

# EFFECTS OF NITROGEN, PHOSPHORUS, POTASSIUM, AND B-NINE ON THE GROWTH OF BROMPTON STOCKS (*MATTHIOLA INCANA*)

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**Abstract.** The effects of five levels of nitrogen (N), phosphorus (P), and potassium (K) and B-Nine (B9) on Brompton stocks (*Matthiola incana*) grown in peat/sand 1:1 (V.V.) were studied. Nitrogen strongly promoted growth which was further enhanced by high K. Deficiency symptoms occurred at low K whereas there was little demand for P, and it tended to depress the response to N. A foliar spray of B9 strongly reduced height and was temporarily phytotoxic at 5000 and 6000 ppm. The two concentrations offset the response to N particularly at 450 and 600g N/m<sup>3</sup> where there was a mild N × B9 negative interaction for foliar dry weight.

## INTRODUCTION

Robinson (11) stated that a "blueprint" for bedding plant production will take a long time to produce although vital progress has been made with problems of nutrition studied at Cleppa Park Research Station, U.K. However, little research has been done to examine the combined influence of nutrition and growth retardants. A study of this nature was carried out by Joiner *et al.* (8), who investigated the influence of N, P, and K and ancymidol on the growth of *Dieffenbachia*.

Stocks (*Matthiola incana*) have long been known for their high K requirements (10) and this was reaffirmed by Cahoon and Crummett (6) using sand and solution cultures. Similar techniques were also used by Semeniuk (12) and Semeniuk and Stewart (13) to study the influence of nutrition on seed production and subsequent germination, and noted a similar high K requirement. Work reported by Robinson (11) and Dight (7) has emphasised the differing nutrition of bedding plants by examining foliar nutrient levels. Robinson (11) also pointed out that species vary in their response to the various growth regulant chemicals and that any new cultivar released to the grower may require individual testing either before or after release so that an appropriate growth regulant regime is obtained.

The use of growth retardants on bedding plants has been fairly limited in New Zealand, but they are widely used on bedding plants overseas, particularly in U.S.A. (9). These chemicals can improve quality by inducing compact darker green foliage and also improve drought resistance and shelf life (4).

The objective of the experiment reported here was to evaluate the influence of added N, P, K and B-Nine (B9) on the growth of stocks and to use response surfaces to describe any

interactions between these factors. This evaluation may allow growers to use improved production techniques for stocks and other plants and also facilitate a better understanding of the relationship between nutrition and growth retardant application for bedding plants.

## MATERIALS AND METHODS

**Plant Species and Growing Conditions.** *Matthiola incana* seedlings were raised from seed sown on 12 April 1978 and pricked out into troughs 40 days later. Eight seedlings were pricked out per trough and placed in a heated glasshouse equipped with automatic fan ventilation. The glasshouse had a maximum temperature of 5°C above ambient and a minimum of 15°C. The seedlings were hand watered when required and sprayed with maneb plus thiram (both at 1.5g/l) at 2 to 3 week intervals during the experiment for control of *Botrytis*, damping-off, and downy mildew.

**Experimental Design, Media and Fertilisers.** A four factor response surface Box-Hunter design, of Cochran and Cox (5), of the central composite second order type with incomplete blocks was used. It involved N, P, K and B9 growth retardant with 30 treatments arranged in 5 blocks each consisting of 3 sub-blocks and 3 replicates per treatment.

The medium used was equal parts (1:1,v:v) Southland peat (Mataura) and coarse sand (crushed shingle grit).

The fertiliser sources used in this experiment for N, P and K were Osmocote (26% N—), superphosphate (8% P), and sulphate of potash (39% K), respectively. All treatments received a basal dressing of the following: Dolomite lime, 4.5kg/m<sup>3</sup>; Agricultural lime, 1.5kg/m<sup>3</sup>; 75g/m<sup>3</sup> "Sequestrene" iron chelate (Na EDTA Fe with 12% iron); and 150g/m<sup>3</sup> "Sporumix A" (containing 1.14% B, 0.62% Zn, 1.27% Cu, 5.46% Mn, 0.06% Mo, 0.05% Co, 9.78% Mg). The media and fertilisers were well mixed and then transferred to 180 × 90mm troughs just prior to pricking out.

The B9 growth retardant was applied 4 weeks after pricking-out as a foliar spray using Alar (85% daminozide wettable powder) combined with a non-ionic wetting agent — Citowett at 0.25 ml/l.

**Data Collection and Analysis.** Plant height was measured 14 and 16 weeks after sowing. On completion of the experiments at 18 weeks (18/8/78) the plants were cut-off just above the top of the medium and the foliage oven-dried, then weighed.

Data from this experiment were statistically analysed for analysis of variance and F Test using Boxhu computer programme. Data presented in graphic form in this paper were

computed from the equations of the response surfaces.

