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Effect of slow release fertiliser on the growth of containerised flannel flower (*Actinotus helianthi* Labill.)

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Abstract

Two controlled-release fertiliser (CRF) formulations, Nutricote Total ® 13N : 5.7P : 10.8K (N13) and Nutricote Total ® 18N : 2.6P : 6.6K (N18), were applied at 0, 1.25, 2, 2.5, 5 and 10 kg m^{-3}, to flannel flower (*Actinotus helianthi* Labill.) seedlings grown in soil-less potting mix in containers. After five months, during peak spring flowering, a number of characters relating to the quality of the cut flower product of this species were assessed. As the rate of fertiliser application increased, the plant height, total number of stems, number of flowering stems and number of flowers and buds increased. There were significantly more stems and flowers overall, and more flowering (saleable) stems, in the N18 treatments at all application rates. Plant height was not affected by fertiliser formulation. Basal foliar necrosis, which scored highly in the control treatment (0 fertiliser), was reduced by fertiliser application.

Key words: Nutrition, controlled-release fertiliser, nitrogen, *Actinotus helianthi*, flannel flower, cut flower

Introduction

The flannel flower (*Actinotus helianthi* Labill.) is an erect annual or perennial herb that is covered with a woolly indumentum (Powell, 1992) giving the plant and particularly the inflorescence its characteristic ‘flannel’ appearance. It occurs naturally in eastern Australia in New South Wales and southern Queensland. This species is generally found on sandy and rocky soils along the coast and also in small sandy patches in the western extent of its distribution.

Belonging to the Apiaceae family, with umbels subtended by large involucral bracts giving an inflorescence reminiscent of daisies, the long-stemmed selections are considered a useful cut flower feature-filler product. Ten years ago, the species was primarily bush harvested for the cut flower market, but in recent years it has been cultivated and export sales are steadily increasing (Worrall *et al.*, 2004).

Originally there were several significant limitations to production of flannel flower, including low seed germination and vegetative propagation rates. These problems have largely been overcome (Offord and Tyler, 1996; von Richter and Offord, 1997, 2000) and attention has recently turned to improving knowledge about cultivation of this species including nutrition, substrate requirements and disease interactions. Little is known about the nutritional requirements of flannel flowers or many other Australian species that occur on low nutrient soils (Brennan *et al.*, 1998).

This paper examines the significance of the effect of two controlled-release fertiliser (CRF) formulations, at increasing application rates, on several reported and unreported growth characteristics of containerised flannel flowers (von Richter and Offord, 1997). Nutricote Total® was used for this experiment as it was readily available in our nursery at that time; however, several other CRF products commercially available would have been equally suitable for this work. CRFs are a commonly used source of nitrogen and other major as well as minor nutrients because they release the nutrients more evenly than conventional soluble fertilisers reducing problems associated with burning or leaching, and without the more labour intensive liquid fertiliser applications that also deliver good plant growth (Cresswell and Weir, 1997; Oliet *et al.*, 2004).

Materials and methods

Plant material: *Actinotus helianthi* seeds were collected in spring (November) from Tea Gardens on the NSW Central Coast (Latitude 32°39′43″S, Longitude 152° 08′58″E). All work on seeds, seedlings and plants was carried out at Mount Annan Botanic Garden (34º04′04″S, 150º46′04″E).

Potting mix, fertiliser formulation and rate: Seeds were sown soon after harvest onto seed raising mix (sand /perlite 1:1 v/v) and the seedlings pricked out at the two leaf stage and planted into 50 mm tubes containing sand/coir mix (4:1 v/v) and 0.5 g L^{-1} $FeSO_4$ and 0.5 g L^{-1} lime. When the seedlings were 80 mm high, 220 seedlings were planted into the sand/coir mix in 140 mm slimline black plastic pots, but with varying application rates of either Nutricote Total® 13N : 5.7P : 10.8K (N13) or Nutricote Total® 18N : 2.6P : 6.6K (N18). The release time for each fertiliser is 270 days at 25ºC. The following rates were applied: 0, 1.25, 2, 2.5, 5 and 10 kg m^{-3}. The rate recommended by the manufacturer is 2 kg m^{-3}.

Experimental design: There were 20 replicates of each treatment. The plants were arranged in a completely random design on raised benches in full sun. Watering was by hand as and when required.

Assessment: At peak flowering time (mid-November), when the plants had been in the different fertiliser treatments for five months, the following measurements were made: plant height, total stem number, flowering stem number and total number of flowers and buds. Foliar leaf necrosis was scored (1 = basal leaves green; 2 = one basal leaf yellow; 3 = two basal leaves yellow or brown; 4 = all basal leaves brown).

