

## Response of seed-propagated geranium (*Pelargonium x hortorum* L. H. Bailey) to application of flurprimidol

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### Summary

In 1998 and 1999 flurprimidol spray applications to seed-propagated geranium (*Pelargonium x hortorum* L.H.Bailey) cultivars were made to evaluate efficacy and identify optimum concentration of flurprimidol. Growth retardant was applied as a single spray at 0, 7.5, 15 and 22.5 mg L<sup>-1</sup>, when plants were 9-13 cm in height. The response of plants to flurprimidol application varied depending on geranium cultivar. At the time of flowering the plants sprayed with flurprimidol at concentrations of 7.5, 15 and 22.5 mg L<sup>-1</sup> were significantly shorter than the untreated ones. The plant diameter, floret diameter, floret peduncle length and inflorescence diameter of geranium treated with flurprimidol were significantly smaller than those of the control plants. Flurprimidol hastened flowering of geranium cultivars 'Suzan Improved', 'Pinto Salmon' and 'Ringo 2000 Violet' by 5-8 days in 1999 but had no significant effect on days to flowering in 1998. The chemical name used: a-(1-methylethyl)-a-[4-(trifluoromethyloxy)-phenyl]-5-pyrimidine-methanol (flurprimidol).

Key words: seed-propagated geranium, pot plants, growth control, flurprimidol

### INTRODUCTION

The method of geranium propagation, by sowing seeds, has been widely used by growers in the USA and many West Countries but recently it has also become popular in Poland. Seed-propagated geranium can be grown either as a pot or bedding plant. It suits large open gardens, planter boxes, window-sills and hanging baskets. The cultivation of geranium propagated by seeds gives the grower many advantages but some of the cultivars are too high to be grown in pots. Growth retardants are used on seed-propagated geranium primarily to keep plants short. In the past geranium was

successfully retarded mainly using chlormequat chloride (S e m e n i u k and T a y l o r, 1970; M i r a n d a and C a r l s o n, 1980; W h i t e and W a r r i n g t o n, 1984; H o n g e t a l., 1986). In order to obtain well compact plants, multiple applications of CCC were required (M i r a n d a and C a r l s o n, 1980), what was costly and labour consuming. Chlormequat chloride can also cause chlorosis of the margins of leaves, when used at recommended concentrations (T a y a m a and Z r e b i e c, 1987). Development of growth retardants of new generation such as uniconazole, paclobutrazol or flurprimidol enabled treating plants with single application of those chemicals without any phytotoxicity. They are effective at much lower concentrations than CCC and usually one application of those chemicals is sufficient to obtain short and well compact geranium (H o n g e t a l., 1986; A n d r a s e k, 1989; S t a r m a n e t a l., 1994; W h i p k e r e t a l., 1997; P o b u d k i e w i c z and N o w a k, 1999). In Poland only flurprimidol of new generation chemicals has been registered for usage in floricultural crops. Flurprimidol has demonstrated activity on a wide range of floricultural crops but there is only one publication concerning application of this chemical in cultivation of geranium propagated from cuttings (P o b u d k i e w i c z and N o w a k, 1999). Flurprimidol has not been applied in cultivation of seed-propagated geranium so far. Therefore this study was undertaken to investigate the effect of single foliar application of flurprimidol on seed-propagated geranium (*Pelargonium x hortorum* L.H.Bailey) cultivars: 'Suzan Improved', 'Pinto Scarlet', 'Pinto White', 'Pinto Salmon', 'Ringo 2000 Light Salmon', 'Ringo 2000 Deep Rose' and 'Ringo 2000 Violet'.

## MATERIAL AND METHODS

Seeds of *Pelargonium x hortorum* L.H. Bailey cultivars 'Suzan Improved', 'Pinto Scarlet', 'Pinto White', 'Pinto Salmon', 'Ringo 2000 Light Salmon', 'Ringo 2000 Deep Rose' and 'Ringo 2000 Violet' were sown on the 23<sup>rd</sup> of January 1998 and 1999. During germination of geranium seeds the medium temperature was 22-24°C. Three weeks following sowing seedlings were selected for uniformity and transplanted into 7 cm plastic pots containing a medium composed of 3 sphagnum peat : 1 perlite (v:v), pH-6.2. When plants had developed two to three expanded true leaves, geranium was transplanted into 10 cm pots. The plants were grown in a glasshouse under natural light conditions with night temperature about 16°C. The day temperature fluctuated with ambient temperatures but did not fall below 20°C. The plants were fertilized with Pokon (0.3 ml/l), applying liquid fertilizer at each watering. Geranium was treated with single foliar application of flurprimidol (Topflor 015 SL) at 7.5, 15 and 22.5 mg L<sup>-1</sup>, when plants were 9-13 cm in height depending on the cultivar. The plants were treated with growth retardant until the foliage was thoroughly covered but the growth retardant solution was not allowed to drip off. The control plants were sprayed with tap water at the same time. No wetting agent was added to the flurprimidol spray solution.

