Reprint from: Potassium Symposium 1966
Published by: International Potash Institute, Berne/Switzerland

A. Influence of substrate and nitrogen on quality of azaleas

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1. *Introduction*

As to the specific nutrition requirements of azaleas *Twigg* and *Link [5]* stated that ericaceous species including azaleas have a low requirement for phosphorus, potassium, calcium and magnesium. *Preston et al. [3]* too could not find any appreciable effect of phosphorus and potassium on the growth of azaleas. On the other hand, they found a most beneficial effect of nitrogen on the production of cuttings.

As to the response of bud formation *Kipplinger* and *Bresser [1]* demonstrated that increased nitrate levels resulted into larger numbers of flower buds per plant. *Shanks et al. [4]* reported similarly; moreover they showed that low levels of phosphorus and potassium were adequate for best flower production.

For setting up a basis on which to advise growers on matters of fertilizing, experiments carried out under nursery conditions are needed. From the preceding data it is evident that these trials should begin by estimating the optimum rate of nitrogen supply. Other factors to be taken into account are the nature of the substrate and the method of fertilizing. Two experiments are summarized in this paper. These experiments will be referred to as: 1. Substrate, fertilizing method and nitrogen supply; 2. Date of pinching and nitrogen supply.

2. *Substrate, fertilizing method and nitrogen supply*

This report concerns a trial carried out in 1961 with azalea variety "*Paul Schäme*" and factorially designed as follows:

- Three substrates:
  S 0 coarse frozen decomposed sphagnum peat, S 1 fine frozen decomposed sphagnum peat, S 2 pine leaf mold.
  For simplicity frozen decomposed sphagnum peat will be referred to as frozen peat. A report on its physical properties has been presented by *Van Dijk* and *Boekel [6]*.
- Two methods of fertilizing:

B0 ⅓ part of the fertilizers as a dry basic dressing, ⅔ part as a repeated liquid topdressing; B1 no basic dressing, only repeated liquid topdressing.

– Four nitrogen levels:
N1 = 18 g, N2 = 36 g, N3 = 54 g, N4 = 72 g per m^2.

All treatments received 18 g P_2O_5, 36 g K_2O and 12 g MgO per m^2, these fertilizers being applied according to the fertilizing method designed for the treatment given. One-year old rooted cuttings were set out in beds in the open on May 26 according to a split-plot design with two replications of twenty plants each. The experiment was terminated on October 15. Several characteristics concerning growth and flowering were measured on the mature plants. Additionally a mark was given to each plant expressing an overall estimate of its quality. This quality rating was performed according to the usual market standards. Data for main effects of the treatments are

Table 1 Influence of substrate, fertilizing method and nitrogen on growth and flowering quality of azaleas

		Quality**	Plant-diameter cm	Plant-height cm	Size of leaf***	"Over-grown" shoots per plant	Flower buds per plant	Regularly shaped plants %	Leaf colour♦
Substrate	S0	8.4	21.1	12.6	5.9	0.42	32.3	60.5	3.3
	S1	8.3	21.6	12.4	6.0	0.46	30.6	61.1	3.5
	S2	8.3	22.6	14.0	6.3	0.53	30.5	49.3	3.3
S2–S0*		0	+	+	0	(+)	0	(+)	+
½ (S2 + S0)—S1		0	0	(+)	0	0	0	0	0
Fertilizing method	B0	8.3	21.5	13.0	6.0	0.49	31.1	57.3	3.5
	B1	8.4	22.0	13.0	6.1	0.44	31.1	56.7	3.5
B1—B0		0	++	0	0	0	0	0	0
N-level	N1	7.7	21.5	13.4	5.1	0.61	26.6	44.4	2.5
	N2	8.3	22.2	12.9	6.0	0.47	30.6	54.4	3.7
	N3	8.5	21.7	12.7	6.4	0.34	32.8	63.1	3.8
	N4	8.8	21.8	13.1	6.6	0.44	34.5	66.1	4.0
N-linear		++	0	++	++	+	++	++	++
N-quadratic		++	0	0	++	+	++	0	++

* 0 = not significant; (+) = significant at P = 0.10; + = significant at P = 0.05; ++ = significant at P = 0.01

** Scale: 3 = very poor; 5 = insufficient; 7 = proper; 9 = very good

*** Scale: 3 = small; 5 = almost normal; 7 = large; 9 = very large

♦ Scale: 1 = very light; 2 = light; 3 = normal; 4 = dark; 5 = very dark presented in table 1. The three substrates appeared to have given on the average the same results viz. judging from the quality of the plants.

