Evaluation of the effect of complementary pollination on *Actinidia deliciosa* CV. "Hayward" in northwest Portugal

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Abstract

The objective of the present research was to study the effect of complementary pollination on kiwifruit production and quality. For 3 years complementary application of wet or dry pollen was done at different stages of flower opening on vines in the Portuguese regions of Entre-Douro e Minho and Beira Litoral. Commercial production data was collected and fruit quality attributes were measured at harvest.
Complementary pollination did not affect fruit soluble solids content or firmness in any year, and was beneficial for fruit size and commercial production in the third year only, showing that it is important in some conditions, when natural pollination is inadequate.

Keywords: Kiwifruit, quality, complementary pollination, firmness, soluble solids content.

1. Introduction

The introduction of *Actinidia deliciosa* in Portugal represents a case of success in fruit production. Rapidly became one of the main crops in the regions of Entre Douro e Minho and Beira Litoral (Northwest Portugal). However, concurring in a high competitive market, kiwifruit production has to be improved in quantity and quality.

Actinidia deliciosa is a deciduous vine. Pollination appears to be a prime factor in kiwifruit production since inadequate pollination leads to small unmarketable fruits, because there is a close correlation between fruit size and seed number (Pyke and Alspach, 1986). Successful pollination and fruit set depend upon receptivity of flowers during the few days following anthesis, so it is crucial to identify the main factor limiting the effective pollination period (Gonzalez and Coque, 1995).
Kiwifruit in the in the preferred size range of 93-110g usually contains 1000-1400 seeds (Pyke and Alspach, 1986). Pollen is transferred from male to female plants both by wind and honey bees, but the process is uneven and a proportion of female flowers often receive inadequate pollination (Bomben et al., 1999). Artificial pollination may represent an interesting way to produce high quality fruit.

The objective of the present research was to study the effect of complementary pollination at different stages of flower opening on the increase of kiwifruit (*Actinidia deliciosa* cv. 'Hayward'), yield and quality.

2. Material and methods

The experiment was set in a vineyard located in Northwest Portugal during three seasons, in 2002, 2003 and 2004. The orchard had the kiwifruit cultivar 'Hayward' (female plants) and 'Tomuri' and 'Matua' (male plants) grown on a T-bar trellis system. The plant spacing was 5m X 5m with a male plant after four female vines in every row. Complementary pollination was applied by dusting pollen (DW) with an atomizer (200g pollen + 400g lycopodium per Ha) and spraying a liquid suspension (WW) of pollen (100g pollen +30L deionised water + 0.5g PollenAid solution + 0.1L marker dye per Ha). Treatments consisted of **T** - free pollination (control), **P1** - DW when 50% of the flowers were at full bloom; **P2** - DW when 75% of the flowers were at full bloom; **P3** - DW when 50% of the flowers were at full bloom + DW when 75% of the flowers were at full bloom; **PC** – WW when 75% of the flowers were at full bloom. In the year 2004 it was decided to change pollen application at 75% full bloom to 90% full bloom in order to get better results. Each treatment was repeated 3 times in 4 plants per replication.

Kiwifruit were harvested in the first half of November, per plant, and separated by size in a mechanical GREEFA-B.B. Machine BOUW Tricht calibrator, set for these fruits. The soluble solids content (SSC) (ºBrix) was measured by a hand Atago refractometer with automatic temperature correction. Firmness was recorded by puncture, with a hand penetrometer fitted with a flat 8mm diameter plunger. The plunger was inserted after skin removal, at the fruit equator to a depth of 7mm.

3. Results

The results showed that marketable production was significantly higher in 2003 followed by 2002 and 2004 (Fig.1). Although without statistically significant differences, pollen application at 75% full bloom gave higher production and there was not an additional benefit by two pollen applications (P3). In the third year of the experiment the treatment P2 (pollen application at 90% full bloom) gave significantly higher production than control. The application of pollen by liquid suspension (PC) did not show an additional benefit in the production.

In figure 2 it can be seen that kiwifruits of size 85-105g had higher production in the 3 years followed by 75-85g (without significant differences) and then by 65-75g. The higher production in the treatment P2 (pollen application at 90% full bloom) in the third year was mainly due to fruits of size 85-105g followed by 75-85g.

The SSC (ºBrix) was higher in 2004 followed by 2003 and 2002 due to latter harvesting as well as ºBrix measurements (Fig. 3). There were not significant differences in SSC among treatments or fruit sizes.