## RESULTS

The response to fertiliser and growth retardant treatments is presented in Table 1 and was assessed by height measurement on two occasions (14 and 16 weeks from sowing) and dry weight at harvest.

**Table 1.** The significance levels for significant factors (only), standard error, coefficient of variation (CV) and percentage variation explained by the model ( $r^2$ ), were as follows:

	Height 14 weeks	Height 16 weeks	Dry Weight 18 weeks
N — linear	—	***	***
— quadratic	—	***	*
B9 — linear	***	***	***
— quadratic	—	—	#
<i>Interactions</i>			
N × P	—	—	#
N × K	—	*	—
N × B9	—	—	#
Standard Error	0.46	0.79	1.43
CV (%)	18	13	24
$r^2$ (%)	27	68	54
[*** = $p < 0.001$ , ** = $p < 0.01$ , * = $p < 0.05$ , # = $p 0.05-0.10$ ]			

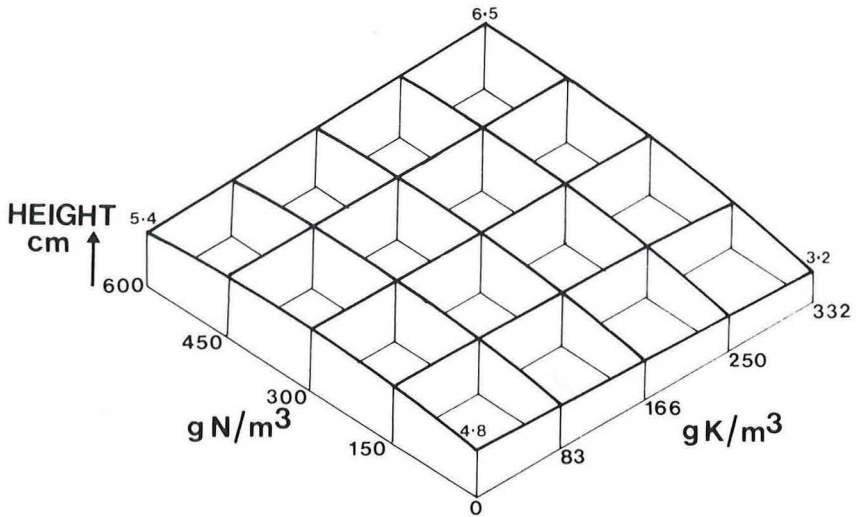
Nitrogen strongly increased growth which was particularly reflected in the dry matter yields at completion of the experiment. Plants given medium to high N rates appeared more robust and darker green than those with very low or nil N. Stocks in the nil N treatment showed the most severe stunting and also death of older leaves. This is illustrated in Figure 1 taken just prior to harvest. Height measurements at 14 weeks failed to indicate a response to N but at 16 weeks the tallest plants were those receiving a combination of high N and K, as indicated by the response surface (Figure 2). Added K only stimulated additional height at the two highest N rates. Plants given increasing amounts of K were similar (Figure 3) when the other additions were at medium levels. Plants given no K showed characteristic small necrotic spots on the leaves.

Phosphorus fertilisation had little influence on growth, and plants appeared similar over the range of P treatments (Figure 4) although those at the high rate appeared a little spindly. Added P depressed the response to N particularly at 450 and 600 g N/m<sup>3</sup>, as shown by the response surface (Figure 5). Phosphorus additions only promoted a small increase in foliar dry weight at nil or 150g N/m<sup>3</sup> but at medium or high N levels, P appeared detrimental.



**Figure 1.** The response to nitrogen with P held at 200, K at 166g/m<sup>3</sup> and B9 3000ppm.

Left to right 0, 300 and 600g N/m<sup>3</sup> (The dimension card indicates cm & ins. for the small and large squares respectively).



