INFLUENCE OF ROOTSTOCK ON WINTERING AND HEALTH STATUS OF PLUM CULTIVAR 'VICTORIA'

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Abstract

The choice of rootstock is the main precondition for establishing of high yielding and sustainable plum orchards. Therefore influence of rootstock on the plum cultivars wintering in Latvia climatic conditions becomes more and more actual. Investigation was carried out with the aim to clarify influence of rootstock on the wintering and health status of plum cultivar 'Victoria'. Investigation was carried out at Pūre Horticultural Research Centre during two different wintering seasons of 2008/2009 and 2009/2010, in the orchard planted in 2001. The winter of 2008/2009 was characteristic with sharp temperature fluctuations, but winter of 2009/2010 was snowy with stable low temperatures. Sixteen widely used rootstocks known in Europe were included. Plum general tree health status (scored by 1-5 points) and percentage of dead trees were evaluated. No statistically significant differences among rootstocks were established according to the evaluation of tree health status. Differences in wintering ability among rootstocks were stated between two years of investigation. Trees grafted on Brompton seedlings and St. Julien d`Orleans demonstrated the highest winter hardiness (4.3 points). No one dead tree was registered on these two rootstocks. Rootstock GF8/1 was the least suitable for Pūre conditions – with general health status scored at 2.3 points after severe winter of 2009/2010, and only 25% of alive trees.
Key words: *Prunus domestica, Prunus cerasifera,* wintering, tree health status.

Introduction

The choice of a rootstock is the main precondition for establishing of high yielding and sustainable orchards. The lack of appropriate rootstocks is one of the main reasons limiting development of intensive plum orchards in Latvia. Compatibility of rootstock and cultivar is the main condition influencing tree productivity and yield comprising parameters. A grafted tree is a complex organism consisting of two different genotypes – rootstock and cultivar. Therefore tree life, resistance to unfavourable weather conditions, crown size, precocity, and yielding intensity depend not only on rootstock or cultivar, but also on their interaction (Wertheim, 1998).

Caucasus plum (*Prunus cerasifera* Ehrk) has been the most used rootstock in Latvia during last several decades. However, it does not meet the demands of intensive orchard because of its vigorous habit (Grzyb et al., 1998). It is not well appropriate also for hobby gardens, if they are located in moist areas. As an additional drawback should be mentioned incompatibility of this rootstock with some cultivars. In Pūre Horticultural Research Centre there was observed insufficient health evaluation of trees grafted on Caucasus plum as rootstock (Lepsis et al., 2008).

Myrobolana and dwarfing Wangenheims Zwetche as rootstocks are used in other European countries (Rozpara and Grzyb, 2007). Pixy is investigated as a dwarfing rootstock in intensive orchards in Europe (Sosna, 2002). Also several other plum rootstocks have been included in the investigations in Europe, but there have not been performed investigations on these rootstocks in Latvia till now.

In Latvia cultivars of European plum (*Prunus domestica*) are popular and very broadly grown, therefore the widespread cultivar 'Victoria' belonging to this group was included in the investigation of different rootstocks. The aim of the investigation was to clarify the influence of different rootstocks on the winter hardiness of cultivar `Victoria` in Latvia conditions. Data obtained during two vegetation seasons (2009 and 2010) and consequently after two wintering seasons of 2008/2009 and 2009/ 2010 are discussed.

Materials and Methods

A plum orchard was established in Pūre Horticultural Research Centre, Latvia, in 2001. In the investigation, cultivar 'Victoria' was grafted on 16 different rootstocks well known in Europe.

Eight vegetatively propagated rootstocks were included in the investigation**:** St. Julien A, Brompton, Ackermann, Pixy, GF8/1, G5/22, GF 655/2, and Hamyra; as well as eight generative propagated rootstocks: St. Julien INRA2, St. Julien d Orleans, St. Julien Noir, Brompton, Wangenheims Zwetche, St. Julien Wädenswill, Myrobolana, and *Pr. Cerasifera* var *divaricata.*

Plants were planted at 3 × 5 m density, in four replications, three trees per plot. Soil was sandy loam on dolomite consisting loamy mother rock, pH KCl 7.2. Content of plant available phosphorus was 183 mg kg^{-1} and potassium – 215.6 mg kg^{-1}. Irrigation in orchard was not available. Weeds in spaces between rows were moved, and herbicides were applied in strips to control the weeds.

General health status of trees was scored in the vegetation period of 2008, 2009, and 2010 by the following scale: 0 – tree completely dead, 1 – tree has lost ability to grow, 2 – overground part is completely damaged, but new

shoots are developed, 3 – two and three years old braches and trunks are damaged, 4 – only annual shoots were damaged, 5 – tree in excellent condition. Average yield per tree (kg) was analysed only for data of the year 2008 due to strong regeneration pruning in the spring of 2009, therefore there was no significant yield for the cultivar in 2009. The number of dead trees was registered starting from 2001 till the end of investigation – the year 2010.