Statistical analysis: Main effects and interactions were analysed by ANOVA and differences between the means compared using LSD (P=0.05). Reponses to the two fertiliser formulations to application rates were analysed by linear regression. All analyses were performed using SYSTAT 11 (SPSS Inc. 2004).

Results

Plant height: Plant height was largely unaffected by the fertiliser formulation, but the rate effect was significant (Table 1), probably mainly due to the much lower zero fertiliser control treatment (Fig. 1A). The regression slopes in Fig. 1A were highly significant for N13 (P = 0.001) and N18 (P = 0.001), indicating that the slopes were not equal to zero and that fertiliser application rate has some effect on plant height. However, the proportions of the total variance explained by the application rates were very low (R^2 = 0.12 and 0.13) (Fig. 1A).

Stem number: Overall, the number of stems produced was greater in the N18 treatment, when compared to the N13 treatments (Fig. 1B). The regression slopes (Fig. 1B) were highly significant for N13(P <0.001) and N18 (P < 0.001), which indicates that the slopes were not equal to zero and that there is a relationship between fertiliser application rate and the stem number produced. Maximum stem numbers were found at N18 at 5 and 10 kg m^{-3} (averages of 6.5 and 8.5 stems); the next highest stem number was at N13 at 10 kg m^{-3} (average of 6 stems). Fertiliser types and rates of application were significant main effects for this variable, and there was also a significant interaction effect detected (Table 1). At the time of measurement, fewer than half of the stems had produced flowers, with the least flowering stems produced at zero fertiliser application (Fig. 1C). The highest number of flowering stems was produced at 10 kg m^{-3} N18 which represented 35% of the total number of stems (Fig. 1B and C).

There was little difference between the formulations in the number of flowering stems produced at 2.5 and 5 kg m^{-3}, but there were small significant differences between the formulations at 1.25 and 2 kg m^{-3} (Fig. 1C). This accounts for the significant and highly significant main effect responses detected for fertiliser formulation and rate respectively (Table 1). Again, the regression slopes for this variable were highly significant for N13 (P<0.001) and N18 (P < 0.001), Fig. 1C), which indicates that the slopes were not equal to zero and that there is a relationship between fertiliser application rate and the flowering stem numbers, but the direction of the regression slopes were less steep (R^2 = 0.2%) (Fig. 1C), than when compared to the total number of stems (R^2 = 0.4 and 0.6%) (Fig. 1B).

Number of flowers and buds: The number of flowers and buds produced was greatly affected by both fertiliser type and rate, although there was no interaction observed between the two (Table 1). The regression slopes were highly significant for N13 (P = 0.001) and N18 (P = 0.001), which indicates that the slopes were not equal to zero and that there is a relationship between fertiliser application rate and flower/bud numbers. Maximum flower numbers were observed at the 10 kg m^{-3} level of both fertilisers (average of 28 and 22 flowers), with the slope of the response being similar (R^2 = 0.49 and 0.5) for both formulations over the range of applications tested (Fig. 1D).

Basal foliar necrosis: Basal foliar necrosis was significantly affected by fertiliser formulation and rate (Table 1), with significantly less necrosis observed for N18, when compared to N13 at the 2 and 2.5 kg m^{-3} application rates (Fig. 1 E), which may account for the significant interaction term for fertiliser x rate. The regression slopes for foliar necrosis were highly significant for N13 (P = 0.001) and N18 (P = 0.001), indicating a relationship between fertiliser application rate and the degree of necrosis observed, despite the weak R^2 values. Overall, fertiliser application, especially N18 greater than 2 kg m^{-3} and N13 at 5 and 10 kg m^{-3}, significantly improved (decreased) the necrosis rating when compared with the control (zero fertiliser).

