

tion of possibilities read the article in the AMERICAN NURSEYMAN, 15 February 1982, by Robert West, entitled "How I Trained a Nursery Computer".

OTHER NURSERY AIDS

Some other efficiency aids in my nursery are:

Intercommunication system between potting shed and house.

Bicycle for quick check up jobs, or maybe quick getaways!

"Richdel" automatic watering system.

Blackboard by the telephone.

Winstone 100 litre spray trailer.

Pre-emergent weed control in containers using "Ronstar", at half the suggested rate, at time of potting up.

Dumping area for waste in a convenient location.

CONCLUSION

There are many ways in which New Zealand nurseries can be made more efficient. I have detailed some aids to production and marketing that have helped me. I hope to encourage others to observe more closely their own organisations and make improvements. Improvements need not involve large cash outlays and, in fact, by definition they should bring early cash benefits.

INFLUENCE OF NITROGEN, PHOSPHORUS, POTASSIUM, AND LIME ON GROWTH AND FLOWERING OF POTTED CYCLAMEN

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Abstract: The effects of five levels of nitrogen (N), phosphorus (P), potassium (K), and lime on potted cyclamen (*Cyclamen persicum*) grown in peat/sand, 1:1 v/v were studied. Nitrogen strongly influenced most aspects of growth and flowering; it was supplied by Osmocote (26% N). Strongest corm and foliage growth occurred at 450 to 600g N m⁻³, while early flowering and flowers per plant were promoted at these levels, as long as added P was low. Low to medium levels of P and K appeared primarily to be required for flower quality, such as size. The plants appeared very tolerant of liming and a rate as high as 24 kg m⁻³ was optimal for flower size (dry weight) and stalk length, when combined with very high N rates.

INTRODUCTION

Previous studies on the nutrition of cyclamen considered (a): simple proprietary mixed or slow release fertilisers, as used by Burghardt (2), Soupcoop and Matous (8) and others or,

(b) the effects of single nutrients (6). Rarely were fertilisers quantified in terms of available nutrients, nor were interactions among nutrients investigated.

The objectives of the two experiments reported here were to examine the influence of N, P, and K fertilisation, and of liming, and to study their interactive effects within a single experiment. An additional experiment was carried out after the first experiment to study the effect of unusually high levels of N, P, K, and lime.

MATERIALS AND METHODS

Experimental Design. A four factor response surface Box-Hunter design, of Cochran and Cox (3), of the central composite second order type with incomplete blocks was used. It involved N, P, K and lime combined in 30 treatments arranged in 10 and 7 blocks for Experiments A and B, respectively. The blocks were divided into three sub-blocks. The treatment nutrient levels were given in Table 1. The same experimental design was used by Thomas (9) for container-grown nursery stock.

Table 1. The levels of N, P, K, and lime applied in Experiments A and B in g of N, P, K, and Kg of lime per m³ of potting medium.

Nutrient	N (g m ⁻³)		P (g m ⁻³)		K (g m ⁻³)		Lime (kg m ⁻³)	
	A	B	A	B	A	B	A	B
Experiment	0	0	0	0	0	0	0	0
	150	300	100	200	83	166	3	6
	300	600	200	400	166	332	6	12
	450	900	300	600	250	498	9	18
	600	1200	400	800	332	664	12	24

Fertilisers. The fertilisers were the same as, or similar to, those in common New Zealand nursery use. Nitrogen was supplied from Osmocote (25% N) applied equally as a basal dressing and a side dressing after three months. All other nutrients were included in the medium at laying-down. Phosphorus and K were supplied from superphosphate (8% P) and potassium sulphate (39% K), respectively. The lime was a mixture of agricultural (CaCO₃) and dolomitic lime (3:1, by weight). The following ingredients at fixed levels were common to all treatments: 75 g m⁻³ sequestrene iron chelate (Na EDTA Fe 12% Fe), 150 g m⁻³ Sporumix (1.14% B, 5.46% Mn, 0.06% Mo., 0.05% Co, 9.78% Mg, 0.62% Zn, 1.27% Cu).

Plant Material and Potting Medium. Three month old seedlings of *Cyclamen persicum* Mill. 'Bonfire' for Experiment A and mixed cultivars for Experiment B were potted into a medium containing 50% sphagnum peat and 50% coarse manufactured sand, (v:v). Experiment A was potted January 9,

1977, using 1.81 Planterbags and Experiment B on April 8, 1978, into plastic 15 cm (1.41) pots.

