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Effect of pollination on dropping of flowers and fruits in new quince (*Cydonia oblonga* Mill.) cultivar and promising genotypes

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ABSTRACT

Access to sufficient and good quality fruits and solving problems such as early abscission of the fruitlets depends on the status of self-fertility and self-incompatibility in cultivars and genotypes and determination of the best pollinizer for them. This research was carried out to study the best pollinizer for some quince cultivars and promising genotypes from the collection of germplasm at the Horticultural Research Station of Isfahan, Iran in 2015 and 2016. For this, the effects of the pollen donor parent, including 'Vidoja', KVD2, KVD4, 'Isfahan', 'Torsh' and also open pollination were studied on quantitative and qualitative characteristics of the pollen recipient parent, including 'Vidoja', KVD2 and KVD4 as a factorial experiment in a randomized complete block design with four replications. To determine the best pollinizer, flowers of pollen recipient parents were emasculated at the balloon stage and were covered with isolation bags. Emasculated flowers were crossed with the pollen of donor parents during receptability of stigmas as well as hand self-pollination for each female parent. Results showed that some traits such as percentage of fruit set, seed numbers and total soluble solids (TSS) were affected by the pollen source. Phenol and pectin were not affected by the foreign pollen sources. According to the results, self-pollination did not have acceptable fruit set. The best pollen source for the 'Vidoja' was KVD2, for KVD4 was 'Torsh' and 'Vidoja' and for KVD2 was KVD4 and 'Vidoja', therefore the cultivation of all three female parents together in the quince orchards is recommended.

1. Introduction

Quince (*Cydonia oblonga* L.) is economically the third fruit of pome fruit group. This species is native of Iran and its distribution centers are the northern forests of this country (Sabeti, 1995). This fruit was cultivated for 4000 years B. C. in Western Asia and it was favorite for many people in Greece and Rome and was called Mala cydonia. The scientific name of this tree has been described to the Sidon city, that had a lot of quince trees (Sabeti, 1995; Maniei, 1995). Quince is cultivated as extensive orchards in different provinces of Iran and area harvested has increased compared to previous years (FAO, 2014).

One of the main problems for quince growers is abscission of flowers and fruits in the early stages of growth that reduce the yield and economic efficiency. Several factors, including the quantity and quality of water, soil quality, pruning, nutrition and environmental conditions before and after flowering can affect on abscission of flowers and fruits and ultimately reduction of yield. In the same condition of these factors, the most important factor in fruit bearing is compatibility and fertilization (Ortega and Dicenta, 2004). Self- incompatibility or incomplete pollination of flowers is as one of the main causes of the fruit dropping (Boskovic and Tobutt, 2001).

Compatible pollen grain, sufficient pollen transfer at the right time on the stigma and pollen tube growth in the style and finally fertilization are essential for successful production of fruit. The absence of pollination vectors or inappropriate weather conditions also cause problems in pollen transfer. In self-incompatible cultivars, pollen tube was not able to grow in the style and reach to ovule, so suitable pollinizer cultivars are essential to achieve economic yield (Socias I Company et al., 2004). Pollinizer cultivars should be compatible with main cultivar and have overlapping in flowering time. Therefore, weak pollination is as a limiting factor in crop production in the various regions (Alizadeh et al., 2009).

Quince is introduced as a self compatible tree in the most references (Maniei, 1995), but based on the presented evidence about self-

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incompatibility alleles on quince, there is a question that the use of cross pollination, what can be effective in increasing fruit in different cultivars of this species (Akbari Bisheh et al., 2016). More species in Rosaceae family have self-incompatibility, that's controlled by a locus with multiple S alleles (Zhang and Xue, 2008). In self-pollination aspect, quince cultivars are classificated into four groups, including the self-compatible cultivars with more than 10% of fruit set, semi self-compatible cultivars with fruit set 3–8%, self incompatible cultivars with 1–2% of fruit set and completely incompatible cultivars with fruit set less that 1% (Nagy-Deri et al., 2013). Based on this classification, if semi self-incompatible cultivars are cultured next to pollinizer cultivars, they will produce more yield. The semi-self incompatible and completely self-incompatible cultivars need to compatible pollinizer cultivars for the appropriate fruit set. Therefore, the self-incompatibility percent of cultivars should be investigated in order to have sufficient yield. There are several methods to study the compatibility or incompatibility of different cultivars and determination of suitable pollinizer for them. These methods include controlled pollination, observation of pollen tube growth with a fluorescence microscope, extraction of ribonuclease from style, specific PCR of S allele and nucleotides sequencing related to incompatibility (Ortega and Dicenta, 2004; Mousavi et al., 2014).

As regards, the controlled pollination method allows to estimate the performance of several cultivars in the orchard, so this method is recommended to determine the appropriate pollinizer (Rasouli et al., 2009).

