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influence of nitrogen, phosphorus and potassium rates on the mineral composition of the leaves of the azalea variety ambrosius

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reprint from: potassium inst., colloq. proc. no. 2 (1972)

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As K rates in excess of the 2nd level had little effect on flower yield (Table 4), the 2nd K rate may be judged optimum, corresponding with 0·70% K in leaves. Compared with other ornamental crops, such as roses having an optimum K in leaves three times as large or chrysanthemums having an optimum K in leaves more than 5 times as large, azaleas seem to have a remarkably low optimum K in leaves.

Table 4—*Plant diameter, flower yield and leaf colour of azalea variety Ambrosius for the N, P and K series.*

Order of fertilizer level	Plant diameter, cm			Flower buds per plant			Leaf colour*		
	N	P	K	N	P	K	N	P	K
1	19·3	21·9	22·5	26·4	32·4	27·8	2·1	3·0	3·0
2	21·8	22·5	23·8	29·4	31·2	31·8	2·6	3·0	3·0
3	22·5	23·0	23·1	29·6	37·5	30·8	2·9	2·8	3·0
4	22·3	22·0	22·5	31·2	33·2	29·4	3·0	2·8	3·0
5	22·1	22·9	22·4	29·9	35·2	33·1	3·0	2·9	2·9
6	22·4	22·3	22·8	32·6	31·9	29·8	3·0	2·9	3·0

*Scale: 1=very light; 2=light; 3=normal: 4=dark; 5=very dark

Calcium and magnesium decreased somewhat at the higher K levels. The other mineral contents in leaves showed no influence of K application.

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1 ARNOLD BIK, R. (1966). *Proc. 8th Congr. int. Potash Inst., Brussels,* 119-204.

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Potassium Institute Ltd.
Colloquium Proceedings No. 2. 1972.

Influence of Nitrogen, Phosphorus and Potassium Rates on the Mineral Composition of the Leaves of the Azalea Variety Ambrosius

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Summary

A trial with the cultivar "Ambrosius" in beds was carried out to study the effect of varying rates of N, P and K applications on the mineral composition of azalea leaves.

Total N content in leaves increased distinctly with N rate, as did P with increasing P rate. K content rose markedly, when increasing K supply from the 1st to the 2nd level; on increasing K supply further, however, leaf K rose at a much lower rate.

Optimum total N, P and K in leaves were found to be 2·19%, 0·18% and 0·70%, respectively.

It is concluded that the contents of total N, P and K in leaves are useful for indicating the N, P and K status of azaleas.

Introduction

Azaleas are usually grown outdoors from the end of May to the end of September. Because of this comparatively short period of growth much attention should be paid to proper fertilizing.

Since foliar diagnosis has proved useful in evaluating the nutritive status of many crops, its use should be considered for azaleas. The use of leaf analysis as a guide in fertilizing azaleas, however, requires knowledge of the extent to which mineral leaf contents respond to changes in the nutritional levels of the growing medium.

This paper presents the results of a trial designed to study the effects of nitrogen, phosphorus and potassium on the mineral composition of azalea leaves.

Materials and Methods

A trial carried out in 1966 included a series of six N rates, a series of six P rates and a series of six K rates, as indicated in Tables 1, 2 and 3.

The treatments were replicated three times, a unit consisting of nine plants.

Nutrients not under test were supplied at 72 g N, 18 g P_2O_5 and 36 g K_2O per m^2. All the treatments received 12 g MgO per m^2, minor elements being added in ample amounts.

The fertilizers were applied as liquid feeds, and the following chemicals were used in the solutions:

N series: N as NH_4NO_3; P as KH_2PO_4; K as KH_2PO_4 and K_2SO_4.
P series: P as $NH_4H_2PO_4$; N as $NH_4H_2PO_4$ and NH_4NO_3; K as K_2SO_4.
K series: K as K_2SO_4; P as $NH_4H_2PO_4$; N as $NH_4H_2PO_4$ and NH_4NO_3.
For all the three series Mg was added as $MgSO_4.7H_2O$.

One-year-old root cuttings of Ambrosius were set out in beds filled with frozen decomposed sphagnum peat, on June 6th.

Irrigation was with rather hard canal water, containing 6·7 meq HCO_3, 3·3 meq SO_4, 2·3 meq Na and 3·0 meq Cl per litre.

At the end of the growing season samples of recently matured leaves were collected to be analysed for total N, nitrate, P, S, Cl, K, Na, Ca and Mg.

Results and Discussion

N Series

As shown in Table 1, total N content in leaves increased markedly with N rate within a range sufficiently wide to use total N in leaves as a satisfactory measure of the N status of the plant. In Table 4 it can be seen that increasing

Table 1—*Effect of nitrogen rates on the mineral leaf composition of the azalea variety Ambrosius*

g N/m²	Per cent of dry weight								
	total N	nitrate	P	S	Cl	K	Na	Ca	Mg
18	1·40	0·03	0·22	0·31	0·29	0·67	0·07	0·96	0·29
36	1·67	0·01	0·17	0·36	0·39	0·63	0·08	0·91	0·31
54	1·97	0·02	0·16	0·33	0·36	0·71	0·06	0·74	0·25
72	2·19	0·02	0·15	0·33	0·42	0·70	0·07	0·77	0·28
90	2·33	0·02	0·15	0·34	0·45	0·76	0·07	0·74	0·25
108	2·42	0·03	0·15	0·32	0·41	0·74	0·08	0·67	0·23

N above the 4th level scarcely raised flower yield, plant diameter and leaf colour. Since, in addition, a N application similar to the 4th level proved optimum in an earlier trial[1], it seems permissible to consider this the optimum. The corresponding total N in leaves was 2·19%, a value almost identical with that found earlier. Apart from a slightly lighter colour, azalea leaves at the lowest N rate showed no visible signs of N deficiency.

