Prohexadione-Calcium, a Gibberellin Biosynthesis Inhibitor, Can Reduce Vegetative Growth in `Bing’ Sweet Cherry Trees

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Abstract
Prohexadione-Ca (P-Ca, BAS 125 11 W), a gibberellin biosynthesis inhibitor, was applied to mature, vigorous ‘Bing’ cherry trees at 3 concentrations (75, 150 or 300 mg a.i./L). Treatments were applied by whole-tree sprays in the autumn (postharvest), with or without a follow-up treatment during the subsequent spring (preharvest) or autumn (one year later), with an untreated control. There were no effects of autumn-applied treatments on reduction of vegetative growth in either the season of application or the next year. Spring-applied P-Ca treatments significantly reduced vegetative growth as measured by shoot length. The reduction in shoot length, both in lateral and terminal positions, was proportional to the dosage applied. Further work is required to formulate definitive recommendations for Chilean conditions, as no measurements on fruit quality were conducted; however, this bioregulator appears promising for in achieving growth control under vigorous conditions typical of Chilean cherry orchards.

INTRODUCTION
There is an increasing tendency to cultivate sweet cherry (Prunus avium L.) more intensely by using higher plant densities. However, much work remains to be done before dwarfing rootstocks can be utilized successfully. High tree vigor under Chilean conditions results in orchard management problems, particularly for harvest. Therefore, there is a need to restrict excessive vegetative growth, especially considering the high number of young cherry orchards that have been planted in Chile in recent years.

Plant bioregulators to retard growth have been used widely for fruit trees. In cherry, paclobutrazol has been effective for reducing shoot growth (Edgerton, 1986; Webster and Quinlan, 1986), but no registration is presently available for its use in Chilean fruit crops. The mode of action of most growth retardants has been related to their reduction of gibberellin biosynthesis (Rademacher, 2000). A new gibberellin-inhibiting bioregulator, prohexadione-Ca (P-Ca), is generating interest for use in fruit trees because of its low persistence in the soil and plant, unlike paclobutrazol. Its use in apple trees is well studied (Unrath, 1999), but research on P-Ca application to cherry trees has only just begun.

MATERIALS AND METHODS
Adult (11-year-old), vigorous trees of ‘Bing’ on Prunus mahaleb seedling rootstock were planted at 5 x 6 m in an orchard (Exportadora Rancagua) located near Rancagua, VI Region (100 km south of Santiago de Chile). P-Ca (BAS 125 11 W, 10% WP) was applied to the trees with a high-volume commercial sprayer (12 to 15 L per tree). The treatments included three dosages (75, 150, or 300 mg a.i./L) applied at different times during spring and autumn (Table 1).
Measurements included total and individual shoot length of labeled branches (with known cross-sectional area), fruit number, terminal shoot growth, and number of internodes on selected branches. Four single-tree replicates per treatment were used. Statistical analysis was performed using ANOVA and Duncan’s multiple range test.
RESULTS

Shoot Growth

‘Bing’ sweet cherry trees treated with the higher spring-applied (T3 and T5) P-Ca dosages (150 and 300 mg a.i./L) had reduced shoot growth during the season (Fig. 1). Conversely, P-Ca applied in autumn (T2, T4 and T6) had no effect on shoot growth. Towards the end of the season, the spring-applied higher concentrations of P-Ca (T3 and T5) clearly had reduced final length of the terminal shoots, and there was no effect for the spring-applied lowest dosage (T1) (Figs. 2, 4). Similarly, P-Ca treatments applied in autumn were not different from the control treatment (data not shown).

Internode Number and Length

The reduction in shoot growth of the trees treated with the higher dosages of P-Ca in spring was due to a reduced number of internodes (Fig. 3), not from differences in mean internode length (data not shown). Moreover, application of P-Ca, both in autumn during the previous season or in spring during the same season, did not result in differences in fruit number per branch (data not shown), but further measurements are required in subsequent seasons to establish possible effects on return bloom and fruit set.

DISCUSSION

Spring applications of P-Ca at dosages of 150 and 300 mg a.i./L reduced extension growth in both lateral and terminal shoots in ‘Bing’ sweet cherry trees, as a result of a reduction in number of internodes. There was no significant reduction of shoot length when P-Ca was applied at 75 mg a.i./L. On the other hand, autumn applications of P-Ca had no effect on extension growth of shoots in the next season. This is probably related to the short-term effect of the compound due to active degradation in the plant (Evans et al., 1999). Further, in these mature cherry trees, most of the growth occurred before harvest and, thus, only when P-Ca is active in the spring can growth be retarded effectively. The number of fruits per unit of branch cross-sectional area was not affected by applications of P-Ca in the same growing season.

These results show the potential of P-Ca for inhibiting vegetative growth in adult cherry trees. They also constitute a basis for developing an effective orchard management tool to reduce excessive vigor and develop higher density cherry orchards as are being planted in Chile. However, fruit quality and other parameters should be considered prior to providing final recommendations for P-Ca use on cherry trees.

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Literature Cited

Webster, A.D. and Quinlan, J.D. 1986. The influence of annual paclobutrazol treatments
on the shoot growth, yield and fruit quality of Early Rivers sweet cherries. Acta Hort. 179: 577-578

Tables

Table 1. Description of Prohexadione-Ca application concentrations and timings.

<table>
<thead>
<tr>
<th>Time of application</th>
<th>Autumn 2000</th>
<th>Spring 2000</th>
<th>Autumn 2001</th>
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<tr>
<td>Treatment</td>
<td>Concentration (mg a.i/L)</td>
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</tr>
<tr>
<td>1</td>
<td>75</td>
<td>75</td>
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<td>2</td>
<td>75</td>
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<td>75</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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<tr>
<td>6</td>
<td>300</td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>7 (control)</td>
<td>-</td>
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</table>

Figures

Fig. 1. Effects of Prohexadione-Ca treatments on mean shoot length (cm) in `Bing’ sweet cherry trees before harvest. T1, T2 = 75 mg a.i./L applied in autumn plus spring or autumn plus subsequent autumn, respectively; T3, T4 = 150 mg a.i./L applied in autumn plus spring or autumn plus subsequent autumn, respectively; T5, T6 = 300 mg a.i./L applied in autumn plus spring or autumn plus subsequent autumn, respectively; T7 = untreated control.
Fig. 2. Effects of autumn- plus spring-applied Prohexadione-Ca treatments on 'Bing' sweet cherry terminal shoot length (cm). T1, T3, and T5 = 75, 150, and 300 mg a.i./L, respectively; T7 = untreated control.

Fig. 3. Effects of autumn- plus spring-applied Prohexadione-Ca treatments on number of internodes in 'Bing' sweet cherry terminal shoots. T1, T3, and T5 = 75, 150, and 300 mg a.i./L, respectively; T7 = untreated control.
Fig. 4. Effect of different concentrations (0, 75, 150, or 300 mg a.i./L) of spring-applied Prohexadione-Ca treatments on terminal shoot growth of ’Bing’ sweet cherry trees.