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ELEMENTAL COMPOSITION OF GROUNDNUT LEAVES AS AFFECTED BY AGE AND IRON CHLOROSIS

KEY WORDS: Leaf age, major and micronutrient composition

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ABSTRACT

We studied the changes with time in the composition of leaves of different age, with particular attention given to the youngest leaves, because relatively little is known of the effect of iron chlorosis on the elemental composition of groundnut leaves (*Arachis hypogaea* L.).

For cultivar TMV2 and a number of breeder's lines, the development of chlorosis did not cause a consistent change in nutrient content of the leaves, but marked changes in content were associated with leaf age independent of chlorosis susceptibility. Concentrations of N, P, K, Cu, Mn, and Zn in the leaves of TMV2 generally decreased with increasing age; N, Zn, and Mn concentrations decreased from the unfolded buds to the second unfolded leaf (L2), but thereafter did not decrease. The concentrations of Ca increased markedly with leaf age and Mg concentrations tended to increase.

These results indicate that while iron chlorosis did not cause any consistent changes in the elemental composition of groundnut leaves, marked changes in content were associated with leaf age.

INTRODUCTION

Chlorosis is widespread in groundnut (*Arachis hypogaea* L.) grown on calcareous and alkaline soils in India. The cause

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appears to be alkalinity-induced iron deficiency, because the visual symptoms are consistent with those caused by iron deficiency (6). Our earlier study also showed that iron chlorosis in groundnut was related to o-phenanthroline extractable iron in the youngest leaves but not to total iron or to the ratio of iron with other elements (6). However, chlorosis is not always removed by spraying iron salts onto the leaves; studies of other nutrients are desirable.

Earlier work on the nutrient content of groundnut leaves has focussed on either the most recently emerged leaf or on bulk samples of leaves (2,5). Relatively little is known of the effect of iron chlorosis on the nutrient content of groundnut leaves; we have therefore studied the changes with time in the composition of leaves of different age, during a period when chlorosis was developing.

MATERIALS AND METHODS

Two separate series of measurements and observations were made on groundnut crops established by other scientists at the Institute during the rainy season in 1981. The first experiment, on an Alfisol (pH 8.0), had four replications using cultivar TMV2. The second experiment was located on an Entisol (pH 8.5), where eight separate breeding lines of groundnut were sampled once. This experiment had three replications. The details of these experiments, including sampling procedure and description of soils, were provided in an earlier publication (6).

Briefly, 10 (first experiment) or 5 (second experiment) plants were removed from each plot, and leaves of the same age bulked for each plot. The leaf samples were washed thoroughly in acidified (HCl) water and distilled water after collection. They were dried for 3 days in an oven at 60C and ground in a mini-Wiley mill with stainless steel blades to pass through a 40-mesh sieve.

Plant samples were analyzed colorimetrically for N and P following digestion on a block digestor using a Technicon Autoanalyzer II (7). Total Ca, Mg, K, Fe, Cu, Zn, and Mn contents were estimated by atomic absorption spectrophotometry following digestion of the plant samples using the tri-acid digestion method (4).

RESULTS AND DISCUSSION

Nutrient contents of groundnut (cv. TMV2) leaves of different age collected during three representative samplings showed that leaf concentrations of N, P, K, Cu, Mn, and Zn generally decreased with increasing age (Table 1). Elemental contents of Ca and Mg

TABLE 1

Elemental Composition of Groundnut Leaves of Different Age (TMV2, Alfisol)[z]

	Leaf Age[y]						
Sampling Date 1981	Mb	Lb	L1	L2	L3	L4	L5
				Total N (%)			
July 29	5.73	5.32	4.34	3.90	3.90	3.94	3.61
July 31	3.47x	6.16w	5.34x	3.90	4.08	4.26	3.98
Aug 3	6.34w	6.16w	5.35x	4.57	4.61	4.26	4.23
SE ±				0.145			
Mean	5 .48	5.88	5.01	4.13	4.20	4.16	3.94
SE ±				0.083			
				Total P (%)			
July 29	0.74	0.68	0.43	0.29	0.25	0.28	0.28
July 31	0.70	0.70	0.51	0.41	0.35	0.38	0.33
Aug 3	0.70	0.70	0.45	0.38	0.34	0.29	0.28
SE ±				0.025			
Mean	0.71	0.69	0.46	0.36	0.32	0.32	0.30
SE ±				0.015			
				Total K (%)			
July 29	3.83	3.28	2.92	1.53	1.55	1.06	1.00
July 31	2.52	3.94	2.71	1.85	1.39	1.34	0.95
Aug 3	3.45	3.77	2.76	2.02	1.57	1.25	1.12
SE				0.152			
Mean	3.27	3.66	2.80	1.80	1.37	1.21	1.02
SE ±				0.008			

(Cont'd.)

