

# NUTRITION OF CONTAINER-GROWN TUBEROUS BEGONIAS

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**Abstract.** *Begonia* × *tuberhybrida* was grown in a peat sand:sawdust (1:1:1, v/v) potting medium using a four factor central composite incomplete block design to measure the response to N, P, K fertilisation and liming, each at five levels. This plant responded strongly to N and P. Nitrogen was singularly the most important nutrient element and its effects were enhanced by P fertilisation and liming.

## INTRODUCTION

There is little published work on the nutrition of tuberous begonias but they have been shown to respond to moderate N and comparatively high K fertilisation (7). It has also been shown that higher N than K in a liquid feed gives the largest container-grown plants (4). The P requirement in both cases was noted to be relatively low. Results from an earlier pot experiment at Lincoln (unpublished) found these plants to have a high N and a moderate P demand but were unresponsive to K and liming. The study reported here was initiated to determine the nutrient requirements of potted tuberous begonias.

## MATERIALS AND METHODS

**Experimental Design.** A four-factor response surface programme of a central composite design with incomplete blocks was used for both experiments as for similar work (9). They involved N, P, K and lime additions with 30 treatments, each with ten replicates. The nutrient levels and lime rates used in both experiments are shown in Figures 1 and 2.

**Fertiliser Rates and Potting Media.** The medium used was equal parts Hauraki sphagnum peat, coarse sand, and untreated *Pinus radiata* sawdust. Nutrient levels were supplied from Osmocote (26%N), superphosphate (8%P) and potassium sulphate (39%K). Liming was based on a mixture of dolomite and agricultural lime (3:1 w/w) while trace elements were applied from "Sporumix A" (150g/m<sup>3</sup>) and "Sequestrene iron chelate" (75g/m<sup>3</sup>).

**Plant Material and Environment.** Seedlings for Experiment A (mixed colours) and of cultivar, 'Gold Plate' for Experiment B were pricked out individually into 1.8 litre planterbags on December 8. Final harvest for Experiments A and B occurred after 20 and 21 weeks, respectively. Plants were placed in a heated glasshouse with minimum temperatures of 8° C and fans set to operate when temperatures exceeded 22° C.

**Data Collection.** Visual ratings of foliage quality and vigour were carried out using a grading system based on plant appearance (0 = dead, to 5 = top grade and quality). Foliage colour was similarly assessed (0 = white, or very chlorotic, to 5 = green and healthy). Flower numbers per plant, foliar dry weights, and tuber measurements were also obtained. Nutrient levels and foliar dry weights were obtained by the methods previously reported (9). Data from the experiments were statistically analysed for analysis of variance and F test. Data presented in graphic form in this paper was computed from the equations of the response surfaces.

## RESULTS

The results in the two experiments indicated similar responses (Table 1) although more interactions between nutrient additions and their growth responses occurred in Experiment B.

**Foliage Growth and Flowering.** Nitrogen strongly influenced the development of leaves and flowers (ratings at 8 weeks after potting) with optimum quality and highest responses at the 450 to 600g N/m<sup>3</sup> level (Table 1). It was further shown in Experiment B that foliage growth can be further enhanced by added P. The response surface (Figure 1) showed that highest foliar dry matter occurred when high N was combined with high P additions. Foliage growth and flowering were most benefited by a rate of 200g P/m<sup>3</sup> in Experiment A (Table 1).

The responses to potassium and lime were much less significant than to N and P (Table 1). There was no positive influence on foliage growth or flowering by K additions except when no lime was added in Experiment B (Figure 2) where the pH was 5.0. Additions of lime raised the pH to as high as 6.5 with the 12 kg/m<sup>3</sup> lime rate but there were few significant effects other than the very low foliar dry weight response shown in Figure 2 where K and lime were added at the highest rates.

