NITROGEN AND POTASSIUM FERTILIZATION OF THE ALSTROEMERIA CULTIVARS 'ORCHID' AND 'CARMEN' GROWN ON PEAT

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Abstract

Responses of two Alstroemeria cultivars 'Orchid' and 'Carmen' to nitrogen and potassium application were assessed in a trial in plastic pots using sphagnum peat moss as a substrate. The trial extending over two consecutive crops included four nitrogen and three potassium rates.

In both crops a favourable effect of both nitrogen and potassium was observed on production of flowering stems, total fresh shoot weight and number of flowers per flowering stem.

It is concluded that in fertilizing Alstroemeria, N and K_2O should be supplied in a ratio ranging from 1 : 1 to 1 : 1.4. The best treatment for 'Orchid' in the second crop gave leaf contents of 4.9% N and 3.9% K, for 'Carmen' 5.1% N and 3.7% K.

1. Introduction

In Dutch floriculture Alstroemeria has gained much interest as a cut flower in recent years. This is illustrated by the greatly increased sales of Alstroemeria flowering stems at the auctions, namely from 16.9 million in 1976 to 46.7 million in 1980, an increase of almost 200% in five years.

The strong rise in interest in this crop may be attributed to its following properties:

- Alstroemeria needs relatively low temperatures for growth; it is a "cool crop" (Wilkins and Heins, 1976), a valuable property in view of the steadily rising energy costs.
- Alstroemeria has attractive flowers with a wide variety of colours, and the flowers have an excellent keepability.

Because Alstroemeria is a relatively new crop, information on its nutritional requirements are scarce, in particular with respect to the quality characteristics. To obtain more data on this point, a factorial trial including four nitrogen and three potassium rates was carried out with the two cultivars 'Orchid' and 'Carmen'. The results of this trial are presented in this paper.

2. Materials and methods

Before treatments were started, young plants of the Alstroemeria cultivars 'Orchid' and 'Carmen' were set out in plastic pots on 31 October 1978. A young Alstroemeria plant is a cluster of fleshy tubers with rhizomes. The pots contained 12.5 l straight Finnish sphagnum peat moss (commercial ST-400 type Ao) limed with 3 g/l of dolomitic limestone up to an initial pH-H_2O of 5.5.

To give the plant sufficient time to establish properly, the real trial was not started until 15 January 1979. Four nitrogen rates were factorially combined with three potassium rates to give a total of twelve treatments which were replicated twelve times (1 unit = 1 pot).

The rates were as follows:
nitrogen: 60, 140, 220 and 300 mg N/pot per week as NH_4NO_3;
potassium: 60,180 and 300 mg K_2O/pot per week as K_2SO_4.
Macronutrients other than nitrogen and potassium, and trace elements, were added in ample amounts. When necessary, dolomitic limestone was applied to maintain the pH at the initial level. The plants were watered with rain water.

The trial included two cropping periods:
The first was from the beginning of the trial until 11 June 1979, when plants entered a state of rest, and the second from 26 June, when reproductive growth resumed, until 31 October 1979. For the first crop harvesting of the flowers started on 23 March and for the second crop on 23 July.

The following plant measurements were made:
number of flowering stems per plant;
length of the flowering stems;
fresh weight of the flowering stems;
number of flowers per flowering stem, which is an essential quality criterion for this flower crop;
total fresh weight of vegetative and flowering shoots per plant.
Leaf samples were collected for analysis during the first three weeks of September. The samples consisted of the eight uppermost leaves on the stem of an inflorescence having just reached cutting maturity.

3. Results

From tables 1, 2, 3 and 4 it can be seen that the average response of number of flowering stems to nitrogen application was markedly favourable in all cases, the optimum rate being N3, except for 'Orchid' in the second crop when N2 was optimum. This beneficial effect of nitrogen on flower production of Alstroemeria sharply contrasts with the results reported by Blomme and Dambre (1979), which indicated a strong inverse relationship between flower production and increase in rate of nitrogen. Yield of flowering stems also responded favourably to potassium application; for 'Orchid' the average best rate was K3, for 'Carmen' it was K2. The average response of flowering stem length of both cultivars in the first crop to nitrogen was negative from N1 upwards. This negative nitrogen effect was not as detrimental to flower quality as may be assumed, since the relative reduction in flower stem length caused by raising the nitrogen rate from N1 to N4 was only in the order of 3%. Rather surprisingly, in the second crop this quality characteristic showed a distinctly favourable nitrogen response in 'Orchid'; in 'Carmen' there was no nitrogen effect. Flowering stem length did not respond to potassium in the first crop. It was marked, however, in the second crop; for 'Orchid' K2 was optimum, for 'Carmen' K3 was best.

