Pollination and fruit set for 'Kordia' and 'Regina' sweet cherry trees in the south of Chile

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Abstract

'Kordia' and 'Regina'are partially self-compatible cultivars and usually their fruit set and crop load are low in the southern Chile. Insufficient pollen availability due to lack of flowering synchronisation with pollinisers are one of the problems in some seasons, also excessive fruitlets drops have been reported. Different trials were carried out over three seasons in order to understand the phenomenon and to improve fruit set. The main objective of this study was to determine appropriate polliniser cultivars and the effective pollination period (EPP) for 'Kordia' and 'Regina'. The research was carried out in commercial orchards in the Central South region. Eight experiments were performed to determine the intensity of fruit set, using pollen from the following compatible cultivars: 'Sam', 'Schneider', 'Staccato', 'Sunburst', 'Summit', 'Sandra Rose', 'Sylvia', 'Alex', 'Katalin' and 'Karina'. To assess the EPP six trials were conducted using pollen from different cultivars, 'Sam' and 'Sunburst' for 'Kordia' and 'Stacatto' and 'Schneider' for 'Regina'. In the third season, one orchard, planted with 'Regina' on rootstock 'Santa Lucia 64', was chosen to sample branches and study the EPP under controlled conditions of light and temperature; 'Kordia' and 'Katalin' were used to pollinate 'Regina'. The advance of pollen tube was observed under fluorescence microscope. In every season the flowering period was monitored. 'Regina' blossom coincided only with the second half of 'Kordia' flowering period. 'Sunburst', 'Summit' and 'Schneider' appear as better polliniser for 'Kordia' with fruit set of 12-30%. For 'Regina', 'Katalin' and 'Schneider' gave the best fruit set (30-40%). Considering the flowering period and 10% as minimum fruit set, 'Sunburst' is good polliniser for 'Kordia'; and 'Schneider', 'Summit' and 'Katalin' for 'Regina'. The EPP was about 5 to 6 days for 'Regina' and 'Kordia', highly influenced by temperature.

Keywords: *Prunus avium*, effective pollination period, polliniser

INTRODUCTION

There has been a high commercial interest for late-maturing sweet cherry cultivars in Chile, due to high export prices, and many ha have been planted for the last 15 years, especially in the southern region (37°28' to 39°38'S) where harvest is late. The main chosen cultivars are 'Kordia', 'Regina', 'Sweetheart' and 'Lapins'. However, cherry cultivation in this area have not been exempt of inconvenience; the main ones are related to climate such as rain during flowering period and maturity period, also low temperatures in autumn and early spring which increases the incidence of bacterial canker infection (*Pseudomona syringae* pv. *syringae*). Not less important are the inconvenience due to inappropriate planting distance and the use of excessively vigorous rootstocks for the local soils conditions. Moreover, 'Kordia' and 'Regina' are partially self-compatible cultivars and usually their fruit set and crop load are low in this area, even when other polliniser is present. A lack of blossom synchronisation between them and with other polliniser cultivars has been observed, which reduces the pollen availability, but also in some season a high proportion of fuitlets fail to set even when enough pollen is available. These problems have been more evident when vigorous rootstocks are used.

It is known that several requisites must be completed for a successful pollination, such as a source of viable and compatible pollen, an effective transfer of this pollen when stigmas are receptive, and opportune pollen tube during the period when embryo sacs have matured

and ovules are viable (Thompson, 1996). The effective pollination period (EPP) is defined as the number of days during which pollination is effective in producing a fruit and is determined by the longevity of the ovules minus the time lag between pollination and fertilization (Williams, 1965). Therefore, the reduction in fruit set not only depends on lack of pollen but also on post-pollination factors, where temperature plays an important role since modified pollen tube growth and longevity of the egg (Hedhly et al., 2004).

The main objective of this study was to determine appropriate polliniser cultivars and the effective pollination period (EPP) for 'Kordia' and 'Regina'.

MATERIALS AND METHODS

Three types of trials were carried out over three seasons; four trials to determine different polliniser effectiveness in both varieties, nine trials to study the EPP in the field – four in 'Kordia' and five in 'Regina' – and one experiment to study the EPP under controlled conditions (18-24°C). All the experimental sites were commercial orchards of mature trees grafted on Colt or F12/1.

For every trial a pollen germination test was performed in vitro.

