

Nutrient concentrations in the leaves of a range of banana varieties grown in the subtropics.

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TENEURS DES FEUILLES EN ELEMENTS NUTRITIFS DANS UNE GAMME DE VARIETES DE BANANIER CULTIVEES EN ZONES SUBTROPICALES

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RESUME - On a mesuré les taux de N, P, S, K, Ca, Mg, Cl, Na, Al, Fe, Mn, Cu, Zn, B et Mo dans la matière sèche de la feuille III de trente variétés de bananier en provenance d'un bloc d'observation variétale à Alstonville (Nouvelle-Galles-du-Sud, Australie). Bien que la disposition sur le terrain ne permette pas des comparaisons précises, certaines tendances sont évidentes.

A l'intérieur du groupe Cavendish, l'extrême nanisme réduit les taux de N, P, S, K, Ca, Mg, Fe et Al, mais les différences entre les variétés Cavendish géantes sont faibles. Les variétés à base de *Musa balbisiana* ont des taux de N, P, S, K, Mn, Cu et Zn plus faibles que les variétés à base de *M. acuminata*.

INTRODUCTION

Nutrient concentrations in leaf dry matter have been used to assess nutrient status of bananas in a number of countries. A comparison of nutrient concentrations in a number of varieties under a range of nutrition and climatic conditions would be useful in establishing whether standards of adequacy have wide application. However, it is unlikely that such an experiment will be conducted in the near future because of its expense and because of the need to establish all the important varieties at a number of locations. In the absence of such experiments we present here data on the concentration of N, P, S, K, Ca, Mg, Cl, Na, Al, Fe, Mn, Cu, Zn, B and Mo in leaf dry matter of 30 banana

varieties growing in a collection at Alstonville, N.S.W. (Lat. 28°51'S). For the international banana trade several varieties within the Cavendish group are widely used while other varieties are more important locally, especially those used for cooking.

The Alstonville collection contains mostly Cavendish varieties but we have examined plantain and cooking bananas available to us as well as wild and ornamental species and two progeny from the Banana Breeding Research Scheme, Jamaica.

MATERIALS AND METHODS

Thirty banana varieties were available, their names (following SIMMONDS, 1966), code (used hereafter to refer to the variety), and genomic constitution are given in Table 1. Within the Cavendish group variety 5 represents extreme dwarfing (Table 2) and is not a commercial variety, varieties

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TABLE 1 - Varieties examined and their genomic constitution (after SIMMONDS, 1966).
Variétés étudiées et leur constitution génomique (selon SIMMONDS, 1966).
Variedades estudiadas y su constitución genómica (según SIMMONDS, 1966).

variety	code	variety	code
WILD BANANAS		GROS MICHEL (AAA)	
<i>M. velutina</i>	1	Highgate	19
<i>M. ornata</i>	2	Bodles Altafort	20
<i>M. acuminata</i> subsp.*	3	2390	21
<i>M. balbisiana</i>	4		
CAVENDISH (AAA)		RED (AAA)	
Dwarf Parfitt	5	Red	22
Dwarf Cavendish	6	Green Red	23
New Guinea Cavendish	7		
Chinese Cavendish	8	POME (AAB)	24
Cavendish C	9		
Cavendish S	10	OTHER	
Cavendish N	11	Silk (AAB)	25
Hochuchu	12	Pisang Awak (ABB)	26
Viemama	13	Silver Bluggoe (ABB)	27
Mons Mari	14	Bluggoe (ABB)	28
Williams	15	Blue Lubin (AAB)	29
Williams (pub)	16	Corne plantain (AAB)	30
Pisang Masak Hijau	17		
Robusta	18		

* - Undescribed subspecies (SHEPHERD, 1973), personal communication
sous-espèce non décrite sub-espece indescrita

TABLE 2 - Mean plant height at bunching and total weight of fresh fruit produced by five plants up to 2.5 years from planting.

Hauteur moyenne de la plante à la floraison et poids frais total des fruits produits par cinq plantes dans les 2 ans 1/2 suivant la plantation.

Altura media de la planta a la floración y peso fresco total de los frutos producidos por cinco plantas durante los 2 años y medio después de la plantación.

