Ciencia e Investigación AGRARIA

*Cien. Inv. Agr. 38(3):339-344. 2011*
*www.rcia.uc.cl*
CROP PRODUCTION

RESEARCH PAPER

# Effects on fruit production and quality of different dormant pruning intensities in 'Bing'/'Gisela®6' sweet cherries (*Prunus avium*) in Central Chile

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**Abstract**

**E. von Bennewitz, C. Fredes, T. Losak, C. Martínez, and J. Hlusek. 2011. Effects on fruit production and quality of different dormant pruning intensities in 'Bing'/'Gisela®6' sweet cherries (*Prunus avium*) in Central Chile. Cien. Inv. Agr. 38(3): 339-344.** Fruit size is a very important quality attribute in cherry trees. Appropriate canopy and crop load management are, therefore, required to obtain an adequate balance between the yield and fruit size. A study was carried out during the 2007-2008 season in the Maule Region of Chile to evaluate the effect of increasing levels of dormant pruning (Control, no removal; Soft pruning, 15% removal; Moderate pruning, 30% removal and Intense pruning, removal of 50% of the fruiting wood) on the fruit yield, quality (size, fruit weight, soluble solids and fruit firmness) and crop value of sweet cherries (*Prunus avium* L.) cv. 'Bing' on the dwarfing rootstock, 'Gisela 6'. Treatments at the 30 and 50% removal intensities had a strong effect on yield reduction (36.1% and 67% decreases, respectively). The fruit size distribution, firmness and soluble solids were positively affected by the removal treatments. The amount of fruit with no fresh market quality (< 22 mm) was reduced by the pruning (15% of the fruit of the control represented this category). Treatment at the 15% removal intensity had a strong effect in reducing the amount of small fruit to very low levels (2% of the total fruit) and promoting the yield of premium fruit (diameter > 28 mm) (52% of the total fruit) without affecting the total yield (kg fruit per tree). The crop value was improved in the cases of soft (212.7%) and moderate (140.4%) dormant pruning. Soft dormant pruning emerges as a practical approach for improving the yield, quality, fruit size distribution and crop value in this rootstock-variety combination, but long-term studies should be carried out to assess any carryover effects on the yield and, especially, the crop load balance.

**Key words:** Crop load regulation, dormant pruning, fruit yield and quality, *Prunus avium*.

## Introduction

Chilean cherry production has been changing during the last 10 years. These changes have involved an increase in the area under cultivation, the orchard density, the introduction of semi-dwarfing or dwarfing rootstocks and the adoption of new training system, such as the "Solaxe" system. In cherry trees, the rise in productivity without appropriate canopy and crop load management may produced trees that produce high crop loads but small fruits (Whiting and Ophardt, 2005;

Received November 17, 2010. Accepted September 26, 2011.
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Whiting *et al.*, 2006). Fruit size is a very important quality parameter, and larger fruit brings a higher export market value. This is a factor that may determine the future viability of a cherry orchard in many cases. Cherry crop load can be managed by dormant pruning (Long, 2002), yet this approach has to be properly managed, especially for combinations of tree/rootstock that yield heavy loads with small fruits, such as the dwarfing rootstock, 'Gisela 6', which can reduce the supply of assimilate for the fruits. Very little scientific testing of the removal of fruiting spurs by means of dormant pruning has been carried out in cherry trees cultivated on dwarfing rootstocks in Chile. Consequently, the main objective of this research was to evaluate the effects of increasing the levels of dormant pruning (removing 15, 30 or 50% of the fruiting wood) on the fruit yield and quality (size, fruit weight, soluble solids and fruit firmness) of sweet cherries (*Prunus avium* L.) cv. 'Bing' on the dwarfing rootstock, 'Gisela 6'.

