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The inheritance of the hypersensitivity resistance of European plum (*Prunus domestica* L.) against the *Plum pox virus*

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Abstract

In between 2003 and 2009 more than 500 seedlings have been tested for hypersensitivity resistance against the *Plum pox virus* (PPV), which causes Sharka disease. The seedlings had at least one hypersensitive parent genotype. They were tested for hypersensitivity resistance by double grafting onto PPV infected interstem in the green house. In crossing combinations with two hypersensitive parents the percentage of hypersensitive seedlings was highest. There is also no equal distribution of the genotypes over the individual hypersensitivity classes (HC) in all crossing combinations. The percentage of hypersensitive seedlings strongly depends on the parentage. Furthermore investigations regarding the origin of the hypersensitivity resistance of the cultivar 'Jojo', which is a descendant of a crossing combination from 'Ortenauer' × 'Stanley', were done. It was shown that the cultivar 'Ortenauer' is the donor of the hypersensitivity trait.

Keywords: *Plum pox virus*, hypersensitivity, inheritance, *Prunus domestica* L., resistance

Introduction

Sharka disease has caused big economic losses during the last decades. Large efforts were done to limit the economic impact of the disease by means of resistant genotypes. At present, the most effective resistance mechanism known is the use of hypersensitivity resistance, which was first described in 1991 by Kegler et al. on 'Kischinever Hybride 4', which was not completely resistant against *Plum pox virus*. In 1997 Hartmann also described this type of resistance in crossings of the cultivar 'Ortenauer' with 'Stanley', 'Ruth Gerstetter' and 'Italian Plum'. From these crossings the cultivar 'Jojo', the first completely resistant genotype against the *Plum pox virus*, arose.

According to our present knowledge, the use of hypersensitivity resistance is the most promising mechanism to control the economic impact of Sharka disease in European plum (*Prunus domestica*). In spite of large efforts during the last years, the inheritance of the hypersensitivity trait is not yet fully understood. Therefore, further investigations regarding the heritability of this hypersensitivity resistance are necessary.

Material and methods

500 seedlings originating from crossing combinations between hypersensitive and sensitive, between hypersensitive and hypersensitive, and between hypersensitive and quantitatively resistant genotypes have been tested for hypersensitivity resistance by using a double grafting method described by Kegler et al. 1994. In January budsticks of the seedling genotype to be tested were grafted onto virus free myrobalane seedlings with an infected scion wood of the cultivar 'Katinka' used as an interstem (Fig. 1 A). The 'Katinka' scion woods were cut on frost-free days in December from systemically infected trees in the field. The budsticks and the grafting area were immersed in 70 °C hot Rebwachs WF (Stähler Agrochemie) and afterwards the plants were potted in 5 l containers. Every genotype was tested in three replications. The grafted plants were cultivated in an insect proof greenhouse at a temperature of 15 °C. After budbreak the temperature was raised to 22 °C. Rootstock suckers were removed continuously. In order to initiate the growth of the testing genotype, the branches of the 'Katinka' interstem were decapitated with the full development of the third leaf.



Fig. 1 A + B: double grafting; white arrow: shoot of a seedling in the testing system; dashed arrow: virus infected 'Katinka' after decapitation; C: necrosis on the bark and on the shoot tip of 'Wei 499' ('Ortenauer' × 'Ortenauer'); D: strong hypersensitive reaction of a successful grafting of 'Wei 4926' ('Hoh 4941' × 'Hoh 7172'), dying shoot.

A first rating was done after 6 weeks and a second one after 20 weeks. Further more if one could not detect any visible PPV symptoms the virus was serological analyzed by DAS-ELISA with PPV universal antibodies (Bioreba Switzerland) (EPP0 2004).

Results and discussion

After budbreak, hypersensitive genotypes showed necrosis on the leaf blade, the bark and the shoot tip depending on the degree of the hypersensitivity resistance (Fig. 1). The genotypes were grouped to the four classes of hypersensitivity (HC): HC 0 – no, HC 1 – weak, HC 2 – normal, HC 3 – strong hypersensitive response with HC 3. In HC 3, being the highest value, it was reported that plants isolate the virus and rapidly stop its replication within in the plant tissue (Neumüller 2005, Neumüller et al. 2008).