Growing Conditions and Plant Protection. The plants were grown in heated, automatically ventilated, glasshouses with a minimum temperature of 15°C and a maximum of 5°C above the ambient outside temperature. At the end of November (early summer) the plants were moved to a Sarlon 50% shade-house where temperatures ranged between 5°C and 37°C. The plants were returned to the greenhouse in April (autumn). Watering was by hand as required.

The medium had been disinfected with methyl bromide. Etridiazole (35 g a.i. m⁻³) was included in the medium as a precaution against *Nectria radicola*, *Botrytis cinerea*, and *Fusarium oxysporum* f. sp. *cyclaminis*. The medium for Experiment B contained Dieldrin (19.5 g a.i. m⁻³) to combat black vine weevil. A regular spray programme of benomyl (75 g a.i. l⁻¹) was altered every seven to ten days with captain (125 g a.i. l⁻¹) as a precaution against *Botrytis cinerea*. A general insecticide (Maldison) was included with these sprays.

Data Collection and Analysis. These were taken as the average of two perpendicular measurements. Flower height was the maximum height of flowers above the corm. In Experiment A, flower stalk length, flower diameter, and width (widest part) were the mean of five flowers randomly selected from each plant at harvest.

For convenience a number of data were measured using arbitrary ratings from one to five. These are on an increasing scale, for example, five being allotted to the largest flower when flower size was being rated.

RESULTS

Foliage Growth. Nitrogen fertilization had much the greatest influence on the foliage of fertilizers used, and all growth parameters measured showed significant N responses. In Experiment B (foliar dry weight) plant width at 81 days and number of leaves per plant, were all greatest at close to 600 g N m⁻³ (Figure 1). There was a linear increase in foliar N. The response in Experiment A was similar, but optimum levels were under 450 g N m⁻³ which probably indicates the lower rates used for all fertilisers, compared to Experiment B. Additions of P, K, and lime had only minor influences on foliage growth. Foliage colour (mostly green) was optimal at medium K levels while plants were most compact at medium and balanced levels of P, K and lime (data not shown). The plants were very tolerant of the extremely high lime rates (up to 24

kg m⁻³ – pH 6) used in Experiment B, and there was little influence on any aspects of vegetative growth.