There were not significant differences in kiwifruit firmness among treatments in 2002 (Fig. 4). In 2003 and 2004 was verified that fruits from treatment P1 (pollen application at 50% full bloom) had slightly lower firmness than the others. It was observed a tendency for the higher size kiwifruits to have slightly higher firmness as well as the ones from treatment P3 (two pollen applications).

4. Discussion

The better result in marketable production in 2004 in the treatment P2 (pollen application at 90% full bloom) indicates that is better to apply pollen when 90% of the flowers are at full bloom than only 75% and that two pollen applications (P3) did not gave an additional benefit. This was probably because the male vines of the orchard ('Matua' and 'Tomuri') start flowering before and are less effective at the full bloom of 'Hayward' (Gonzalez et al., 1994; Testolin et al., 1997). This higher production was mainly due to fruits of higher size 85-105g followed by 75-85g.

In the years of the study the application of pollen by liquid suspension (PC) did not show an additional benefit. Thorp (1994) also reported no additional benefit for this way of pollen application in California because of its warmer, drier and more suitable for pollination by bees weather during kiwifruit bloom than in New Zealand.

Complementary pollination is not always necessary. If in the orchard we increase pollinizer density, improve bee-hive management at flowering time and adopt good male selections, natural pollination can be enough (Testolin et al., 1997).

Complementary pollination is important in years when there is no synchronization between male and female flowering, when ratios or distribution of male vines are not optimum, or the environmental conditions do not allow an efficient natural pollination (Thorp, 1994; Gonzalez and Coque, 1995; Bomben et al., 1999). Because in 2004 the production was lower, the fact that treatment P2 (pollen application at 90% full bloom)

increased the production, can justify its importance in years of less conditions for natural pollination.

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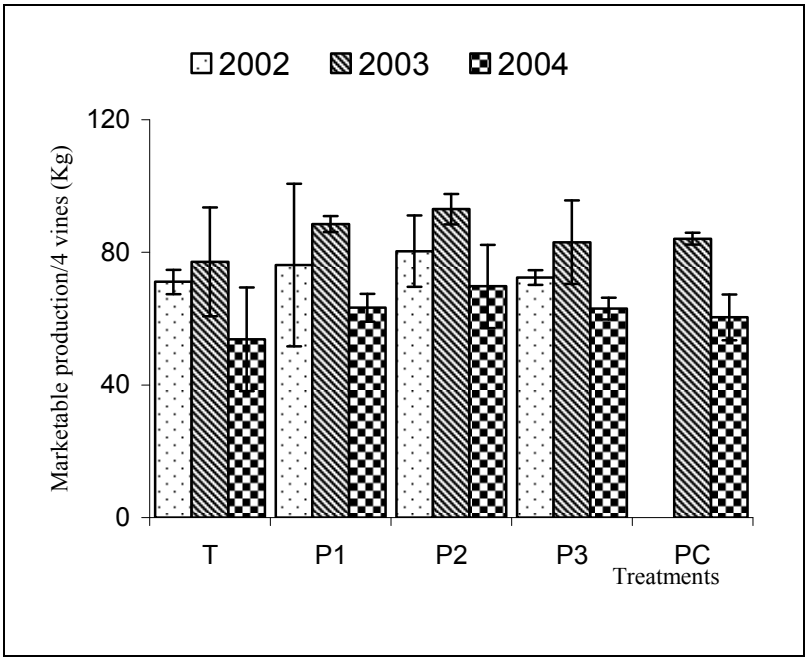

Figure 1- The effect of complementary pollen application on 'Hayward' kiwifruit marketable production in the years 2002, 2003 and 2004. T - Free pollination (control), P1 - DW when 50% of the flowers were at full bloom; P2 - DW when 75% of the flowers were at full bloom (90% in 2004); P3 - DW when 50% of the flowers were at full bloom + DW when 75% of the flowers were at full bloom(90% in 2004); PC – WW when 75% of the flowers were at full bloom (90% in 2004).

