UDC: 577.118:634.23
original scientific paper

Acta Agriculturae Serbica, Vol. XIII, 26 (2008) 11-16

Acta Agriculturae Serbica
FACULTY OF AGRONOMY • CACAK •

Micronutrient Status in Sweet Cherry Leaves As Affected by Rootstock and Crown Shape

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Abstract: A sweet cherry trial was conducted at the Horticulture Faculty of MUAF in Lednice to study the behavior of spindle and Spanish bush growing systems in combination with three of the most popular rootstocks, namely, a Czech selection of *P.avium* (P-TU-1), Colt and Gisela 5. The cultivars 'Kordia' and 'Burlat' were chosen, being very common in Czech plantings. Foliar analysis was used for the measurement of levels of five mineral elements: iron, manganese, zinc, copper and boron. Some differences between the rootstocks were observed in the uptake of boron in 'Burlat' and in the uptake of manganese and boron in 'Kordia'. Differences between the spindle and Spanish bush systems were observed in the uptake of manganese in 'Burlat'.

Key words: leaf analysis, *Prunus avium*, Spanish bush, spindle, microelement nutrition.

Introduction

Sweet cherries are traditional and very common fruit species in Central Europe, but their production is currently lower than demand. Therefore, farmers are planting new high-density orchards, using either the traditional rootstocks or promising new semi-dwarfing or dwarfing rootstocks, in combination with a wide range of different cultivars. In traditional Czech orchards, *P. avium* or Colt rootstocks were used in the past. Currently, Gisela 5 is very popular, as in Germany (Franken-Bembenek 2005, Stehr 2005), the USA (Whiting *et al*. 2005) and other countries. It is well known that the rootstock influences the growth, precocity and nutrition of cultivars (Nielsen and Kappel 1996, Jiménez *et al*. 2007). The pruning technique can also influence the mineral nutrition of the plant and fruit, by supporting either growth or flower setting, as in other fruit species.

All micronutrients are involved in many physiological processes in the plant, and they also influence the uptake of macronutrients. For example, it is well known that boron (B) is an essential nutrient required by higher plants. It plays an important role in many physiological processes that affect photosynthetic rate (Brown *et al.* 2002, Marschner 1995), and it also plays a key role in reproductive processes by affecting anther development, pollen germination, and pollen tube growth (Loomis and Durst 1992, Robbertse *et al*. 1990). Where there is a boron deficiency, B-sensitive crops set low amounts of fruits or seeds (Goldbach 1997). Furthermore, symptoms of boron deficiency may be observed on soils with adequate boron levels if its uptake is impeded by over-liming or wet or dry soil conditions (Goldberg 1997, Wojcik 2003b). All of the microelements under observation here are less available in basic soil conditions, and different rootstocks react differently in this situation (Usenik *et al*. 2005).

Materials and Methods

Plant material

Two very common cultivars were used for this trial, ‘Burlat’ and ‘Kordia’, grown on three different rootstocks, P-TU-1 (a selection of *P. avium* L.), Colt (*P. avium* L. x *P. pseudocerasus* Lindl.) and Gisela 5 (*P. cerasus* L. x *P. canescens* Boiss.), using standard 2-year-old planting material.

Field trial

The trial started in the spring of 2005 at the Horticulture Faculty of MUAF in Lednice, Czech Republic. The soil is a calcareous, silty loam, pH 7.5, having low levels of P, adequate K, high Mg and excessive Ca.

Trees were planted at a spacing of 5 x 4 m on P-TU-1 and 5 x 3 m on the other rootstocks. Each combination of cultivar, rootstock and growing system was represented by a block of 4 trees, replicated twice. After planting, the trees were grown in either a spindle or a Spanish bush style of canopy. The spindle trees had the first five buds behind the terminal bud removed, on both the terminal branch and the main branches. The Spanish bush trees were pruned in winter to 3 buds and then summer pruning took place when the shoots were about 40 cm long. Trees were irrigated using a drip-irrigation system as required.

Mineral analysis

Sampling was done at the end of July 2006 and July 2007. Leaf samples (100 g of fresh leaves per block of four trees) were taken from the middle portion of the extension shoots from all parts of the crown, and the dried tissue was mineralized using Kjehldahl method. The total amounts of iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were measured by atomic absorption spectroscopy, while boron (B) levels were measured spectrophotometrically with azomethin H.

Data analysis

The data were evaluated by analysis of variance using Unistat 5.6 (Unistat Ltd., London, UK). When the F test was significant, means were separated by Duncan`s multiple range test ($P \leq 0.05$).

Results and Discussion

The mineral content of Zn, Cu, and Fe varied significantly from one year to the next in both 'Burlat' and in 'Kordia', as Moreno *et al.* (2001) also observed. In the present study, the differences were probably caused by different weather conditions during the growing season.