Pollinisers determination

The study consisted of hand-pollination experiments with 6 or 8 compatible pollen donors for 'Kordia' and 'Regina' each season. The experimental layout used in all trials was a randomised complete block design; blocks consisted of two similar trees and the experimental unit was a spur on two- or three-year-old wood; treatments were the different pollen used for hand-pollination. Pollen donor cultivars for 'Kordia' were 'Regina', 'Sam', 'Schneider', 'Staccato', 'Summit', 'Sunburst', 'Karina', 'Sandra Rose' and 'Sylvia'; and 'Kordia', 'Sam', 'Schneider', 'Staccato', 'Summit', 'Sunburst', 'Alex' and 'Katalin' for 'Regina'.

Spurs were tagged when they were at the beginning of white bud stage (Chapman and Catlin, 1976) and covered with a white glassine paper bag. Pollination was carried out as soon as the flowers were open, for ca. 3 to 4 days. The percentage of fruit set using each cultivar was determined approximately 30 and 50 days after full bloom (dafb).

Effective pollination period in the field

To assess the EPP in the field, hand-pollination trials were performed; one trial in 'Kordia' and one in 'Regina', which were replicated in two commercial orchards over two seasons. Pollen from 'Sam' and 'Staccato' were used in 2009 and 'Sunburst' and 'Schneider' the following season. Experimental layout was complete randomised block design, consisting of 8 treatments and 6 blocks, with one spur as the experimental unit. Treatments were the days of pollination after anthesis (day 1 to 8).

Spurs on three year-old wood were selected when they reached 50% of bloom and covered with white a glassine paper bag, only flowers that were in a white bud stage were left, the others were thinned out. Hand-pollination was carried out for 8 days from anthesis. The day of anthesis was considered as the day one. The percentage of fruit set obtained for each day of pollination was determined approximately 30 and 50 dafb.

Effective pollination period under controlled conditions

One trial was conducted in 2011 with an experimental design consisted of complete randomised block design, with 6 blocks, in a factorial arrangement of 2×4, with two cultivars as source of pollen and four days of pollination (2, 3, 4 and 5 days after anthesis). Blocks consisted of two similar and adjacent trees of 'Regina' in a commercial orchard and the experimental unit was a two-year-old branch.

Eight branches were collected from each block at the beginning of blossom; branches were mainly at white bud stage. Two flowers were collected and preserved in FAA (formalin acetic acid) after 12, 24, 48 and 72 h from pollination.

The samples were prepared and subjected to special staining (aniline blue) for then be observed and photographed under an epifluorescence microscope, from where the following measurements were carried out: stigma-style length, the length for the most advanced

pollen tube, the amount of flowers with pollen tubes which reaches the ovary and number of pollen grains added to the stigma.

RESULTS AND DISCUSSION

In most of the trials fruit set was lower in 'Kordia' than 'Regina', which is coincident with cherry growers' reports.

Figure 1 shows the results for fruit set in two seasons using several cultivars as pollinisers. In 2009 spring temperature was low, with mean temperature under 10°C, and some rainy days during the flowering period, therefore fruit set was low in most of the orchards. In the pollinisers trials spurs' fruit set was between 10 to 20%, which is acceptable for a good polliniser according to several author (Arzani and Khalighi, 1998; Békefi and Brózik, 2005; Tosun and Koyuncu, 2007; Mahmoodi et al., 2008). No relevant differences were obtained between pollen-donor cultivars in 'Kordia' and 'Regina' trials. The following season where weather conditions were warmer (most of mean temperatures were above 20°C), the differences between the potential fruit set for 'Kordia' and 'Regina' were evident. Most of the fruit set in 'Kordia' was under 10%, which is considered low according to Békefi and Brózik (2005); whereas fruit set in 'Regina' was around 40% using pollen from 'Alex', 'Schneider' or 'Katalin'. In the following season the trials were carried out in two orchards in a colder area; fruit set in 'Kordia' was between 10 to 20% when 'Regina' and 'Skeena' were used as polliniser and between 20 to 30% when 'Summit' pollen was tested (data not shown).

In relation to the EPP for 'Kordia' and 'Regina', it was expected to get a decreasing fruit set curve, since the effectiveness for fertilisation is reduced with time (Hedhly et al., 2004). However, during the first season, fruit set was between 10 to 20% in both cultivars and it was maintained for at least 8 days (data not shown), this was very associated with the low temperature that most probably increased the ovule longevity. The following season we obtained a decreasing curve for fruit set with the days of pollinations after anthesis (Figure 2). A higher fruit setting in 'Regina' was also noticeable in comparison to 'Kordia'. It could be determined an EPP, even under warm conditions, of at least 5 days for both cultivars.