TABLE 1 (Cont'd.)

Elemental Composition of Groundnut Leaves of Different Age (TMV2, Alfisol)[z]

Sampling Date 1981	Leaf Age[y] Mb	Lb	L1	L2	L3	L4	L5
				Total Ca (%)			
July 29	0.90	0.78	1.12	1.47	1.76	1.92	2.20
July 31	0.81	0.77	0.92	1.35	1.77	1.96	2.25
Aug 3	0.59	1.00	1.08	1.40	1.53	2.09	2.10
SE $\pm$				0.096			
Mean	0.77	0.85	1.04	1.40	1.68	1.99	2.18
SE $\pm$				0.056			
				Total Mg (%)			
July 29	0.55	0.45	0.39	0.38	0.48	0.48	0.63
July 31	0.38	0.41	0.31	0.37	0.38	0.53	0.65
Aug 3	0.47	0.52	0.55	0.56	0.57	0.65	0.71
SE $\pm$				0.043			
Mean	0.47	0.46	0.41	0.44	0.48	0.55	0.66
SE $\pm$				0.025			
				Total Zn (μg/g)			
July 29	67	66	49	46	47	43	33
July 31	55	64	54	52	49	54	54
Aug 3	70	68	48	55	50	48	52
SE $\pm$				3.0			
Mean	64	66	50	51	48	48	46
SE $\pm$				1.7			

Elemental Composition of Groundnut Leaves of Different Age (TMV2, Alfisol)[z]

	Leaf Age[y]						
Sampling Date 1981	Mb	Lb	L1	L2	L3	L4	L5
				Total Mn (μg/g)			
July 29	38	39	40	31	44	44	38
July 31	36	35	32	43	46	46	53
Aug 3	23	27	31	36	46	40	51
SE ±				5.12			
Mean	32	33	34	37	45	43	47
SE ±				2.95			
				Total Cu (μg/g)			
July 29	9.1	9.4	9.2	6.7	10.5	12.3	8.4
July 31	13.1	11.6	11.1	11.5	13.2	10.3	10.7
Aug 3	18.2	18.0	15.8	15.2	7.1	7.3	8.6
SE ±				1.57			
Mean	13.5	13.0	12.0	11.1	10.2	10.0	9.2
SE ±				0.85			

[z]The experiment was planted on 15 July 1981.
[y]Leaf age: Mb is main bud; Lb is lateral bud; L1 is youngest unfolded leaf; and L5 is the oldest unfolded leaf.
[x]Slight chlorosis.
[w]Marked chlorosis.

generally increased with leaf age but the increase was greater for Ca. Nitrogen, Zn, and Mn concentrations decreased from the unfolded bud to the second unfolded leaf (L2), but thereafter did not decrease. The changes in P, K, and Ca concentrations were highly significant ($P<0.01$) with increasing age of leaf. The P concentration decreased from 0.70% in the buds to 0.30% in the older leaves, and K decreased from 3.3 to 3.6% in buds to 1.0% in the older leaves. Calcium concentration increased with leaf age from less than 1% in buds to over 2% in leaf-5 (L5). Magnesium also increased with age, but to much lesser extent than Ca. Nitrogen concentration decreased markedly with leaf age to L2 but older leaves showed little change with age. Zinc and Mn concentrations changed significantly with leaf age, but the major difference was between buds and the older leaves. The Zn concentration was significantly higher in the buds (65 μg/g) than in all opened leaves (47-51 μg/g); Mn content in buds and first two opened leaves (32-37 μg/g) was less than that of the three older leaves (43-47 μg/g). Copper concentration usually decreased with leaf age. There was no consistent effect of iron chlorosis on elemental composition of groundnut leaves and it was perhaps confounded by its interaction with age of the leaf.