Statistical analysis of results was performed by using ANOVA.

Meteorological data were obtained from automatic meteorological station 'Lufft', registering meteorological conditions each 10 minutes. Actual meteorological data were compared to long-term data.

Average air temperature in 2008 – 2010 and long-term temperature are displayed in Figure 1. Years of investigations were characterised by different meteorological conditions. In 2008, relatively sharp temperature fluctuations were registered during the first three months: in January from -14.1 °C to + 7.9 °C, but at the 2nd part of March from - 11.6 °C to + 15.1 °C. Also the January of 2010 was cold, when the 3rd decade was the coldest and the temperature dropped down to - 28.6 °C.

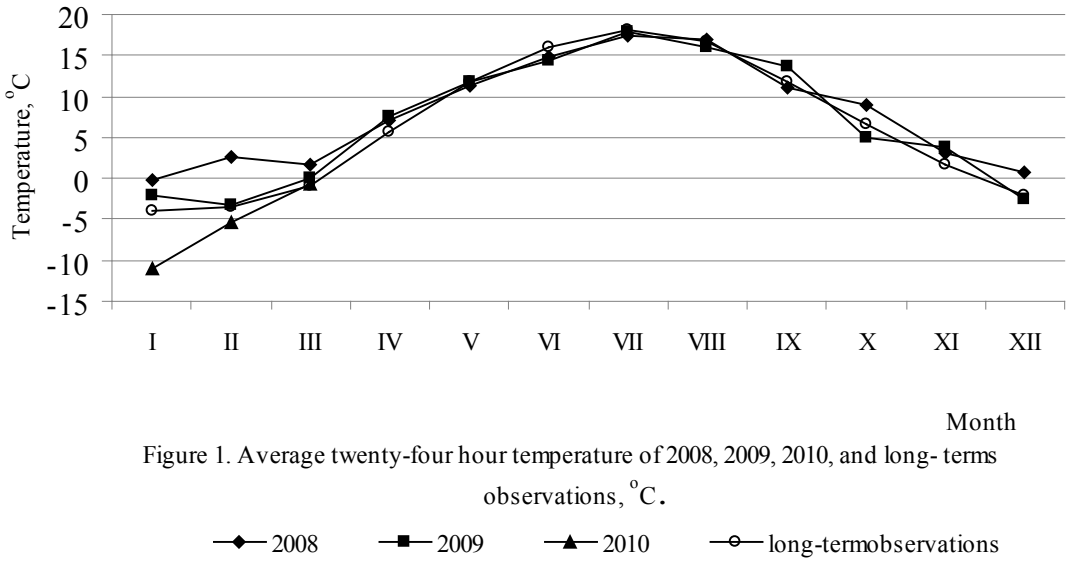

Figure 1. Average twenty-four hour temperature of 2008, 2009, 2010, and long- terms observations, °C.

The average amount of precipitation in 2008 – 2010 and long-term observations are illustrated in Figure 2. The wintering period of 2008 was rich in precipitation. The total amount of precipitation was 426 mm according to observations of the local meteorological station in Pūre. A lot of precipitation was observed also in June and July of 2009 – 81.4 and 107 mm respectively. That is much higher than in long-term observations.

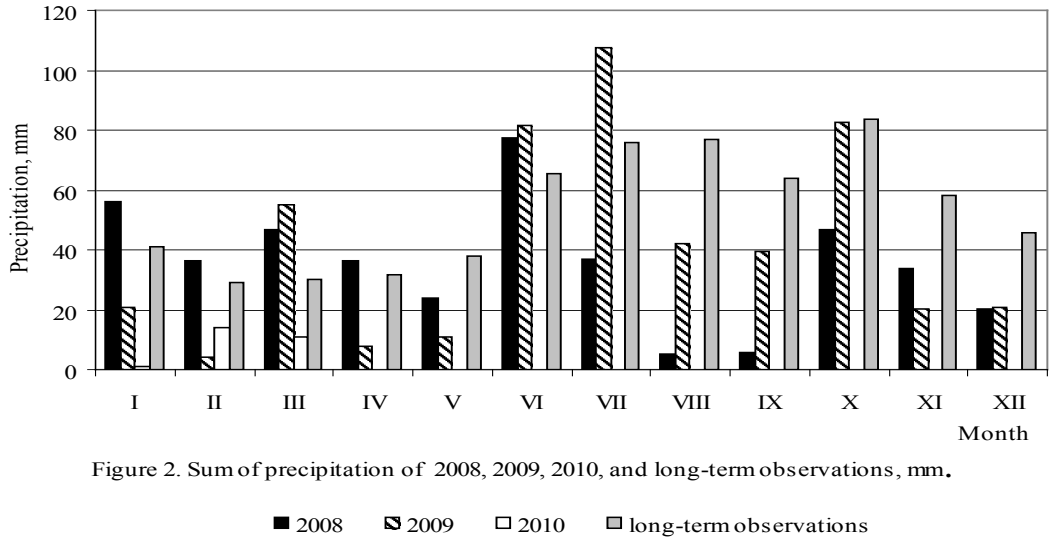

Figure 2. Sum of precipitation of 2008, 2009, 2010, and long-term observations, mm.

