

# CONTRIBUTIONS TO THE STUDY OF SPIKE-DISEASE OF SANDAL (*SANTALUM ALBUM*, LINN.).

## Part II.—Analysis of leaves from healthy and spiked trees.

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It was thought that a study of the diseased and healthy sandal plants might reveal some marked differences in metabolism and perhaps yield some information as to whether spike is due to faulty nutrition. It was further hoped that such work might, in due course, suggest a line of attack by which the cause of the disease might be determined. For this purpose a study of the carbohydrate content, total nitrogen and mineral matter was made, and in the present paper the results obtained with the leaf tissue are described.

According to Coleman (*Mysore Dept. Agric. Mycol. Ser., Bull.*, No. 3, 1917) the deficiency in the mineral contents noted in the case of spiked leaves from different areas could not be traced to the actual contents of the respective soils. Narasimha Iyengar and Shankar Rao Badami (*Mysore Forest Journal*, 1922) recorded a general increase in the nitrogen content of spiked leaves of one locality as compared with that of healthy specimens from another locality. In the present paper, an attempt is made to compare these observations with those obtained for samples from the same area and collected at different periods. It is hoped thereby to obtain a chemical measure of the difference between spiked and healthy plants and thus to distinguish between them by a study of the purely analytical data.

### ANALYTICAL METHODS.

The samples were collected from two areas near Bangalore, Ragihalli and Uttarahalli, at the same time of the morning. The details are presented in Part I (*This Journal*, 1928, 11A, 23). To render the data comparable, young leaves and shoots were discarded in both cases.

A small portion of the fresh sample was weighed to determine the moisture content. Another portion was utilised for the carbohydrate determinations for which the method developed by Davis and Daish (*J. Agr. Sci.*, 1914, 6, 159-160) was followed with some modifications. Dialysed iron was preferred to basic lead acetate as a clarifying agent,

since the latter removes some of the sugars also. The direct reducing power of the concentrated extract, calculated as dextrose, was represented as free reducing substances. An aliquot part was hydrolysed with concentrated hydrochloric and the reducing power after neutralisation denoted as total sugars calculated as dextrose, the difference between this and the previous figure being referred to as acid hydrolysable substances calculated as dextrose. The residue was utilised for starch estimation by the takadiastase method.

The total nitrogen was determined on the air-dry material by the Kjeldahl-Gunning method modified to include nitrates, and then computed on the moisture-free material.

The mineral constituents were usually estimated by the A.O.A.C. methods (1925, p. 39). The method as described in page 43 was adopted for the estimation of potash, precipitated as perchlorate. Subsequently it was found more convenient to carry out the estimation without removing calcium, sodium, etc., by the perchlorate method as described by Sutton (*Standard Methods of Chemical Analysis*, 1927, Vol. I, p. 412).

Fig. 1.  
Dry - Matter Content  
in Healthy and Spiked leaves.

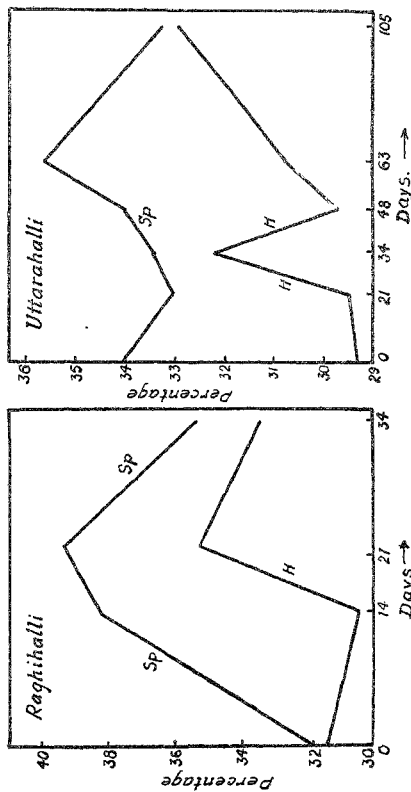
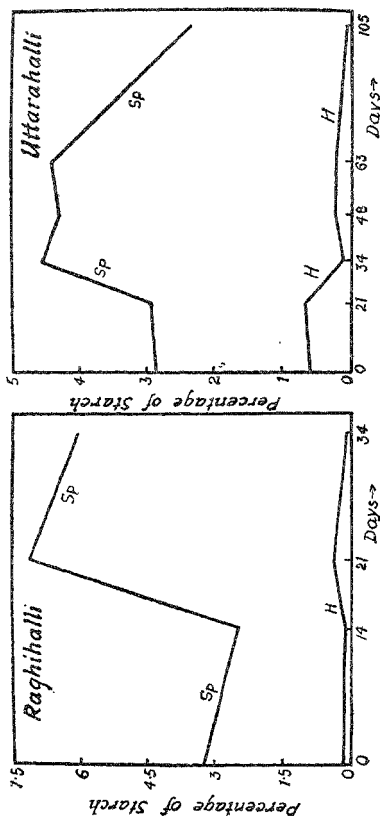