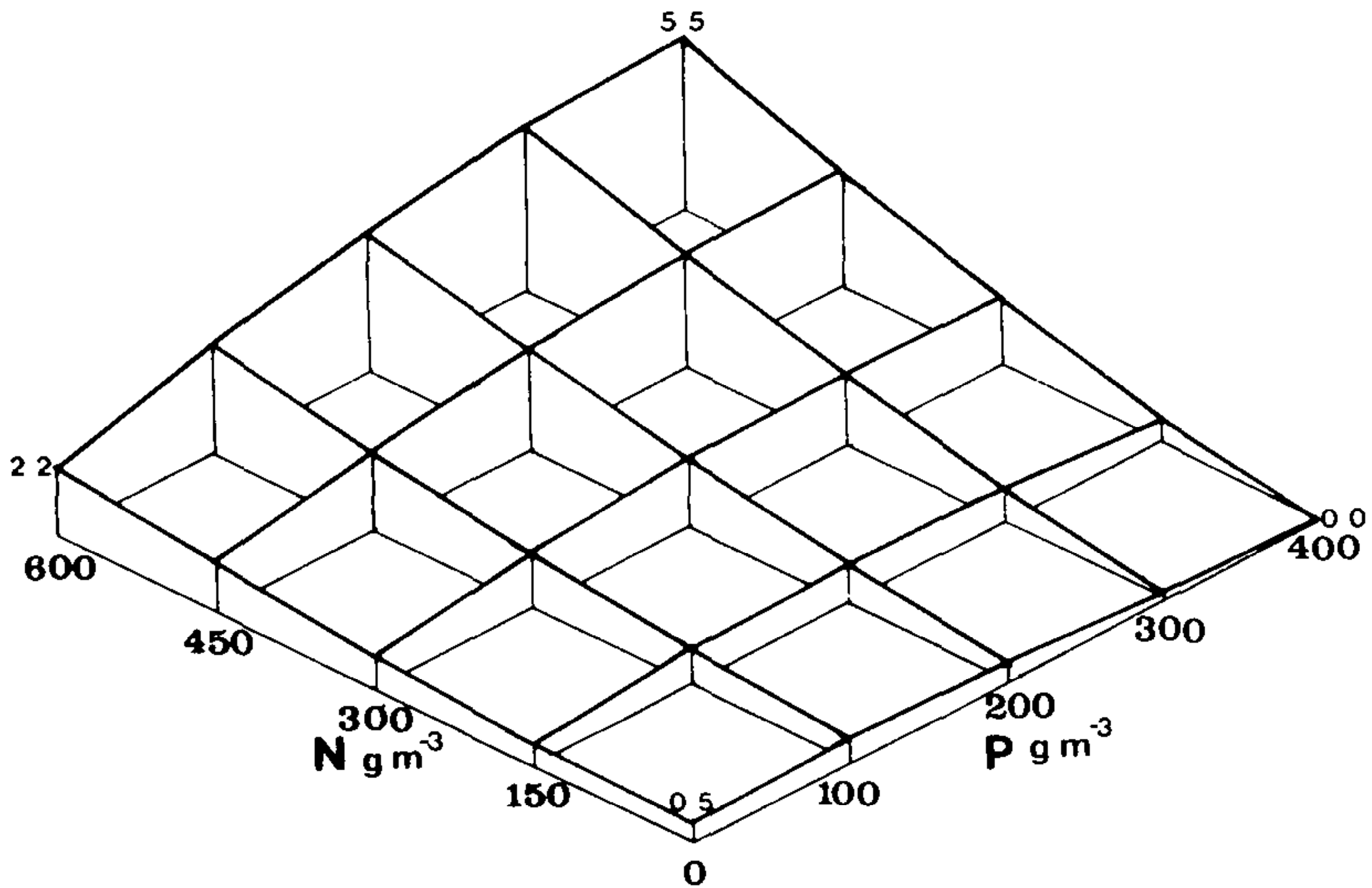
**Tuber Growth and Nutrient Analyses.** Tuber growth in both experiments was influenced by all added nutrients and particularly N fertilisation (Table 1). Phosphorus strongly enhanced the effect of N on tuber fresh weights (Experiment B, Figure 3) so that the heaviest tubers were at the top rate of N and at least 200 g P/m<sup>3</sup>. The combination of the highest N and lime additions also yielded

the heaviest tubers (Experiment B, Figure 3) while thickness and diameter were also maximised by high N (Table 1) and in the presence of high lime (Experiment B, data not shown). Potassium fertilisation showed no positive influence on tuber growth.