The experiment was designed as a randomized complete block with three replications. Within each replication, treatments were randomly assigned to twenty-eight rows of six plants each. The experiment was repeated twice. Data were subjected to analysis of variance and Duncan's multiple range test was used at the 5% level of

significance. The plant height (measured from the medium surface to the tallest point of the plant) and plant diameter (measured in perpendicular directions) were recorded when three inflorescences on each plant were fully developed. Observations also included floret diameter (average of 5 mature florets per inflorescence), floret peduncle length, and inflorescence diameter. Time to flower (number of days from sowing) was recorded at the opening of the first floret.

## RESULTS AND DISCUSSION

Flurprimidol had a highly significant effect on many growth responses of all geranium cultivars 'Suzan Improved', 'Pinto Scarlet', 'Pinto White', 'Pinto Salmon', 'Ringo 2000 Light Salmon', 'Ringo 2000 Deep Rose' and 'Ringo 2000 Violet'. At the time of flowering there was a significant difference in the height of all tested geranium cultivars between control plants and plants sprayed with flurprimidol at concentrations of 7.5, 15 and 22.5 mg L<sup>-1</sup> (Tab. 1). The results of this experiment have shown that response of seed-propagated geranium to application of flurprimidol varied depending on geranium cultivar. The more vigorous was the geranium cultivar the higher concentration of flurprimidol was required for control of plant height. In this experiment geraniums 'Ringo 2000 Violet' and 'Ringo 2000 Deep Rose' were least vigorous cultivars of all tested ones and most vigorous geranium cultivars were 'Suzan Improved', 'Pinto

Table 1.

Effect of single flurprimidol application on plant height (cm) of seed-propagated geranium cultivars

Cultivars	Flurprimidol concentrations mg l <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	44.2 o	36.1 lm	31.7 hi	28.8 d-g
'Pinto Scarlet'	40.8 n	36.4 lm	32.3 h-j	28.9 d-g
'Pinto White'	40.4 n	34.4 j-l	31.3 f-i	28.6 c-f
'Pinto Salmon'	37.5 n	31.2 f-i	28.3 c-e	26.4 b-d
'Ringo 2000 Light Salmon'	35.2 k-m	30.7 e-h	28.0 c-e	26.5 b-d
'Ringo 2000 Deep Rose'	33.5 i-k	28.0 c-e	24.7 ab	23.4 a
'Ringo 2000 Violet'	33.5 i-k	28.8 d-g	26.0 bc	23.5 a

Values followed by the same letter are not different at 5% level of significance

Scarlet' and 'Pinto White'. Desirable height control of seed propagated geranium was obtained when flurprimidol was applied at 15 mg L<sup>-1</sup> to 'Ringo 2000 Violet' and 'Ringo 2000 Deep Rose' or at 22.5 mg L<sup>-1</sup> to 'Ringo 2000 Light Salmon' and 'Pinto Salmon'. The heights of geranium 'Suzan Improved', 'Pinto Scarlet' or 'Pinto White' were reduced by 30% as compared with the control plants but in order to achieve plants shorter than 28.6-28.9 cm in height slightly higher concentration of flurprimidol is suggested. The results of this experiment verify those of other reports. H o n g et al. (1986) or

Tayama and Carver (1992) have also demonstrated that response of geranium to growth retardant application depends on the cultivar. Chung et al. (1998) found that 'Pinto Scarlet' was more sensitive to growth retardants treatment than 'Pinto Rose' and Whipker et al. (1997) noted that 'Pink Satisfaction' was a less vigorous cultivar than 'Medallion Dark Red' or 'Aurora' and required lower rates of paclobutrazol. Flurprimidol has affected the plant diameter and produced compact stature of seed-propagated geranium (Tab. 2). The diameters of all tested geranium cultivars treated with flurprimidol at concentrations of 7.5-22.5 mg L<sup>-1</sup> were significantly smaller than those of the untreated plants and the size of the geranium diameter varied depending on growth retardant concentration (Tab. 2). Latimer and Baden (1994), Whipker et al. (1997) or Pobudkiewicz and Nowak (1999) have also reported smaller canopy diameter of growth retardant treated geranium.