Fresh weight of flowering stem of both cultivars showed no nitrogen effect in the first crop. In the second crop, however, a notably favourable response to nitrogen was evident; for 'Orchid' the best rate was N4, for 'Carmen' it was N3.
Potassium application was beneficial, in the second crop even more so than in the first; the best rate was K3, except in the case of 'Orchid' in the first crop, when K2 was optimum.

The number of flowers per flowering stem rose with increasing rates of nitrogen. Increasing rates of potassium had the same effect, except for 'Orchid' in the first crop when there was no response to potassium.

Total fresh weight of shoots of both cultivars showed a striking, favourable nitrogen effect, in second crop even more so than in the first crop, N3 being optimum in most cases.
Although to a somewhat lesser degree, total fresh weight was increased by potassium application, and also more strongly in the second than in the first crop; K3 was generally the best rate.

From tables 1, 2, 3 and 4 it is evident that flower production for the second crop was considerably lower than for the first crop. Undoubtedly, this was due to adverse temperatures during the first months of the second crop. To promote flower production, temperatures should be relatively low, viz., about 17 °C (Vonk Noordegraaf, 1981a). For the first crop this requirement could readily be met, for the second crop it was not feasible because of the prevailing high temperatures in July and August. In addition, the growing period for the second crop was much shorter. As a result, flower production in the second crop was strongly inferior to that of the first crop.

When climatic conditions are optimum, most of the vegetative shoots develop into flowering shoots so that flower production in the first instance is determined by shoot production (Vonk Noordegraaf, 1981b). As a consequence, a close relationship between the two plant properties should exist. This proved to be true for the first crop. The regression equations are:

for 'Orchid': $y = 0.02x + 1.39$ ($r = 0.905$)

for 'Carmen': $y = 0.02x - 0.32$ ($r = 0.961$)

in which y is yield of flowering stems per plant and x is total fresh weight in g per plant.
Thus it can be reasoned that, particularly under climatic conditions detrimental to flowering, like those during the second crop, total fresh weight of shoots would be a better criterion of response to fertilizers than yield of flowering stems.

There was a tendency for some of the observed plant characteristics to respond more sharply to changes in nitrogen and potassium rates in the second than in the first crop. This could well be due to the presence of reserve organs, like tubers, in the young plants set out in the pots, which would level out the differences in response to the fertilizer rates during the initial stages in the first crop.

In terms of total fresh weight, the best of the 12 NK-combinations for the first and second crop of 'Orchid' and also for the first crop of 'Carmen' was N3K3. The best combination was only slightly different for the second crop of 'Carmen', viz., N4K3. Thus in fertilizing Alstroemeria, N and K_2O should be supplied in sufficient amounts in the ratio ranging from 1 : 1 to 1 : 1.4.

Leaf nitrogen content (Table 5) showed a distinct increase with rising nitrogen rates. Potassium leaf content rose markedly with increasing potassium rates. It decreased when the nitrogen rate was increased from N1 to N3, and increased with a further rise of the nitrogen rate from N3 to N4.
The increase in leaf nitrogen content with increasing nitrogen rate was larger for 'Orchid' than it was for 'Carmen'; the same was true for the increase in leaf potassium content with increasing potassium rate.

The best treatment for the second crop of 'Orchid', N3K3, produced the following leaf contents: 4.9% N, 0.36% P, 3.90% K, 0.44% Mg, 1.48% Ca, 195 ppm Mn, 217 ppm Fe, 101 ppm Zn, 6.1 ppm Cu and 20.6 ppm B.

The best treatment for the second crop of 'Carmen', N4K3, gave: 5.14% N, 0.31% P, 3.69% K, 0.62% Mg, 1.42% Ca, 195 ppm Mn, 175 ppm Fe, 84 ppm Zn, 7.1 ppm Cu and 27.9 ppm B.

From these data no large differences were evident in the chemical leaf composition among the best treatments for both cultivars in this trial.

