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Cross-pollination response of loquat cv. 'Algerie'

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SUMMARY – In order to explore cross-pollination response in loquat, we carried out controlled pollinations on 23 year-old trees of cv. 'Algerie'. Flowers of labelled shoots were bagged and either self- or cross-pollinated with a mixture of pollen from 'Tanaka' and 'Golden Nugget'. Control shoots were left exposed to open-pollination. Number and quality of the fruits formed were recorded for the three treatments. Our results show that under experimental cross- and open-pollination higher fruit set can be obtained when compared with self-pollination treatments. Despite a higher crop load, fruits obtained under open- and cross-pollination were also heavier and larger, at least partly due to a significant increase in seed number. Cross-pollination also provided fruits with advanced development as shown by a noticeable increase of its total soluble solids content. No variation in pulp/seed ratio was observed. Observations under microscopy showed that self-incompatibility of 'Algerie' is not complete. Microscopy observations matched effects of pollination treatments on seed number, but low fruit set under self-pollination suggests that arrival of pollen tubes to ovules may be an inadequate estimation for successful fertilization in this species.

Key words: *Eriobotrya japonica*, pollen-pistil interaction, self-incompatibility, fruit set, fruit quality.

RESUME – "Réponse à la pollinisation croisée chez le cultivar de néflier 'Algerie'". Pour étudier la réponse à la pollinisation croisée chez le néflier du Japon, on a fait des pollinisations contrôlées sur des arbres âgés de 23 ans du cv. 'Algerie'. Des fleurs de rameaux étiquetés ont été emballées et soit auto-pollinisées soit pollinisées avec un mélange de pollen du cv. 'Tanaka' et 'Golden Nugget'. Des rameaux-contrôles ont été exposés à la pollinisation libre. On a déterminé le nombre et la qualité des fruits formés dans les trois traitements. Nos résultats montrent que sous pollinisation croisée et libre on peut obtenir une plus grande nouaison qu'avec l'auto-pollinisation. Malgré une plus grande récolte, les fruits obtenus avec la pollinisation croisée et libre furent plus lourds et plus grands dû au moins en partie à une augmentation significative du nombre de semences. La pollinisation croisée fournit aussi des fruits avec un développement plus rapide qui se manifeste par une augmentation notable du contenu total de sucre. On n'a remarqué aucune variation dans le ratio pulpe/semences. Des observations sous microscope ont montré que l'auto-incompatibilité de 'Algerie' n'est pas complète. Les observations au microscope correspondaient aux effets de traitements de pollinisation sur le nombre de semences, mais la basse nouaison en auto-pollinisation suggère que la pénétration de l'ovule par les tubes polliniques peut être une appréciation inadéquate pour une fertilisation réussie dans cette espèce.

Mots-clés : *Eriobotrya japonica*, interaction pollen-pistil, auto-incompatibilité, nouaison, qualité des fruits.

Introduction

Loquat shares with other pomes flower design and fruit type, but in contrast with apple or pear, is considered a self-compatible species (Rodríguez, 1983). Despite that assumption, loquat flowers strongly attract pollinators that obtain high reward for their visits in form of pollen and nectar. Although those plant expenses do not preclude a recent acquisition of self-compatibility, they are better understood in the context of preferential allogamy as reproductive system for loquat. In Spain, loquat is being increasingly planted in solid blocks under mesh (Martínez-Calvo *et al.*, 2000), where bee activity and pollen transfer from other genotypes is often precluded. Under those conditions, reports of low fruit set and small fruit size are common. On the other hand, previous experiences have shown us the strong influence that seed number exerts on loquat fruit size and also that a high proportion (65%) of fruits harvested in a solid orchard of 'Algerie' possesses only one seed despite relentless activity of bees and bumblebees (Salvador-Sola, 1999). Considering such background information, we have evaluated cross-pollination response of 'Algerie' in terms of fruit set and quality in order to determine pollination requirements of the species.

Materials and methods

Flowers of 23 years-old 'Algerie' loquat trees were either self- or cross-pollinated. Self-pollination was achieved applying own pollen with a small brush to all flowers developed in four panicles in each four different trees. Same number of panicles was cross-pollinated, same procedure, with a mixture of fresh pollen of 'Tanaka' and 'Golden Nugget'. Unwanted pollinations were prevented bagging with microperforated polyethylene sacs previous to bloom. Finally, open-pollinated flowers, left exposed to bee activity, served as control. Fruit set as number of fruits per panicle was determined on those shoots. Fruit size and earliness were also estimated for every harvested fruit from labeled shoots. Harvesting was done on the same day for all fruits, irrespective of their stage, and was programmed when first fruits showed full color. Therefore, some fruits were collected before they fully complete their development, especially under self-pollination treatment. Number of seeds per fruit was also recorded. Experimental design corresponds to randomized blocks where the trees act as blocks and repetitions. On a different sample of flowers pollen-pistil interaction was studied by means of fluorescence microscopy (Martin, 1959). Pollen adhesion, germination and pollen tube growth was followed on 20 flowers per date collected at 1, 2, 4 and 8 days after pollination. Fertilization as ovule penetration was calculated on a flower level, that is, percentage of flowers with at least one ovule penetrated by pollen tubes, and on an ovule level considering percentage of ovule penetrated by pollen tubes.