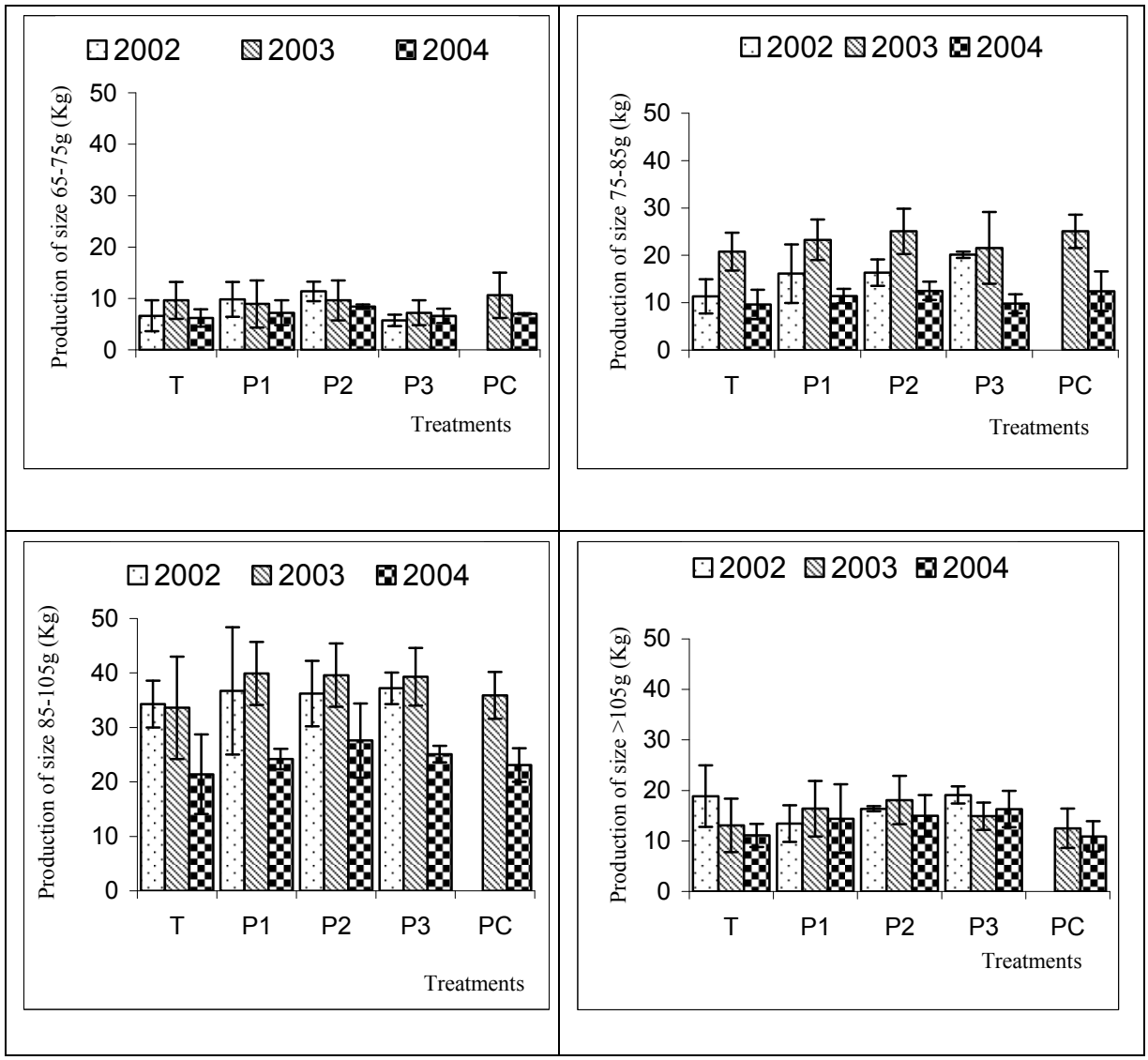

Figure 2 - The effect of complementary pollen application on 'Hayward' kiwifruit production, per 4 vines, by fruit size, in the years 2002, 2003 and 2004. T - Free pollination (control), P1 - DW when 50% of the flowers were at full bloom; P2 - DW when 75% of the flowers were at full bloom (90% in 2004); P3 - DW when 50% of the flowers were at full bloom + DW when 75% of the flowers were at full bloom(90% in 2004); PC – WW when 75% of the flowers were at full bloom (90% in 2004).