Flurprimidol has also effected the floret peduncle length (Tab. 3) and floret diameter (data not shown) of seed-propagated geranium. Comparing with the control, floret peduncles of growth retardant treated plants were significantly shorter, when

Table 2

Effect of single flurprimidol application on plant diameter (cm) of seed-propagated geranium cultivars

Cultivars	Flurprimidol concentrations mg L <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	37.4 m	33.1 j-l	28.5 d-h	24.8 a-c
'Pinto Scarlet'	34.1 kl	29.6 e-i	27.1 c-f	24.6 a-c
'Pinto White'	34.8 l	32.1 i-k	29.7 f-i	28.1 d-h
'Pinto Salmon'	35.1 lm	30.2 g-i	27.6 d-g	24.8 a-c
'Ringo 2000 Light Salmon'	33.4 kl	29.2 d-h	26.9 b-e	24.5 a-c
'Ringo 2000 Deep Rose'	30.7 h-j	27.2 c-f	23.8 a	22.7 a
'Ringo 2000 Violet'	32.2 i-k	26.7 b-d	24.2 ab	22.9 a

Values followed by the same letter are not different at 5% level of significance

flurprimidol was applied at 7.5-22.5 mg L<sup>-1</sup> to geranium 'Pinto White' or 'Ringo 2000 Light Salmon', at 15-22.5 mg L<sup>-1</sup> to 'Suzan Improved', 'Pinto Scarlet', 'Pinto Salmon' or 'Ringo 2000 Deep Rose' and at 22.5 mg L<sup>-1</sup> to 'Ringo 2000 Violet' (Tab. 3). Due to smaller floret size and shorter floret peduncle length of flurprimidol treated geranium, the inflorescence diameters of those plants were also smaller as compared with those of untreated ones (Tab. 4). Inflorescence diameter was significantly suppressed by flurprimidol at 7.5-22.5 mg L<sup>-1</sup> in 'Ringo 2000 Deep Rose' and at 15-22.5 mg L<sup>-1</sup> in other tested cultivars of seed-propagated geranium (Tab. 4). Andrasek (1989), Starmann et al. (1994) or Pobudkiewicz and Nowak (1999) have also reported smaller inflorescence of growth retardant treated geranium.

Table 3.

Effect of single flurprimidol application on floret peduncle length (cm)  
of seed-propagated geranium

Cultivars	Flurprimidol concentrations mg l <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	3.86 no	3.73 m-o	3.43 g-m	3.28 e-l
'Pinto Scarlet'	3.68 l-o	3.40 f-m	3.23 d-k	3.08 a-h
'Pinto White'	3.65 k-o	3.21 b-j	3.00 a-d	3.05 a-f
'Pinto Salmon'	3.48 i-o	3.23 c-k	3.05 a-f	2.90 a
'Ringo 2000 Light Salmon'	3.90 o	3.46 h-n	3.10 a-i	3.01 a-e
'Ringo 2000 Deep Rose'	3.81 m-o	3.51 j-o	3.06 a-g	2.98 a-c
'Ringo 2000 Violet'	3.46 h-n	3.15 a-j	3.15 a-j	2.91 ab

Values followed by the same letter are not different at 5% level of significance

Table 4

Effect of single flurprimidol application on inflorescence diameter (cm) of seed-propagated  
geranium cultivars

Cultivars	Flurprimidol concentrations mg l <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	11.5 m	11.1 k-m	10.5 e-j	9.9 a-e
'Pinto Scarlet'	10.6 f-k	10.2 c-h	9.8 a-d	9.3 a-c
'Pinto White'	11.1 k-m	10.7 g-k	10.1 b-g	9.6 a-c
'Pinto Salmon'	10.8 h-l	10.2 c-h	9.85 a-e	9.7 a-d
'Ringo 2000 Light Salmon'	11.3 lm	10.9 i-m	10.2 c-h	10.1 b-g
'Ringo 2000 Deep Rose'	11.1 k-m	10.3 d-i	9.6 a-c	9.5 ab
'Ringo 2000 Violet'	10.9 j-m	10.4 e-j	9.7 a-f	9.6 a-c

Values followed by the same letter are not different at 5% level of significance

Unlike previous research with other cultivars and other growth retardants (Miranda and Carlson, 1980; Armitage, 1986; Chmiele, 1988; Cox, 1991; Andrasek, 1989) total flowering time from sowing to anthesis of tested geranium cultivars was not accelerated nor delayed by flurprimidol in 1998 (Tab. 5). In 1999 the effect of flurprimidol on the number of days to flowering varied with geranium cultivar and growth retardant rate (Tab. 6). Flurprimidol hastened flowering of seed-propagated geranium 'Suzan Improved', 'Pinto Salmon' and 'Ringo 2000 Violet' by 5-8 days (Tab. 6). Starmann et al. (1994) has also reported that flowering of growth retardant treated geranium depended on the cultivar. In reports of White and Warrington (1984), Cox and Keever (1988), Tayama and Carver (1990) or Pobudkiewicz and Nowak (1999) growth retardants had no

Table 5

Effect of single flurprimidol application on number of days to flowering of seed-propagated geranium in 1998.