Variety Code	Plant* height (cm) hauteur de la plante altura de la planta	weight of fruit (kg) poids du fruit peso del fruto	Variety Code	Plant* height (cm) hauteur de la plante altura de la planta	weight of fruit (kg) poids du fruit peso del fruto
1			16	187±6	133
2			17	266±11	88
3			18	209±16	137
4			19	214±6	88
5	78±6	28	20	324±11	47
6	154±4	170	21	200±7	151
7	193±3	175	22	347±3	53
8	189±9	158	23	354±6	57
9	192±4	137	24	297±5	98
10	181±4	153	25	261±11	74
11	202±9	136	26	290±10	147
12	197±7	171	27	271±5	79
13	204±7	141	28	252±8	60
14	214±5	131	29	262±8	77
15	203±4	148	30	287±5	103

* - Mean of five plants in plant crop - moyenne de cinq plantes de premier cycle
promedio de cinco plantas de primer ciclo.

TABLE 3 - Concentration of N, P, S, K and Ca in leaf III dry matter of a range of banana varieties at Alstonville, N.S.W. Values are means of samples taken in November 1977 and November 1978. Concentration de N, P, S, K et Ca dans la matière sèche de la feuille III sur une série de variétés de bananier à Alstonville, N.S.W. Les valeurs sont les moyennes des échantillonnages de novembre 1977 et novembre 1978.

Concentraciones de N, P, S, K y Ca en la materia seca de la hoja III en una serie de variedades de plátano en Alstonville, N.S.W. Los valores son los promedios de los muestreos de noviembre 1977 y noviembre 1978.

Variety Code	percent				
	N	P	S	K	Ca
1	3.71	0.22	0.29	3.47	0.57
2	3.71	0.23	0.28	2.22	0.82
3	3.95	0.23	0.28	2.76	0.96
4	2.99	0.18	0.20	2.79	0.66
5	4.14	0.23	0.33	3.50	1.20
6	3.78	0.22	0.30	3.46	1.09
7	3.76	0.22	0.30	3.26	1.05
8	3.77	0.21	0.30	3.29	0.90
9	3.71	0.21	0.28	3.20	0.99
10	3.56	0.20	0.27	3.31	0.82
11	3.62	0.21	0.28	3.24	0.77
12	3.84	0.21	0.28	3.14	0.71
13	3.66	0.21	0.27	3.15	0.73
14	3.72	0.20	0.29	3.25	0.66
15	3.62	0.21	0.28	3.33	0.65
16	3.59	0.22	0.27	3.25	0.74
17	3.66	0.20	0.28	3.26	0.60
18	3.73	0.20	0.28	3.31	0.65
19	3.63	0.19	0.26	3.59	0.54
20	3.99	0.22	0.32	3.36	0.66
21	3.77	0.20	0.28	3.15	0.84
22	2.92	0.17	0.22	3.25	0.68
23	2.97	0.18	0.22	3.38	0.63
24	3.54	0.21	0.25	3.00	0.73
25	3.53	0.20	0.27	2.72	0.64
26	2.94	0.17	0.21	2.95	0.46
27	3.09	0.19	0.23	2.79	0.62
28	3.05	0.20	0.23	2.67	0.62
29	3.22	0.19	0.24	2.69	0.61
30	3.32	0.20	0.25	3.35	0.52

7 to 16 are selections of 'Giant Cavendish' (nomenclature following SIMMONDS, 1966) and variety 17 is the tallest of the Cavendish group, often called Lacatan. Variety 19 is a dwarf mutant of Gros Michel; it does poorly in New South Wales, being affected adversely by the cool winter. Varieties 20 and 21 are progeny from the Banana Breeding Research Scheme, Jamaica.

Five plants of each variety were planted in an observation block in November, 1976. The soil was a free draining krasnozom (NICOLLS, COLWELL and TUCKER, 1953) which

had previously been planted to pineapples and subsequently a *Lab lab purpurea* cover crop. At planting 700 g blood and bone and 500 g dolomite were mixed with soil in the planting hole and a further 1500 g dolomite was spread within a 2 m radius around each plant. Annually 200 kg N, 50 kg P and 400 kg K per hectare were applied. During the first twelve months 32 kg Zn and 260 kg Mg per hectare were applied in response to the appearance of zinc and magnesium deficiency symptoms 3-5 months after planting. The Cavendish clones showed more severe zinc deficiency symptoms

TABLE 4 - Concentration of Mg, Cl, Al, Fe, Mn in leaf III dry matter of a range of banana varieties at Alstonville, N.S.W. Values are means of samples taken in November 1977 and November 1978.

