How Much Potassium do Flowering Plants Growing in Soilless Media Really Need?

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The minimum potassium/nitrogen (K/N) ratio of fertilisers that produce optimum quality in *Petunia* 'Celebrity Salmon' growing in soilless media depends on the composition of the medium. For peat/perlite medium the minimum K/N (mg/mg) is about 0.8. For media containing materials such as bark, which have a store of native K, the ratio can be as low as 0.4 for short-term crops. For media whose components are being decomposed by microbial activity, and therefore in which there is much "drawdown" of soluble N, the ratio need not be higher than about 0.4. Fertilizers with K/N ratios above these minima, applied in amounts that produce maximum growth, do not increase flower numbers in *Petunia*. Broadly similar results have been obtained for *Fuchsia coccinea*.

INTRODUCTION

A glance at manufacturers' product lists shows that fertilisers sold for use on containerised plants have a wide range of nitrogen/phosphorus/potassium (NPK) compositions. In particular, the ratios of P and K to N vary considerably. Fertilisers stated to have been designed for foliage and woody ornamental plants often have K/N ratios (%/%) in the range 0.4 to 0.5, but they can be much higher. Those that claim to boost flowering typically have K/N ratios of well over 1, and sometimes over 2. Yet the optimum K/N ratio for at least one flowering plant—African violets—has been found to be in the range 0.52 to 0.83 (Poole et al., 1990), with the variation apparently caused by differing composition of the potting medium used.

A search of the literature on K requirements of plants in potting media and hydroponics solutions suggested one reason for differences in optimum K/N ratios found in different experiments might be the amount of nitrogen drawdown (immobilisation) taking place in the growing medium. This paper summarises the results of several experiments which have been conducted to test this hypothesis.

OVERVIEW OF THE EXPERIMENTS

In one experiment, *Petunia* 'Celebrity Salmon' seedlings were grown in three soilless media and fertilised with nutrient solutions containing 200, 300, or 600 mg litre^{-1} N and K to give 10 K/N ratios in the range 0.08 to 1.6 (mg/mg). The media were 5 peat : 1 perlite (v/v), 2 peat : 3 composted *Pinus radiata* bark (v/v) and 11 peat : 12 composted eucalypt sawdust (v/v), all of pH 6. Micronutrients, P, Ca, Mg, and S were incorporated into the media to give optimum initial amounts, as determined by extraction with dilute DTPA (Standards Australia, 1993). There were five, 125-mm plastic pots of each medium for each K/N treatment, each planted with one *Petunia* seedling.

Nutrient solutions were applied weekly at 200 ml per pot. Symptoms of K deficiency and general quality were noted from time to time and the shoots harvested at 42 days (peat and perlite, and peat and bark) and 71 days (peat and sawdust). The shoots were analysed for total N and K.

In a second experiment, *Petunia* 'Stereo Red' seedlings were grown in media composed of peat and composted eucalypt sawdust mixtures containing 0 to 60% sawdust. They were fertilised with nutrient solutions containing 300 or 600 mg $litre^{-1}$ N and K to give five K/N ratios in the range 0.33 to 1.1 (mg/mg). The nitrogen drawdown index values (NDI_{75}) (Handreck, 1992a,b) of the mixtures ranged from 1 to zero. General cultural conditions were similar to those of the first experiment. At harvest 72 days after planting the shoots were dissected into old leaves, mid-stem leaves, shoot tips, stems, and flowers, which were analysed separately for total K and N.

RESULTS AND DISCUSSION

First Experiment. K deficiency symptoms appeared first in plants growing in peat and perlite medium, at 28 days after transplanting and at the lowest fertiliser K/N ratio. By harvest, plants in peat and perlite showed deficiency symptoms at K/N ratios up to 0.67, but not at 0.83 (Table 1).

Table 1. K/N ratios for whole shoots of *Petunia* 'Celebrity Salmon' as affected by potting medium composition and the K/N ratio and N concentration of the liquid fertiliser solution applied weekly.

	Shoot K/N ratio						
	Peat/pine bark		Peat/perlite		Peat/sawdust		
Fertiliser K/N ratio	200 mg/l N	300 mg/l N	200 mg/l N	300 mg/l N	200 mg/l N	300 mg/l N	600 mg/l N
0.08	0.51*	0.42*	-	-	-	-	-
0.17	0.56*	0.49*	0.24*	0.26*	0.32*	0.33*	0.43*
0.33	0.76	0.82	0.38*	0.43*	0.96	0.74	0.71
0.50	1.02	0.84	0 50*	0.61*	1.30	1.21	0.84
0.67	1.04	1.11	0.58*	0.80	1.44	1.62	1.19
0.83	1.21	1.19	0.77	1.08	1.84	1.87	1.53
1	1.41	1.48	0.92	1.40	2.13	2.44	1 90

* = K deficiency symptoms.

In contrast, in peat and bark as well as in peat and sawdust media, deficiency symptoms were less severe and were restricted to plants receiving fertiliser with K/N ratios up to 0.17, but not 0.3 (Table 1). Examination of data for the K/N ratios of the shoots (Table 1) gives a clue to the reasons for these differences in response to the same fertiliser solutions by plants growing in different media. These data show that the K/N ratios of the shoots were similar to those of the fertiliser solution for plants growing in peat and perlite, but they were much higher in plants growing in the other two media. A cause for plants growing in the peat and bark medium lies in the amount of K in medium components. The peat and perlite contained a total of 40 mg K per pot, while the peat and bark contained 204 mg per pot. Much of this extra K in the bark was available to and taken up by the plants, so they were protected from the deficiency that would normally accompany use of a fertiliser with a very low K/N ratio.

