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Comparative study of effects of a complex fertilizer and a biostimulator on macroelement content of leaf and fruit quality on sweet cherry (*Prunus avium*)

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Summary: In this study, we are partly focusing on consumer acceptance of fruit, like fruit cracking, weight and flavours, and maturation, fruit density and content of nutrients which are undelie consumer acceptance, and important equally to the growers and marketers. the results on the dynamics of N-uptake corresponded ti thephenological phases of cherry and independent on the applied treatments. Younger leaves contain more N than elder due to the effective N uptake of young leaves. Based on the measurements conducted in June, the P content of leaves was in low P supply category at the control and the Benefit treatment, while was in the lower range of optimal category at Damisol treatment. According to our measurements, the K of cherry leaves decreases continuosly until September, expcept the control at which it increased from the end of June to September, the fruit weight was increased significantly by applying Benefit PZ. the best results for fruit cracing observed at Benefit treatment too. The best result for fruit density was observed at Damisol treatment.

Key words: drying **process**, dried fruits, stone fruits, sour cherries, European plums, quality parameters, sensory test.

Introduction

The main aims of modern fruit nutrition are to produce healthy, tasty, coloured and storable fruits in high quantity for the consumers. Improving fruit nutrition is one of the best ways to achieve this intention, because fertilization influences fruit quality in many ways. The most substantial being direct effects of minerals on fruit disorders. Other effects are more subtle and often harder to quantify. Moreover, it is very difficult to define fruit quality. It means different things to different people: for the grower, achieving high yield; for the transporter, long storage potential and continuity of supply; for the consumer, nutritional value and eating quality. In this study we are partly focusing on consumer acceptance of fruit, like fruit cracking, weight and flavours, and maturation, fruit density and content of nutrients which are underlie consumer acceptance, and important equally to the growers and marketers.

Materials and methods

The study was conducted during 2005–2006 in West Hungary on cv. 'Germersdorfi 3' grafted on *Prunus mahaleb* rootstock. Trees were planted in the spring of 1999. Trees spaced 7 x 5 m, and growing in a calcareous chernozem soil at Siófok in West-Hungary. Orchard was not irrigated in 2005 and 2006. For the purpose of the experiment, 20 trees were randomly selected from a population of trees with uniform characteristics. The applied foliar applications are presented in *Table 1*.

Components of applied fertilizers are showed in *Table 2*.

Table 1. Applied foliar fertilization system

Applied fertilizers	Dose (L/ha)	Time of applications	Code of treatment
Control	–	–	C
Benefit PZ as biostimulator	2.5	at fruit set 10 days after fruit set 20 days after fruit set	BPZ
Damisol kondi as complex fertilizer	10	2 weeks after full bloom 5 weeks after full bloom 7 weeks after full bloom	DK

Soil sampling and preparation

Two soil samples were collected from three layers (0–20, 20–40 and 40–60 cm) of each treatment by using manual soil sampling equipment following the Hungarian sampling guidelines (*MSZ-08 0202-77*) and according to *Nagy* et al. (2006). Sampling was performed before treatments, at the beginning of the vegetation period in March 2005. Sample preparation of the soil samples was performed according to Hungarian guideline (*MSZ 20135:1999*). The following

Table 2. Components of applied foliar fertilizers

Benefit PZ		Damisol kondi	
Components	*Dose (%)*	*Components*	*Dose (g/L)*
Organic N	3	Nitrogen	60
Nucleotids	0.2	Phosphorous	40
Proteins of enzyme such as: DNS-, RNS- polymerase, DNS-ligase	16	Potassium	50
Vitamins (PP, B1, B6, B5)		Magnesium	0.5
Glycine		Boron	0.15
Alanine	0.25	Zinc	0.25
Aspartate acid	1.5	Manganese	0.1
Glutamine acid	0.7	Copper	0.15
Organic matter	25	Iron	0.25
		Molybdenum	0.05

parameters were measured: pH, K_A, content of humus, easily soluble N forms, content of $CaCO_3$ and AL soluble P and K according to Hungarian guidelines.

Plant sampling and preparation

Plant (leaf) samples were taken, from May to September (14 May, 30 May, 30 June and 10 September) in 2005 and 2006. Leaves were taken from all trees according to international conception and Hungarian sampling guidelines (*Stiles & Reid,* 1966; *MI-08 0468-81*).

Leaf samples were washed with distilled water to remove dust and possible remains of pesticide, than firstly dried outdoors, in an airy place for a week. After outdoor drying, samples were dried in a well-ventilated drying oven for 6 hrs at 40 °C. After that, the whole sampled material was finely grounded and homogenized. Samples were then stored in paper bags in a dark and dry place until use.

Nitrogen content of leaves was determined using the dry combustion method according to *Nagy* (2000) using an Elementar Vario EL analyser (Elementar Analysensysteme GmbH, Hanau, Germany).