Results and discussion

Fruit set were significantly higher for open and cross-pollination treatments ($p < 0.001$). Fruit set under self-pollination was extremely low, with an average close to one fruit per panicle. By the contrary, when cross pollen was used or no restriction to bee activity was imposed (open-pollination) number of fruits per panicle was very high (perhaps excessive) resembling usual set of this species (Table 1). Despite higher number of fruits in these treatments, fruit size was also greater, in part due to higher number of seeds per fruit (Table 1). Increase of fruit size was apparent for fruit diameter as well as for fresh fruit weight. In this parameter we found differences between open and cross-pollination, higher for the former, possibly due to its lower set. Open and cross-pollination also led to earlier ripening, therefore making compatible a high level of fruit set and better fruit size with improved earliness. Earliness differences were not significant, in part due to small sample size under self-pollination. However, sugar content of fruits produced under open and cross-pollination was higher than estimated sugar content for self-pollination fruits. At this point it is convenient to repeat that harvesting was performed with some fruits immature, particularly under self-pollination. Number of seeds per fruits, parameter that check efficiency of pollen transfer and fertilization was significantly different among treatments. Open-pollinated flowers formed more seeds than self-pollinated ones, but less than flowers that were hand cross-pollinated (Table 1). No variation ($p = 0.33$) was found in seed/pulp ratio (in width), indicating that although fruits for cross and open-pollination were larger, more and larger were also their seeds.

Table 1. Effects of pollination treatments on fruit characteristics

Parameters and treatments	Fruit set (fr./infl.)	Fruit weight (g)	Fruit diameter (mm)	Seed number	Pulp/seed ratio	Earliness (°Brix)
Self-pollination	0.9c	18.8c	30.4b	1.04a	1.27a	8.2a
Open-pollination	11.6b	32.2a	36.3a	1.74b	1.09a	9.0a
Cross-pollination	16.9a	28.9b	34.9a	2.58c	1.08a	10.6a

Pollen-pistil interaction was followed under fluorescence microscopy in a different set of flowers for each pollination treatment. In general, pollen adhesion and germination were good and widespread in all treatments. Only under open-pollination, some flowers collected first days did not present pollen reflecting dependency on bee activity. High fruit set in this treatment indicates that delayed pollination did not affect subsequent fruit development, although fertilization level was lower and date belated (Figs 1 and 2).