An examination of the leaf composition (Mb and L1) of 8 groundnut breeding entries showed that chlorosis caused few changes in the elemental contents of leaves that were consistent in both Mb and L1 and in the plants of contrasting vigor and growth (Tables 2 and 3). Magnesium concentrations were higher in chlorotic than in healthy tissue of both buds and leaf tissue of the various breeding entries. Calcium concentrations were also consistently higher in the chlorotic than healthy buds not L1, whereas P concentrations were higher in L1 but not the Mb. Manganese contents were variable but chlorosis decreased its concentration in L1.

Calcium and P have been implicated as nutrients involved in causing precipitation of iron in plant tissue and causing chlorosis (1,3,8). In our study the P concentration was consistently about 0.70% and decreased with leaf age, and Ca concentration increased from 0.59 to 1.00% in the buds to over 2% in the older leaves (Table 1). The higher P concentration in the young tissue could be a contributing factor for decreasing iron status of plant and causing chlorosis; cultivars which differed strongly in chlorosis did not differ in P or Ca levels. However, these detailed samplings were only preliminary and tnerefore could not reveal the cause of chlorosis.

These results indicate that while iron chlorosis did not cause any consistent changes in the elemental composition of groundnut leaves, marked changes in content were associated with leaf age.

TABLE 2

Content of N, P, K, Ca, Mg (%) in Main Bud (Mb) and First Fully Opened Leaf (L1) of Different Groundnut Breeding Entries[z]

Extent of Chlorosis[y]	Plant Growth[y]	Breeding Entry	N		P		K		Ca		Mg	
			Mb	L1	Mb	L1	Mb	L1	Mb	L1	Mb	L1
Severe	Poor	FESR 12-P5	4.65	3.86	0.61	0.40	3.33	3.27	1.61	1.51	0.66	0.57
		FESR 12-P6	4.66	3.86	0.57	0.40	3.34	3.08	1.23	1.49	0.56	0.68
Severe	Good	NCAC 664	5.25	4.23	0.52	0.41	3.10	3.04	1.47	2.08	0.65	0.68
		U-1-2-1	5.47	4.29	0.55	0.40	3.10	2.94	1.66	2.46	0.69	0.67
Nil	Poor	TMV 2	4.78	3.28	0.59	0.27	3.36	2.97	1.06	1.72	0.47	0.33
		Krapovikas	5.12	4.42	0.58	0.23	3.53	3.30	0.88	1.75	0.41	0.37
Nil	Good	C. No. 501	4.91	4.16	0.56	0.27	3.58	2.08	0.89	1.62	0.42	0.31
		E. runner	5.35	4.00	0.61	0.25	3.83	2.00	1.16	1.73	0.55	0.19
SE ±			0.090	0.143	0.017	0.013	0.125	0.054	0.059	0.079	0.018	0.029

[z]Leaves sampled on 1 September, 1981, 72 days after sowing.
[y]Extent of chlorosis and plant growth scores made on a scale of 0-10; the highest value was given for maximum growth or maximum chlorosis.

TABLE 3

Content of Mn, Zn, Cu (µg/g) in Mainbud (Mb) and First Fully Opened Leaf (L1) of Different Groundnut Breeding Entries[z]

Extent of Chlorosis[y]	Plant Growth[y]	Breeding Entry	Mn (µ[illegible]		Zn (µg/g)		Cu (µg/g)	
			Mb	L1	Mb	L1	Mb	L1
Severe	Poor	FESR 12-P5	54.3	51.0	72.6	57.3	10.6	9.0
		FESP 12-P6	44.0	60.0	72.6	47.6	8.0	8.0
Severe	Good	NCAC 664	73.0	88.0	69.3	51.6	11.3	8.3
		U-1-2-1	58.3	56.6	65.6	49.6	12.6	9.3
Nil	Poor	TMV 2	54.0	105.0	73.0	50.6	10.3	9.3
		Kravopikas	44.0	75.0	56.0	62.0	8.0	11.0
Nil	Good	C. No. 501	47.3	122.0	58.0	40.0	8.6	6.0
		E. runner	47.0	90.0	63.3	38.6	12.3	9.0
Se ±			2.73	7.25	2.01	3.47	0.86	1.34

[z]Leaves sampled on 1 September, 1981, 72 days after sowing.
[y]Extent of chlorosis and plant growth scores made on a scale of 0-10; the highest value was given for maximum growth or maximum chlorosis.

FOOTNOTE

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