The flowering period of the different pollen donors allowed us to determined better cross pollinisers under field conditions. 'Alex' and 'Katalin' are shown as potential cultivars to pollinate 'Kordia' and 'Regina' orchards, the percentage of fruit setting is high and they show much coincidence in blooming period (Figure 3). 'Summit' is a cultivar used for cross pollination in many 'Kordia' and 'Regina' orchards in the Central Zone of Chile, however, under colder conditions during blooming period appears as a good polliniser only for 'Kordia' (Figure 4). 'Schneider' resulted as a good cultivar to pollinate orchards with 'Kordia' and 'Regina' since it overlaps well with 'Regina' (Figure 5). It has to be considered that 'Regina' needs a donor which is already open to cover its flowering period, since the earlier flowers have better quality (San Martino et al., 2014). Also it has to be taken into account that the higher the overlapping the higher fruit set; it is mentioned that the synchrony of bloom should cover at least 70% of the blooming period (Nyéki, 1989, cited by Nyéki et al., 2003).

The occurrence of the flowering period vary from year to year depending on the weather conditions, therefore only one polliniser is not enough to ensure an acceptable fruit set. The secure allogamy is increased by 2 to 4 mutually compatible cultivars being planted together (Nyéki, 1989, cited by Nyéki et al., 2003).