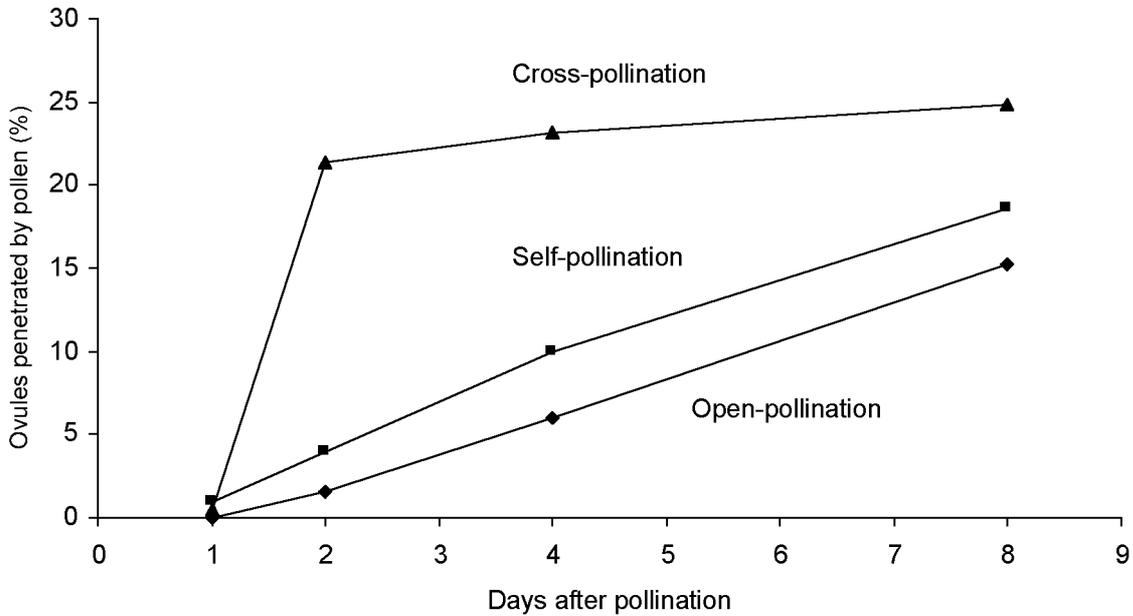


Fig. 1. Evolution of percentages of ovules penetrated by pollen tubes under self-, open- and cross-pollination.

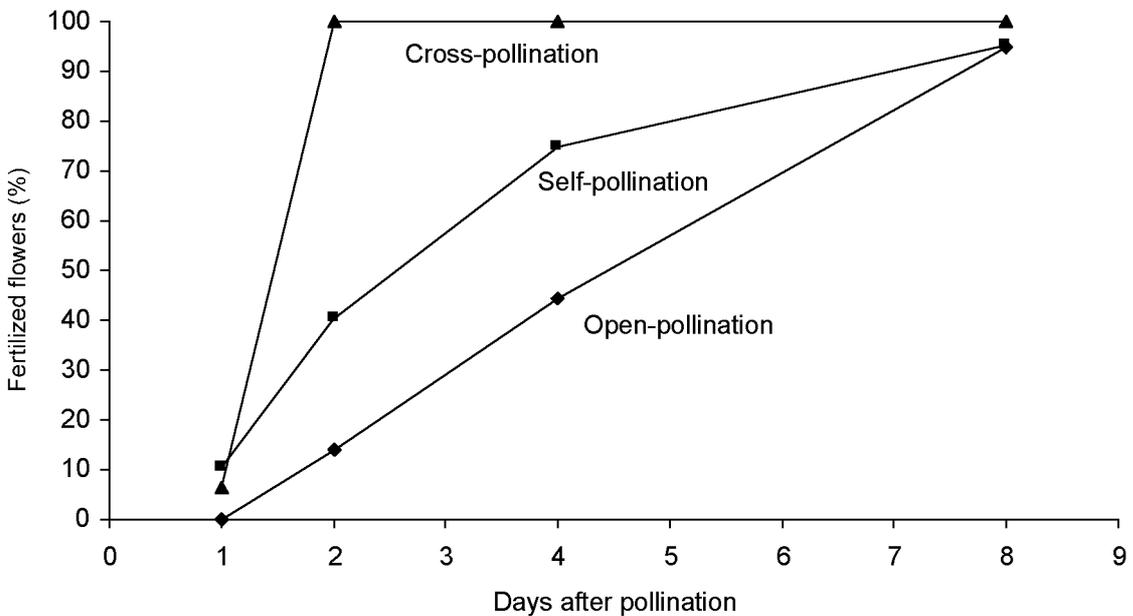


Fig. 2. Evolution of fertilized flowers under self-, open- and cross-pollination.

Observations under microscopy showed that self-incompatibility of 'Algerie' is not complete. However, under self-pollination, pollen tubes reach ovules later than under hand cross-pollination, and fertilization was commonly limited to one ovule per flower (Fig. 2). Microscopy observations matched effects of pollination treatments on seed number. Ovule penetration by pollen tubes could be seen in a high proportion of self-pollinated flowers (Fig. 1). In spite of that, self-pollination rendered a very low fruit set perhaps indicating that ovule penetration by pollen tubes may be an inadequate estimation for successful fertilization. Seed abortion or lack of effective discharge of male gametes into embryo sac are both plausible explanations for the lack of correspondence between ovule penetration and fruit set under self-pollination.

Conclusions

In summary, 'Algerie' has shown a positive response to cross-pollination and must be considered at least as a partially self-incompatible cultivar. Cross-pollination of this cultivar with pollen of 'Tanaka' and 'Golden Nugget' led to higher fruit set and to consecution of fruits of higher quality: larger, heavier, and more precocious. Benefits of cross-pollination can be explained for higher and earlier fertilization that caused fruits with more seeds. However, a noticeable number of ovules under self-pollination were seen penetrated by pollen tubes as soon as 4 days after pollination. These results suggest a seed abortion process, although a more precise determination of fertilization could be convenient to discard lack of effective discharge of male gametes into embryo sac as cause of low fruit set. Extreme self-incompatibility behavior of 'Algerie' advises further confirmation of such character, moreover, when incompatibility response in this species may present some variation from year to year (Crescimanno, 1958).

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