Contents of Eight Nutrients in Central Stem Leaf Segments of Ten Peanut Cultivars and Lines[1]

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ABSTRACT

Petioles and blades of central stem leaves of 10 peanut (**Arachis hypogaea L.**) cultivars or lines grown in fertilized field plots in 1972 and 1973 and the last of four consecutive crops grown in pots during 1971 to 1973 were analyzed for evidence of relative differences in nutritional requirements. Runner-types included were Florigiant, Florunner, Va. 72R, NC 5, Avoca 11, and Va. 61R and bunch-types were NC 17, NC-Fla. 14, Va. 68 Composite, and Va. 70 Composite. The peanuts were grown in Woodstown (Aquic Hapludult) loamy fine sand.

Significant (5% level) differences among cultivars or lines occurred in the K, Ca, and Mg contents and not in the P, B, Mn, Zn, and Cu contents of leaf portions of peanuts grown in the field. However, none of the cultivars or lines contained markedly higher or lower contents of any nutrient considered. Lines Va. 68 Composite and Va. 70 Composite and the cultivar Avoca 11 had not been evaluated in similar previous research. These generally were intermediate or higher in contents of the nutrients, except the Mg content of Va. 70 Composite petioles was lower than in most cultivars or lines but equivalent to NC 5 and Va. 72R. Petioles were higher in K and Mg contents, whereas the blades were higher in P, Ca, B, Mn, Zn, and Cu contents.

Continuous cropping of soil in the pots did not develop any apparent restrictive levels of nutrient availability. Hence, the fourth crop was not subjected to nutritional conditions for elucidation of abnormal nutrient-uptake capabilities among cultivars or lines.

Florigiant, Va. 72R, and NC-Fla. 14 cultivars were labeled as superior in yield potential in Virginia in previous research. Portions of these cultivars were highest 25%, intermediate 50% and lowest 25% of the cases, in contents of one or more of the eight nutrients of both field and pot-grown plants.

The average contents of the nutrients in leaf portions of the bunch or runner type cultivars or lines were similar.

The productivity of peanuts (*Arachis hypogaea* L.) like many crops, has been increased considerably by development of new cultivars having superior yield capability. Nutrient requirements and utilization efficiencies of new lines and cultivars may vary with productivity potentials.

Nutrient content of various plant parts varies considerably during development of peanuts (1,2, 3,5,9). When grown under nutrient sufficiency conditions (5,6,9), no definite relationship between yield level or apparent yield potential of many cultivars or lines and nutrient content of the plant portions was noted. However, in one study (7), the Mg and Mn contents of petioles and blades were considerably higher in some cultivars with high yield potentials.

This paper presents the average contents of eight nutrients in petioles and blades of central stem leaves of 10 peanut cultivars or lines grown in fertilized field plots in 1972 and 1973. Similar data are presented concerning the last of four consecutive crops grown in pots which were not fertilized. Two lines, 'Va. 68 Composite' and 'Va. 70 Composite', and one cultivar, 'Avoca 11' had not been evaluated previously (7). This research was part of a project to evaluate differences in nutritional requirements of new peanut lines and cultivars.

Materials and Methods

This research was conducted at the Tidewater Research and Continuing Education Center, Holland Station, Suffolk, Va. during 1971-73. Peanuts were grown on Woodstown loamy fine sand, classified as Aquic Hapludult (fine loamy, siliceous mesic), in both the field and the pot studies. Phosphorus, K, B, Mn, Zn, and Cu at rates of 149, 560, 2.2, 5.6, 16.8 and 5.6 kg/ha, respectively, were broadcast on the field plots and disked in prior to planting. Peanuts grown in the pots were not fertilized.

Cultivars and lines included were 'Florigiant', 'Florunner', 'Va. 72R', 'NC 5', Avoca 11', and 'Va. 61R' which are botanically runner types and 'NC 17', 'NC-Fla. 14', Va. 68 Composite, and Va. 70 Composite which have a bunch type habit of growth.