Nitrate in leaves did not appear to be affected by N rate. So, unlike grapes[2] total N in leaves seems more appropriate as an index of N status than nitrate for azaleas.

The levels of other constituents in leaves were as follows:

P tended to decrease slightly with N rate, at least in the lower range; S was normal; Cl, though rather high, may be regarded as normal for azaleas irrigated with water containing an amount of chlorine as large as in this case. K was about the optimum value found in the K series. Na was low, even more so if compared with Ca, and considering the small difference in concentration between the two ions in the irrigation water. This finding may suggest a preference of azaleas for Ca and a certain ability to resist the influx of Na.

Ca in leaves was found to be high, undoubtedly due to the presence of Ca in the irrigation water. Another remarkable feature was its continuous decrease with N rate, which might be attributed to the competing effect of NH_4, NH_4NO_3 being used as N source. Such a depressive influence on NH_4 may be expected to arise from applying NH_4—N at a low pH in the medium[3], a condition tending to inhibit the nitrification of NH_4—N. In this connection it may be noted that the initial pH (water) of the azalea substrate was 3·8.

Regarding the competitive action of NH_4 it is of interest to consider also the organic salt content in leaves. If total cations (C) is equal to K + Na + Ca + Mg and total inorganic anions (A) is equal to NO_3 + H_2PO_4 + SO_4 + Cl, C and A both being expressed in meq per kg dry matter, then (C—A) is equal to organic salts[4].

Organic salt content or (C—A) content must be regarded as an important growth criterion as well as a valuable test of ionic balance in plants. The (C—A) contents of azalea leaves, as calculated from the data of Table 1, were in increasing order of N rate: 627, 578, 500, 535, 502 and 473 meq per kg dry matter, respectively. Neglecting the slight irregularity at the 4th N rate, the (C—A) content did clearly reflect the competitive effect of NH_4. Reduction of (C—A) content resulted from a decreasing C, A remaining fairly constant. This result confirms earlier findings with gloxinia and chrysanthemum[8]. On account of the values found, the normal (C—A) content for azalea leaves may be estimated as lying between 500 and 535 meq per kg dry matter, which is about one third the value found for gloxinia and less than one half the value found for chrysanthemum. Obviously, the organic salt content of azaleas is unusually low, thus exhibiting a characteristic ionic behaviour of this plant species.

Finally, Mg in leaves was normal.

P series

As shown in Table 2, P in leaves increased consistently over a fairly wide range with P rate. Consequently, P in leaves seems suitable as an index of P status in azaleas. The 3rd P level having yielded the largest number of flowers (Table 4), the optimum P in leaves may be estimated at 0·18 %.

Table 2—*Effect of phosphorus rates on the mineral leaf composition of the azalea variety Ambrosius*

g P_2O_5/m^2	Per cent of dry weight								
	total N	nitrate	P	S	Cl	K	Na	Ca	Mg
6	2·23	0·03	0·11	0·34	0·40	0·78	0·08	0·71	0·24
12	2·28	0·02	0·13	0·40	0·44	0·73	0·07	0·67	0·25
18	2·21	0·04	0·18	0·37	0·39	0·73	0·06	0·74	0·21
36	2·12	0·03	0·26	0·32	0·27	0·70	0·08	0·66	0·19
54	2·21	0·03	0·37	0·35	0·29	0·77	0·07	0·69	0·22
72	2·13	0·04	0·39	0·38	0·29	0·78	0·09	0·78	0·23

Total N in leaves was about the optimum value found in the N series. Ca in leaves did not appear to be affected by P rate, nor did the other constituents in leaves.

K series

As shown in Table 3, leaf K rose sharply when K application increased from the 1st to the 2nd level; beyond the 2nd level the rise of K in leaves was at a much lower rate. Nevertheless, on account of these results, K in leaves

Table 3—*Effect of potassium rates on the mineral leaf composition of azalea variety Ambrosius*

g K_2O/m^2	Per cent of dry weight								
	total N	nitrate	P	S	Cl	K	Na	Ca	Mg
12	2·40	0·03	0·17	0·37	0·38	0·45	0·07	0·78	0·30
24	2·23	0·04	0·18	0·36	0·44	0·70	0·10	0·88	0·27
36	2·11	0·05	0·16	0·38	0·39	0·71	0·08	0·72	0·25
48	2·19	0·03	0·17	0·39	0·44	0·80	0·08	0·83	0·27
60	2·15	0·03	0·15	0·38	0·37	0·87	0·07	0·78	0·24
72	2·15	0·02	0·15	0·38	0·40	0·83	0·06	0·64	0·23

may be regarded as promising to serve as an index of K status in azaleas.

As K rates in excess of the 2nd level had little effect on flower yield (Table 4), the 2nd K rate may be judged optimum, corresponding with 0·70% K in leaves. Compared with other ornamental crops, such as roses having an optimum K in leaves three times as large or chrysanthemums having an optimum K in leaves more than 5 times as large, azaleas seem to have a remarkably low optimum K in leaves.

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5	22·1	22·9	22·4	29·9	35·2	33·1	3·0	2·9	2·9
6	22·4	22·3	22·8	32·6	31·9	29·8	3·0	2·9	3·0

*Scale: 1=very light; 2=light; 3=normal: 4=dark; 5=very dark

Calcium and magnesium decreased somewhat at the higher K levels. The other mineral contents in leaves showed no influence of K application.

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