60-1.10	0.920	16.03

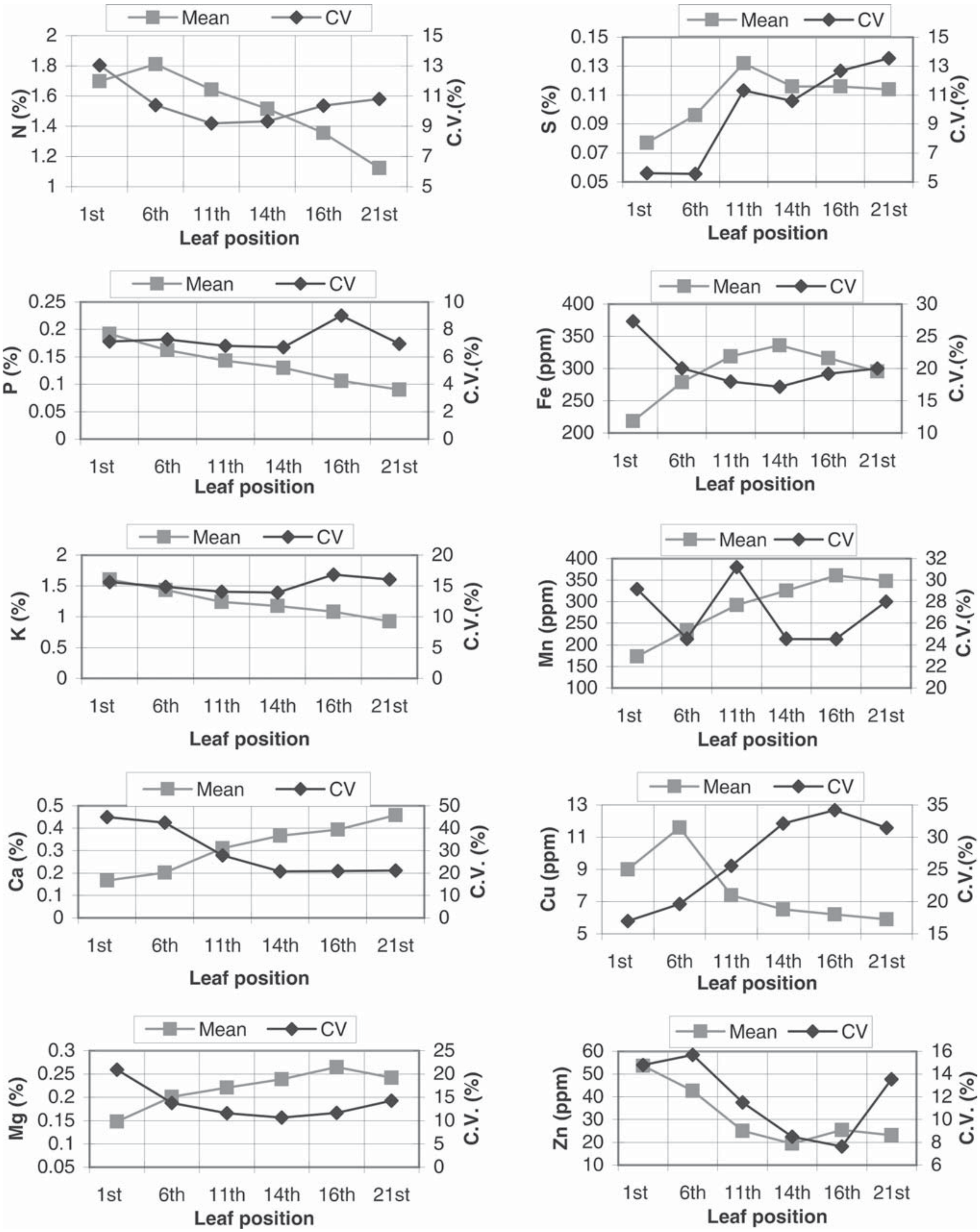

Fig.1. Mean leaf nutrient contents and coefficient of variation for different leaf positions.

Table 2. Nutrient (Ca, Mg and S) content (%) in different leaf positions in coconut palm.