Thiram-treated seeds of these cultivars and lines were machine-planted in mid-May each year. The rows were 91 cm apart with plants spaced about 15 cm apart. Four Thiram-treated seeds were hand-planted in the pots of the continuous cropping experiment and later thinned to one plant per pot. Neither gypsum nor fungicides containing Cu or S was applied in either the field or pot studies.

Each plot or pot represented a different peanut cultivar or line. The field plots were 3.64 m (4-rows) wide and 4.57 m long. In the continuous cropping experiment, large pots (drums) lined with plastic and containing 135 kg of soil obtained from a single lot were used for the first three crops of peanuts in 1971-72. Earthenware pots 30 cm in diameter filled with 17 kg of cropped soil (surface 20 cm) stockpiled and mixed from the large pots was used for the fourth crop. All crops were grown outside subject to natural precipitation (supplemented occasionally) except for the last three months of growth of the second crop which was completed in the greenhouse in 1971. No crop was grown in the pots during the winter of 1972-73. Growth and development of all crops in the field and in pots appeared normal. Treatments (cultivars and lines) in the field and pot experiments were arranged in randomized complete block designs replicated four times.

Foliar samples were taken near maturity. The main stem branches from 10 or more plants per field plot and all branches from the pot experiment were thoroughly washed in distilled and deionized water. Leaves of these branches were removed and separated into blades and petioles. The samples were dried at 70 C and finely ground in a blendor and/or small mill, both stainless steel, and then stored in soft glass bottles until analyzed.

Dry (70 C) 1-g subsamples of leaf tissue were ashed at 450 C for 2.5 hours and the nutrient constituents of the ash dissolved in 100 ml of 0.5 N HNO_3. Contents of K, and Ca and Mg in solution were determined by flame emission and atomic absorption spectrophotometry, respectively, and P contents by an ammonium vanadate procedure (8). Another 1-g subsample of dry leaf tissue

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was ashed at 450 C for 2 hours in preparation for Mn, Zn, and Cu determinations. The ash was shaken for 1 hour with 15 ml of 6 N HCl and filtered. The filtrate was dried and the resulting precipitate dissolved in 15 ml of 0.5 N HCl. Contents of Mn, Zn and Cu in the acidic solution were determined by atomic absorption spectrophotometry. Total B in the dry tissue was determined by a curcumin procedure (10).

Soil samples, obtained from the field plots (plow layer) and pots when peanuts were harvested, were analyzed for pH and contents of dilute HCl-H_2SO_4 extractable P, K, Ca and Mg by rapid soil-testing procedures (11). Contents of Cu, Mn, and Zn were extracted by shaking 5 g of soil with 50 ml of 0.1 N HCl for 1 hour. A 25-ml aliquot of the acidic solution was dried on a steam plate, and the resulting precipitate was dissolved in 15 ml of 0.5 N HCl and filtered. Concentrations of these elements were determined by atomic absorption spectrophotometry. Hot water soluble B extracted by refluxing 10 g of soil for 10 minutes with 20 ml of deionized water was determined by a curcumin procedure (10).

Statistical methodology utilized was analysis of variance and Duncan's Multiple Range Test (4). Cited differences are significant at the 5% level.

Results

WEATHER-SOIL ANALYSES

Seasonal (May to September) precipitation during 1971, 1972, and 1973 was 64.3, 61.7, and 50.6 cm, respectively. A deficit of 12.2 cm in 1973 did not cause abnormal crop growth and development. Air temperatures were near normal during all three growing seasons.

Soil analyses of the field plots and continuously cropped pots are given in Table 1. Although four crops were grown in the pots without fertilization, Ca, P, B, Zn, and Cu contents were somewhat higher than in the field plots. Contents of soil Mg, K and Mn were higher in the field plots. No visual nutrient deficiencies were observed in the peanuts grown in either environment.

Table 1. Analyses of the Woodstown loamy fine sand in the field and pot experiments.

