Sweet cherry resistance to spring frost damage at bloom stage

R. Vávra[1], P. Suran[1], V. Nekvindová[1], I. Žďárská[1], A. Skřivanová[1], J. Blažková[1] and T. Litschmann[2]

Abstract

Spring freezes can cause severe economic loss in cherry orchards due to bud, flower or fruitlet damage in many places in Europe. Spring frost resistance at the bloom stage was evaluated on twenty five sweet cherry genotypes during frost event in the spring 2017. Cherry genotypes were evaluated in two orchards at location Holovousy, Czech Republic. Night temperatures dropped to - 3.1 °C in the first orchard respective - 3.3 °C in the second orchard. Frost resistance was evaluated as % damage of flowers (minimum and maximum damage). Differences between cultivars showed different level of resistance to spring frost at the full bloom stage. As the most resistant to frost damage were evaluated cultivars 'Sylvana' (31 % minimum damage), 'Korvik' (32 % minimum damage), 'Early Korvik' (33 % minimum damage) and 'Jacinta' with 36 % minimum damage. The worst damage was observed on cultivars 'Kordia' and 'Sonata' with maximum damage 99 %, followed by cultivar 'Tamara' with 97 % maximum damage. With 96 % maximum damage were evaluated cultivars 'Halka' and 'Vilma'.

Keywords: *Prunus avium* L., sweet cherry genotypes, freeze damage, critical temperatures, frost event

Introduction

Frequency of spring frosts according to available records in the last decade is higher than fifty or more years ago in many European countries. The protection against spring frosts at the time of flowering is therefore very timely and necessary. Breeding of sweet cherry cultivars to late blooming, resistance to frost damage in bloom stage and disease resistance are important focuses of breeding programmes (Nam *et al*., 2017; Stegmeir *at al.*, 2014). Plants of fruit species are most likely to encounter two types of frost: radiation and advection frost. Radiation frosts occur in clear nights without clouds and usually windless nights. In radiation frosts the surface of the soil loses its temperature due to more pronounced radiation heat from the soil in dry nocturnal and clear weather. The rate of heat loss is affected by air humidity. The deeper the air is, the faster the heat losses. The second type is the advection frosts that is associated with a large scale incursion of cold air, the cold Arctic air is fed into a region where the warm air layers lie above the cold layers. In cold weather, therefore, the temperature on the surface of the soil is the lowest, and on the contrary the wind can stir the air and heat it (Pavloušek, 2016). Advection frosts caused by the influx of Arctic air mass usually last for several days. In some cases, it is unclear to indicate that the frost event is the typical radiation or advection type, causes of the frost can be combined.

Material and Methods

Research of frost resistance of 25 sweet cherry genotypes was done at two experimental plantations located at the Research and Breeding Institute of Pomology Holovousy Ltd. on

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[1] Testing resistance of apple cultivars to Marssonina coronaria
H. J. Schaerer, M. Ludwig, T. Oberhaensli and L. Tamm

[2] AMET group, Žižkovská1230, 691 02 Velké Bílovice, Czech Republic

a mild southern slope at the altitude approximately 300 - 315 m above sea level. Trees were planted in the year 2005 with a spacing of 4.2 x 1.5 m in orchard named “U parku” and a 5 x 2 m at the orchard named “Bobule” on rootstocks Gisela 5 and PHL-A. Experimental trees were trained as spindles using strong wooden stakes as supports. Irrigation was applied in both orchards. Clean strips were kept under the trees by contact herbicides or cultivated whereas frequently cut sod was kept in alleys between the tree rows. Fertilizers were applied according to soil analyses. Spraying treatment against pests and diseases was conducted based on recommendations used for commercial orchards. Genotypes ‘Adélka’, ‘Amid’, ‘Aranka’, ‘Early Korvik’, HL15463 (Elza), HL16165 (Felicita), ‘Halka’, ‘Helga’, ‘Horka’, ‘Jacinta’, ‘Justyna’, ‘Kasandra’, ‘Kordia’, ‘Korvik’, ‘Regina’, ‘Sandra’, ‘Sandra rose’, ‘Santina’, ‘Skeena’, ‘Sonata’, ‘Sylvana’, ‘Tamara’, ‘Těchlovan’, ‘Tim’ and ‘Vilma’ were involved in the evaluation of frost resistance. From each cultivar 100 flowers in two repetitions in full bloom stage (BBCH 65) were removed from all parts of the crown after frost event in the night in April 21st to April 22nd 2017 and flowers were visually evaluated. As the undamaged were evaluated flowers with green colour of pistils, as the frost damaged were evaluated flowers with brown to black colour of pistils. The representation of undamaged and damaged flowers is expressed as a percentage. Meteorological conditions (minimum night temperatures) were recorded directly in the orchards by the MeteoUNI weather stations (AMET, Czech Republic) in each plantation. The lowest night temperature in the night from April 20th on April 21st dropped to – 3.3 °C that was recorded in the planting “U parku” and – 3.1 °C in the planting “Bobule” at 6.00 before sunrise.