**Figure 2.** Interaction of N and K fertilisation on the foliage height at 16 weeks after sowing.

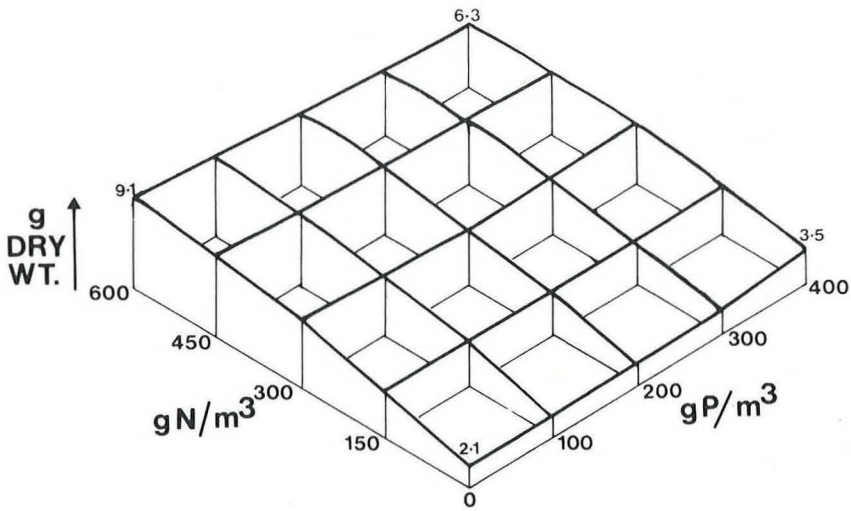


**Figure 3.** The response to potassium with N held at 300 g/m<sup>3</sup>, P at 200g/m<sup>3</sup> and B9 3000ppm.

Left to right 0, 200 and 400 gK/m<sup>3</sup>.



**Figure 4.** The response to phosphorus with N held at 300 g/m<sup>3</sup>, K at 166g/m<sup>3</sup> and B9 3000ppm.  
 Left to right: 0,200, and 400g P/m<sup>3</sup>.

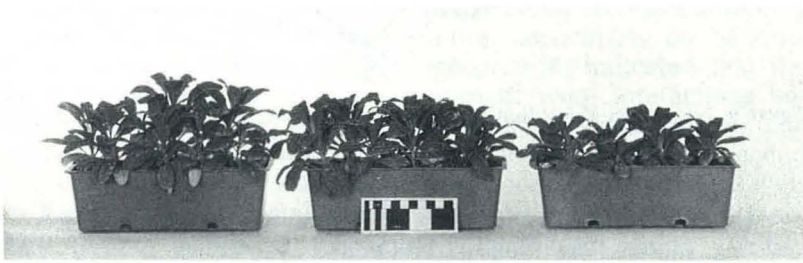


**Figure 5.** Interaction of N and P fertilisation on foliar dry weight.<sup>5</sup>

Foliar-applied B9 had a strongly depressing effect on the height of the plants, which was apparent at harvest (Figure 6) and during the experiment. There was a linear response (Figure 7) and it was notable that plants receiving 6000 ppm B9 were only half the height of untreated plants at 16 weeks. The interaction with N was mildly significant on dry matter production while N was promotory and B9 had an opposing influence. The response diagram (Figure 8) shows how increasing rates of B9 will severely depress foliar dry matter accumulation such that at 600g N/m<sup>3</sup> plus 6000 ppm B9 the top weight was only 4g compared to 9g per plant for unsprayed plants at the same N level. Growth depres-

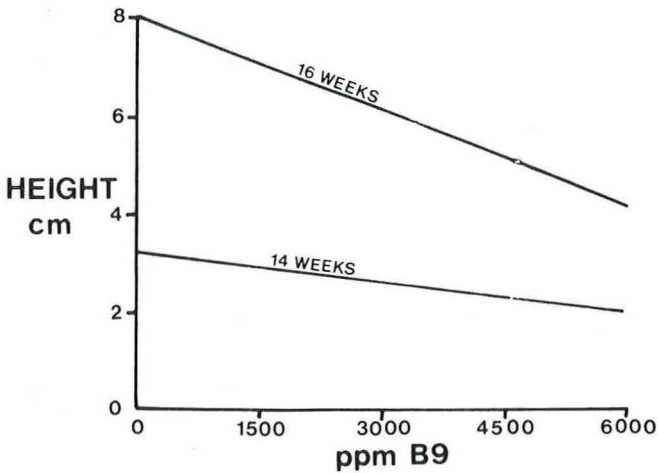
sion related strongly to B9 concentration at all N rates so that there was a relatively small decrease in foliar dry weight at 1500 ppm B9, but increasing reductions at higher B9 levels.

Plants were visually rated for B9 phytotoxicity 1½ weeks after spraying. More than 50% of the plants receiving 6000 ppm B9 showed large amounts of chlorosis and some necrosis on the leaves. There was a linear relationship between phytotoxicity and spray concentration (data not shown), such that those receiving only 1500 ppm showed very few symptoms. Phytotoxicity was barely visible 4 weeks after rating and recovery was generally rapid and complete.



**Figure 6.** The influence of B9 on foliage growth with N held at 300g/m<sup>3</sup>, P at 200g/m<sup>3</sup> and K 166g/m<sup>3</sup>.