Plants grown on pine leaf mold, however, had a larger plant diameter and height, but with a higher number of "overgrown" shoots (shoots with excessive length) and consequently a less regular plant shape than those grown on frozen peat.

Apparently frozen peat produced more compact growth than pine leaf mold. This difference in substrate behaviour is regarded as being related to a difference in physical properties. Pine leaf mold is noted for its high leachability, this promoting a low salinity. Frozen peat, on the other hand, possesses a high moisture retention along with a low permeability both contributing to salt accumulation in the substrate. As a result of this the soil solution of frozen peat will be higher concentrated than that of pine leaf mold, which accounts for the observed difference in growth. No difference was found between the two tested types of frozen peat.

The method of fertilizing had no marked effect upon plant growth, which is rather unexpected in view of the sensitivity of azaleas to salinity *[2]*. The plants with a dry basic dressing and subsequently a liquid topdressing showed only a slightly larger diameter than those liquid-fed from the beginning. The difference between the two treatments has presumably been too small to give a distinct effect. The outstanding effect found in this experiment, however, is that of nitrogen. Increasing the nitrogen level resulted into an improvement of both quality and leaf colour, a greater leaf size and more regularly shaped plants; furthermore, it reduced both plant height and number of "overgrown shoots". Nitrogen also proved to be highly beneficial to flower production which agrees with the results found by the previously mentioned authors *[1, 4, 5]*.

A distinct optimum for the response to nitrogen has not been attained in this experiment. The course of the nitrogen response curve, however, is such that the optimum point could not possibly lie far above the highest nitrogen level. For practical reasons, therefore, it seems permissible to regard a dosage of 72 g/m^2 as the optimum rate of nitrogen for azaleas. Significant interactions did not occur in this experiment. In the subsequent spring the plants were forced into bloom. The treatments did not show any effect upon the readiness of flowering.

3. *Date of pinching and nitrogen supply*

In a second experiment carried out in 1965 and chiefly intended to study the combined effect of nitrogen supply and date of pinching of the cuttings, an attempt was made to relate the quality of azaleas to the nitrogen content of leaves. The treatments consisted of combinations of four nitrogen levels being exactly the same as in the previous study: N1 = 18, N2 = 36, N3 = 54 and N4 = 72 g/m² and three pinching dates: March, April and May. One-year old cuttings of azalea variety "Ambrosius" were planted out in straight frozen peat according to a splitplot design with three replications. At the end of the trial samples of recently matured leaves were collected to be analyzed for their nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulphur and chlorine contents.

The relation between quality and nitrogen content of leaves for three pinching dates is presented graphically in figure 1. The quality of the azaleas

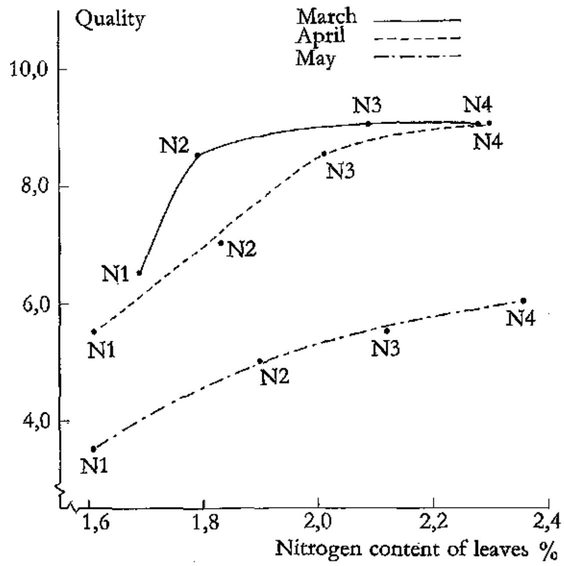

Fig. 1 Diagram of quality of azalea "Ambrosius" in relation to nitrogen content of leaves for each of the three pinching dates

has been estimated in the same manner as previously outlined. In the graph the corresponding nitrogen levels are denoted by N1, N2, N3 and N4.

