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

R. Arnold Bik
Institute for Soil Fertility, Groningen, Experimental Station for Floriculture, Aalsmeer, The Netherlands

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)

ments received 500 mg K_2O per liter substrate. Moreover, 400 mg P_2O_5 per liter was added to the c.i.u.-treatments and to the control. All the fertilizers were incorporated into the soil before planting. Rooted cuttings of chrysanthemum variety "Discovery" were potted on April 23 in clay pots (size 280 ml). The substrate used consisted of 1 part coarse sand plus 9 parts frozen decomposed spagnum peat (by volume). 5 g calciumcarbonate per liter was added to raise the pH to about 6.0. Each treatment was replicated twelvefold, placed according to a lattice design. The experiment was terminated on June 24, the average date of bloom for most treatments. Now were measured height and width of the plants, the number of head branches, the number of flowers and the intensity of leaf colour. Samples of the tops of the plant were collected for the determination of fresh and dry weight and of the content of certain major elements.

3. *Results and discussion*

Correlation coefficients calculated for each of the above properties of the plants except for leaf colour are presented in table 1.

Table 1 Correlation coefficient of fresh shoot weight per plant with other plant properties (n = 25 observations)

	Number of flowers	Plant height	Plant width	Number of head branches	Dry shoot weight per plant
Fresh shoot weight per plant	0.93	0.95	0.97	0.79	0.98

It is evident that the mentioned plant characteristics are intimately mutually correlated. Therefore it seems justified to use fresh shoot weight per plant as the measure of treatment response representing the other plant properties as well. The intensity of leaf colour serves as a second response criterion.

The relation between fresh shoot weight and nitrogen content of shoots for the various fertilizer treatment is presented graphically in figure 1. The type of fertilizer is denoted by a characteristic dot, the fertilizer rates by a number from 1 to 6. As can be seen from figure 1 the data for the various treatments are scattered round the same curve. The steep slope in the range below 2.9% N, corresponding with rates less than 10 g m.a.p. per liter, indicates a high nitrogen response and confirms the high requirement of chrysanthemums for nitrogen *[5]*. A further increase of m.a.p. to 12 g/l,

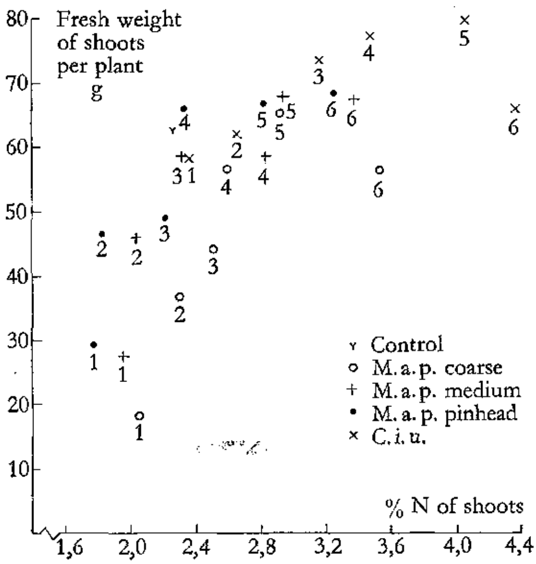

Fig. 1 Relation between fresh shoot weight per plant and nitrogen content of shoots

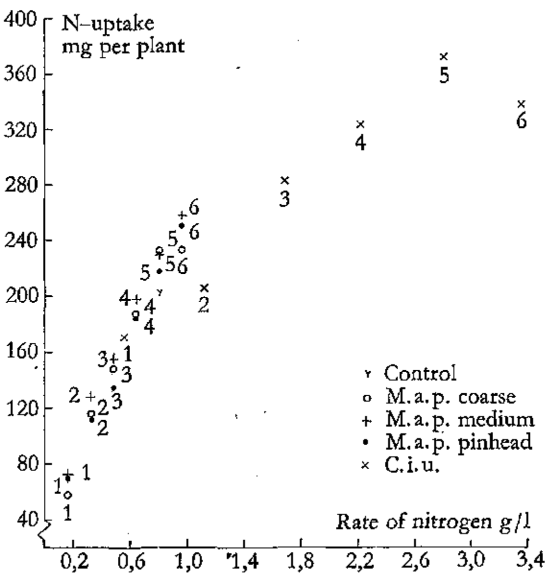

Fig. 2 Relation between N-uptake per plant and rate of nitrogen for each type of fertilizer