## Materials and methods

### *Plant material and experimental design*

The study was carried out during the 2007-2008 season in the Maule Region of Chile (34.58ºS, 71.14ºW). The plant material consisted of 'Bing' sweet cherry trees, planted in 2004 on 'Gisela 6' rootstock and spaced 2.5 × 4.5 m in north-to-south rows. The trees were trained to a Solaxe system (Lauri, 2005). The soil was a very fine sandy loam from the Andisol order, 0.8 m in depth. A soil mineral analysis showed the following results: Available N (58 ppm), K (221 ppm), P (20 ppm), pH/KCl (6.5), OM (4.3%) and EC (1.2 dS $m^{-1}$). The trees were irrigated weekly with under-tree microspinklers from November to late March. Standard orchard management practices (irrigation, fertilization, pest and weed control and dormant pruning) were followed each year. The trees were selected on the basis of uniform vigor and development and were assigned to a completely randomized design. An analysis of variance was conducted using the JMP program, and the means were compared using Tukey's test at a significance level of 0.05. The dormant pruning treatments were performed on the entire tree and consisted of an unpruned control and increasing levels of dormant pruning (removing 15, 30 or 50% of the fruiting wood). Ten trees were selected for each treatment on the basis of uniform vigor, canopy architecture and fruiting spur number. The total number of fruiting spurs was adjusted to 800 spurs per tree before commencing with the pruning treatments. The removal of fruiting wood was carried out at the BBCH 51 stage (Meier *et al.*, 1994). The treatments are presented in Table 1.

### *Yield and fruit quality*

The fruit was harvested on 12 December of 2007 (82 DAFB) from ten trees for each treatment and the fruit yield was expressed as kg fruit per tree. From each tree, 100 randomly sampled fruit were evaluated at room temperature for mass, diameter

**Table 1.** Pruning treatments: the intensity and number of spurs left on each 'Bing'/'Gisela 6' sweet cherry tree.

| Treatments | Pruning intensity (%) | Type and amount of fruiting wood removed | Number of fruiting spurs left on each tree after pruning |
|---|---|---|---|
| Control | Without pruning | None | 800 |
| Soft pruning | 15 | One-year-old shoots removed | 600 |
| Moderate pruning | 30 | One-year-old shoots and a ¼ of two-year-old shoots length removed | 400 |
| Intense pruning | 50 | One-year-old shoots and ¾ of two-year-old shoots length removed | 200 |

(fruit size and fruit size distribution), firmness (electronic durofel), soluble solids and titratable acidity. The crop value per tree was calculated from the fruit yield and size relationships (Whiting *et al.*, 2006); the values were based upon average returns per size category for fresh market quality 'Bing' sweet cherries from the 2007-2008 season in Chile. The values were expressed as a ratio: actual value of the treatment/maximum value obtained among all of the treatments (maximum value = 1).

## Results and discussion

In the year that they were performed, the pruning treatments reduced the fruit yield (except for soft pruning) and fruit number per tree and improved the fruit weight and diameter (Table 2).

### *Fruit yield effect*

The highest yields were obtained with no pruning or with soft pruning treatments, whereas moderate and intense pruning caused substantial yield reductions per tree (36.71 and 67% reduction, respectively) (Table 2). These results agree with those reported by Whiting *et al.* (2005); these authors found that the removal of the blossoms and fruiting spurs at an intensity of 50% considerably reduced the fruit number and yield in Bing sweet cherry trees on Gisela 5 and Gisela 6 rootstocks. Radivojevič *et al.* (2006) also reported a substantial yield reduction per tree in severely pruned trees. The drastic yield reduction in these cases could be a direct result of the removal of the two-year-old fruiting wood, where the majority of the cherry fruits are borne. Another important aspect to consider is the supply of assimilate to the fruits. In sweet cherry trees, the carbohydrates partitioned to the fruit are mainly provided by the leaves of the reproductive and vegetative spurs and the current-season shoots (Ayala, 2009). The removal of ¼ of the two-year-old wood (moderate pruning) to ¾ of the two-year-old wood (severe pruning) may have significantly limited the assimilate supply and altered the fruit-to-leaf area ratio (F:LA). However, the tree leaf area (*i.e.*, canopy F:LA ratio) was not determined in this study. Even more dramatic yield reductions may occur in successive years if the same pruning intensity is applied every year to the trees.

### *Fruit number effects*

Soft pruning reduced the fruit number per tree by 25% and moderate and intense pruning reduced the fruit number by 50 and 75%, respectively. Whiting and Lang (2004) estimated that the ideal number of fruit per mature 'Bing'/'Gisela 5' tree is approximately 1800. This target was very nearly achieved by the soft pruning treatment and suggests that no important limitation of the assimilate supply to the fruits was imposed by this pruning intensity. The high reduction in the fruit number in the moderate and intense pruning treatments suggests an altered source-sink relationship and a very limited assimilate supply to the fruits.