Concentration de Mg, Cl, Al, Fe, Mn dans la matière sèche de la feuille III sur une série de variétés de bananier à Alstonville, N.S.W. Les valeurs sont les moyennes des échantillonnages de novembre 1977 et novembre 1978.

Concentraciones de Mg, Cl, Al, Fe, Mn en la materia seca de la hoja III en una serie de variedades de plátano en Alstonville, N.S.W. Los valores son los promedios de los muestreos de noviembre 1977 y noviembre 1978.

Variety Code	percent		ppm		
	Mg	Cl*	Al	Fe	Mn
1	0.40	1.24	93	158	1101
2	0.31	0.62	64	140	1485
3	0.45	1.02	57	129	1107
4	0.41	0.50	53	130	540
5	0.40	0.79	68	253	1795
6	0.38	0.81	56	183	1257
7	0.37	0.77	53	180	1240
8	0.36	0.80	48	141	957
9	0.36	0.77	51	138	1454
10	0.33	0.73	31	131	972
11	0.35	0.70	49	147	1394
12	0.35	0.77	37	180	1917
13	0.37	0.85	40	149	2068
14	0.37	0.75	22	131	1471
15	0.37	0.67	28	138	1221
16	0.38	0.74	37	138	1703
17	0.34	0.71	32	142	1812
18	0.39	0.77	53	153	1728
19	0.35	0.88	40	118	1082
20	0.34	0.72	39	170	1178
21	0.38	0.69	39	170	2221
22	0.29	0.55	41	95	910
23	0.29	0.55	39	97	842
24	0.37	0.73	44	147	1277
25	0.34	0.54	37	114	1020
26	0.35	0.55	42	112	626
27	0.31	0.61	36	104	734
28	0.32	0.63	50	108	828
29	0.35	0.58	51	107	1102
30	0.40	0.87	57	103	910

* - 1978 data only - données de 1978 seulement - datos de 1978 solamente.

than the other groups while the Red group displayed Mg deficiency symptoms more clearly than the other varieties. The plants were spaced 3 m x 3 m. If 25 mm of rain was not received each week then 25 mm of irrigation water was applied by overhead sprinklers.

Leaf samples were taken 12 and 24 months after planting. Nutrient deficiency symptoms were not apparent at sampling time. The first sample was from the plant crop while the second was from the ratoon 1 crop. A 15 cm wide

strip was taken from the centre of the third youngest leaf and from each side of the midrib. The sample from the five plants was bulked and the concentration of N (Kjeldahl method with selenium catalyst), P (auto-catalyser), K, Ca, Mg, Na, Mn, Fe, Cu, Zn (atomic absorption spectroscopy), S (x-ray fluorescence), Cl (titration), Al (spectro fluorimetry), B (colorimetry) and Mo (toluene - 3.4 - dithol method) measured in the dry matter.

TABLE 5 - Concentration of Cu, Zn, B and Mo in leaf III dry matter of a range of banana varieties at Alstonville, N.S.W. Values are means of samples taken in November 1977 and November 1978.

Concentrations de Cu, Zn, B and Mo dans la matière sèche de la feuille III sur une série de variétés de bananier à Alstonville, N.S.W. Les valeurs sont les moyennes des échantillonnages de novembre 1977 et novembre 1978

Concentraciones de Cu, Zn, B and Mo en la materia seca de la hoja III en una serie de variedades de plátano en Alstonville, N.S.W. Los valores son los promedios de los muestreos de noviembre 1977 y noviembre 1978.