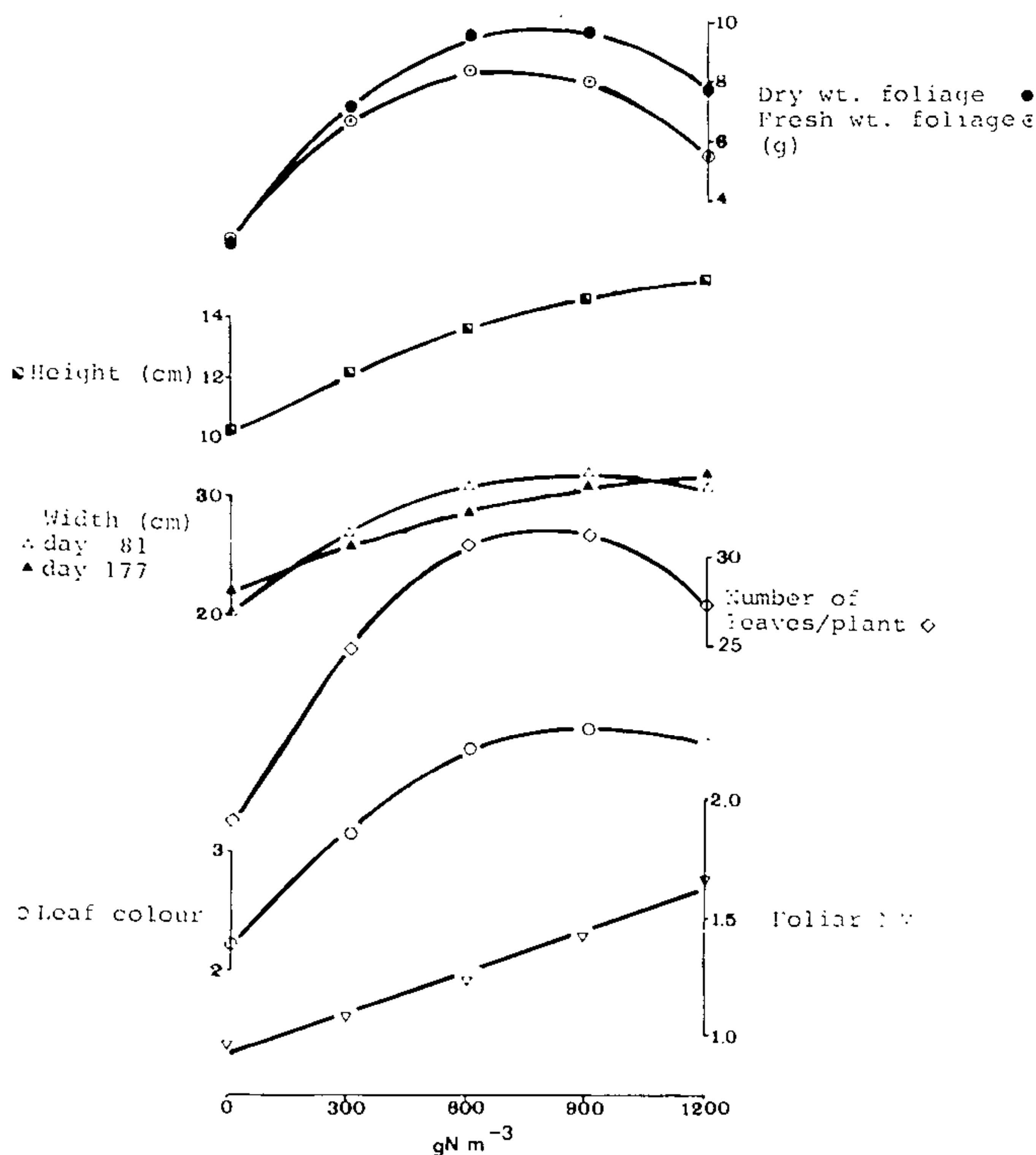


Figure 1. Influence of nitrogen fertilization on foliage growth (Exp. B).

Corm Growth. The results obtained from Experiment B indicated that corm dry weights were greatest at about 600 g N m⁻³ and were depressed, along with corm diameter, above this level (Figure 2). Phosphorus, K, and lime levels again had a moderate influence on growth and, in general, high levels of P or K depressed corm development. For example, high levels of P or K depressed corm diameter (data not shown).

Flowering. Nitrogen strongly influenced flowering while additions of P, K, and lime often interacted together to affect flower quality. In Experiment A flowering was 40 to 50 days earlier at the highest rate of N and nil P, than at low N and nil P (Figure 3). Figure 3 also indicates that P depressed flowering at high N rates. Nitrogen mildly promoted early flowering in Experiment B (Figure 2), while the number of flowers per plant was highest at medium to high N levels (Figure 2). Ratings of flower size indicated that quality was highest when