**Table 1.** Effects of nitrogen and phosphorus on foliage, tuber growth, and flowering of tuberous begonias (Experiment A) and significance levels for significant factors only in Experiments A and B (\*\*\*) $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ ; # = 0.05 to 0.1)

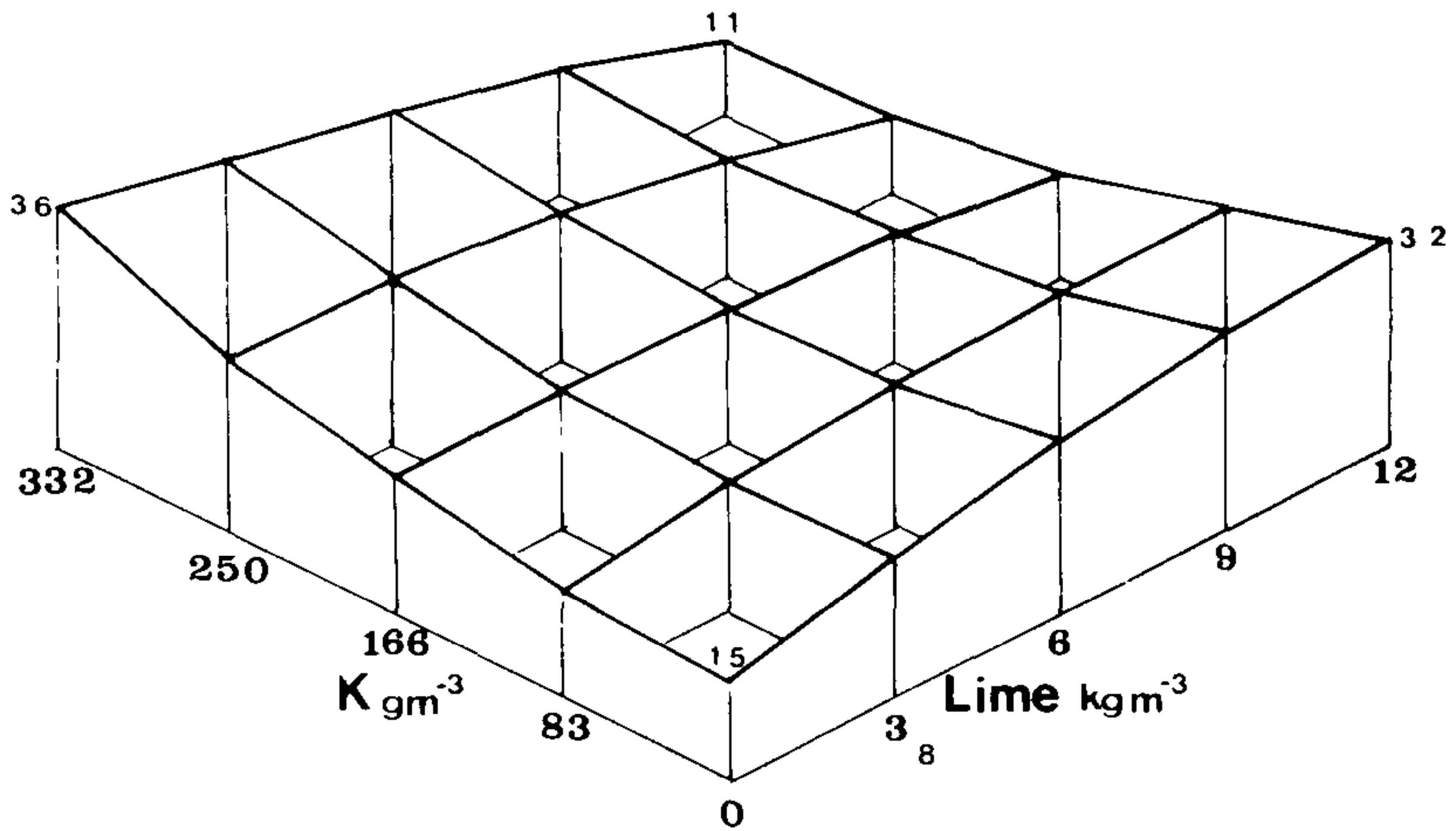
Term	Foliage vigour rating	Foliage colour rating	Foliage dry weight (g)	Max tuber thickness (cm)	Max tuber diameter (cm)	Tuber fresh weight (g)	Flowers per plant
<i>Experiment A</i>							
N ( $\text{g m}^{-3}$ )							
0	1.6***	1.8***	1.0***	1.5***	2.6***	9.2***	1.6***
150	2.7	2.4	1.9	2.1	3.8	18.0	3.7
300	3.4	2.8	3.0	2.5	4.7	27.4	5.2
450	3.5	2.9	4.3	2.7	5.2	37.3	6.2
600	3.2	2.8	5.7	2.7	5.5	47.7	6.7
P ( $\text{g m}^{-3}$ )							
0	2.4***	2.9	1.2***	1.8***	3.1***	10.6***	1.8***
100	3.1	2.9	2.5	2.3	4.2	22.5	4.3
200	3.4	2.8	3.0	2.5	4.7	27.4	5.3
300	3.2	2.8	2.8	2.4	4.5	25.3	4.7
400	2.6	2.7	1.8	2.1	3.7	16.2	2.5
K	*	-	-	-	**	*	-
Lime	-	-	*	-	**	*	-
Interactions	-	-	-	-	-	-	-
CV%	32	21	60	25	23	58	65
<i>Experiment B</i>							
N	***		***	***	***	***	***
P	**		**	**	-	**	**
K	-		-	-	-	-	-
Lime	-		-	-	-	-	#
Interactions	-		NxP*			NxP*	-
			KxLime*	NxLime*	NxLime*	NxLime*	
CV%	20		48	16	16	37	48

