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Self-pollination versus cross-pollination of six self-compatible almond cultivars: Pollen tube growth and fruit set

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SUMMARY – The behaviour of six self-compatible almond cultivars after self- or cross-pollination was studied. Four cultivars were selections obtained at CEBAS (S2332, S4017, Antoñeta and Marta) and the other two were Guara and Lauranne. Fruit set was determined in the field after open-pollination, self-pollination by hand, self-pollination by bagging the branches showing flower buds, and cross pollination (both with a self-compatible and with a self-incompatible cultivar). Assays were also performed in the laboratory. The growth of the pollen tube after 24, 48, 72 and 96 hours was studied after self-pollination or cross-pollination. The results obtained showed no differences between self-pollination or cross-pollination regarding pollen tube growth or fruit set, which indicates the real possibility of cultivating monovarietal orchards of self-compatible cultivars.

Key words: Almond, *Prunus dulcis* Miller, self-compatibility, autogamy, self-pollination, cross-pollination, open-pollination.

RESUME – *"Autopollinisation versus pollinisation croisée chez six cultivars d'amandier autocompatibles : Croissance des tubes polliniques et fructification". Le comportement de six cultivars d'amandier autocompatibles après autopollinisation ou pollinisation croisée a été étudié. Quatre cultivars étaient des sélections obtenues au CEBAS (S2332, S4017, Antoñeta et Marta) et les deux autres étaient Guara et Lauranne. La fructification a été déterminée au champ après pollinisation ouverte, autopollinisation manuelle, autopollinisation en ensachant les branches qui montraient des bourgeons floraux, et pollinisation croisée (toutes deux avec un cultivar autocompatible et un cultivar auto-incompatible). Les essais ont également été effectués en laboratoire. La croissance des tubes polliniques après 24, 48, 72 et 96 heures a été étudiée après autopollinisation ou pollinisation croisée. Les résultats obtenus n'ont pas montré de différences entre l'autopollinisation ou la pollinisation croisée en ce qui concerne la croissance des tubes polliniques ou la fructification, ce qui pointe vers une réelle possibilité de cultiver des vergers monovariétaux de cultivars autocompatibles.*

Most-clés : *Amandier,* Prunus dulcis *Miller, autocompatibilité, autogamie, autopollinisation, pollinisation croisée, pollinisation ouverte.*

Introduction

Most almond varieties present floral self-incompatibility. This characteristic forces growers to establish plantations with two or more intercompatible varieties of simultaneous flowering for cross-pollination purposes, with all the well-known inconveniences (the risk of non-simultaneous flowering, the possible absence of bees, poor weather, harvesting at different dates, etc.).

The obtention of new self-compatible varieties in breeding programmes (Monastra *et al.,* 1988; Socías i Company and Felipe, 1992; Legave *et al.,* 1997; Egea *et al.,* 1999) can offset the inconveniences mentioned by making possible the establishment of monovarietal orchards, as occurs in other fruit species.

Because of the lack of information concerning the behaviour of these monovarietal plantations, growers are generally advised to maintain the presence of another cross-compatible variety in the plantation and to keep beehives.

The objective of the present work was to study the productive behaviour of self-compatible almond cultivars under different pollination conditions to determine the possibility of cultivating them in monovarietal plantations.

Material and methods

Six self-compatible almonds were studied: Guara (SIA, Spain), Lauranne (INRA, France), Antoñeta and Marta (CEBAS-CSIC, Spain) and the selections S2332 and S4017 (CEBAS-CSIC, Spain). In each of these genotypes, pollen tube growth in the pistil was studied in the laboratory and the fruit set in field, after different types of pollination.

Pollen tube growth

A branch with at least 10 floral buds per variety and treatment was placed in jars with water and sucrose (5%) at 25ºC. Each variety was self-pollinated or cross-pollinated (with Ramillete) one day after emasculation. The pistils were put into a fixer (FAA) 24, 48, 72 and 96 hours after pollination and prepared for observation with fluorescence microscopy (Martin, 1959; Kho and Baër, 1968). The number of pollen grains on the stigma, and the number of tubes in the first, second and third part of the style, and in the ovary were counted. A total of 486 pistils were analysed, which involved 2430 observations.

Fruit set

In this assay, 3 branches per treatment and variety were studied in field. The 5 applied pollination types were:

(i) Self-pollination:

- By hand.
- Bagging branches showing closed flower buds.

(ii) Cross-pollination:

- With a self-compatible variety (S2332 and S4017; Lauranne and Guara; Antoñeta and Marta).
- With a self-incompatible variety (Ramillete).

(iii) Open pollination.

A total of 7441 flowers were involved: 1354 self-pollinated, 1211 pollinated with a self-compatible variety, 1116 pollinated with a self-incompatible variety (Ramillete), 1809 cases of open pollination and 1951 of bagged branches. 30 days after pollination, bagging or flowers count (in open pollination), the fruit set was determined.

Results

Pollen tube growth

In Fig. 1 the average number of pollen tubes of the six varieties 24, 48, 72 and 96 hours after the self or cross-pollination, is jointly represented.

No important differences were observed between self and cross-pollination as regard the number of tubes that reach the ovary. The number of tubes reaching the ovary increased with time, more or less levelling out after 72 hours. Although at 24 and 48 hours the tubes seemed to grow more quickly in the case of the cross-pollination, this situation stabilised or it was reversed at 72 hours.