There was a different cause for high shoot K/N ratios in plants growing in the peat and sawdust medium, which contained a similar amount of K (46 mg per pot) to that in the peat and perlite medium. The data of Table 1 show that the effective K/N ratio of the fertiliser was about doubled for plants in peat and sawdust. In this medium, microbial decomposition of the sawdust was using soluble N at a very high rate. Its nitrogen drawdown index (NDI_{75}) was only 0.1 (Handreck, 1992a, b). This means that each week about 20 mg N per pot was being consumed during microbial decomposition of the sawdust (Handreck, 1993). This is half the 40 mg N per week applied in the fertiliser. An assumption that K is not used during microbial decomposition, or if it is, it is quickly recycled, leads directly to a conclusion that the effective K/N ratio of the fertiliser would be doubled in a medium such as this.

Table 2. Effect of nitrogen drawdown and fertiliser on K and K/N ratio of *Petunia* 'Stereo Red' shoots.

NDI_{75} of the medium	Fertiliser K/N ratio 0.33 Shoot K % dm	0.33 Shoot K mg/pot	0.33 Shoot K/N ratio	0.50 Shoot K % dm	0.50 Shoot K mg/pot	0.50 Shoot K/N ratio
300 mg/litre N in fertiliser						
1.0	1.31	139	0.46	1.96	247	0.68
0.76	1.67	173	0.59	2.02	254	0.63
0.69	1.83	159	0.66	2.05	219	0.57
0.46	2.22	154	0.84	2.07	221	0.64
0.28	2.53	159	0.73	4.35	231	1.13
0.05	3.23	140	0.87	5.18	214	1.25
0	4.18	118	1.11	6.06	194	1.52
600 mg/litre N in fertiliser						
1.0	1.99	324	0.49	2.97	443	0.66
0.76	2.28	298	0.52	2.79	519	0.69
0.69	2.51	309	0.60	2.46	457	0.66
0.46	2.23	319	0.53	3.55	399	0.73
0.28	2.25	293	0.65	3.61	414	0.75
0.05	3.02	271	0.78	4.97	352	1.34
0	2.88	257	0.67	4.00	334	0.95

Second Experiment. The second experiment confirmed and extended this link between nitrogen drawdown and effective fertiliser K/N ratio. Some of the results, shown in Table 2, show a progressive increase in effective K/N ratio with lowering of the NDI_{75} of the medium. The effect is somewhat swamped through application of the large amounts of K in more concentrated fertiliser solutions, but is still in evidence (Table 2).

EFFECT OF K/N RATIO ON FLOWERING

The second experiment provided interesting information on the effect of K deficiency on flowering and on the partitioning of K amongst the various parts of *Petunia* plants. Potassium deficiency symptoms in the leaves did not impair flowering (Table 3). This can be understood by considering the data of Table 4. These show that the plants were able to maintain a fairly constant K concentration in the flowers, at the expense of greatly reduced concentrations in the leaves and stems. The flowers (and shoot tips) were protected. Raising the amount of K applied to a very high level (Table 4) produced only modest increases in the K concentration in the flowers.

Table 3. Effect of the K/N ratio of the fertiliser solution on the number of flowers per *Petunia* 'Stereo Red' plant (averaged over all mixes).

Fertiliser K/N ratio				
0.33	0.5	0.67	0.83	1.1
300 mg $litre^{-1}$ N				
20	25	23	20	21
600 mg $litre^{-1}$ N				
35	36	40	41	38

These data do not support the notion that flowering is improved by providing plants with large amounts of K. There is an optimum, which varies with type of medium, above which there is little increase in flower K content, or in flower numbers.

Table 4. Examples of the effect on K (% dm) in various parts of *Petunia* 'Stereo Red' shoots of fertiliser composition and of the NDI_{75} of the medium in which they had been grown.

NDI_{75} of medium	Oldest leaves	Middle leaves	Shoot tips	Stems	Flowers
		K/N = 0.33: 300 mg/litre N			
1.0	0.66	0.57	1.83	1.03	1.8
0.76	0.89	1.13	2.21	1.37	2.11
0.69	1.70	1.62	2.31	1.45	1.88
0.46	1.89	2.09	2.62	1.91	2.14
0.28	3.17	2.96	2.80	2.09	2.15
0.05	4.75	3.41	3.33	2.53	2.59
0	3.87	4.33	4.21	4.11	no fl.
		K/N = 0.83: 600 mg $litre^{-1}$ N			
1.0	5.87	4.90	4.68	4.21	2.70
0.76	5.31	4.92	4.69	3.59	2.76
0.69	6.10	5.46	4.72	4.33	2.61
0.46	7.26	6.38	4.87	3.95	2.82
0.28	7.71	5.20	5.58	5.07	3.02
0.05	7.84	8.54	7.18	8.70	4.48
0	8.36	8.87	6.88	5.90	3.87

EPILOGUE

An experiment with *Fuchsia coccinea*, of similar design to the second experiment described here, has given broadly similar results, suggesting wide applicability of the results to flowering plants in potting media.

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