The nutrient levels in the tubers for different elements were in the following ranges (observed values) N:0.98 to 2.37%, P:0.09 to 0.96%, K:1.23 to 1.47%, Ca:0.12 to 0.37%, Mg:0.14 to 0.37%. Computer analysis of tuber nutrient levels showed a strong negative influence of liming on tuber P levels while N additions had a positive effect. This resulted in tuber P being at a minimum level



**Figure 1.** Interaction of N and P additions on plant foliage dry weight (g)  
Experiment B

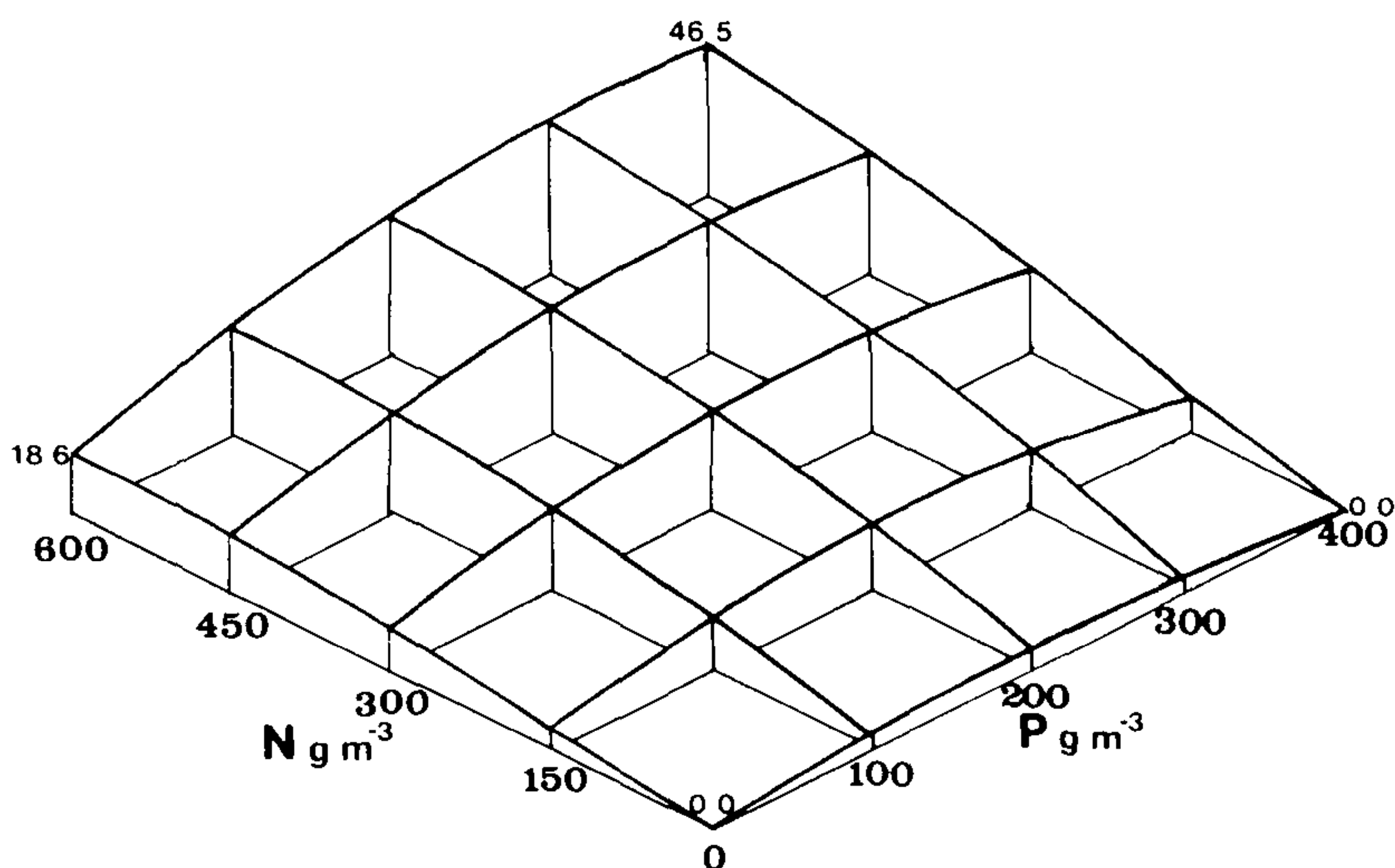
of 0.1% when N and lime were highest, while in contrast the maximum predicted value for tuber P of 2.5% was at nil lime and the highest rate of N.