Chemical Property	Field	Pots
pH	5.8	6.3
Dilute HCl-H_2SO_4 Extractable P, kg/ha	115	140
Dilute HCl-H_2SO_4 Extractable K, kg/ha	172	115
Dilute HCl-H_2SO_4 Extractable Ca, kg/ha	1025	1390
Dilute HCl-H_2SO_4 Extractable Mg, kg/ha	160	60
0.1 N HCl-extractable Cu, ppm	1.6	2.7
0.1 N HCl-extractable Zn, ppm	3.0	5.8
0.1 N HCl-extractable Mn, ppm	4.1	1.5
Hot water soluble B, ppm	0.56	0.75

P, K, CA, MG CONTENTS

These nutrient contents in the petioles and blade portions of leaves of 10 peanut cultivars or lines grown in two environments are given in Tables 2 & 3. The P content in the blades was higher than in the petioles of both field and pot-grown peanuts. Relative P contents were higher in the field than in the pot-grown peanut leaf portions (4th crop). No difference among cultivars and lines was found in P contents of similar leaf portions for either growth environment.

In contrast to P, K contents of the petioles were higher than in the blades of peanuts grown in pots or field plots. Relative contents of either portion were higher in field-grown peanuts than in pot-grown peanuts. Differences in K contents of petioles and blades occurred among cultivars and lines produced in the field. The K contents of Florigiant and Avoca 11 petioles were higher and those in Florunner and Va. 61R lower than most

Table 2. Nutrient contents in portions of leaves (mature stage) of the last of four consecutive crops of 10 peanut cultivars and lines grown in pots, 1971-73.

Nutrient	Leaf Section	NC 17	NC-Fla. 14	Va. 72R	Florunner	Florigiant	Va. 70 Composite	Va. 61R	Avoca 11	Va. 68 Composite	NC 5	Mean*
P, %	Petioles	0.04	0.06	0.10	0.10	0.08	0.06	0.10	0.12	0.10	0.10	0.09B
	Blades	0.14	0.20	0.18	0.18	0.17	0.20	0.24	0.24	0.24	0.20	0.20A
K, %	Petioles	1.84	2.24	1.71	1.84	1.76	1.62	2.12	1.60	1.35	1.08	1.72A
	Blades	1.05	1.40	1.19	1.09	1.19	1.14	0.89	1.22	1.10	1.03	1.13B
Ca, %	Petioles	3.37	3.55	3.02	3.36	2.88	2.52	2.77	2.66	2.72	3.32	3.02B
	Blades	3.13	3.60	3.10	2.97	3.00	3.23	3.38	2.85	2.94	3.43	3.16A
Mg, %	Petioles	0.80	0.87	0.66	0.73	0.88	0.72	0.74	0.76	0.91	0.92	0.80A
	Blades	0.32	0.41	0.39	0.37	0.43	0.35	0.34	0.28	0.41	0.27	0.36B
B, ppm	Petioles	41	40	41	39	38	39	38	38	36	36	39B
	Blades	147	150	112	131	134	123	122	130	142	98	129A
Mn, ppm	Petioles	5	7	9	5	3	3	8	11	7	14	7B
	Blades	26	24	25	10	17	20	22	24	17	22	21A
Zn, ppm	Petioles	45	44	72	54	50	44	47	60	54	46	52
	Blades	45	54	67	48	60	45	51	52	57	57	54
Cu, ppm	Petioles	4.7	7.1	4.7	5.7	4.3	3.4	6.7	5.2	6.1	6.0	5.4
	Blades	6.6	6.8	5.5	8.1	6.7	6.0	6.0	7.0	5.6	6.6	6.5

*Means followed by all unlike letters differ significantly (5% level).

Table 3. Nutrient contents in portions of leaves (mature stage) of 10 peanut cultivars and lines grown in the field, 1972 and 1973.