Variety Code	ppm			
	Cu	Zn	B	Mo
1	13	34	12	0.08
2	10	23	15	0.06
3	11	24	15	0.06
4	5	13	19	0.15
5	13	21	15	0.15
6	12	18	17	0.17
7	12	16	16	0.28
8	12	16	16	0.21
9	12	17	16	0.20
10	12	27	16	0.22
11	12	17	16	0.16
12	12	17	19	0.16
13	12	17	17	0.14
14	12	16	17	0.13
15	12	17	17	0.13
16	13	18	18	0.07
17	12	16	16	0.07
18	12	17	18	0.07
19	12	18	14	0.13
20	14	21	12	0.16
21	12	16	16	0.15
22	10	14	15	0.09
23	9	15	14	0.12
24	10	15	20	0.10
25	10	16	16	0.16
26	9	17	12	0.04
27	8	14	17	0.05
28	7	15	17	0.04
29	7	15	18	0.08
30	9	21	14	0.14

RESULTS AND DISCUSSION

Because there were only five plants of each variety in the observation plot and they were not randomly planted, precise comparisons of differences between varieties cannot be made. With this in mind, the results can give only a very general indication of differences between varieties.

Growth measurements (plant height at bunching) and yield are given in Table 2. The height measurements refer to the plant crop only. The Mg and Zn deficiency effects

seen earlier in the life of the plant may have reduced plant height and yield, although these effects could not have been large as fruit production was normal for this environment and plant density. The two leaf samples therefore come from healthy specimens of each variety.

Variety 4 (*Musa balbisiana*) had lower concentrations of N, P, S, K, Mn, Cu and Zn than other wild of Cavendish group bananas. This effect carried over to varieties with a *balbisiana* component (AAB, ABB) for N, P, K, Mn, Cu and to a lesser extent Zn. Within the AAA groups the Red group

TABLE 6 - Change in concentration of nutrients in leaf III dry matter from first to second sampling over all 30 varieties.

Différences de concentration en éléments nutritifs dans la matière sèche de la feuille III entre le premier et le second échantillonnage, sur l'ensemble des 30 variétés.

Diferencias en la concentración de los nutrientes en la materia seca de la hoja III del primer al segundo muestreo, en las 30 variedades juntas.

Element	Mean concentration		t	percent change
	1977	1978		
N (%)	3.67±0.04	3.43±0.09	3.93**	-7
P (%)	0.21±0.002	0.20±0.004	3.11**	-5
S (%)	0.27±0.004	0.26±0.008	3.88**	-4
K (%)	3.41±0.06	2.86±0.07	9.16**	-16
Ca (%)	0.82±0.04	0.65±0.03	5.96**	-21
Mg (%)	0.35±0.01	0.36±0.01	1.19	
Al (ppm)	68±3	23±3	11.85**	-66
Fe (ppm)	149±5	131±9	2.72*	-12
Mn (ppm)	962±54	1567±116	6.49**	+63
Cu (ppm)	10.6±0.4	10.7±0.4	0.63	
Zn (ppm)	18.0±0.9	17.5±0.9	0.64	
B (ppm)	13.1±0.1	18.4±0.7	6.22**	+40
Mo (ppm)	0.16±0.02	0.09±0.01	5.26**	-44
Cl (%)		0.73±0.03		

* - significant at P = 0.05

** - significant at P = 0.01

had lower concentrations of N, P, S, Mg, Fe, Mn and Cu than the Cavendish group (Tables 3, 4 and 5).

Within the Cavendish group (Varieties 5 - 18) trends were less obvious, effects being apparent only at the extremes of height encountered. Extreme dwarfing (variety 5) increased the concentration of N, P, S, K, Ca, Mg, Fe and Al. The tallest variety (17) had lower Ca and possibly lower Mg and Mo concentrations than the shorter Cavendish varieties but differences in other elements were small (Tables 3, 4 and 5).

Most commercial varieties fall within the Robusta (variety 18) and Giant Cavendish groups (variety 7 - 16) and since differences in concentrations are small detailed experimentation will be needed to establish the differences more precisely.

Sodium concentration (0.01 percent) did not differ between varieties.

Over all varieties concentrations of N, P, S, K, Ca, Al, Fe, Mn, B and Mo changed from the first sampling date to the second (Table 6). The decrease in N, P and S, while statistically significant, was small. The largest changes were in Al which decreased 66 percent and Mn which increased 63 percent. Mg, Cu and Zn showed no significant changes.

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