Results and Discussion

In 2008, relatively sharp temperature fluctuations were registered during the first three months, when in January temperature ranged from - 14.1 °C to + 7.9 °C, but at the 2nd part of March – from - 11.6 °C to + 15.1 °C. Nevertheless temperature fluctuations did not influence wintering of flower buds, plum blossoming was good, and the following yield developed very well. The highest yield in 2008 was registered for trees on the rootstock Hamyra – 60.7 kg per tree (Fig. 3). The yield exceeding 50 kg per tree was obtained from trees grafted on St. Julien d` Orleans, GF 655/2, St. Julien Noir, *Prunus cerasifera*, and Ackermann. The lowest yields were obtained from the trees grafted on G5/22 and Pixy (36.7 and 40.3 kg per tree respectively). Tree health status was evaluated as good because the 1st part of the summer was warm and rich in precipitation.

August was warm, but with insignificant amount of precipitation – 5mm. Also in September was registered low precipitation – only 5.8 mm. It could influence wintering ability of some rootstocks, especially those which are sensitive to insufficient moisture with shallow root system. Also intensity of yielding can influence negatively the wintering ability of trees in the succeeding winter, especially it is characteristic for cultivar `Victoria` (Jänes and Kahu, 2008). In 2009, during wintering period a rapid decrease in air temperature was observed – down to - 21.8 °C, which could negatively influence tree wintering.

This statement partly was approved in the season of 2009. Trees suffered less in 2009 after the relatively mild winter of 2008/2009. The regeneration pruning was performed in spring, which facilitated development of leaf surface during the following summer, and also the yield was not high. Good health status was observed for trees grafted on Wangenheims Zwetche (4.0 points), although in 2008 average yield for trees on this rootstock was 45.1 kg per tree.

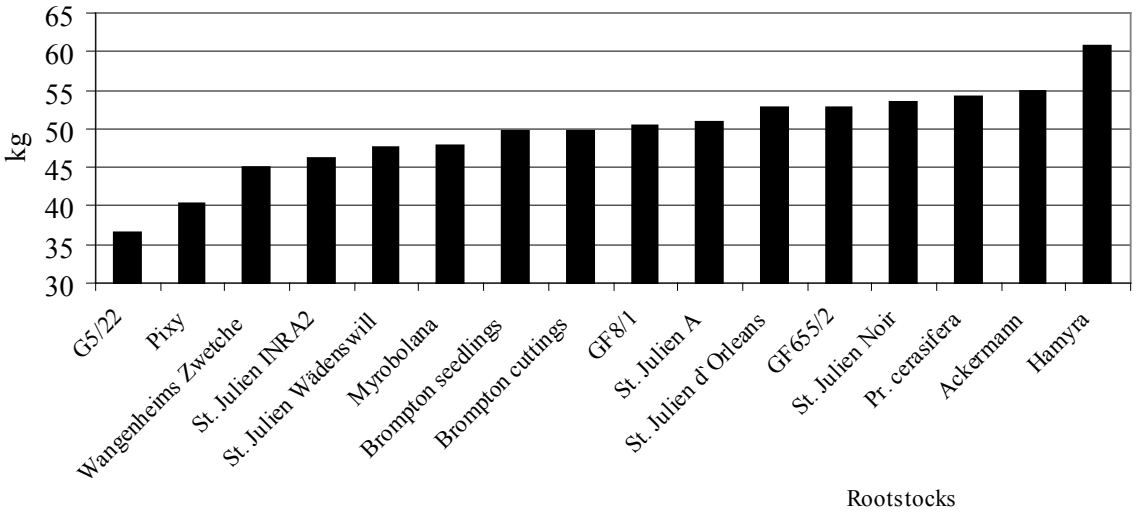

Figure 3. Average yield kg per tree in 2008.

In November of 2009, precipitation was relatively low (20.4 mm) if compared with long-term observations. A rapid decrease in temperature was observed in December (-22.7 °C in the 2nd decade), which could influence plum wintering processes negatively.