Nutrient	Leaf Section	NC 17	NC-Fla. 14	Va. 72R	Flo-runner	Flori-giant	Va. 70 Composite	Va. 61R	Avoca 11	Va. 68 Composite	NC 5	Mean
P, %	Petioles	0.14	0.16	0.15	0.16	0.16	0.13	0.16	0.16	0.16	0.15	0.15B
	Blades	0.24	0.24	0.25	0.23	0.24	0.22	0.26	0.24	0.24	0.24	0.23A
K, %	Petioles	3.98ab	3.73bc	3.77bc	3.54c	4.34a	3.88b	3.60c	4.39a	3.82bc	3.87b	3.89A
	Blades	1.82b	1.60bc	1.59bc	1.55bc	1.40a	1.72b	1.70b	2.08a	1.57bc	1.40c	1.64B
Ca, %	Petioles	1.96b	2.25ab	2.30ab	2.06b	2.00b	2.24ab	2.42a	2.16ab	1.93b	2.42a	2.17B
	Blades	2.75ab	2.76ab	2.87a	2.70ab	2.66b	2.70ab	2.90a	2.58b	2.56b	2.79ab	2.73A
Mg, %	Petioles	1.07c	1.26b	1.18bc	1.42a	1.17bc	1.07c	1.15bc	1.04c	1.11c	1.10c	1.16A
	Blades	0.66b	0.62b	0.59bc	0.73a	0.72a	0.54c	0.60b	0.64b	0.66b	0.49c	0.62B
B, ppm	Petioles	24	26	24	27	24	25	23	25	24	24	25B
	Blades	51	54	44	44	52	50	36	48	48	42	47A
Mn, ppm	Petioles	10	14	12	14	14	14	12	12	12	13	13B
	Blades	24	30	28	32	23	32	28	30	26	30	28A
Zn, ppm	Petioles	18	19	21	25	22	25	20	20	20	22	21B
	Blades	22	22	26	23	24	26	25	24	23	24	24A
Cu, ppm	Petioles	4.5	5.1	5.0	5.2	5.2	4.6	5.4	5.0	4.4	5.0	5.0B
	Blades	6.0	6.7	6.5	6.6	6.1	5.8	6.0	6.7	5.9	6.2	6.2A

Means followed by all unlike letters differ significantly (5% level). Compare means followed by small letters horizontally and by capital letters between leaf parts in each case only.

cultivars and lines. Avoca 11 blades were higher in K, whereas K levels in Florigiant and NC 5 blades were lower than most other cultivars or lines. Relatively large differences in K content of petioles of pot-grown peanuts occurred but were not significant within the limits imposed.

The blades were higher in Ca content than the petioles whether grown in pots or in the field. However, the difference was greater between the two portions produced in the field, although Ca contents were higher in pot-grown portions, generally. Differences in Ca contents of petioles or blades occurred among cultivars or lines which were field-grown. Va. 61R petioles and blades were higher, whereas Florigiant and Va. 68 Composite portions were lower than most cultivars or lines in Ca content. Also, NC 5 petioles and Va. 72R blades were higher, whereas Avoca 11 blades were lower in Ca content than most other cultivars or lines.

The Mg content of the petioles averaged about double that in the blades of peanut leaves whether grown in the field or pots. Magnesium contents of petioles and blades were higher than for pot-grown leaf portions and varied among cultivars or lines only when grown in the field environment. The blades of Florigiant and both the petioles and blades of Florunner were higher, whereas both portions of NC 5 and Va. 70 Composite were lower in Mg content than most cultivars or lines. The Mg contents of petioles of NC 17, Avoca 11, and Va. 68 Composite were lower than in most cultivars or lines.

B, Mn, Zn, and Cu Contents

The B, Mn, Zn, and Cu contents of the petioles and blade portions of leaves of 10 peanut cultivars or lines grown in two environments are given in Tables 2 & 3. Contents of any of these micronutrients were similar among cultivars or lines. Micronutrient contents of blades exceeded that in the petioles in each case, except for Zn and Cu contents of leaf portions of peanuts grown in pots. Leaf portions of peanuts grown in the field were higher in Mn and lower in B and Zn contents than in pot-grown peanuts. Contents of Cu were similar in plants grown in either environment.

Discussion

None of the cultivars included in this study contained markedly higher or lower contents of the eight nutrients considered. The lines Va. 68 Composite and Va. 70 Composite and the cultivar Avoca 11 had not been evaluated previously (7). Generally these were intermediate or higher in contents of the nutrients considered except in Mg content of Va. 70 Composite petioles. However, the Mg content of the petioles of this line was similar to that in NC 5 and Va. 72R (Tables 2 and 3).