The number of hypersensitive seedlings in some of the investigated progenies is given in Fig. 2. It varies between 0 and 63 %. The highest percentage of hypersensitive seedlings can be observed if both parents are hypersensitive ('Hoh 4517' × 'Jojo', 'Hoh 4517' × 'Hoh 7184'). Having chosen a hypersensitive and a sensitive genotype as a parent genotype, the percentages of hypersensitive seedlings in the progenies varied between 0 and 50 %. In all crossing combinations of a hypersensitive genotype with a genotype which is quantitatively resistant and tolerant (e. g. 'Hoh 2043', 'Mirabelle de Nancy'), less than 15 % hypersensitive seedlings were obtained.

These results are in line with the observations made by Neumüller (2005). There seems to be an oligogenic control for the hypersensitivity trait or the large differences relating to the combining ability of parent genotypes can hardly be explained.

The first genotype with hypersensitivity resistance to the broad range of PPV stains and isolates known in *Prunus domestica*, the cultivar 'Jojo', is a hybrid between the highly sensitive cultivar 'Ortenauer' and the fruit tolerant cultivar 'Stanley' (Hartmann 2002). Hartmann (2002) assumed that the hypersensitivity trait originates from the cultivar 'Ortenauer'.

In order to check this hypothesis descendants of the following crossing combinations were investigated: 'Ortenauer' × 'Ortenauer', 'Stanley' × 'Ortenauer' and 'Stanley' × 'Stanley'. In descendants of 'Stanley' × 'Stanley', no hypersensitive seedlings (HC 2 or 3) could be found. 20 % of the seedlings resulting from 'Stanley' × 'Ortenauer' and 53 % originating from 'Ortenauer' × 'Ortenauer' are strongly hypersensitive. These results show that 'Ortenauer' is the donor of the hypersensitivity resistance to PPV (Fig. 2).

The investigations on the inheritance of hypersensitivity resistance confirm the results described by Neumüller (2005) and Hartmann and Neumüller (2008) and improve our understanding of the inheritance of the resistant trait. The selected genotypes provide a base for further selection and breeding of PPV resistant European plum cultivars.

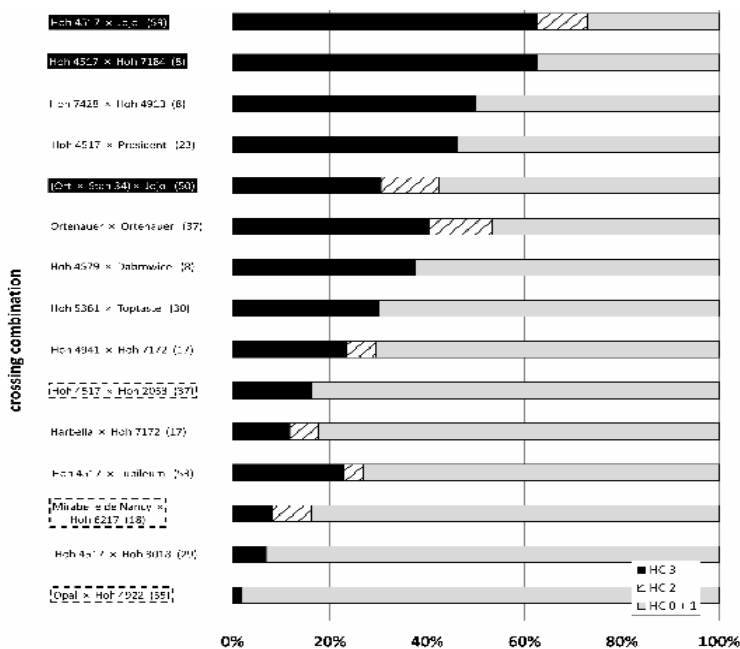


Fig. 2 Percentages of seedlings of some investigated crossing combinations belonging to the different hypersensitivity classes (HC: HC 0 – no, HC 1 – weak, HC 2 – normal, HC 3 – strong hypersensitive response). Crossing combinations of hypersensitive genotypes with hypersensitive ones (marked in black and written in white), hypersensitive with sensitive genotypes and hypersensitive with quantitatively resistant ones (framed with bars). The number in brackets gives the amount of tested seedlings of the respective crossing combination.

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