Effects of Synchron® and Nitroactive® on Flowering and Ripening in Sweet Cherry

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Abstract

Dormancy breaking agents are used in fruit tree species to induce budbreak in situations of insufficient winter chilling or to advance and synchronize fruit ripening. In order to test whether a new product, Synchron® and Nitroactive®, may have positive effects on flowering and ripening time, different treatments were evaluated in two sweet cherry cultivars, ‘Earlise’ and ‘Lapins’ grafted on ‘Santa Lucia 64’ rootstock. A combination of Synchron 2% and Nitroactive 20% was applied at three dates during dormancy in two consecutive years with different winter weather conditions. In the first year, the treatments advanced the time of flowering and ripening in ‘Earlise’, but effects were less remarkable in ‘Lapins’. In the second year, the effects of the applications were more appreciable in ‘Lapins’ than in ‘Earlise’. The different effects observed between years in both cultivars treated at the same dates are discussed in terms of the chilling accumulated at each date and the stage of bud development in which the applications were made.

INTRODUCTION

Sweet cherry, as other temperate fruit trees, survives to winter temperatures entering a dormant stage. This is not just a survival strategy, but chilling is also required for release of flower dormancy and for proper flower bud development and flowering (Perry, 1971). Chilling requirements are cultivar-specific and determine the adaptation of each cultivar to particular areas (Horvath et al., 2003). In the last decades, with scenarios of insufficient winter chilling for cherry growing, there is an increasing interest in the use of dormancy-breaking agents, to advance and synchronize flowering and hence to advance and synchronize fruit ripening (Erez et al., 2008; Subhadrabandhu, 1995). However, some of these products have been shown to be phytotoxic, especially in stone fruit trees (Erez et al., 2008), and can even be toxic to humans, so they are banned in several countries (Atkinson et al., 2013; Luedeling, 2012). The search for safe and efficient phytochemicals is currently of major importance for the industry and growers (Erez et al., 2008). In order to test whether a new product, Synchron® and Nitroactive®,

may have positive effects on flowering and ripening time, different treatments were evaluated over two years in two sweet cherry cultivars, 'Earlise' and 'Lapins'.

MATERIALS AND METHODS

Trees of sweet cherry cvs 'Earlise' and 'Lapins' grafted on Santa Lucia 64 (*Prunus mahaleb* L.) rootstock were selected from a commercial orchard located at Caspe, Zaragoza (Spain) at 41°18'57" N 0°04'56" W 150 m altitude. Synchron contains 80% (w/w) organic matter, 2% (w/w) amino acids, 0.3% (w/w) total nitrogen, and Nitroactive contains 17% (w/w) total nitrogen, 11.5% (w/w) nitric nitrogen, 5.5% ammonium nitrogen, and 12.3% (w/w) calcium (CaO).

The experimental design was a randomized complete block design, with three replicates of three trees for each cultivar and application time. The experiment was performed over two consecutive years, 2010-2011 and 2011-2012. A combination of Synchron 2% and Nitroactive 20% were applied at two different times during dormancy the first year: Mid-January (Time 1) and Late-January (Time 2), and three times the second year: Mid-January (Time 1), Late-January (Time 2) and Mid-February (Time 3). The number of cold hours (CH) -evaluated as hours below 7.2 °C (Weinberger, 1950)- were calculated in both years using temperature hourly records from a meteorological station located at the orchard.

In each tree, four mid-canopy branches were randomly selected containing 70-80 flowers per branch. In order to compare the time of bloom between treatments, the number of open flowers in the selected branches was recorded every 3-4 days, until the opening of all the flowers. The day in which 50% of flowers were opened was considered the date of flowering in each cultivar and treatment. To ascertain the percentage of fruit set, in the same branches the number of flowers and fruits were recorded every other week from anthesis to fruit ripening. In order to compare the ripening time between treatments, the first day of harvest for each cultivar, all the fruits from the different treatments were collected and classified as commercial or still non-commercial fruits.