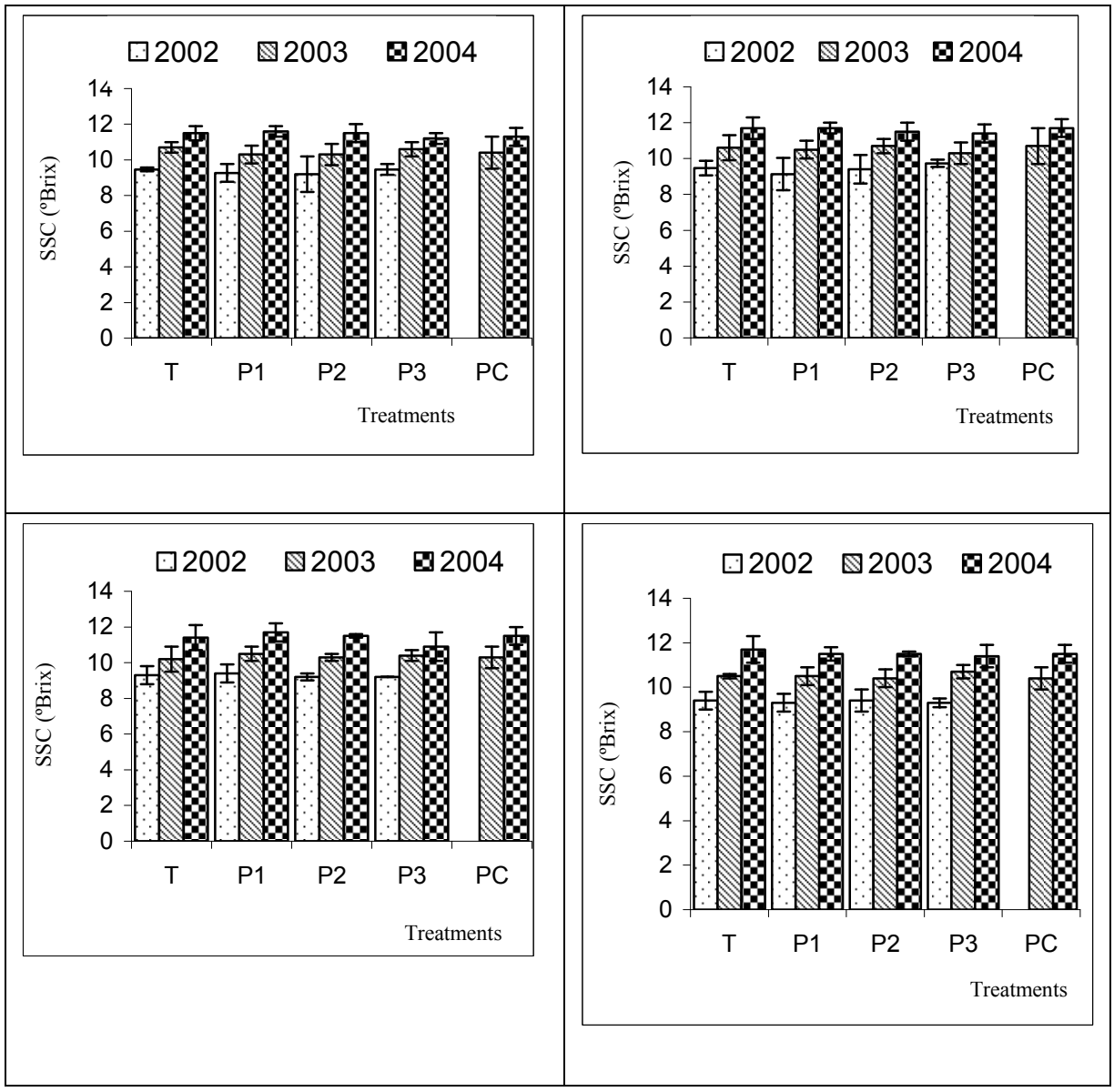

Figure 3 - The effect of complementary pollen application on 'Hayward' kiwifruit soluble solids content (SSC), by fruit size, in the years 2002, 2003 and 2004. T - Free pollination (control), P1 - DW when 50% of the flowers were at full bloom; P2 - DW when 75% of the flowers were at full bloom (90% in 2004); P3 - DW when 50% of the flowers were at full bloom + DW when 75% of the flowers were at full bloom(90% in 2004); PC – WW when 75% of the flowers were at full bloom (90% in 2004).