Nuzzo and Rubbi (2004) studied 22 quince cultivars in Italy and reported that most of them were self incompatible that required cross pollination to yield production. A number of cultivars have also been compatible that use of pollinizer was preferably necessary to obtain better yield. In order to study of the self-incompatibility and determination of the best pollinizer for 'Isfahan' commercial cultivar, female parent was pollinated with four genotypes that named KM1, PK3, KVD2 and NB4. KM1 genotype was introduced as the best pollinizer for 'Isfahan' with 80% of overlapping in flowering time and 23.42% of fruit set (Akbari, 2014). According to Talaei et al. (2007) fruit set percentage after the self-pollination was less than cross pollination. In the study of pollination status in 23 quince cultivars in various regions of Yugoslavia, it was found that only five cultivars of them are self-pollinated (Ershov, 1989).

Pollination and fertility are one of the important issues in the quince trees. Some quince cultivars and genotypes, like other relatives in the Rosaceae family, including apples and pears, have self-incompatibility S-alleles. Self- incompatibility or incomplete pollination of flowers leads to fruitlet dropping and reduce yield, Therefore, it's necessary to be examined self or cross compatibility percent of any new cultivar with the introduction of it.

Fourteen genotypes were identified and collected during the collection program of Iranian quince cultivars and genotypes in Isfahan, Iran. KVD1, KVD2 and KVD4 genotypes have been proposed as promising genotypes after preliminary evaluation of them. KVD1 genotype was released in the name of 'Vidoja'. The aims of this study were the determination of the pollination status and suitable pollinizer for these genotypes and cultivar with the same time flowering period to achieve high performance.

2. Material and methods

2.1. Plant materials and flowering period

This research was carried out at the Horticultural Research Station of Isfahan, Iran in 2015 and 2016. For this purpose, two promising quince genotypes called KVD2 and KVD4 along with 'Vidoja' cultivar that recently has been introduced were considered as the female parent. 'Torsh' and 'Isfahan' cultivars along with three female parent ('Vidoja', KVD2 and KVD4) were considered as the pollen donor parent for pollination studies. Characteristics of the recipient and donor parent is as follows. Vidoja is early-flowering with a high density of the flowers, spore type, dwarf and without alternate bearing. Its fruit size is medium and uniformity, juicy, fragrant with low astringency and desirable quantitative and qualitative characteristics. KVD2 is early-flowering and high flowers density, spore type, dwarf, high yielding, early fruiting and without alternate bearing, fruits with medium to large size, uniform, juicy, fragrant with good quality properties. Characteristics of KVD4 are included early flowering and fruiting and without alternate bearing, spore type, dwarf, high yielding, large fruit and almost juicy with great aroma and sour taste. Isfahan cultivar is Late flowering and fruiting, without alternate bearing, invigorating, intermediate yields, large fruit, juicy, fragrant with low astringency and good quality. Torsh cultivar is early-flowering and fruiting, intermediate vigor, intermediate yields. Its fruit size is medium to large and almost juicy.

The opening of 10%, 80% and 95% of flowers were considered as the beginning of flowering, full bloom and the end of flowering stages, respectively (Gharaghani et al., 2009).

2.2. Collection and viability test of pollen grains

In order to collection of pollen grains, some branches of donor parents contain a sufficient number of flowers that are at the balloon stage were cut and transported to the laboratory. Brunches were placed in the sugar solution (4%). After opening flowers, the anthers were separated from flowers and were placed on glossy paper at room temperature (26–24°C) for 24–48 hours to be losing their moisture and drying of anthers. Pollen grains were separated from anthers and were collected in a sterile glass container with cotton cap. In order to study of viability, pollen grains were distributed in a petri dish containing medium with 1% agar, 15% sucrose and 50 mg/L of boric acid (Dalkilic and Osman, 2011) and germination percentage of pollen grains were recorded using a light microscope after 24 h exposure to laboratory temperature. Pollens with more than 75% of germination percentage were selected and were used as a pollen source. Sterile glasses containing pollen grains were stored in cold and dry condition at 4°C until pollination time.

2.3. Pollination

With swelling of buds, suitable branches containing flower buds and uniform were randomly selected in the four geographical directions of each tree. Flowers were emasculated at the balloon stage and weak, immature and opened flowers as well as flower buds were removed from selected branches and were covered with cloth bags. After receptibility of stigma to accept pollen grain, each isolated branch was brought out of the bag and emasculated flowers were pollinated with considered pollen using a glass rod for each crosses. Pollinated flowers were counted and labeled and again were covered with cloth bags. To ensure of pollination, flowers were again pollinated with considered pollen 24 h later.

Open pollination was evaluated as control treatment, while natural (only covered flower) and hand self-pollination was used for the study of self-pollination treatment. Self-pollination was carried out after emasculation by manually as hand self-pollination treatment. For each crosses, 100 flowers were emasculated and pollinated. These flowers were counted and labeled. For self-pollination treatment also 100 flowers were counted at the balloon stage and were covered with cloth bags without emasculation or any crosses. Cloth bags were removed after petal fall to allow the flowers to place under normal conditions.