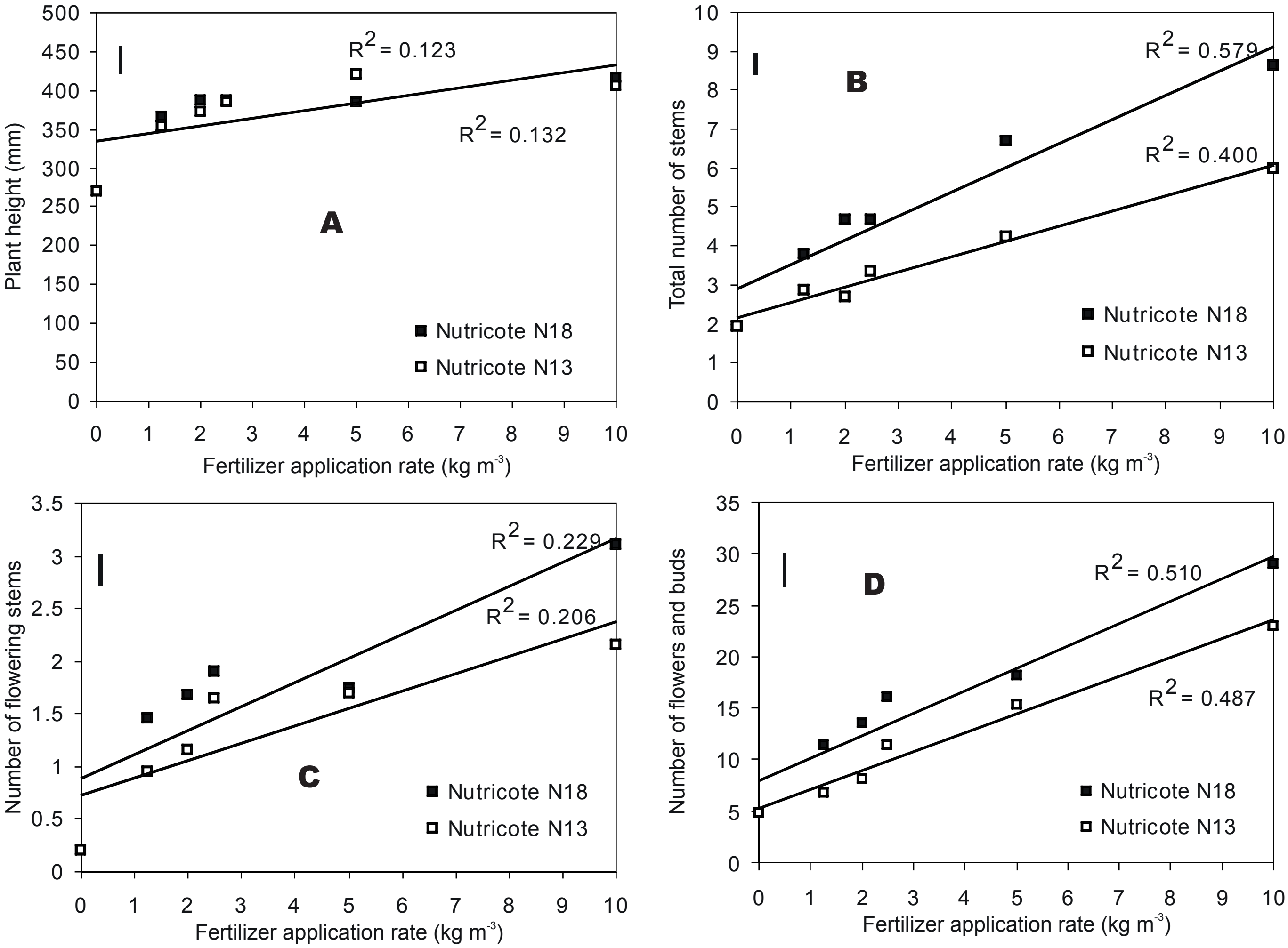
Discussion

In terms of the quality of the flowering stems produced, flannel flowers appeared to respond positively to all the imposed fertiliser treatments in this study when compared with the control treatment (zero fertiliser application), with no adverse affects observed at any applied level. The recommended rate of 2 kg m^{-3} was exceeded up to five times (to 10 kg m^{-3}) and the plants produced more stems and more flowers as the application rates increased. This high tolerance of applied nutrients is in contrast to some other Australian and South African native species which require little fertiliser to achieve optimal results (Brennan *et al.*, 1998; Clark and Burge, 1999),while others responded in a similar fashion to *A. helianthi* (Lamont *et al.*,1990; Bennell and Williams, 1992; Brennan *et al.*, 2000). It has commonly been observed that flannel flowers are found in abundance after bushfire, at which time there may be increased nutrient levels are often available depending on the nutrient status of the plant material that has been burnt (Ashton and Martin, 1996; Enright *et al.*, 1997). Further work is required to determine the ecological significance of this response.