**Figure 2.** Interaction of K additions and liming on plant foliage dry weight (g)  
Experiment B

## DISCUSSION

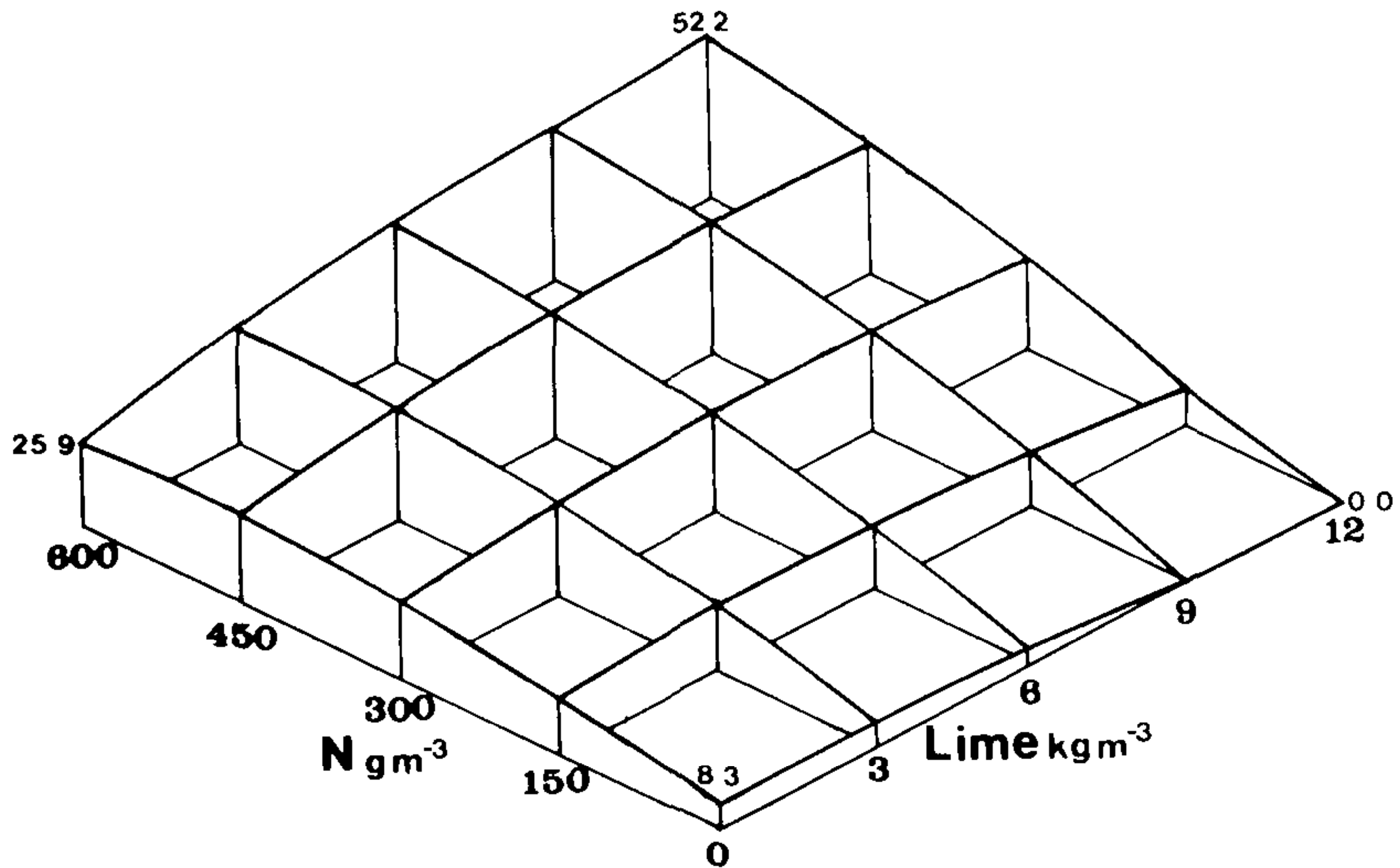
The strong influence of N fertilisation on foliage, flower and tuber production confirms the work of others (4,7). High K rates only promoted foliage growth at nil lime (Figure 2) and showed little other influence, which is in agreement with previous unpublished results with this plant at Lincoln. However, this contradicts the general response of begonia and other container-grown plants to K fertilisation (5,6) and where flowering of some pot plants was enhanced by high rates of K (1). Further work with a slow release form of potassium fertiliser would allow stronger conclusions on K requirements.



**Figure 3.** Interaction of N and P additions on tuber fresh weight (g)  
Experiment B

There was a strong positive interaction between N and P on both foliage and tuber growth which agrees with work on the flowering and corm production of potted freesias (8). The influence of lime on tuberous begonias was dependent on the level of applied N. Liming at high N rates enhanced tuber growth but at low N it was detrimental to growth. There appears to be a desirable balance between liming and P rates which, in turn, may influence the response to N. High liming can reduce P availability due to P combining with calcium and carbonate ions from insoluble salts (2,3). This was confirmed in the present work where liming strongly depressed tuber P levels particularly at high N rates. Tuber fresh weight was enhanced when high N was combined either with high

P or high lime (Figures 3 and 4). It, therefore, seems possible that all three additions at high levels of at least 600g N/m<sup>3</sup>, 300g P/m<sup>3</sup> and liming at 6kg/m<sup>3</sup> (pH 6.4) should promote high tuber yields for this medium. Liming therefore appears to help to balance high N and possibly P rates, although further work is needed to confirm this.



**Figure 4.** Interaction of N additions and liming on tuber fresh weight (g)  
Experiment B

**Acknowledgements.** We thank M Spurway for technical assistance, and Dalgety Limited for the supply of Osmocote fertiliser. We are also grateful to A. Cox for providing begonia seedlings.

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