Statistical analyses were performed with SPSS 12.0 statistical software (SPSS Inc., Chicago, IL, USA). Pearson's chi-square test of independence for categorical variables was performed to analyze the percentages of fruit set and commercial fruits. When Pearson's chi-square test of independence generated significant differences ($P < 0.05$), percentage separations were determined by chi-square test of independence in two-way contingency tables generated for each pairwise comparison with Yates' correction for continuity. In those cases in which expected cell frequencies were low, Fisher's exact test was implemented.

RESULTS AND DISCUSSION

Flowering time and fruit set

The treatments advanced flowering time, but the effect was variable in the two cultivars and in both years. In 2011, the treatments advanced the time of flowering in both cultivars, being more significant in 'Earlise' than in 'Lapins'. However, in 2012, the effects of the applications were more patent in 'Lapins' than in 'Earlise' (Table 1). The influence of treatments on fruit set was also variable depending on cultivars and years. In 2011, fruit set in the treated trees was lower ('Earlise') or with no differences ('Lapins')

in relation to the control. However, in 2012 all the treatments showed either higher or no different fruit set than the control (Fig. 1).

Ripening time and fruit quality

In 2011, the treatment of mid-January significantly advanced ripening time in 'Earlise', but no clear effects were observed in 'Lapins'. However, in 2012, the three applications (Mid-January, Late-January and Mid-February) advanced ripening time in 'Lapins', but no remarkable effects were observed in 'Earlise' (Fig. 2). The maximum advance of flowering time was reflected in the maximum advance of fruit ripening [applications of Mid January 2011 (1067 CH) in 'Earlise', and Mid February 2012 (1175 CH) in 'Lapins'] (Fig. 2). Thus, within these variable results, it appears clear that differences in fruit ripening time encompass the differences in flowering time and appear derived of these.

Chilling accumulation

The effects of the time of application on flowering, fruit set, fruit quality and ripening were variable depending on cultivars and years. Since the two years of experiments showed different winter weather conditions, a cold winter in 2010-2011 (1037 CH, 31/01/2011) and a mild winter in 2011-2012 (877 CH, 31/01/2012), data were also analyzed in relation to the accumulated cold hours at the time of treatment. Taking in account the chilling hours accumulated, rather than the date of application, a consistent pattern was found in the effect of the time of treatment on flowering and ripening. The advance of flowering time increased with chilling accumulation at the time of treatment until reaching a maximum value, and then decreased in both cultivars (Fig. 3). However, differences were patent in the number of chilling hours required for each of these cultivars to attain this maximum, being 1067 for 'Earlise' and of 1175 for 'Lapins'. This may be related to the different chilling requirements for each of these cultivars. While chilling requirements for these cultivars are unknown, they indeed have different flowering times.

Application time is one of the unresolved issues with the application of dormancy-breaking agents. While their efficiency depend on the stage of development and depth of endodormancy (Arora et al., 2003), information is missing on when is the optimum time of application. Results herein showed that the effect of the application of Synchron® and Nitroactive® on flowering and ripening time varied among cultivars and the amount of chilling accumulated at the date of application, being more effective during a specific phase of winter dormancy, in which most of chilling requirements of each cultivar could be fulfilled.

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Tables

Table 1. Flowering advance in days and chilling accumulated at time of treatment with Synchron® and Nitroactive® on two sweet cherry cultivars over two years.

TREATMENT	Advance of flowering (days)		Cold Hours ($< 7.2^{\circ}\text{C}$)
	Earlise	Lapins	
2011			
Mid January	3.4	1.1	1067
Late January	2.1	2.2	1318
2012			
Mid January	0.25	1	526
Late January	1.3	1.9	784
Mid February	1.3	3.4	1175

Figures

Fig. 1. Percentage of fruit set in the different treatments of Synchron® and Nitroactive® on two sweet cherry cultivars, 'Earlise' and 'Lapins', over two years. Different letters indicate significant differences ($P < 0.05$) between treatments within a cultivar and year.

Fig. 2. Percentage of commercial fruits collected when the first mature fruits were observed in the different treatments of Synchron® and Nitroactive® on two sweet cherry cultivars, 'Earlise' and 'Lapins', over two years. Different letters indicate significant differences ($P < 0.05$) between treatments within a cultivar and year.

Fig. 3. Days of advance of flowering and chilling accumulated at the date of application of Synchron® and Nitroactive® on two sweet cherry cultivars.