Relative differences between the two fertiliser treatments are of greatest horticultural interest. The plants responded to the higher nitrogen formulation by producing more saleable product *i.e.* more stems and flowers. Nutricote N13 is recommended for potted flowering plants because of its balance of lower nitrogen when compared to phosphorus and potassium, while the N18 formulation is recommended by the manufacturer (Yates Pty Ltd)

Table 1. Significance (P value) of main effects (fertiliser type and rate) and interactions for characteristics of flannel flower plants five months after fertiliser application

	Height of plant	Number of stems	Stems with flowers	Flower number	Basal foliar necrosis
Fertiliser type	0.960	0.001	0.015	0.001	0.041
Rate	0.001	0.001	0.000	0.001	0.001
Fertiliser x Rate	0.730	0.003	0.482	0.362	0.021



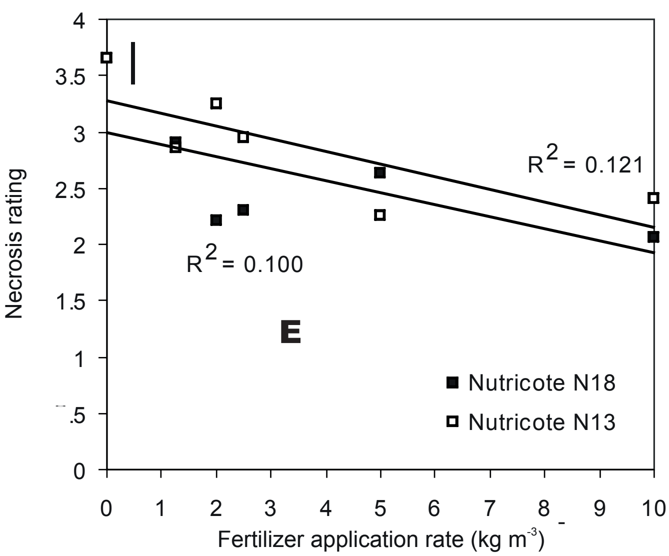


Fig. 1. Responses of containerised flannel flower (*Actinotus helianthi*) to applied slow release fertilisers, Nutricote Total ® 13N: 5.7P: 10.8K and Nutricote Total ® 18N: 2.6P: 6.6K, at different application rates (0, 1.25, 2, 2.5, 5 and 10 kg m^{-3}). A. plant height; B. total number of stems; C. number of flowering stems; D. number of flowers and buds per plant; E. necrosis rating (1 = basal leaves green; 2 = one basal leaf yellow; 3 = two basal leaves yellow or brown; 4 = all basal leaves brown). Regression slopes were all highly significant from zero at $P \leq 0.001$ level. The bar represents the LSD of the means at $P = 0.05$.

for foliage plants because of its higher nitrogen ratio. Certainly, greater flowering stem production is a desired aim in cut flower production in this species, and it would appear that the high nitrogen formulation achieved the best result in this respect. Although the overall number of flowering stems was greatest at high nitrogen, the number of flowers produced per flowering stem (derived from Figs 1 C and D) was very similar for the two fertiliser treatments at each rate. For example, at 2 kg m^{-3} the N18 treatment had an average of 8.0 flowers per flowering stem and N13 had 7.1; at 10 kg m^{-3} N18 had 9.4 and N13 had 10.7. Therefore, it appears that the higher nitrogen treatment did not suppress flower number per stem.

Stem height was not greatly affected by the fertiliser formulation or application rates greater than zero, which is likely to reflect that plant height in this species is primarily determined genetically, rather than environmentally. In wild stands, we have observed very tall plants, with few stems, reflecting the low nutrient status of the soil in most of these areas and the adaptation of the species to variable nutrient conditions. Plant height is a major selection criterion for Flannel flower development, and we have documented the differences between populations, which are maintained by the plants in cultivation (Offord and Tyler, 1996). For example, short headland-growing varieties are being developed for the pot plant market, while inland forest forms are useful for cut flower production because of their naturally long stems.

There are many forms of *Actinotus helianthi* and some of the tall growing cut flower types show basal leaf necrosis much sooner than short pot plant types. Based on evidence from tissue cultured plants (von Richter, unpublished) there are differences in nutrient requirements for these different forms. Considering the axenic nature of tissue culture, the necrosis is likely to be caused by the movement of nutrients, particularly nitrogen away from the basal leaves to be reutilised in the apical region rather than the effects of a pathogenic infection. The faster growing varieties are likely to have a higher nutritional requirement than smaller, slower growing ones.