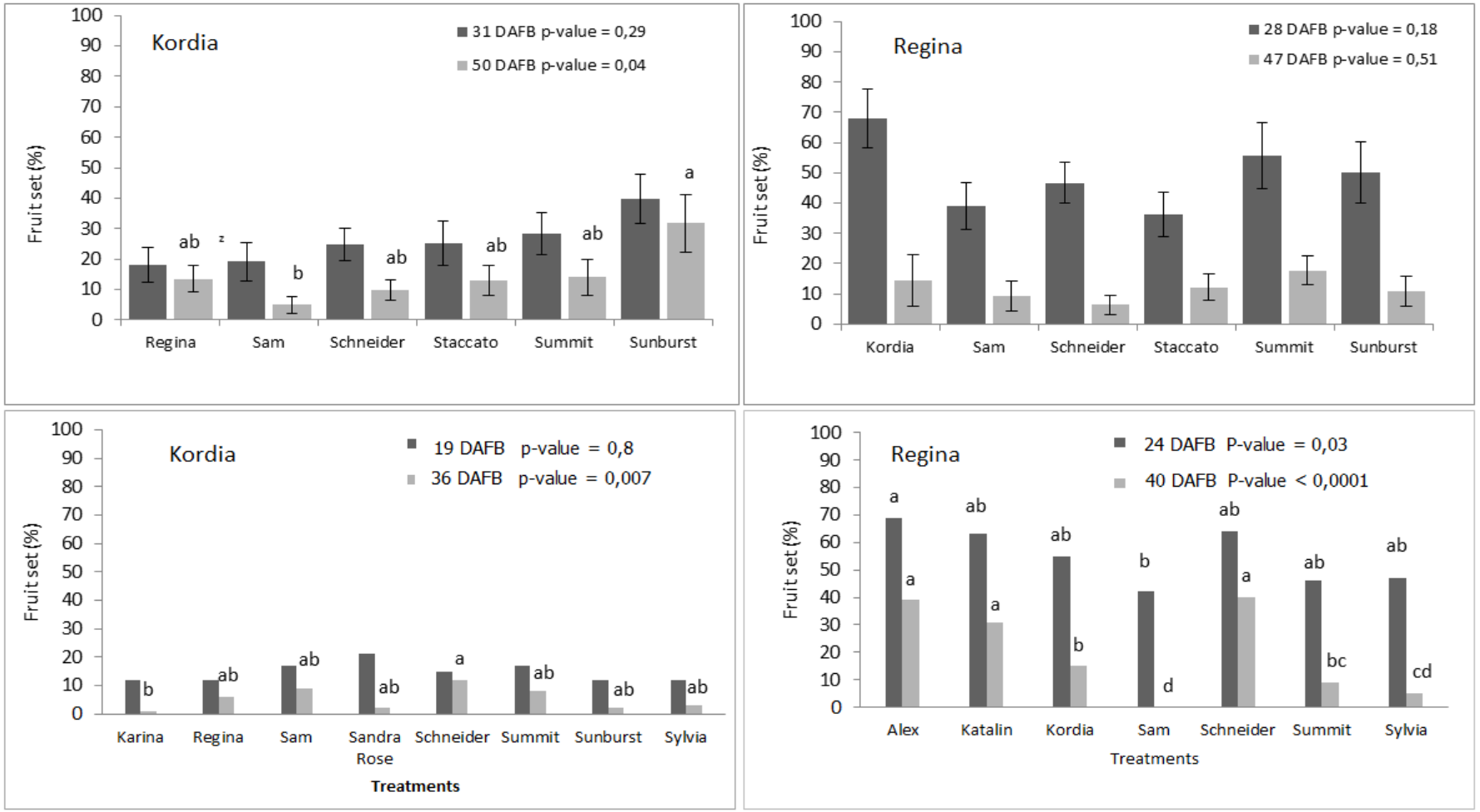

Figure 1. Percentage of fruit set for 'Kordia' and 'Regina' when different pollen donors where used in for hand pollination in two seasons Season 2009 upper graphs and season 2010 botton graphs. [z]Means separation at 5% level (Tukey's test).

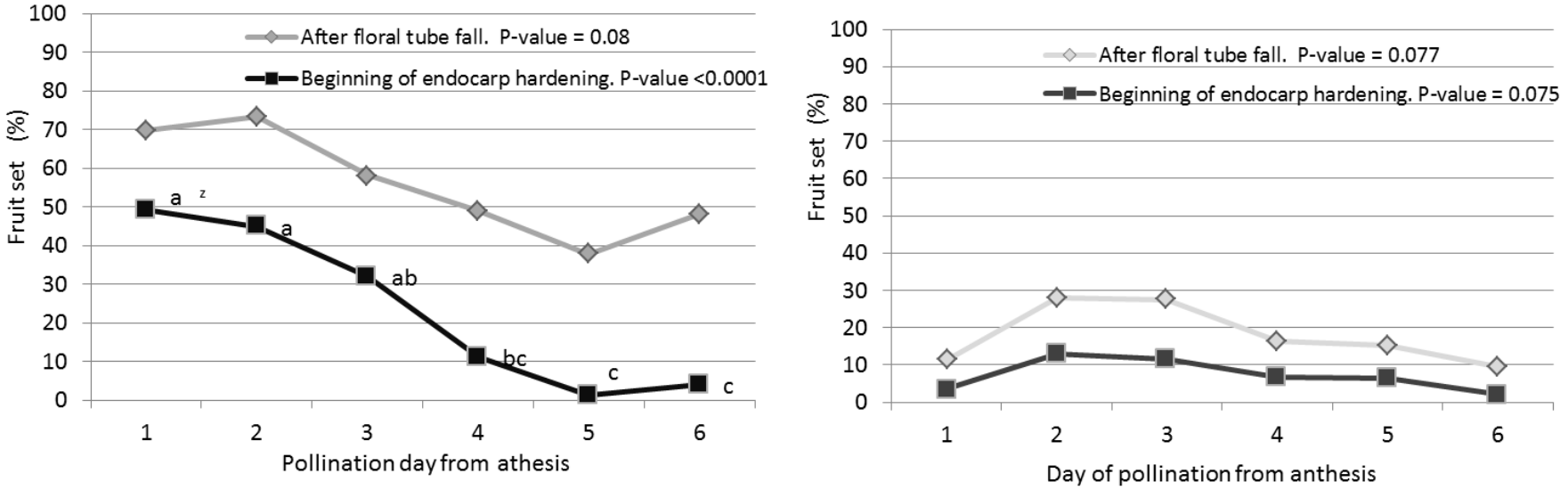

Figure 2. Percentage of fruit set for 'Regina (left) and 'Kordia' (right) when when hand-pollinated from anthesis. [z]Means separation at 5% level (Tukey's test).