References

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Table 1 - Effect of nitrogen and potassium fertilization on some important plant characteristics of 'Orchid' (first crop).

	Fertilizer level	Fl.stems per plant	Length fl.stem cm	Fresh wt. fl.stem g	Flowers per fl.stem	Tot.fr.wt. shoots g per pl.
	N1	17.8	125	44.2	11.1	895
	N2	21.8	124	46.2	12.1	1096
	N3	25.8	119	44.5	12.4	1236
	N4	21.8	117	45.2	13.0	1054
Nl [1]		+++	+++		+++	+++
Nq		+++				+++
	K1	20.2	121	44.1	12.2	976
	K2	21.7	121	47.4	12.7	1122
	K3	23.5	121	43.6	11.6	1113
Kl		+++				+++
Kq				+		++
N × K						+

[1] Nl = linear N effect; Nq = quadratic N effect; Kl = linear K effect; Kq = quadratic K effect.
Statistically significant at P = 0.05 : +; P = 0.01 : ++; P = 0.001 : +++

Table 2 - Effect of nitrogen and potassium fertilization on some important plant characteristics of 'Carmen' (first crop).

	Fertilizer level	Fl.stems per plant	Length fl.stem cm	Fresh wt. fl.stem g	Flowers per fl.stem	Tot.fr.wt. shoots g per pl.
	N1	16.7	120	44.2	8.6	858
	N2	21.3	118	46.1	9.4	1129
	N3	25.1	116	44.4	9.7	1249
	N4	23.4	116	44.6	9.8	1170
Nl		+++	+		+++	+++
Nq		+++				+++
	K1	20.0	117	43.1	9.1	989
	K2	22.8	118	45.1	9.3	1173
	K3	22.0	118	46.2	9.8	1143
Kl		+		+	+	+++
Kq		++				+++
N × K						++

Table 3 - Effect of nitrogen and potassium fertilization on some important plant characteristics of 'Orchid' (second crop).

	Fertilizer level	Fl.stems per plant	Length fl.stem cm	Fresh wt. fl.stem g	Flowers per fl.stem	Tot.fr.wt. shoots g per pl.
	N1	7.6	73	17.5	6.7	376
	N2	11.7	92	26.7	7.9	796
	N3	9.3	104	34.6	9.5	971
	N4	2.9	118	39.4	10.2	717
Nl		+++	+++	+++		+++
Nq		+++			+++	+++
	K1	5.6	86	23.1	8.0	486
	K2	8.0	103	30.7	8.2	811
	K3	10.0	102	34.7	9.4	848
Kl		+++	+++	+++		+++
Kq			+++		+	+++
N × K						+

Table 4 - Effect of nitrogen and potassium fertilization on some important plant characteristics of 'Carmen' (second crop).

	Fertilizer level	Fl.stems per plant	Length fl.stem cm	Fresh wt. fl.stem g	Flowers per fl.stem	Tot.fr.wt. shoots g per pl.
	N1	6.6	71	17.9	6.5	384
	N2	10.4	76	23.6	8.0	924
	N3	12.9	80	26.6	8.7	1309
	N4	9.1	69	21.8	8.0	1359
Nl		+		+++	+++	+++
Nq		+++	+++	+++	+++	+++
	K1	9.3	63	16.7	7.2	647
	K2	10.5	75	22.6	7.8	1131
	K3	9.4	84	28.1	8.5	1204
Kl			+++	+++	+++	+++
Kq						+++
N × K				+++		+++

Table 5 - Contents (%) of nitrogen and potassium in leaves of 'Orchid' and 'Carmen' on 31 August, as affected by various treatments.

Treatments	'Orchid'		'Carmen'	
	N	K	N	K
N1K1	3.35	2.08	3.26	1.96
N2K1	4.29	1.03	3.84	0.83
N3K1	5.39	1.52	4.59	0.87
N4K1	6.40	2.72	4.98	0.99
N1K2	3.36	4.55	3.36	4.60
N2K2	4.17	3.12	3.78	2.96
N3K2	4.91	2.39	4.39	1.46
N4K2	5.72	3.74	5.02	1.63
N1K3	3.50	5.02	3.39	4.15
N2K3	3.79	4.89	3.76	4.67
N3K3	4.91	3.90	4.46	3.42
N4K3	5.85	4.54	5.14	3.69