As is shown in figure 1, quality is greatly reduced by postponing pinching of the cuttings particularly from April to May. Obviously, this treatment has retarded growth to such an extent that a satisfactory quality could no more be attained. As in the previous study quality has benefited much from increasing the nitrogen level. Figure 1 also shows that an increase of the nitrogen level resulted into a rise of the nitrogen content in the leaf. Evidently, pinching did not affect the accumulation of nitrogen in the leaf, nitrogen contents of leaves for the three pinching dates being practically alike at the same nitrogen level. On the other hand, quality does not appear to have responded similarly to the increase of nitrogen in the leaves for the three pinching dates. Actually the slopes of the curves in figure 1 indicates that as to quality, the nitrogen content of the leaves reached its optimum point at a lower level according as pinching date fell at an earlier date. From figure 1 the following optimum nitrogen contents in leaves can be derived: 2.1% for the plants pinched in March, 2.3% for the plants pinched in April and a value above 2.4% for the plants pinched in May. Moreover, the diagram shows that the optimum contents for the two earlier pinching dates were reached at the respective nitrogen levels 54 g and 72 g/m^2, the latter value being in close agreement with the optimum level of nitrogen from the previous study.

With regard to the effect of the pinching date upon the optimum nitrogen content of the leaves, though no satisfactory explanation can be advanced, pinching the cuttings at a later date is believed to produce plants of which the shoots having been formed at a later stage, are physiologically younger and, therefore, require higher nitrogen contents in their leaves.

Foliar analyses for the other nutrients did not show large variations resulting from different treatments. The range of the leaf contents was for phosphorus 0.19–0.20% (0.29%), for potassium 0.81–0.90% (0.80%), for magnesium 0.22–0.31% (0.17%), for calcium 0.76–0.90% (0.22%), the values between parentheses representing the critical levels from *Twigg* and *Link [5]*. Only phosphorus appeared to be lower than the corresponding critical level. However, apart from the total absence of phosphorus deficiency symptoms in the trial, treatments at adequate nitrogen levels showed such a vigorous growth that it may be considered highly improbable that phosphorus should have acted as a limiting factor. Therefore, the critical level of phosphorus for the azalea variety "Ambrosius" is more likely to be lower than the value given. More data from leaf analyses are sodium: 0.03–0.06%, chlorine 0.22–0.40% and sulphur 0.31–0.36%. The leaf contents of sodium and chlorine may be regarded as lying safely below the injurious levels.

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B. Quality of potted chrysanthemums in relation to their nitrogen and phosphorus contents when fertilized with certain slow release fertilizers

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1. *Introduction*

Potted chrysanthemums have only a very limited soil volume at their disposal, an unfavourable condition stressed by the noted high nutrient requirement of this species, particularly for nitrogen *[5]*. Consequently, the plants are apt to suffer from either nutrient shortage or salt excess. To compensate for this drawback special fertilizing techniques, such as frequent topdressing in soluble form, must be applied when using the conventional fertilizers. However, for the sake of saving labour it is desirable to apply a fertilizer in one single turn before planting, and still be sure that neither salt damage nor nutrient deficiency at any time up to maturity will be the consequence. In this regard some of the so-called slow release fertilizers, such as magnesiumammoniumphosphate *[6]* or crotonylidenediurea *[1* and *4]*, have given promising results. In 1965 an experiment was conducted to test the suitability of the mentioned slow release fertilizers for potted chrysanthemums. Some of the results with respect to quality are dealt with in this paper.

2. *Materials and methods*

The experiment included three different particle sizes ("coarse", "medium", "pinhead") of magnesiumammoniumphosphate* (m.a.p.) (8% N, 40% P_2O_5 and 14% MgO) and a fertilizer** containing 2.8% nitrate—N plus 25.2% N as crotonylidenediurea (c.i.u.). To compare these dressings with a conventional nitrogen fertilization the application of 800 mg N per liter substrate (320 mg N as ammoniumnitrate and the rest as urea) was included in the trial as the dressing considered optimal by the practical grower. All treat-

* commercial "Magamp" (Grace & Co., USA)
** commercial "Floranid" (BASF, West-Germany)