### *Fruit weight and fruit diameter effects*

The fruit weight was considerably increased in the dormant pruning treatments. These data partly

**Table 2.** Effect of pruning treatments on the fruit yield, fruit number, fruit weight and fruit diameter of 'Bing'/ 'Gisela 6' sweet cherry trees.

| Treatments | Yield (kg fruit per tree) | Fruit number per tree | Fruit weight (g) | Fruit diameter (mm) |
|---|---|---|---|---|
| Control | 15.8 a[1] | 2393.9 a | 6.6 a | 22.5 a |
| Soft pruning | 15.6 a | 1793.1 b | 8.7 b | 27.9 b |
| Moderate pruning | 10.1 b | 1202.3 c | 8.4 b | 27.8 b |
| Intense pruning | 5.2 c | 597.7 d | 8.7 b | 28.5 b |

confirm the results of Whiting *et al.* (2005), concerning the increase in fruit weight after the manual removal of fruit spurs and disagree with a report on the negative effects of this management on the fruit weight by Lenahan and Whiting (2006). The removal of the fruit spurs by means of dormant pruning did significantly increase the fruit diameter at the moment of the harvest (20% average increase in fruit diameter). We have to consider the substantial yield reduction per tree in the case of moderate and intense pruning and its effect on a decreased competition among the fruits for the assimilate. Similar results on fruit diameter increases have been reported by Claverie and Lauri (2005a) and Claverie and Lauri (2005b) after the removal of fruiting spurs by means of spur extinction (30 and 30-50%, respectively). Both studies were carried out using the 'SummitVTabel®/Edabriz', combination. Von Bennewitz *et al.* (2010) also reported an increase in the fruit diameter (17%) in the 'Lapins'/'Maxma 14' combination after the removal of 50% of the dormant fruiting spurs by means of spur thinning.

*Fruit quality effects*

The firmness and soluble solid content increased following the pruning treatments (Table 3). Similar results were documented by Whiting and Lang (2004) after large decreases (68%) in the crop yield, although such effects have not been consistent over time (Whiting *et al.*, 2006). Many other studies that included fruit spur removal in the crop load strategies reported no effects on the above quality characteristics (Nielsen *et al.*, 2007; Ayala and Andrade, 2009; Wedeles, 2006). The titratable acidity was not affected by the treatments.

*Fruit size distribution effects (Figure 1)*

The amount of fruit of no fresh market quality (< 22 mm) was reduced in the pruned trees (15% of the fruit of the control represented this category). Soft pruning had a strong effect in reducing the percentage of the small fruit to very low levels (only 2% of the total fruit), in addition to promoting the yield of premium fruit (diameter > 28 mm) (52% of the total fruit), attaining both effects without affecting the total yield (Table 2).

*Crop value effects*

The results for the effects on the crop value are presented in Table 4. Soft pruning treatment resulted in the maximum crop value (maximum value=1). When compared to the control treatment, the crop values were improved in the cases of soft (an increase of 212.7%) and moderate dormant pruning (an increase of 140.4%). The crop value of the control and intense pruning represented less than 50% of the soft pruning treatment.

Taken together, we conclude that, in the year of application, the pruning treatments significantly affected the fruit yield and quality (fruit

**Table 3.** Effect of pruning treatments on the fruit quality parameters of 'Bing'/'Gisela 6' sweet cherry trees.

| Treatments | Firmness (0-100 duofel units) | Soluble solids (°Brix) | Titratable acidity (%) |
|---|---|---|---|
| Control | 76.3 a[1] | 18.8 a | 0.7 a |
| Soft pruning | 80.8 b | 22.2 b | 0.8a |
| Moderate pruning | 80.2 b | 22.8 b | 0.8a |
| Intense pruning | 80.9 b | 21.6 b | 0.7a |

[1]Means followed by the same letter do not differ at $P \leq 0.05$, according to Duncan's multiple range t-test.