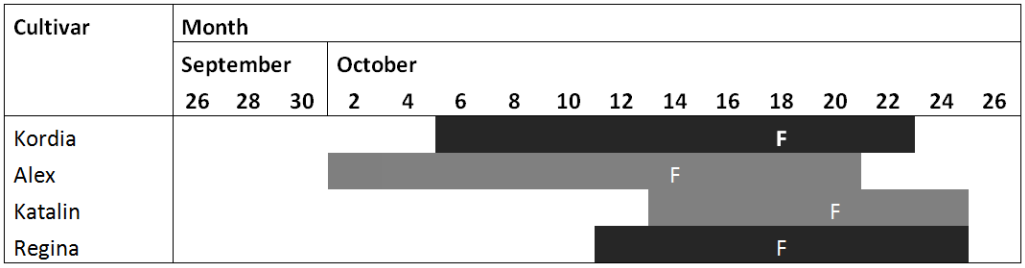

Figure 3. Blooming period for 'Kordia' and 'Regina', and two pollinisers in the Los Angeles area, season 2009.

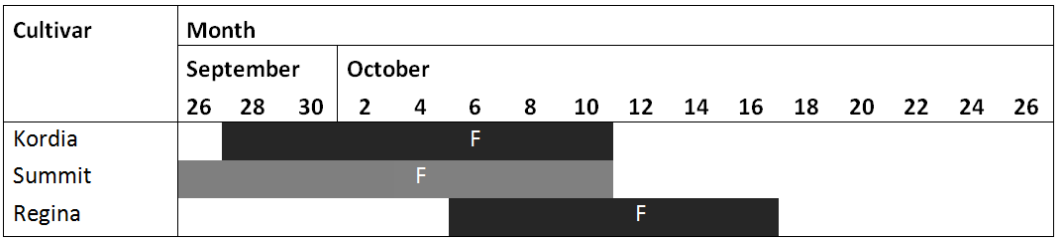

Figure 4. Blooming period for different cultivars in the Angol area, season 2010.

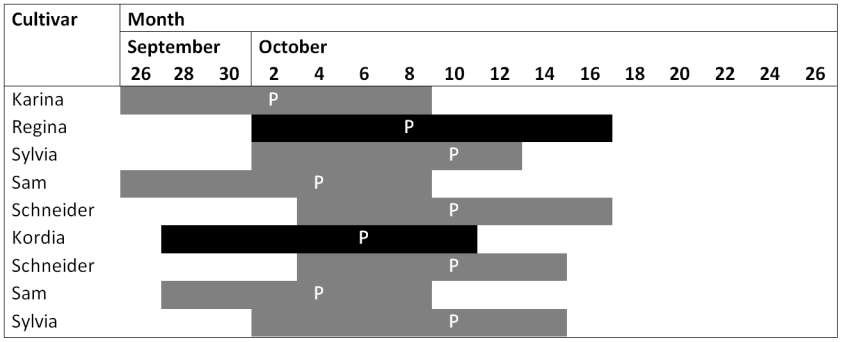

Figure 5. Blooming period for different cultivars in the Angol area, season 2010.

Not only the flowering period has to be taken into account to choose donor cultivars, it is known that there is a stigma-pistil interaction that allows better or erratic pollen tube development (Hedhly et al., 2005). Therefore some cultivars are better than others, in this regard. Keulemans (1984) cited by Nyéki et al. (2003) reported the possibility of finding pollinisers and raised questions about the differences of fruit set obtained between the combinations of cultivars. The success of pollination not only depends on the polliniser but also on the season and trees and flowers characteristics, such as rootstock, vigour, nutrition, among others. In the experiment of EPP under controlled conditions, 'Katalin' was chosen as a good polliniser for 'Regina' and 'Kordia' as the standard; it was determined that pollen tube growth was faster using 'Katalin' than 'Regina'. Some pollen tube of 'Katalin' reached the base of the style in only 24 h whereas 'Kordia' pollen tubes took not less than 48 h (data not shown).

CONCLUSIONS

The most effective cultivars for fruit set of 'Kordia' for the southern region of Chile were 'Sunburst', 'Summit' and 'Schneider' with 12 to 30% of the flowers becoming fruitlets. For 'Regina', 'Katalin' and 'Schneider' gave the best fruit set (30-40%). Considering the flowering period and 10% as minimum fruit set, 'Sunburst' is a good polliniser for 'Kordia'

and ‘Schneider’, ‘Summit’ and ‘Katalin’ for ‘Regina’. The EPP was about 5 to 6 days for ‘Regina’ and ‘Kordia’, and was highly influenced by the temperature.

ACKNOWLEDGEMENTS

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