The optimal fertiliser regime could not be determined by this study, but it would be expected to not exceed the highest application rate and may be less, especially in terms of the cost of application (Obreza *et al.*, 1999) or leaching into the soil/water environment, mainly in the form of nitrate (Cox, 1993; Huett, 1997). The results of this study are based on seedlings from one population only. The recommendations for fertiliser use found here is only an indicator of the nutrient usage of one flannel flower type and at one point in time. The temporal effects of fertiliser formulations and rates to enable growers to optimise their usage of CRFs alone, or in combination with water soluble fertilisers depends on the varieties being produced and the timing of production required in nursery situations (Jacobs *et al.*, 2005) or in the field (Brennan *et al.*, 1998).

Acknowledgements

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References

Ashton, D.H. and D.G. Martin, 1996. Regeneration in a pole-stage forest of *Eucalyptus regnans* subjected to different fire intensities in 1982. *Australian Journal of Botany*, 44: 393-410.

Bennell, M.R. and R.R. Williams, 1992. Cultivation of the pink mulla mulla *Ptilotus exaltatus* Nees. 2. Nutrition and growth regulation. *Scientia Horticulturae*, 51: 107-110.

Brennan, R.F., A.M. Crowhurst and M.G. Webb, 1998. The growth of Yellow Bells (*Geleznowia verrucosa*) seedlings in response to additions of nitrogen, potassium and phosphorus fertiliser. *Australian Journal of Experimental Agriculture*, 38: 385-390.

Brennan, R.F., M.G. Webb and A.M. Crowhurst, 2000. Yield responses of mulla mulla (*Ptilotus exaltatus* Nees.) seedlings to additions of nitrogen, potassium and phosphorus fertiliser. *Australian Journal of Experimental Agriculture*, 40: 847-871.

Clark, G.E. and G.K. Burge, 1999. Effects of nitrogen nutrition on *Sandersonia* cut flower and tuber production in a soil-less medium. *New Zealand Journal of Crop and Horticultural Science*, 27: 145-152.

Cox, D.A. 1993. Reducing nitrogen leaching-losses from containerized plants: the effectiveness of controlled-release fertilizers. *Journal of Plant Nutrition*, 16: 533-545.

Cresswell, G.C. and R.G. Weir, 1997. *Plant nutrient disorders 5, Ornamental Plants and Shrubs.* Inkata Press, Melbourne.

Enright, N.J., D. Goldblum, P. Ata and D.H. Ashton, 1997. The independent effects of heat, smoke and ash on emergence of seedlings from the soil seed bank of a healthy *Eucalyptus* woodland in Grampians (Gariwerd) National Park, western Victoria. *Australian Journal of Ecology*, 22: 81-88.

Huett, D.O. 1997. Fertiliser use efficiency by containerised nursery plants. 2. Nutrient leaching. *Australian Journal of Agricultural Research*, 48: 259-265.

Jacobs, D.F., D.L. Hasse and R. Rose, 2005. Growth and foliar nutrition of Douglas-fir seedlings provided with supplemental polymer-coated fertilizer. *Western Journal of Applied Forestry,* 20(1): 58-63.

Lamont, G.P., G.C. Cresswell and G.J. Griffith, 1990. Nutritional studies of Christmas Bell. *HortScience*, 25: 1401-1402.

Obreza, T.A., R.E. Rouse and J.B. Sherrod, 1999. Economics of controlled-release fertilizer use on young citrus trees. *Journal of Production Agriculture,* 12: 69-73.

Offord, C.A. and J.L. Tyler, 1996. Flannel Flowers. In: *Horticulture of Australian Plants.* Burchett, M. and Johnston K. (Eds), UNSW Press, Sydney, pp. 212-217.

Oliet, J., R. Planelles, M.L. Segura, F. Artero and D.F. Jacobs, 2004. Mineral nutrition and growth of containerized *Pinus halepensis* seedlings under controlled-release fertilizer. *Scientia Horticulturae,* 103: 113-129.

Powell, J.M. 1992. Apiaceae. In: *Flora of NSW*. G.J. Harden (Ed). Vol. 3. New South Wales University Press, Sydney, pp. 87-116.

von Richter, L. and C. Offord, 1997. Flannel flower (*Actinotus helianthi*) as a cut flower crop. RBG 1A. Rural Industries Research and Development Corporation, Canberra, 66 pp.

von Richter, L. and C.A. Offord, 2000. Development of a Flannel flower production system. Rural Industries Research and Development Corporation, Canberra, Publication NO. 00/106, 54pp.

Worrall, R., C. Offord and L. von Richter, 2004. Flannel flower. In: *The New Crop Industries Handbook.* Salvin, S., Bourke, M. and Byrne, T. (Eds), Rural Industries Research and Development Corporation, Canberra, pp. 434-441.