*Left to right 0, 3000 and 6000ppm B9.*



**Figure 7.** The influence of B9 on foliage height at 14 and 16 weeks after sowing.

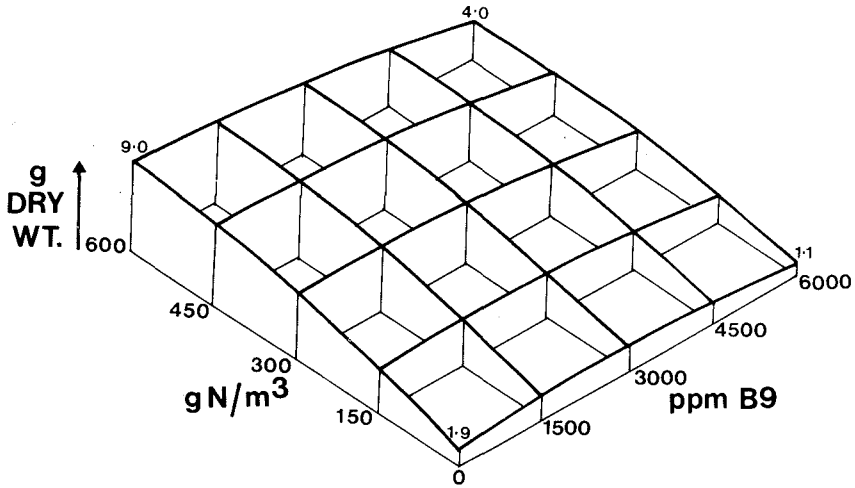


Figure 8. Interaction N fertilisation and B9 foliar application on foliar dry matter.

### DISCUSSION

Dight (7) using a peat/sand (3:1) mix found that a range of bedding plants were highly responsive to added N and that inadequate levels resulted in pale small plants as was found in the work described here. Semeniuk and Stewart (13) grew *Matthiola incana* in sand using nutrient solutions and found that early removal of N gave shorter, smaller plants with fewer flowers and poorer seed production than those given a continuous N supply.

Stocks appear to have a low P requirement and a range of levels has been shown in the work reported here and by others (13) to have little influence on foliage growth. Furthermore, Semeniuk (12) noted that additional P depressed seed production and germination percentage. Cahoon and Crummett (6) found that P accumulation, which was absorbed relatively independently of the K levels from solution cultures, was only absorbed in relatively small amounts compared to N, K and Ca and primarily at the early stages of growth.

Early work by Cahoon and Crummett (6) established that stocks are a K-sensitive crop due to a high K requirement and a limited ability to obtain K from the soil. They were found to have a high threshold value for visible K deficiency symptoms (1.2 to 1.5% in the leaves) and also to normally have high foliar K levels of 4 to 6 %. They found that K uptake was most rapid in the early stages of growth and slower later when grown at low K. In the work reported here, K deficiency symptoms occurred quite early and lasted till maturity. Dight (7) reported that 300 to 400g K/m<sup>3</sup> provided inadequate feed for commercial bedding plants and that potassium symptoms were frequently seen in retail out-

lets. However, in this investigation, 332 K/m<sup>3</sup> appeared to give good results, particularly when coupled with nil or low P and high N.

A single 5000 ppm foliar spray of B9 at stem elongation was reported to be sufficient for retarding the growth of bedding plants (2) and will reduce the height of petunias by one-third at this concentration (4). Cathey (3) stated that B9 is non-toxic at normal concentrations but in the work reported here, phytotoxicity was apparent 1½ weeks after spraying; however plants appeared healthy one month later. The typical characteristics (3) of more compact habit and darker green foliage, compared to unsprayed plants, was also observed.

There have been relatively few detailed studies combining growth retardant and nutrition studies, particularly on bedding plants. One such study on *Dieffenbachia* (8) indicated that the most striking results of their experiment were interactions between ancymidol and N,P,K fertilisation on shoot growth. The numbers of axillary breaks rose to a maximum with the second highest level of both treatments. Ancymidol and fertiliser levels influenced height independently. In the work reported here there was a minor interaction between N and B9 on foliar dry weight and it appears that the influence of N at medium to high rates is simply offset by B9 to a degree dependent on concentration. Medium rates of both are most likely to give well developed but relatively compact good quality stocks.

#### CONCLUSIONS AND PRACTICAL IMPLICATIONS

Stocks grew strongly in response to added N and K when grown in peat/sand with 6kg/m<sup>3</sup> of lime. This work indicates that optimum growth in this medium could be obtained from a high rate of commercial fertiliser such as 3kg/m<sup>3</sup> of Osmocote N,P,K 14/6/12 plus 0.5kg/m<sup>3</sup> of sulphate of potash (39% K). No additional P is required.

Ball (1) recommends a porous soil with a pH of about 6 plus regular liquid feeding for stocks, as determined by soil tests. The suggested readings were 2.5, 5.0 and 30 to 40 ppm of nitrates, phosphorus, and potassium, respectively. The strong response to N and the negative influence of P reported here could be considered when following the programme recommended by Ball (1).

A foliar spray of B9 can be used to improve quality, shelf life and provide compact plants. This appears to be a useful production technique and a foliar spray of 3000 to 6000 ppm B9 can be applied when the plants begin active growth at about 4 weeks after pricking-out.

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