Results

In the figure 1 are showed results of the frost damage. In the evaluation were recorded frost damage in both plantings. The worst record of the flower damage (maximum damage) and lowest damage record (minimum damage) from both plantings on each genotypes were taken in the final results. As the most resistant to frost damage were evaluated cultivars ‘Sylvana’ (31 % minimum damage), ‘Korvik’ (32 % minimum damage), ‘Early Korvik’ (33 % minimum damage) and ‘Jacinta’ with 36 % minimum damage followed by cultivar ‘Amid’ with 40 % minimum damage. The worst damage was observed on cultivars ‘Kordia’ and ‘Sonata’ with maximum damage 99 %, followed by cultivar ‘Tamara’ with 97 % maximum damage. With 96 % maximum damage were evaluated cultivars ‘Halka’ and ‘Vilma’. Differences between recorded maximum and minimum damage fluctuated from 1 % to 60 % according to genotypes. Very low (up to 3 kg / tree) and low (3.1 – 6 kg / tree) yield was recorded on all evaluated cherry genotypes after frost damage in the year 2017 (table 1).

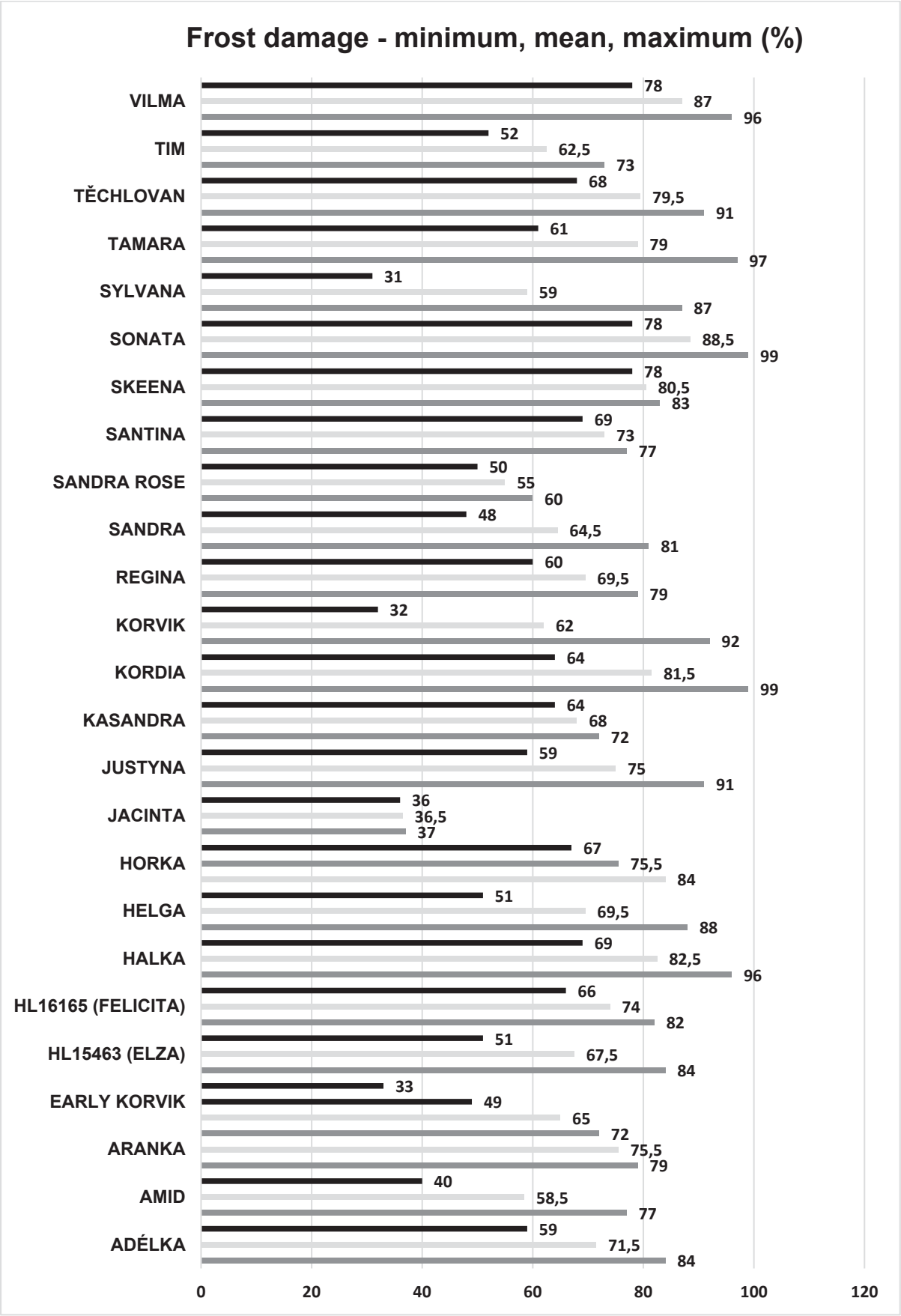


Figure 1: Records of frost damage on flowers at full bloom stage.