Fig. 1 represents graphically the dry-matter content of spiked and healthy leaves in both the areas. The spiked tissues have generally a high dry-matter content.

Fig. 11  
Starch Content  
in healthy and diseased leaves.



The starch content of the two specimens is represented in Fig. 11. It is evident that spike is characterised by an excessive accumulation of starch and the starch values for the normal plant are on the whole significantly low; the figures are based on dry weight. (Sp = Spike; H = Healthy).

## RESULTS.

TABLE I.

Free reducing substances and acid hydrolysable substances expressed as dextrose in healthy and diseased leaves.

Date in 1927	Locality	Free reducing substances expressed as percentages of dextrose		Excess or deficiency in disease expressed as percentages		Acid hydrolysable substances expressed as percentages of dextrose		Excess or deficiency in disease expressed as percentages	
		HEALTHY	DISEASED	HEALTHY	DISEASED	HEALTHY	DISEASED	HEALTHY	DISEASED
July 8	... Raghalli...	0.365	0.139	— 62	0.598	0.005	— 99		
" 22	" " "	0.42	0.387	— 8	0.230	0.206	— 29		
" 29	" " "	0.298	0.327	+ 9	0.442	0.475	+ 8		
August 11	" " "	0.228	0.728	+ 219	0.681	0.628	— 8		
July 15	Uttrahalli.	0.007	0.065	+ 829	0.205	0.59	+ 188		
August 5	" "	0.158	0.874	+ 453	0.398	1.116	+ 181		
" 18	" "	0.331	0.377	+ 14	0.639	0.863	+ 28		
September 1...	" "	0.150	0.360	+ 140	0.181	0.556	+ 207		
" 15...	" "	0.164	0.804	+ 390	0.179	0.611	+ 241		
October 27	" "	0.146	0.253	+ 73	0.085	0.224	+ 136		

Note:—(1) The percentage of free reducing material is generally higher in diseased leaves with two exceptions.

(2) Diseased specimens from Uttrahalli show a more uniform increase in the acid hydrolysable matter, while in Raghalli, the figures are varying, sometimes the diseased samples having a smaller content of the hydrolysable material. The total carbohydrate content of the affected leaves has been noted in general to be distinctly higher than that of the healthy ones.

TABLE II.

*Total Nitrogen and Calcium content in healthy and diseased leaf tissues.*

Date in 1927	Locality	Total Nitrogen expressed as percentage on dry weight		Calcium expressed on dry weight	
		HEALTHY	DISEASED	HEALTHY	DISEASED
July 8	Ragihalli	1.92	2.41	1.85	.84
" 22	"	2.24	2.75	1.60	.76
" 29	"	2.17	2.28	1.69	.77
August 11	"	1.97	2.08	1.99	.76
June 2	Uttarahalli	4.45	4.94	2.4	1.12
July 15	"	2.64	2.89	3.48	.85
August 5	"	1.62	2.69	3.18	.94
" 18	"	2.88	3.29	2.46	.86
September 1	"	2.03	3.17	1.68	.43
" 15	"	2.19	2.92	2.16	.69
October 27	"	3.36	2.40	2.24	.58

For samples of same date and area, the total nitrogen content in spiked leaves is greater except in one case than in the healthy ones.