Nutrient contents of leaf portions of peanuts grown in pots, although not significantly different among cultivars or lines, varied relative to that in comparable field-grown portions where significant differences occurred. Among the field-grown group, Florigiant and Avoca 11 were highest and Florunner lowest in average K content, whereas NC-Fla. 14 was highest and NC 5 lowest among the pot-grown group. Va. 61R and NC-Fla. 14 were highest in Ca content among the field and pot-grown groups, respectively, whereas several were lowest in both cases. Relative differences among the cultivars or lines in average Mg contents of the leaf portions were more consistent between the two growth environments.

Previously (6), Florigiant, Va. 72R, and NC-Fla. 14 were labeled as superior in yield potential. Leaf portions of Florigiant grown in the field were among the highest in contents of one or more of the eight nutrients (Table 2) in only 3 of 16 cases (2 portions X 8 nutrients) and were among the lowest in 4 of 16 cases. Va. 72R and NC-Fla. 14 were each among the highest in these nutrient contents in 2 of 16 cases and lowest in 0 and 1 of 16 cases, respectively. However, Va. 72R leaf portions grown in pots were among the lowest in content of any 1 of the 8 nutrients in 3 of 16 cases, and NC-Fla. 14 was among the highest in 10 of 16 cases. Although NC-Fla. 14 is a bunch type cultivar, average contents of the portions for the four bunch types were similar to that for the runner type cultivars or lines grown in either environment.

The petioles of central stem leaves were higher in K and Mg, whereas the blades were higher in P, Ca, B, Mn, Zn, and Cu contents.

Continuous cropping of the pots by the cultivars and lines studied did not develop any apparent restrictive levels of nutrient availability. Hence, the plants apparently were not subjected to sufficient nutrient uptake stress to effectively compare the performance of these cultivars and lines under nutrient deficiency and nutrient sufficiency environments. Some of the differences in nutrient contents of peanuts between environments probably were related to differences in soil nutrient levels. Reduction of the levels of available nutrient in the pots through cropping or dilution of the media with infertile sand will help elucidate nutritional weaknesses of new cultivars and lines in future research.

Literature Cited

1. Bledsoe, R. W. and H. C. Harris. 1950. The influence of mineral deficiency on vegetative growth, flower and fruit production and mineral composition of the peanut plant. Plant Physiol. 25:63-77.
2. Burkhart, Leland and N. R. Page. 1941. Mineral nutrient extraction and distribution in the peanut plant. J. Am. Soc. Agron. 33:743-755.
3. Cox, F. R. and P. H. Reid. 1964. Calcium-boron nutrition as related to concealed damage in peanuts. Agron. J. 56:173-176.
4. Duncan, D. B. 1955. Multiple range and multiple F tests. Biometrics 11:1-42.
5. Hallock, D. L., D. C. Martens, and M. W. Alexander. 1969. Nutrient distribution during development of three market types of peanuts. I. P, K, Ca, and Mg contents. Agron. J. 61:81-85.
6. ________________. 1971. Distribution of P. K, Ca, Mg, B, Cu, Mn, and Zn in peanut lines near maturity. Agron. J. 63:251-256.
7. Hallock, D. L., D. C. Martens, and P. H. van Schaik. 1972. Comparative nutrient composition of lateral versus central branch leaves of 10 Virginia variety peanut lines and cultivars. J. APREA 4:130-144.
8. Jackson, M. L. 1958. Soil Chemical Analysis. Prentice Hall, Inc., Englewood Cliffs, N. J.
9. Martens, D. C., D. L. Hallock, and M. W. Alexander. 1969. Nutrient distribution during development of three market types of peanuts. II. B, Cu, Mn, and Zn contents. Agron. J. 61:85-88.
10. Mulford, F. R. and D. C. Martens. 1970. A simple procedure for drying solutions for boron determinations by the curcumin method. Soil Sci. Soc. Amer. Proc. 34:155-156.
11. Rich, C. I. 1955. Rapid soil testing procedures at Virginia Polytechnic Institute. Virginia Agr. Exp. Sta. Bull. 475. 8p.