Transferring resistance to Plum pox virus (PPV, sharka) from almond to peach by crossing and grafting

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Transferring resistance to *Plum pox virus* (PPV, sharka) from almond to peach by crossing and grafting

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Abstract. *Plum pox virus* (PPV) is a limiting factor for peach and many other stone fruit production in the areas that are affected. Although no natural sources of resistance have been identified in peach, intespecific crosses with almond can transmit this resistance. In addition, recent studies have demonstrated that grafting almond cultivar 'Garrigues' onto 'GF305' (a very PPV susceptible indicator) peach seedlings heavily infected with PPV, can progressively reduce disease symptoms and virus accumulation. This response appears to be specific between almond and peach. Furthermore, grafting 'Garrigues' onto 'GF305' before PPV inoculation completely prevented virus infection, showing that resistance is constitutive and not induced by the virus. This study aims to analyze the transmission of PPV resistance from almond to peach by grafting from a breeding point of view. In addition, the regulation of gene expression of the resistance to PPV transmitted by grafting among *Prunus* species will be discussed.

Keywords. Almond – Peach – Sharka – *Plum pox virus* – Resistance.

Transfert de la résistance au virus de la sharka (PPV) de l'amandier au pêcher par croisement et greffage

Résumé. Le Plum pox virus *(PPV) est un facteur limitant pour la pêche, et pour beaucoup d'autres productions de fruits à noyau de la zone, qui sont touchées. Bien qu'aucune source naturelle de résistance n'ait été identifiée chez le pêcher, les croisements interspécifiques avec l'amandier peuvent transmettre cette résistance. En outre, des études récentes ont démontré que le greffage du cultivar d'amandier 'Garrigues' sur plants de pêchers 'GF305' (un indicateur très sensible au PPV) fortement infectés par PPV, peut progressivement réduire les symptômes de la maladie et l'accumulation de virus. Cette réponse semble être spécifique entre l'amandier et le pêcher. En outre, le greffage de 'Garrigues' sur 'GF305' avant inoculation du PPV a complètement empêché l'infection par le virus, montrant que la résistance est constitutive et non induite par le virus. Cette étude vise à analyser la transmission de la résistance au PPV de l'amandier au pêcher par greffage du point de vue de l'amélioration. En outre, la régulation de l'expression du gène de résistance au PPV transmis par greffage entre espèces de Prunus sera discutée.*

Mots-clés. *Amandier – Pêcher – Sharka* – Plum pox virus – *Résistance.*

I – Introduction

Sharka, caused by *Plum pox virus* (PPV), is the most important viral disease affecting stone fruit species from the genus *Prunus*, in which varietal susceptibility is widespread. The importance of this disease is due to the strong symptoms it produces on fruits, making them unmarketable, and the reduced yield of infected trees. Moreover, transmission of PPV by both aphids and vegetative propagation of infected plant material has in many cases undermined efforts to contain the disease. These features make PPV one of the ten most important plant viruses in the world, and one of the most studied viral diseases (Scholthof *et al.*, 2011). Within the genus *Prunus*, peach [*Prunus per-*

sica (L.) Batsch] is the most economically important species, with a world production of more than 20 million tons in 2010. For breeders and producers, the lack of widely studied sources of resistance to PPV in peach (Rubio *et al*., 2012) is the most significant factor limiting the release of new resistant varieties.

The incorporation of resistance genes from other related wild species has been an alternative. For instance, *P. ferganensis* (Kostov and Rjabov) Kovalev and Kostov and particularly *P. davidiana* (Carrière) Franch were the first species described as potential sources of resistance to PPV in peach (Pascal *et al*., 2002). However, the ability of some clones of *P. davidiana* to transmit PPV resistance to descendants has been questioned, and the importance of the genetic background in the expression of this resistance has been highlighted (Rubio *et al*., 2010), significantly limiting the use of this species as a source of resistance. Another alternative is the use of the closely related species almond (*P. dulcis* Mill, DA Webb).

In this work, transferring resistance to PPV from almond to peach by crossing and grafting is presented as an alternative to the lack of resistance in peach cultivars.

II – Transferring PPV resistance from almond to peach by crossing

Rubio *et al*. (2003) evaluated the resistance to PPV of ten almond varieties on peach 'GF305' rootstock infected with PPV-D and observed that no almond variety showed symptoms. Martínez-Gómez *et al.* (2004) subsequently demonstrated the usefulness of almond as a donor of resistance to peach through interspecific crosses (Fig. 1). Finally, Rubio *et al*. (2003) observed that sharka symptoms on 'GF305' rootstocks on which 'Garrigues' was grafted tended to disappear.