Cultivars	Flurprimidol concentrations mg l <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	99.0 a-d	99.2 a-d	101.1 cd	102.9 d
'Pinto Scarlet'	95.6 a	97.1 a-c	99.5 a-d	96.1 ab
'Pinto White'	96.1 ab	97.7 a-c	96.7 a-c	97.7 a-c
'Pinto Salmon'	99.1 a-d	100.0 a-d	96.2 a-c	100.4 a-d
'Ringo 2000 Light Salmon'	98.8 a-d	97.2 a-c	99.0 a-d	99.0 a-d
'Ringo 2000 Deep Rose'	101.0 b-d	99.8 a-d	98.5 a-d	98.7 a-d
'Ringo 2000 Violet'	96.9 a-c	99.5 a-d	99.0 a-d	99.2 a-d

Values followed by the same letter are not different at 5% level of significance

Table 6

Effect of single flurprimidol application on number of days to flowering of seed-propagated geranium in 1999

Cultivars	Flurprimidol concentrations mg l <sup>-1</sup>			
	Control	7.5	15	22.5
'Suzan Improved'	110.9 i-j	105.5 a-f	106.2 a-g	105.2 a-e
'Pinto Scarlet'	111.8 j	108.5 d-j	107.3 c-i	109.6 f-j
'Pinto White'	106.4 b-h	103.5 a-c	102.2 a	102.8 ab
'Pinto Salmon'	119.8 k	109.1 e-j	111.8 j	111.3 ij
'Ringo 2000 Light Salmon'	110.6 h-j	109.4 e-j	107.4 c-i	110.3 g-j
'Ringo 2000 Deep Rose'	108.9 e-j	107.4 c-i	107.7 c-j	106.6 b-h
'Ringo 2000 Violet'	110.7 h-j	104.5 a-d	105.1 a-e	107.4 c-i

Values followed by the same letter are not different at 5% level of significance

effect on flowering of geranium but in other studies flowering was significantly delayed by growth retardants (S t a r m a n et al., 1994, C h u n g et al., 1998). Plants treated with flurprimidol had darker green foliage than the control plants. No phytotoxicity was noted on seed-propagated geranium from any of the treatments.

## CONCLUSIONS

1. Single spray application of flurprimidol, when plants are 9-13 cm in height is sufficient to obtain well compact plants with a good habit.
2. The response of seed-propagated geranium to flurprimidol application varies depending on geranium cultivar.
3. An application of flurprimidol at 15 mg L<sup>-1</sup> and 22.5 mg L<sup>-1</sup> is satisfactory to achieve well retarded geranium 'Ringo 2000 Violet', 'Ringo 2000 Deep Rose' and 'Ringo 2000 Light Salmon', 'Pinto Salmon', respectively.
4. In order to obtain geranium 'Pinto White', 'Pinto Scarlet' and 'Suzan Improved' shorter than 28 cm in height concentration of flurprimidol slightly higher than 22.5 mg L<sup>-1</sup> is suggested.

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### **Reakcja pelargonii uprawianej z nasion (*Pelargonium x hortorum* L.H. Bailey) na traktowanie flurprimidolem**

#### **Streszczenie**

W 1998 i 1999 roku traktowano flurprimidolem pelargonie rozmnażaną z nasion (*Pelargonium x hortorum* L.H. Bailey) odmian 'Suzan Improved', 'Pinto Scarlet', 'Pinto White', 'Pinto Salmon', 'Ringo 2000 Light Salmon', 'Ringo 2000 Deep Rose' i 'Ringo 2000 Violet' aby ocenić skuteczność oraz określić optymalne stężenia flurprimidolu. Retardant wzrostu stosowano dolistnie jednokrotnie w stężeniach 7,5, 15 i 22,5 mg · l<sup>-1</sup>, gdy rośliny miały 9-13 cm wysokości. Reakcja roślin na traktowanie flurprimidolem zależała od odmiany pelargonii. Stwierdzono, że w czasie kwitnienia rośliny traktowane flurprimidolem w stężeniach 7,5; 15 i 22,5 mg · l<sup>-1</sup> były istotnie niższe niż rośliny nie traktowane retardantem. Średnica roślin, średnica kwiatostanu, średnica kwiatu, oraz długość szypułki kwiatowej pelargonii traktowanej flurprimidolem były istotnie mniejsze niż na roślinach kontrolnych. W porównaniu do kontroli, pelargonie odmian 'Suzan Improved', 'Pinto Scarlet' i 'Ringo 2000 Violet' kwitły o 5-8 dni wcześniej w 1999 roku, ale nie stwierdzono istotnego wpływu retardantu na kwitnienie roślin w 1998 roku.