Fig. III.  
Ratio N: Ca in Healthy and Diseased Leaves.

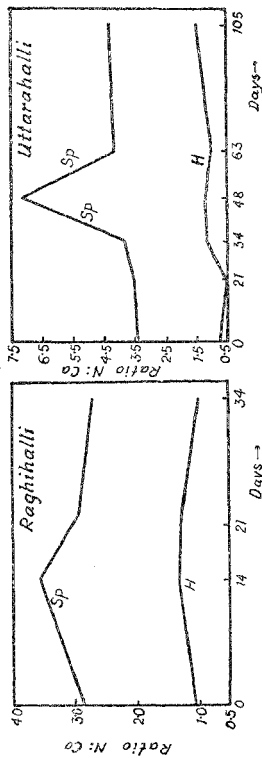


Fig. III illustrates the ratio of nitrogen to calcium in the diseased and healthy leaf tissues of the two areas. The values for the affected specimens are distinctly higher than those for the healthy ones. An attempt is being made to correlate these two figures, if possible. (Sp-Spike, H-Healthy).

TABLE III.  
*Mineral Matter in healthy (H) and diseased (D) leaves (calculated on dry weight).*

Date in 1927	Locality	Ash		SiO <sub>2</sub>		P <sub>2</sub> O <sub>5</sub>		Fe <sub>2</sub> O <sub>3</sub>		CaO		K <sub>2</sub> O	
		H	D	H	D	H	D	H	D	H	D	H	D
July 8 ...	Raghalli	7.71	6.01	.81	.88	...	.65	.09	.13	2.59	1.18	2.18	1.2
" 22 ...	"	8.30	4.96	.51	.73	.68	.54	.05	.08	2.36	1.06	1.84	.91
" 29 ...	"	8.61	5.58	1.15	.72	.58	.59	.13	.11	2.37	1.07	1.80	.82
August 11 ...	"	7.45	6.05	1.01	.84	.50	.42	.16	.12	2.79	1.06	2.07	1.15
December 19 ...	"	13.13	5.96	.37	.50	.38	.27	.05	.09	2.66	1.22	3.30	1.61
June 2 ...	Uttarahalli	14.89	13.65	1.22	1.17	.71	.55	.11	.08	3.31	1.57	2.08	.99
July 15 ...	"	15.42	11.01	1.25	1.1	1.16	.76	.12	.09	4.87	1.19	2.25	1.41
August 5 ...	"	13.24	8.34	1.4	.93	.72	.52	.14	.02	4.45	1.31	1.82	1.25
" 18 ...	"	10.61	6.25	.78	.43	.56	.37	.05	.05	3.44	1.2	2.18	.78
September 1 ...	"	13.65	8.64	1.00	.87	.40	.29	.05	.02	2.55	.60	3.2	1.93
" 15 ...	"	14.36	9.24	1.09	.64	.72	.43	.07	.04	3.02	.57	2.67	1.84
October 27 ...	"	12.45	15.63	.80	1.89	.39	.65	.06	.08	3.13	.81	2.42	1.63

The healthy leaves of a particular area collected on a particular date, are richer in total ash, potash, lime and generally in phosphoric acid. The lime figures are the most striking, however irrespective of the period of collection. The values for the ash content can be assumed to be significant since it has a value of 3.17.



## SUMMARY.

Sandal leaves affected with spike contain more free reducing sugars, total carbohydrates, starch, total nitrogen and dry matter than the healthy ones, the moisture being lower. Consistent differences were noted in lime and potash contents of the diseased and healthy leaves, the diseased samples being deficient in these salts. The ash is higher in the healthy leaves.

The significance of these findings will be discussed in a subsequent paper.

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