medium rates of P and K (200 g m^{-3} , 166 g K m^{-3}) were

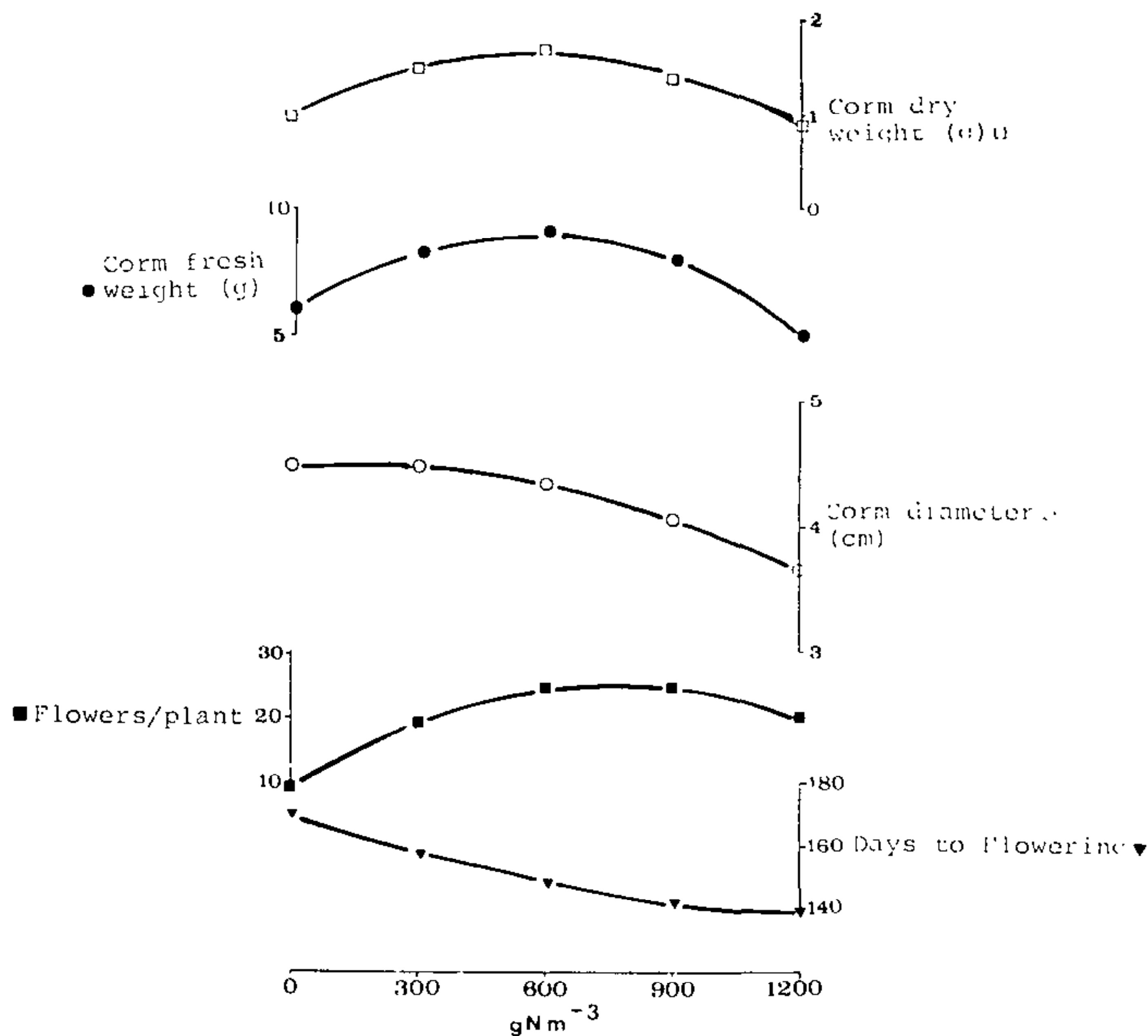


Figure 2. Influence of nitrogen fertilization on corm growth and flowering.