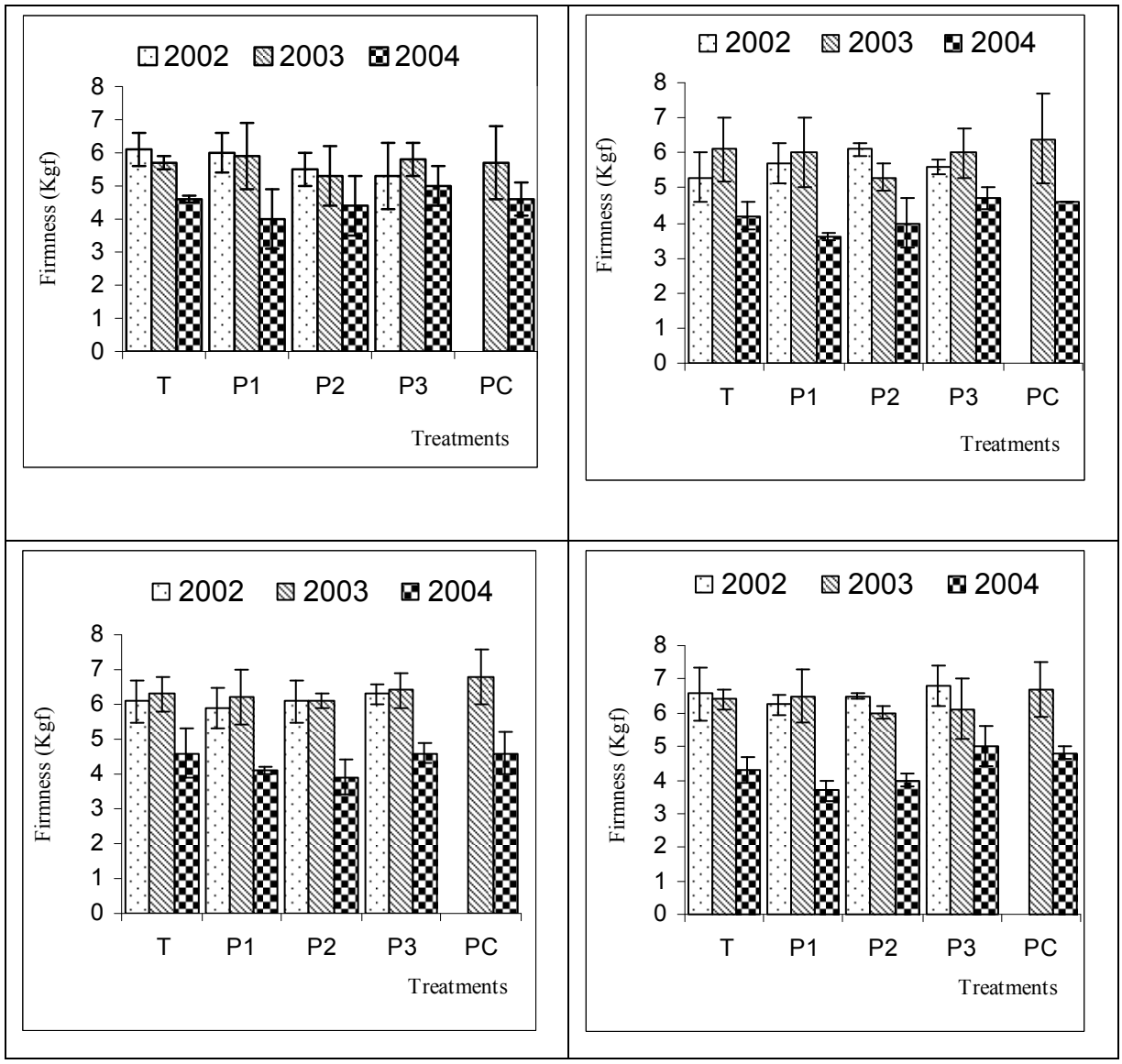

Figure 4 - The effect of complementary pollen application on 'Hayward' kiwifruit firmness, by fruit size, in the years 2002, 2003 and 2004. T - Free pollination (control), P1 - DW when 50% of the flowers were at full bloom; P2 - DW when 75% of the flowers were at full bloom (90% in 2004); P3 - DW when 50% of the flowers were at full bloom + DW when 75% of the flowers were at full bloom (90% in 2004); PC – WW when 75% of the flowers were at full bloom (90% in 2004).