though still producing a rise of the nitrogen content up to 3.4%, has not brought about higher yields. From the relation between fresh weight and N-uptake it becomes apparent that an inadequate N-supply has not been the limiting factor with m.a.p. Actually, an increase of yield in the range above 2.9% was only produced by c.i.u. The optimum rate of m.a.p. being 10 g/l (=800 mg of total N), coincided with a c.i.u.-rate of about 5 g/l (=1400 g of total N). Calculation of total N-uptake by the plant proved that nitrogen of m.a.p. was considerably more available than that of c.i.u. (figure 2). There was, however, no evidence that particle size has affected the availability of nitrogen of m.a.p. Because of the superior overall quality of the c.i.u. supplied plants as compared to the m.a.p. supplied plants at optimum level, the former fertilizer appeared better suited to serve as a longlasting nitrogen source for potted chrysanthemums. The four highest rates of c.i.u. were superior to the standard treatment; at the optimal rate m.a.p. was slightly better.

In figure 3 the relation between fresh shoot weight and phosphorus content is presented graphically. As can be seen a phosphorus content of about 0.4%, corresponding with 1 g double superphosphate per liter, proved adequate for a high production of fresh shoots. This is in fair agreement with the findings of *Kofranek et al. [3]* that chrysanthemums, adequately supplied with phosphorus, contained from 0.17 to 0.41% phosphorus in their shoots. The phosphorus contents of m.a.p.-treatments appeared all in excess of this optimum range. Yet increasing the m.a.p.-rate caused a marked rise of the phosphorus content ranging from 0.72 to 1.65%, leaving little doubt that m.a.p., when incorporated in the soil, is a highly effective source of phosphorus. In fact, due to the high phosphorus contents relative to the associated nitrogen contents this fertilizer should be regarded as a source of phosphorus rather than of nitrogen, the availability of these nutrients being in agreement with its formula.

In figure 4 the relation between intensity of leaf colour and nitrogen content of the shoots is presented.

The intensity of leaf colour is apparently raised at increasing levels of nitrogen in shoots. Obviously, this effect is best reflected in the c.i.u.-series, since this fertilizer is a sole source of nitrogen supplied at a constant phosphate level. In this respect c.i.u. consequently behaved differently from m.a.p., the intensity of leaf colour at increasing levels steadily rising up to the highest level with the former but declining above 2.8% with the latter. Apart from this, c.i.u. produced on the average a proper to excellent leaf colour, whereas m.a.p. at not any level and of not any particle size produced an adequate intensity of leaf colour. This apparent adverse effect of m.a.p. upon leaf colour proved to be enhanced by diminishing particle size appar-

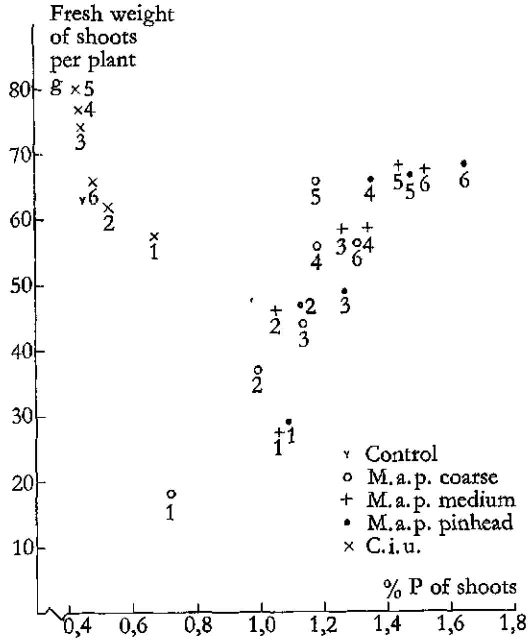

Fig. 3 Relation between fresh shoot weight per plant and phosphorus content of shoots

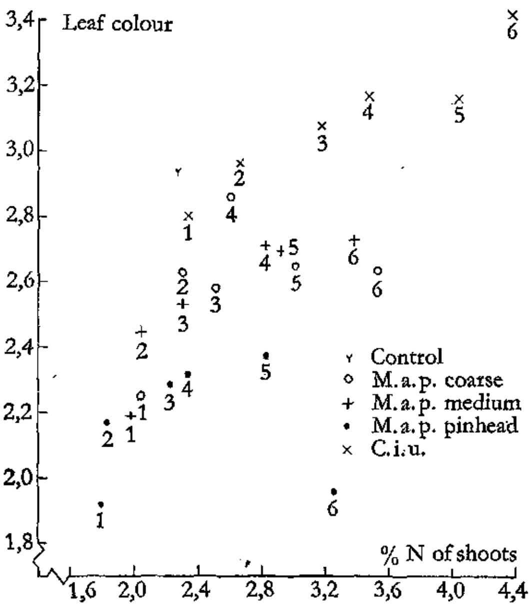

Fig. 4 Relation between leaf colour and nitrogen content of shoots (scale of leaf colour: 1 = very light, 2 = light, 3 = proper, 4 = dark, 5 = very dark)