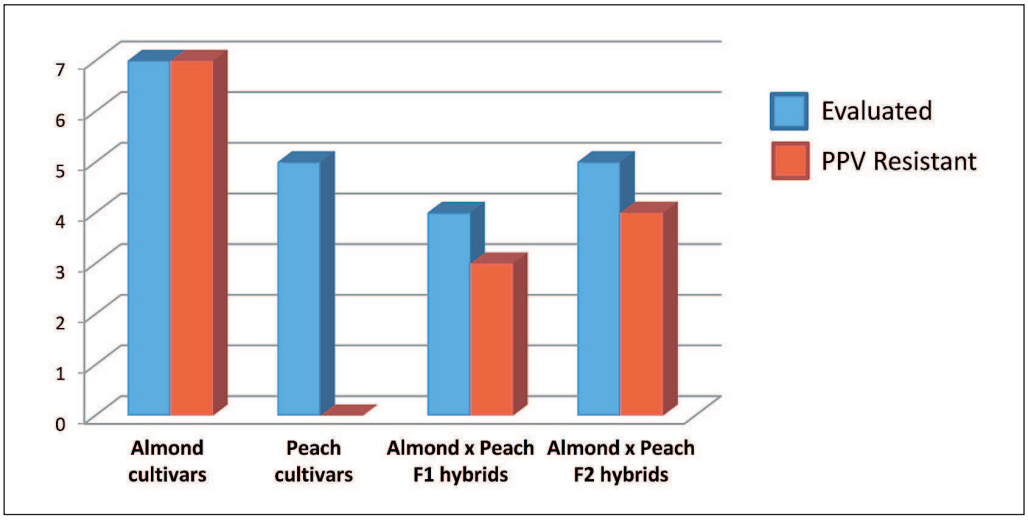

Fig. 1. Evaluation of resistance to PPV in almond and peach cultivars and in F1 and F2 interspecific crosses. Adapted from Martínez-Gómez *et al*. (2004).

III – Transferring PPV resistance from almond to peach by grafting

Recent studies, however, have also demonstrated that grafting the almond cultivar 'Garrigues' onto 'GF305' (a very PPV susceptible indicator) peach seedlings heavily infected with PPV, can progressively reduce disease symptoms and virus accumulation (Rubio *et al*., 2013). This response appears to be specific between almond and peach. The ability to induce resistance to PPV in 'GF305' was transmitted to the sexual descendants of Garrigues.

Furthermore, grafting 'Garrigues' onto 'GF305' before PPV inoculation completely prevented virus infection, showing that resistance is constitutive and not induced by the virus (Fig. 2). This fact suggests that resistance may be due to the transfer of a defense factor from 'Garrigues' almond through the graft union and its interaction with specific factors of 'GF305' peach to produce the antiviral response.

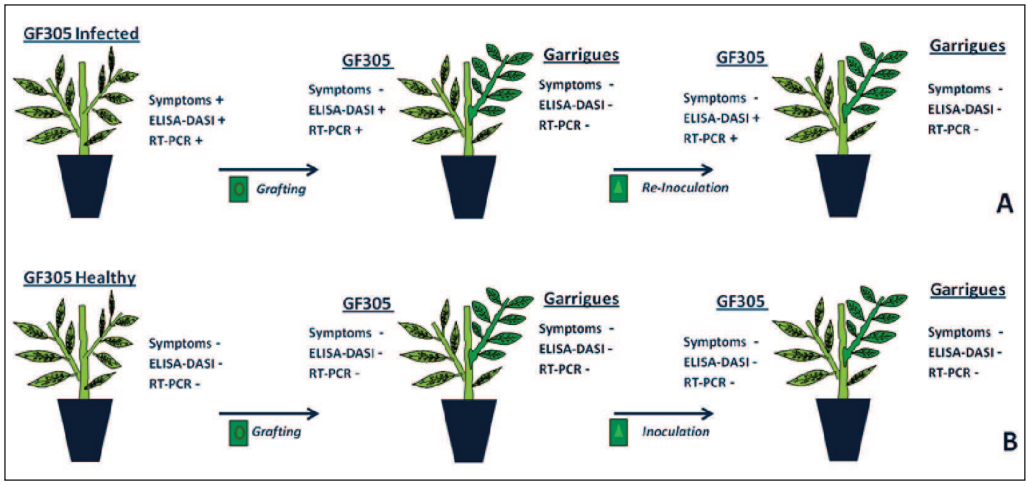

Fig. 2. Transmission of PPV resistance from almond to peach by grafting. Adapted from Rubio *et al*. (2013). Schematic representation of the assay processes infected GF305 peach showing strong sharka symptoms grafted with Garrigues almond (A) and healthy GF305 grafted with Garrigues and later inoculated with PPV (B). GF305 peach seedling inoculated with PPV and showing strong sharka symptoms.

IV – Conclusions

Results have shown the successful transmission of PPV resistance from almond to peach by crossing and grafting. These results open new avenues to potential protection against PPV in peach, the most economically important species among stone fruits.

Acknowledgements

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