As for the percentage of penetrated ovaries, the tubes did not reach any ovary before the 48 hours except in the case of 1 cross-pollinated pistil. In general no important differences were observed between the cross and self-pollinated, with both showing a gradually increased percentage of ovaries penetrated up to the 96 hours.

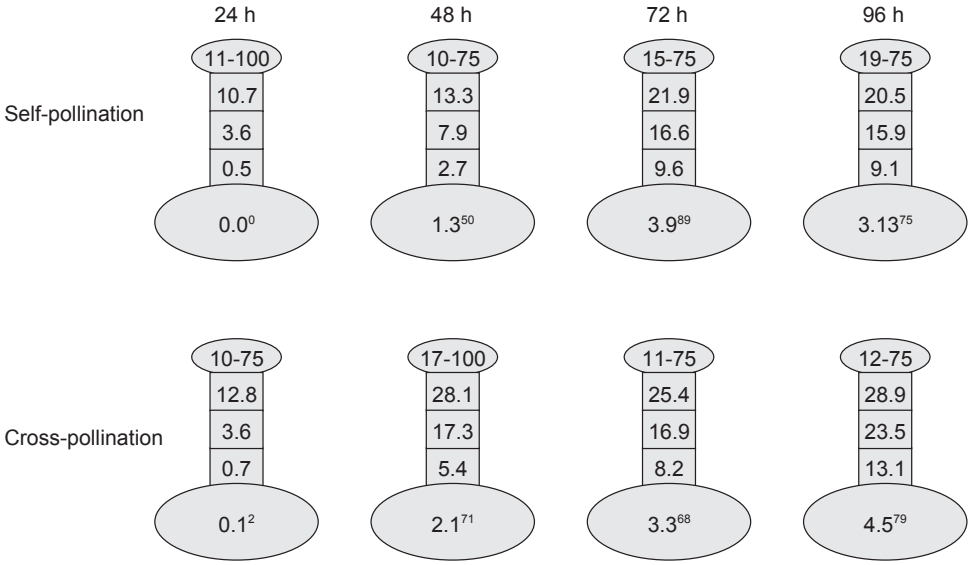

Fig. 1. Pollen tube growth in the pistil 24, 48, 72 and 96 hours after self or cross-pollination (with pollen of Ramillete), of the six self-compatible varieties studied. From top to bottom in each figure: grains of pollen in the stigma, average number of pollen tubes in the first, second and third part of the style and in the ovary. In superscript the percentage of penetrated ovaries.

Fruit set

Figure 2 shows the mean fruit set of the six self-compatible varieties studied pollinated in the five different ways.

No important differences were observed in fruit set between self-pollination and cross-pollination although it was slightly lower in the case of the bagged branches. The average fruit set percentages ranged from 42 to 56%.

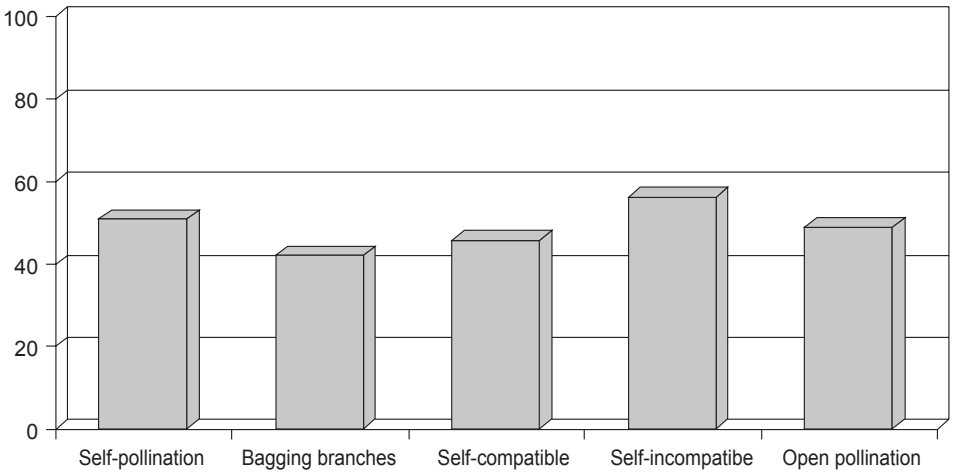

Fig. 2. Mean fruit set (%) of the 6 self-compatible varieties pollinated with each of the 5 treatments: manual self-pollination, bagging of branches (passive self-pollination), cross-pollination with a self-compatible variety, cross-pollination with the self-incompatible variety Ramillete, and open pollination.

Discussion

The results show that in general the self-compatible varieties behave in the same way when they are self-pollinated or pollinated with pollen of another variety (self-compatible or self-incompatible), which shows the possibility of cultivating monovarietal plantations of self-compatible varieties without introducing, as is still habit, a second cross-compatible variety.

Even in the bags, the fruit set obtained was sufficiently high to provide an abundant crop in most cases. This means that it is possible to obtain a good yield even in weather conditions which are adverse to potential pollinating insects (low temperatures, fog, wind), although if we compare the data of the bagged branches with those obtained in open pollination it is clear that the presence of bees does still improve fruit set. In other words, it is still advisable to install beehives in a monovarietal plantation.

Comparative studies of self-pollination and cross-pollination in self-compatible almond varieties are scarce, although those carried out with the varieties Guara (Socías i Company and Felipe, 1992) and Lauranne (Legave *et al.,* 1997) confirm the results here obtained.

Therefore we can conclude that the establishment of new plantations of self-compatible varieties is a real possibility with none of the inconveniences associated to traditional plantations of two or more varieties, and including many advantages, such as those mentioned.

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