Also January of 2010 was cold, and the 3rd decade of the month was the coldest, when temperature dropped to - 28.6 °C. February was relatively cold, with minimal temperature - 21.6 °C, but in the 3rd decade temperature increased to + 3.5 °C causing very sharp temperature fluctuations, which can cause tree damages. April, too, had changeable weather, which could cause mechanical injuries to trees. Nevertheless, tree health status in 2010 was evaluated as relatively good, despite unfavourable wintering conditions. Statistically significant differences among rootstocks were not found according to the evaluation of tree health status (p=0.62).

Rootstocks were evaluated more or less differently for a three-year time period of the investigation according to health status and number of dead trees. In 2010, trees grafted on St. Julien d` Orleans and Brompton seedlings were in the better condition (evaluated at 4.3 points). Also other researchers have reported about good wintering ability of trees grafted on these rootstocks (Lepsis et al., 2008). Comparing the two wintering seasons in Pūre, it is clearly visible that health evaluation of trees grafted on GF 8/1 has decreased with each year – in spring of 2008 – 3.1 points, but in 2010 – only 2.1 points. From the year of planting the orchard, 25% of trees were dead for the cultivar 'Victoria' on this rootstock. However, in Estonia small injuries have been registered for trees on rootstock GF 8/1 (Jänes et al., 2007).

Table 1

Tree health status (in points) and percentage of dead trees for cultivar 'Victoria'

Rootstock	Year			Dead trees, %
	2008	2009	2010	
Ackermann	3.8	4.0	3.8	0.0
St. Julien INRA2	3.8	3.7	3.5	8.3
Brompton seedlings	4.1	4.4	4.3	0.0
Myrobolan	3.8	3.3	3.2	16.7
GF8/1	3.1	2.3	2.1	25.0
G5/22	3.9	3.8	3.6	0.0
St. Julien d`Orleans	4.2	4.4	4.3	0.0
Brompton cuttings	3.9	3.8	3.5	16.7
St. Julien Noir	4.2	4.0	3.9	8.3
St.Julien Wädenswill	4.2	3.6	3.4	0.0
Wangenheims Zwetche	4.1	4.0	4.0	0.0
St. Julien A	3.7	3.3	3.2	16.7
Pixy	3.7	3.5	3.2	8.3
Hamyra	4.2	3.7	3.7	8.3
P. cerasifera var. divaricata	3.7	3.4	3.2	8.3
GF655/2	3.9	3.9	3.8	0.0
$LSD_{0.05}$	0.56	0.62	0.92	-

Different results are also reported for trees grafted on *Prunus cerasifera* which has unsatisfactory wintering results in Pūre. In Estonia its wintering ability is evaluated higher (Jänes et al., 2007), which indicates the possible influence of soil and microclimatic conditions on the wintering ability of trees grafted on *Prunus cerasifera*. The possible cause of such differences can be the relatively long vegetation period of the rootstock, which influences tree wintering ability in the fluctuating meteorological conditions so frequently observed in Latvia.

In the investigations in Poland, widely grown dwarfing rootstock Pixy had average wintering results. It should be taken into account that in the case of sufficient wintering good yields from trees grafted on this rootstock could be obtained by planting trees in increased density (Grzyb and Sitarek, 1998). In addition there is advisable watering system because of shallow root system of the rootstock (Grzyb et al., 1998). Sensitivity to moisture conditions could be the reason for insufficient wintering ability of the rootstock in Pūre in 2008/2009 when low precipitation in August and September of 2008 was observed (Figure 2).

In 2010, 16.7% of dead trees were registered on the vegetatively propagated Brompton, Myrobolan and St. Julien A. Trunk injuries were observed for trees grafted on Brompton vegetatively propagated rootstock after the severe winter of 2009/2010 with sharp temperature fluctuations in March. Good overwintering was observed for trees grafted on GF 655/2. Similar results are reported on this rootstock also in other researches (Lepsis et al., 2008).

Since planting in 2001, no one dead tree was observed in Pūre for cv. 'Victoria' grafted on Ackermann, Brompton seedlings, G5/22, St. Julien d` Orleans, St. Julien Wädenswill, Wangenheims Zwetche, and GF655/2. This indicates the possible compatibility of the cultivar and the rootstock and/or good adaptation to Pūre climatic conditions. Overall, tree winter hardiness evaluations were less satisfactory on all rootstocks included in the investigation after the winter of 2009/2010 with severe temperature conditions.

Conclusions

1. The highest wintering and better health status were observed for cultivar 'Victoria' grafted on rootstocks St. Julien d`Orleans and Brompton seedlings. This proves good compatibility of the cultivar and the rootstocks and ability to overcome different overwintering conditions.
2. The worse health status and more dead trees were observed for trees grafted on GF8/1, which indicates the unsuitability of the rootstock to the climatic conditions in Pūre.
3. The highest yields in 2008 were obtained from trees grafted on Hamyra rootstock.

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