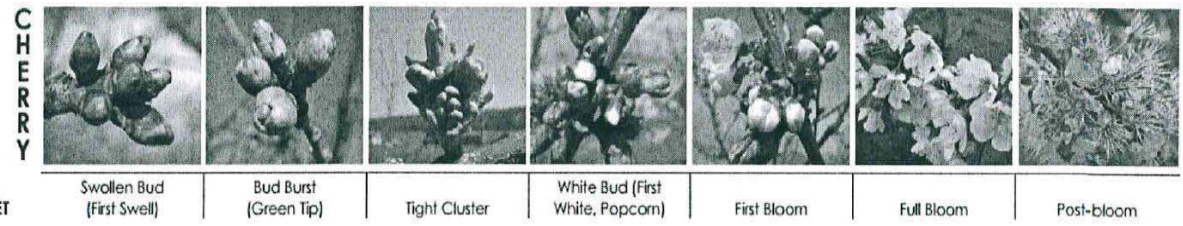
Table 1: Record of yield after frost damage in 2017.

Yield 2017	
Very low (up to 3 kg/tree)	Adélka, Aranka, Early Korvik, Helga, Jacinta, Kasandra, Santina, Sonata,
Low (3.1 - 6 Kg/tree)	Amid, HL15463 (Elza), HL16165 (Felicita), Halka, Horka, Justyna, Kordia, Korvik, Regina, Sandra, Sandra rose, Skeena, Sylvana, Tamara, Těchlovan, Tim, Vilma

Discussion

Spring frost damage of fruit trees at the bloom stage comes more and more frequent in recent years. The occurrence of spring frosts in the third decade in April and the first decade in May are not an extraordinary phenomenon in climatic conditions of the Czech Republic. The intensity of damage on fruit trees is related to the start of growth and flowering time. In the case of the very early vegetation start, spring frosts can reach fruit trees in the full bloom stage and frost damage can be significantly higher. Critical temperatures for the frost damage on sweet cherries differ according the stage of development (Ballard *et al.*, 1973). The evaluation of the frost damage resistance of sweet cherry cultivars was done after the frost event with the lowest night temperatures – 3.1°C respective – 3.3 °C. For the bloom stage of sweet cherries critical temperatures - 2.2°C for 10 % damage and - 3.9°C for 90 % of damage are established and are showed in table 2 (Ballard *et al.*, 1973).

Table 2: Critical temperatures for frost damage on sweet cherries (°C) for 10 % and 90 % damage for different stage of development (according Utah state university)



10 %	- 8.3	- 8.9	- 3.3	- 2.9	- 2.2	- 2.2	- 2.2
90 %	- 15.0	- 10.0	- 8.3	- 4.4	- 3.9	- 3.9	- 3.9

The frost damage can appear even in winter after bud break (stage First swell or Green tip) with severe frost event. This can appear in years with the period of high temperatures in January or February fallowed by the period with temperatures lower than – 10°C. Cherry trees can develop in this case from the dormant stage to the stage First swell in worm period and buds can loss resistance to low temperatures less than –10°C. Trees are not in dormant stage and tissues are sensitive to frost damage. Sensitivity to frost damage is related to defoliation caused by pathogen *Blumeriella jaapii* (Cherry leaf spot). Howell and Stackhouse (1973) described that early loss of leaves reduced hardiness and also reduced bud set the following spring caused by mid-summer defoliation. Cultivars sensitive to cherry leaf spot can lose hardiness due to early defoliation. There is also effect of tree foliage on tree photosynthesis (Gruber at al., 2012) and fruit set establishment in next growing season. Lower yield of cherry cultivars depend on several circumstances in the growing season. This study confirmed difference to frost resistance in sweet cherry cultivars. Evaluation of

resistance of sweet cherry cultivars to frost damage in bloom stage and relations with resistance to cherry leaf spot is important study for organic fruit growing. Relation between frost damage resistance and sensitivity to pathogen *Blumerialla jaapii* was not involved in this study and is challenge for next evaluation.

Acnowledgement

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