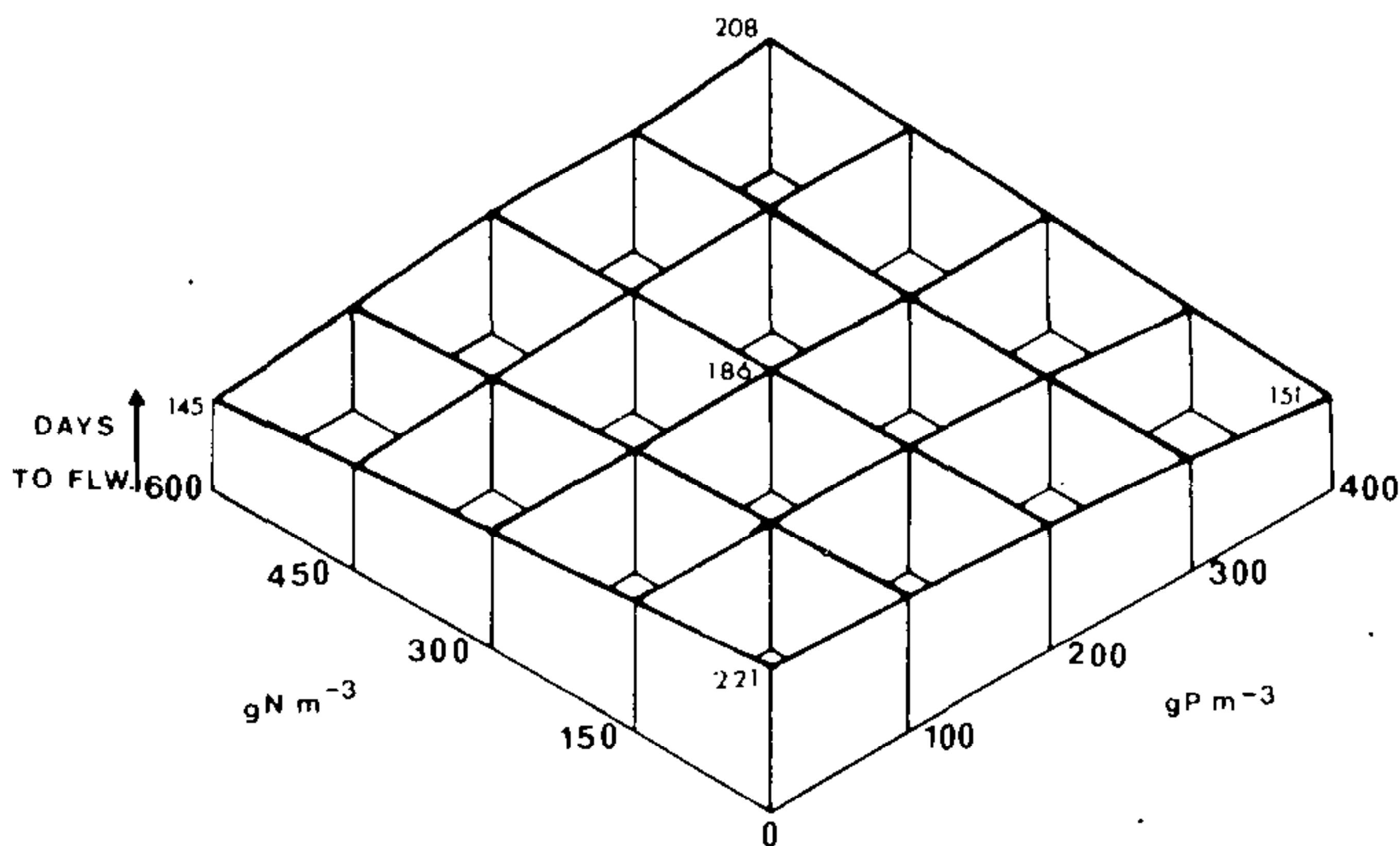


Figure 3. Interaction between nitrogen and phosphorus fertilisation on number of days to flowering (Exp. A).

combined (data not shown). The combined or interactive effects of N and lime levels had very similar influences on the dry weight per flower (Figure 4) and flower stalk length (data not shown). In both cases greatest responses were when the

highest N rate was supplemented with an extremely high lime rate (24 kg lime m^{-3} – pH 6 : nil lime – pH 4.8). High N rates with low or nil lime depressed the weight and stalk length of each flower. Tall flowers were also obtained when medium to high levels of P (300 to 400g m^{-3}) and K (166 to 332g m^{-3}) were combined with about 6 kg lime m^{-3} (pH 5.3 to 5.7).