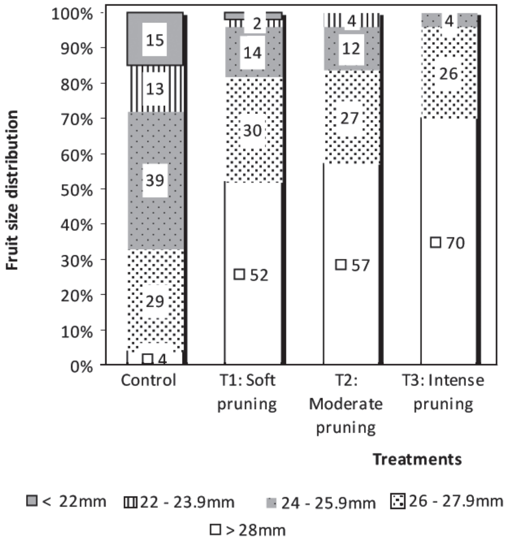


**Figure 1.** Fruit size distribution of sweet cherries, cv. ‘Bing’.

size and fruit size distribution, fruit weight and soluble solids) of sweet cherries cv. ‘Bing’ on the dwarfing rootstock, ‘Gisela 6’. Soft pruning positively affected the average fruit size fruit size distribution and crop value, reducing the number of fruits per tree without affecting the total yield. The removal of the fruiting spurs by means of dormant pruning may reduce the supply of assimilate for the fruits in the ensuing years, therefore, long-term studies should be carried out to assess any carryover effects on the yield and, especially, the crop load balance of this strategy on the precocious and dwarfing rootstock, Gisela 6. We found that moderate and intense dormant pruning, when used as a crop load management strategy, was insufficient for the Bing/Gisela 6 combination because of its negative effects on the yield and crop value.

**Table 4.** Effect of dormant pruning treatments on crop value ratios of four-year-old ‘Bing’/‘Gisela 6’ sweet cherry trees. Values expressed as the ratio: crop value of the treatment/maximum crop value obtained among all treatments (maximum value =1). Season 2007-2008.

| Treatment | Crop value ratios (Value $kg^{-1}$) |
|---|---|
| Control | 0.47 |
| Soft pruning | 1.00 |
| Moderate pruning | 0.66 |
| Intense pruning | 0.40 |


## Acknowledgements

This study was supported by the Research plan, MSM6215648905 “Biological and technological aspects of sustainability of controlled ecosystems and their adaptability to climate change,” which is financed by the Ministry of Education, Youth and Sports of the Czech Republic.


## Resumen


**E. von Bennewitz, C. Fredes, T. Losak, C. Martínez y J. Hlusek. 2011. Efectos sobre la producción y calidad de frutos de diferentes intensidades de poda invernal en cerezos ‘Bing’/‘Gisela®6’ (*Prunus avium*) en Chile central. Cien. Inv. Agr. 38(3): 339-344.** El tamaño del fruto es un atributo muy importante de calidad en cerezo. Para obtener un tamaño adecuado de fruto se requiere realizar manejos agronómicos de canopia y carga frutal, de modo de obtener un adecuado equilibrio entre el rendimiento y el tamaño del fruto. Durante la temporada 2007-2008 se realizó un estudio en la Región del Maule-Chile, para evaluar el efecto de niveles crecientes de poda invernal (Control: sin poda, poda liviana: 15% de remoción, poda moderada: 30% de remoción y poda intensa: 50% de remoción de madera frutal), sobre el rendimiento, calidad (tamaño, peso del fruto, contenido de sólidos solubles, firmeza del fruto y valor del cultivo) en cerezos (*Prunus avium* L.), cv. ‘Bing’ sobre el patrón ‘Gisela 6’. El tratamiento con una intensidad de remoción de madera de 15% tuvo un fuerte efecto sobre la reducción en la producción de frutos pequeños hasta niveles muy bajos (2% del total de la fruta), promoviendo además la producción de frutos ‘Premium’ (diámetro mayor a 28 mm) (52% de la fruta), sin afectar el rendimiento total (kg de fruta por árbol). El valor de cultivo fue mejorado en el caso de poda invernal ligera (212,7%) y moderada (140,4%). La poda invernal moderada puede ser una alternativa práctica para mejorar el rendimiento, la calidad, la distribución de diámetros y el valor de cultivo para esta combinación patrón-cultivar de cerezo. La remoción de dardos frutales puede, sin embargo, reducir el suministro de asimilados para los frutos durante las próximas temporadas de cultivo. Se requieren, por ello, estudios de largo plazo, para evaluar los posibles efectos de podas invernales sucesivas sobre el rendimiento y especialmente sobre el equilibrio de carga en esta combinación patrón-cultivar de cerezo.

**Palabras clave**: Poda invernal, *Prunus avium*, regulación de carga frutal, rendimiento y calidad de frutos.

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