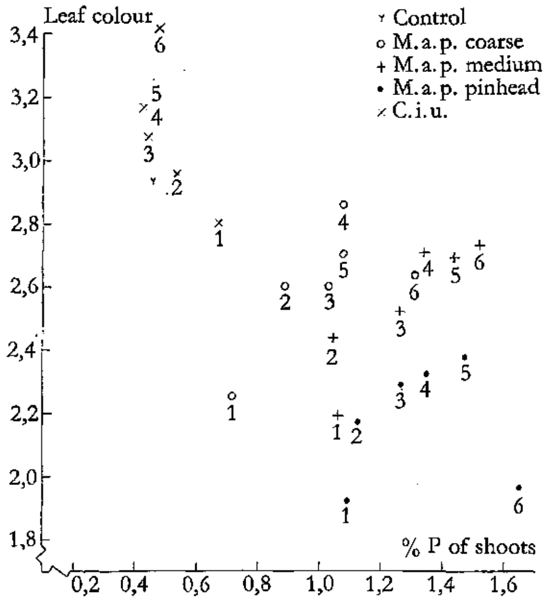

Fig. 5 Relation between leaf colour and phosphorus content of shoots

ently because of the higher uptake of phosphorus as indicated by the higher phosphorus contents.

If compared with the standard treatment, c.i.u. produced a darker leaf colour in contrast to m.a.p., which remained below that level.

The relation between intensity of leaf colour and phosphorus content of shoots is presented in figure 5. Generally the intensity of leaf colour appeared to decrease at increasing levels of phosphorus in the shoots. The remarkably high uptake of phosphorus using m.a.p. at normal rates is illustrated by dressing with 10 g m.a.p. "medium" per liter. This rate, equivalent to a dosage recommended for potted chrysanthemums by *Lunt [6]*, produced a phosphorus content of shoots three times as high as that occurring at the highest c.i.u.-rate. However, in spite of that, plants grown with high rates of m.a.p. had a better leaf colour than those grown at low levels, the favourable N-effect probably masking the detrimental P-influence. As to the nature of the adverse effect of excess phosphorus on leaf colour, mention can be made of the successful use of iron chelates by *Kofranek* and *Lunt [2]* to remedy the chlorosis occurring after heavy applications of m.a.p., thus indicating decreasing mobility of iron as a result of excessive rates of phosphorus.

The magnesium contents of shoots appeared to rise with increasing m.a.p.-rates, this effect being larger with "pinhead" than with "coarse".

From the foregoing data it may be concluded that nitrogen has a beneficial effect on quality of potted chrysanthemums including leaf colour, whereas phosphorus at excessive rates affects leaf colour adversely. A single preplant application of fertilizers using slow release fertilizers proved satisfactory for potted chrysanthemums. C.i.u. seems preferable compared with m.a.p., the latter having the disadvantage of the adverse effect of excessive supply of phosphorus. As to assessing the correct rate of c.i.u. further study is needed*.

* *In later studies lower optimum rates are found than in the present experiment.*

Bibliography

1. *Gordon, M.*, and *Springer, M.:* Dauergedüngtes Torfkultursubstrat eine Utopie? Torfnachrichten *13*, 21–26 (1962)
2. *Kofranek, A.M.*, and *Lunt, O.R.:* Slow release fertilizers on pot chrysanthemums. Reprint: The Florists' Review, December 21 (1961)
3. *Kofranek, A.M., et al.:* Tolerance of *Chrysanthemum morifolium* variety Kramer to saline conditions. Proc.Amer.Soc.Hort.Sci. *61*, 528–532 (1953)
4. *Loeser, H.:* Versuche mit Pflanzensubstraten und schnell- und langsamwirkenden Düngern. Süddeutscher Erwerbsgärtner *17*, 665–668 (1963)
5. *Lunt, O.R.*, and *Kofranek, A.M.:* Nitrogen and potassium nutrition of chrysanthemum. Proc. Amer.Soc.Hort.Sci. *72*, 487–497 (1958)
6. *Lunt, O.R.*, and *Kofranek, A.M.:* Some properties and applications of metal ammonium phosphate fertilizers. Proc. 16th International Horticultural Congress *4*, 352–361 (1962)