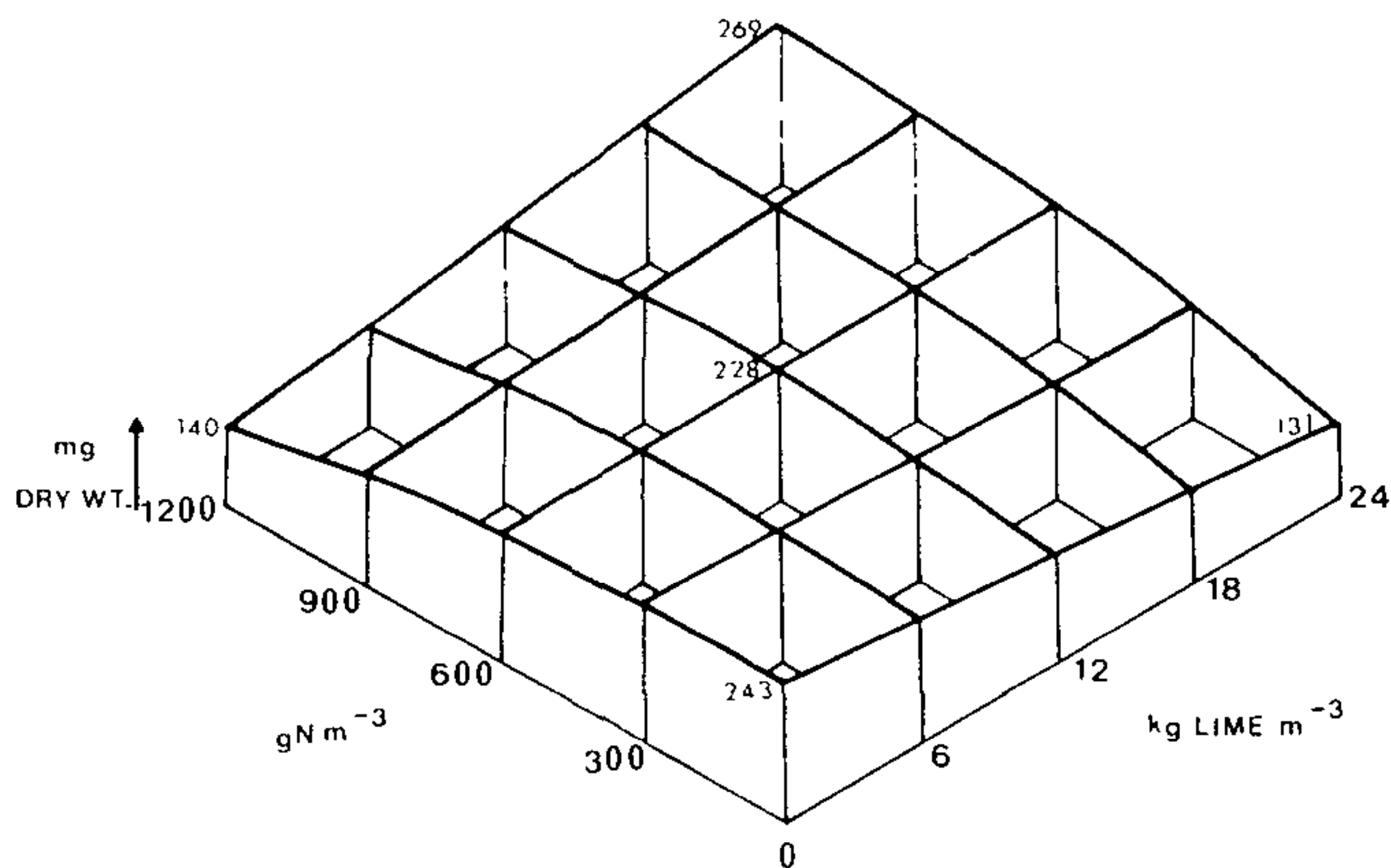


Figure 4. Interaction between nitrogen fertilisation and liming on dry weight per flower (Exp. B).

DISCUSSION

The maximum levels of nutrients supplied in Experiment A did not generally cause strong depression of flowering, nor were any other symptoms of toxicity present. The second experiment was carried out to investigate the influence of very high levels of fertilisation. Far from depressing growth or causing salinity problems, the high rates served to increase the response to N and a number of significant responses to other nutrients. Greater numbers of flowers, larger plants, and improved flower size were observed in Experiment B compared to A.

It can be concluded that cyclamen can tolerate unusually high nutrient levels and liming, providing adequate watering and growing conditions are provided.

Good responses to N have been recorded for most pot plants including cyclamen (6,7). Bunt (1) stated that they have very modest N requirements, but the work reported here indicates that under good growing conditions high N can give satisfactory flowering and growth if other nutrients and pH are adequate. Gugenhan (4) reported that P shortage delayed flowering while in the two experiments here, P appeared important to flower quality, but usually only at moderate levels

and when combined in interaction with other nutrients. Miura (6) reported that P had little influence on cyclamen shoot or root growth, and this was confirmed in the current results.

Cyclamen, in both experiments reported here, was very tolerant of very high lime rates. Hangitae (5) reported that although cyclamen does best under low pH conditions, it has a high calcium requirement. Miura (6,7) reported that excessive lime suppressed growth and caused leatheryness of cyclamen leaves, but nothing of this nature was noticed in the current work, possibly because the pH did not exceed six in the peat-based medium. Miura (6,7) reported that cyclamen will respond to high levels of K, but this also was not observed to any great extent, although high K was applied without detrimental effect.

Both experiments were carried out under warm growing conditions with high natural illumination and, under conditions conducive to rapid growth, the cyclamen responded strongly to high N and lime levels while P and K responses were quite minor.

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