In the case of 'Burlat', leaf nutrient concentrations of boron were signify-cantly affected by the rootstock (Table 1). Gisela 5 produced lower concentrations of B (60.1750 mg kg^{-1}) than the other rootstocks (70.65 mg kg^{-1} and 70.9125 mg kg^{-1}), although in the two years of observation these levels were still adequate. There were no significant differences between the rootstocks regarding the concentrations of Zn, Mn, Cu and Fe.

Tab. 1. Leaf mineral analysis of sweet cherry cultivar ´Burlat´

	Zn [mg kg^{-1}]	Mn [mg kg^{-1}]	Cu [mg kg^{-1}]	Fe [mg kg^{-1}]	B [mg kg^{-1}]
Year					
2006	19,1100 a	78,6700 a	9,1200 a	130,9000 b	65,6500 a
2007	13,3000 b	72,1000 a	6,9100 b	97,7000 a	67,4800 a
Rootstock					
P-TU-1	17,5750 a	69,0250 a	8,4250 a	123,2500 a	70,6500 b
Colt	17,8125 a	76,0500 a	7,8875 a	112,3750 a	70,9125 b
Gisela 5	13,9125 a	77,9000 a	7,9375 a	111,7500 a	60,1750 a
Crown shape					
Spanish bush	16,5375 a	87,1375 b	7,2375 a	110,0000 a	66,9125 a
spindle	15,9833 a	67,5500 a	8,5333 a	117,1667 a	66,3333 a

In the case of 'Kordia', leaf nutrient concentrations were also affected by the rootstock (Table 2). Mn concentrations were lowest in Colt (62.35 mg kg^{-1}), P-TU-1 was higher (68.95 mg kg^{-1}) and Gisela 5 had the highest concentrations (80.7 mg kg^{-1}). Jiménez (2007) also observed the highest values of Mn in the leaves of sweet cherries grafted on Gisela 5. Low Mn levels in the leaves of the trees grown on Colt compared to other rootstocks were also observed by Moreno *et al.* (2001) but, according to Leece (1975), the Mn values in our case are to be regarded as optimal.

Gisela 5 also produced significantly lower concentrations of B (59.6 mg kg^{-1}) than the other two rootstocks (70.175 mg kg^{-1} and 70.225 mg kg^{-1}), as it did with "Burlat".

Tab. 2. Leaf mineral analysis of sweet cherry cultivar ´Kordia´

	Zn	Mn	Cu	Fe	B
Year	[mg kg^{-1}]	[mg kg^{-1}]	[mg kg^{-1}]	[mg kg^{-1}]	[mg kg^{-1}]
2006	20,7900 a	72,5200 a	10,1800 a	134,3000 b	65,9600 a
2007	12,4200 b	69,5000 a	6,1600 b	97,5000 a	65,9700 a
Rootstock					
P-TU-1	21,1000 a	68,9500 ab	7,8250 a	109,5000 a	70,1750 b
Colt	17,0750 a	62,3500 a	8,2750 a	119,8750 a	70,2250 b
Gisela 5	13,8875 a	80,7000 b	8,2375 a	115,1250 a	59,6000 a
Crown shape					
Spanish bush	19,2750 a	77,8625 a	8,4250 a	122,8750 a	66,7875 a
spindle	14,8250 a	66,4417 a	8,0000 a	111,2500 a	65,4167 a

The concentration of elements was also affected by the crown shape (Table 1). The Spanish bush system had significantly higher concentrations of Mn (87.1375 mg kg^{-1}) than the spindle system (67.55 mg kg^{-1}). The observed differences in the content of Mn and other micronutrients between the spindle and Spanish bush systems were probably caused primarily by the summer pruning in the Spanish bush and, secondarily, by the lower cropping level of the Spanish bush.

Conclusions

In our growing conditions, the microelement concentrations in sweet cherry leaves were significantly affected by the rootstock and crown shape. However, even though these differences were statistically significant, the levels of Mn, Cu and Fe with both pruning systems were still optimal, whereas the levels of Zn were deficient, in all cases, but they did not lead to leaf deficiency symptoms or lower quality of fruit. It is recommended to make the leaf analysis every year to watch the Zn levels in the soils that have excessive levels of Ca. If this deficiency becomes critical, it is advisable to apply the Zn foliar nutrition to neutralize it. On the other hand, the boron levels in our conditions were high, especially on P-TU-1 and Colt, but they also did not cause any problems.

All rootstocks are suitable for this type of growing conditions with the spindle system or Spanish bush in both of the cultivars. The leaf micronutritional status was more affected by the weather conditions during the growing season than by the rootstocks, cultivars or growing systems. The grower should also focus on regulating water and heat conditions of the soil.

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UTICAJ PODLOGE I OBLIKA KRUNE NA SADRŽAJ MIKROELEMENATA U LISTU TREŠNJE

-originalni naučni rad -

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Rezime

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