Leaf position	Calcium			Magnesium			Sulphur		
	Range	Mean	CV (%)	Range	Mean	CV (%)	Range	Mean	CV (%)
1st	0.08-0.29	0.167	44.89	0.11-0.21	0.148	20.92	0.070-0.085	0.077	05.60
6th	0.10-0.36	0.202	42.44	0.17-0.26	0.201	13.79	0.085-0.105	0.096	05.57
11th	0.20-0.48	0.311	27.88	0.20-0.27	0.221	11.62	0.108-0.155	0.132	11.32
14th	0.27-0.54	0.367	20.76	0.21-0.30	0.239	10.65	0.095-0.136	0.116	10.59
16th	0.29-0.56	0.394	20.91	0.22-0.33	0.265	11.65	0.095-0.140	0.116	12.68
21st	0.33-0.63	0.458	21.17	0.20-0.31	0.242	14.25	0.085-0.135	0.114	13.54

per cent in 1st and 11th leaf positions, respectively. The lowest coefficient of variation was observed in 6th leaf position and the highest coefficient of variation was obtained in 21st leaf position. The linearity for sulphur was obtained between 1st and 6th leaf positions. However, the stable curve position was obtained in 14th and 16th leaf positions that recorded same concentration of sulphur. The calcium and magnesium content gradually increased as the leaf ages. However, sulphur content did not show any consistent trend with respect to leaf positions.

The micronutrient (Fe, Mn, Cu and Zn) contents in the leaves of the coconut palm at different leaf positions were estimated and are presented in Table 3 and Fig. 1. The iron content has increased gradually from 1st leaf position to 14th leaf position and decreased thereafter up to 21st leaf position. The mean iron content varied from 218.3 ppm in 1st leaf to 336.0 ppm in 14th leaf position. The 16th and 21st leaf positions recorded 316.2 and 295.6 ppm iron, respectively. The coefficient of variation for this element ranged between 17.14 and 27.36 per cent in 14th and 1st leaf positions, respectively. However, the linearity was observed between 11th and 14th leaf positions. Manganese content in different leaf positions ranged between 173.6 and 360.6 ppm in 1st and 16th leaf positions, respectively. The lowest coefficient of variation was found in the 16th leaf position and the linearity was observed between 14th and 16th leaf positions (Fig. 1). The mean copper content varied from 9.00 ppm in 1st leaf to 11.60 ppm in 6th leaf position. Similarly, the coefficient of variation ranged between 16.96 and 34.20 per cent in 1st and 16th leaf positions, respectively. However, the linearity was observed between 14th and 16th leaf positions. A critical look indicated that the zinc concentration was high at first, then dropped and increased again in different leaf positions. It varied from 19.40 ppm in 14th leaf position to 53.60 ppm in the 1st leaf. The linearity for zinc was observed between 14th and 16th leaf positions and the lowest coefficient of variation was obtained in 16th leaf position.

The iron and manganese concentration was observed to increase with increase in the age of leaf upto a certain point after which, the concentration falls. Copper has shown an increasing trend up to 6th leaf and decreased thereafter. The zinc content was found to be highest at first, then dropped and increased again. Similar trend of increasing Fe and Mn concentration in older leaves of oil palm was reported by Southern and Dick (21). De Silva (6 and 7) has also reported that younger leaves for Cu and older leaves for Fe and Mn provide information on their status in the palms. The present study also revealed same result having lowest coefficient of variation in older leaves for Fe and Mn and in younger leaves for copper. The variations in the leaf nutrient concentrations at different leaf positions might be due to their relative exposure to light and simultaneously its effect on photosynthesis.

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

Leaf position	Iron			Manganese			Copper			Zinc		
	Range	Mean	CV (%)	Range	Mean	CV (%)	Range	Mean	CV (%)	Range	Mean	CV (%)
1st	124-372	218.3	27.36	93-312	173.6	29.16	6.5-11.1	9.00	16.96	41.5-72.5	53.60	14.80
6th	194-412	278.7	20.06	142-378	233.5	24.58	7.4-16.5	11.60	19.63	36.5-67.3	42.60	15.70
11th	224-452	319.1	17.96	168-498	292.2	31.22	4.3-10.7	7.40	25.55	18.2-29.5	25.10	11.52
14th	262-463	336.0	17.14	183-520	325.6	24.58	3.4-10.2	6.51	32.10	16.1-22.0	19.40	8.51
16th	222-434	316.2	19.17	217-610	360.6	24.55	2.1-10.0	6.21	34.20	22.3-29.0	25.41	7.64
21st	209-404	295.6	20.00	211-590	348.0	28.00	2.8-9.2	5.90	31.46	12.9-29.0	23.20	13.55

REFERENCES

1. Chapman, H.D. 1964. Foliar sampling for determining the nutrient status of crops. *World Crops* **16**: 37-46.
2. Chesnin, L. and Yein, C.H. 1950. Turbidimetric determination of sulphur. *Proc. Amer. Soc. Soil Sci.* **15**: 149-51.
3. Clarkson, D.T. and Hanson, J.B. 1980. The mineral nutrition of higher plants. *Ann. Rev. Plant Physiol.* **31**: 239-98.
4. Coomans, P. 1977. First experimental results of hybrid coconut fertilization in the Ivory Coast (Premiers resultas experimentaux sur la Fertilisation des cocotiers hybrids in Cote-d-Ivoire). *Oleagineux* **32**: 155-66
5. Fremond, Y., Ziller, R. and De Nuce de Lamothe, M. 1966. *The Coconut Palm*. International Potash Institute, Berne, Switzerland, p. 227.
6. De Silva, M.A.T. 1974. Micronutrients in the nutrition of coconut. 1. Methods and preliminary investigations. *Ceylon Coconut Quarterly* **24**: 116-27.
7. De Silva, M.A.T. 1974. Micronutrients in the nutrition of coconut. I. Methods and preliminary investigation. *Ceylon Coconut Quarterly* **25**: 116-24.
8. Guha, M.M. and Mitchell, R.L. 1966. The trace and major element composition of the leaves of some deciduous fruits-II. Seasonal changes. *Plant Soil* **24**: 90-112.
9. Green, A.H. 1958. The diagnosis of nutrient deficiencies in coconut palm. *Proc. Ninth Pacific Sci. Cong.*, Bangkok. **6**: 15-18.
10. Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice-Hall of India Pvt. Ltd., New Delhi.
11. Korikanthimath, V.S., Gaddi, A.V. and Anke Gowda, S.J. 2003. Selection of index leaf in cardamom (*Elettaria cardamomum* Maton) for nutrient diagnosis. *Indian J. Hort.* **60**: 108-12.
12. Lim. T. K., Luders, L. and Poffley, M. 1999. Seasonal changes in durian leaf and soil mineral nutrient element content. *J. Plant Nutrition* **22**: 657-67.
13. Lindsay, W.L. and Norvell, W.A. 1978. Development of a DTPA test for zinc, iron, manganese and copper. *Soil Sci. Soc. Amer. J.* **42**: 421-28.
14. Manciot, R., Ollagnier, M. and Ochs, R. 1979. Mineral nutrition and fertilization of the coconut around the world. II. Study of the different elements (Nutrition minerale et fertilization du cocotier dans le monde. II, Etude des differents elements). *Oleagineux* **34**: 563-80.
15. Prevot, P. and Bachy, A. 1962. Diagnostic foliaire du Cocotier. Influence du rang de la feuille et du developpment vegetatif sur les teneurs en elements. *Oleagineux* **17**: 451-58.
16. Prevot, P. and De Montbreton, C.P. 1958. Etude des gradients en divers elements mineraux selon le rang de la feuille chez le palmier a huile (Study of the gradients of different mineral elements according to leaf order in the oil palm). *Oleagineux* **13**: 317-21.
17. Ravi Savery, M.A.J., Madhiazhagan, K. and Rettinassababay, C. 1994. Leaf sampling and critical nutrient levels in coconut. *Indian Coconut J.* **25**: 6.
18. Robson, A.D. 1981. Principles and approaches used in plant analysis. **In:** *Proc. Nat. Workshop Plant Analysis*, pp. 1-7.
19. Singh, D., Chhonkar, D.K. and Pandey, R.N. 1999. *Soil-Plant-Water Analysis: A Methods Manual*. IARI, New Delhi.
20. Smith, R. W. 1969. Fertilizer responses by coconut in two contrasting Jamaican soils. *Experimental Agric.* **5**: 133-45.
21. Southern, P. J. and Dick, K. 1968. The distribution of trace elements in the leaves of the coconut palm, and the effect of the trace element injection. *Oleagineux* **23**: 521-27.
22. Wahid, P.A., Kamala Devi, C.B. and Pillai, N.G. 1974. Inter-relationship among root CEC, yield and monovalent and divalent cations in coconut. *Plant Soil* **40**: 607-19.
23. Ziller, R. and Prevot, P. 1962. Foliar diagnosis: A method of studying mineral nutrition- Its application to the coconut palm. *Indian Coconut J.* **15**: 156-59.

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