For determining P and K of leaf, 0.5 g dried and homogenized plant sample was used. Samples were digested with cc. 5 ml H_2SO_4 and 5 ml H_2O_2 in a heating block digestor, at approximately 280 C until full destruction. Then phosphorus was quantified by colorimetrically with phospomolybdovanadate method using a spectrophotometer (Metertech VIS SP-850 Plus; Metertech Inc., Taipei, Taiwan). Potassium content was determined by flame atom emission spectrophotometry.

For Ca, Mg and microelement content of leaf, 0.5 g plant sample was dried and homogenized. Samples were digested with cc. HNO_3 and H_2O_2 in a heating block digestor, at 120 °C for 2 h.

Then the amount of these elements in the leaves was quantified by flame atomic absorption spectrophotometry, using a SpectrAA-10 Plus spectrophotometer (Varian Australia Pty Ltd. Mulgrave, Australia).

Examinations of fruit quality

For fruit assessments, 50 fruits were examined.

Fruit cracking (%)

It was calculated as a ratio of the number of cracked fruits and the number of total fruits.

Fruit weight (g)

It was measured with a digital analytical scale with 0.1 g punctuality.

Fruit density (1–9)

This parameter was given a number on a subjective scale from 1 to 9 (determined at 10 trees). Where, 1 means the tree without fruit and 9 means the tree fully covered fruits. It was established two weeks before harvest.

Maturity (1–9)

This parameter was given a number on a subjective scale from 1 to 9 (determined at 10 trees). Where, 1 means the unripe fruit and 9 means the totally ripe fruit. It was established two weeks before harvest.

Soluble solids and sugars

The sugars (fructose and glucose) and soluble solids (Brix) were studied at harvest in the sweet cherries (*Prunus avium* L.) cv. 'Germersdorfi 3' in 2005 and 2006. All fruit samples had been picked at the optimal ripening time. For examination 12 fruits were performed. Fruits were pressed and the obtained juice was filtered through (FILTRAK Qual. grade:132) folded filters. Soluble solids and sugars were determined in the juice by refractometer (ATAGO PAL series) at 20 °C.

Results and Discussion

Soil analysis

The orchard soil type is calcareous chernozem soil. The most important soil parameters are shown in *Table 3*. The upper layer of soil (0–60 cm) contained 1.7% humus. The N supply of soil is low. The easily soluble N forms of soil are low due to the soil type and properties. From easily soluble N nutrients the nitrate is the dominant form as can see in *Table 3*. The content of ammonium-N is very low in the examined soil layer. There is 112 mg/kg and 216 mg/kg

Table 3 Main soil parameters of examined area

	Depth (cm)			
Soil parameter	**0–20**	**20–40**	**40–60**	**0–60**
Plasticity index (K_A)	36	38	42	*39*
pH (H_2O)	7,11	7,54	8,02	*7,56*
Humus (%)	2,09	1,49	1,39	*1,66*
NO_3^--N (mg/kg) (0,01 M $CaCl_2$)	11,45	13,86	10,20	*8,50*
NH_4^+-N (mg/kg) (0,01 M $CaCl_2$)	1,94	1,53	1,06	*1,51*
P_2O_5 (mg/kg) (AL)	139,89	124,08	72,44	112,14
K_2O (mg/kg) (AL)	289,73	189,43	167,69	215,62
$CaCO_3$ (%)	2,5	8,2	22,0	*10,9*

AL-soluble P and K in the upper 60 cm soil layer. The plasticity index according to Arany (K_A) was 39. According to our results the soil is slightly alkaline ($pH_{(H2O)}$=7.65) loamy soil and calcareous in deeper layers.

Leaf analysis

The results on the dynamics of N-uptake (*Table 4*) corresponded to the phenological phases of cherry and independent on the applied treatments. Younger leaves contain more N than elder due to the effective N uptake of young leaves.

The most important data of growing season is the time of ripening. Because, the nutrient supply level of the different nutrients in cherry leaves are based on the data of late June (at gathering) all over the world (*Failla*, 1992).

Although the N supply of soil is low, the N content of leaves is in the range of the optimum category according the data of June (*Mills & Jones*, 1996). There is a significant difference in the N content of leaves between control and foliar treated treatments.

The dynamics of P-uptake corresponded to the phenological phases of cherry (*Table 4*) too. The phosphorus was found to be in higher quantity at the first sampling in all treatments. Later, continuous decrease was observed.

Based on the measurements conducted in June, the P content of leaves was in low P supply category at the control and the Benefit treatment, while was in the lower range of optimal category at Damisol treatment (*Mills & Jones*, 1996). The results of soil analysis corresponded to the data of leaf analysis.

According to our measurements, the K content of cherry leaves decreases continuously until September, except the control at which it increased from the end of June to September.

The content of leaf K is in the low K supply category at the control and the Damisol treatment. Leaf K is in the optimal K supply category at the Benefit treatment (*Table 4*) (*Mills & Jones*, 1996).

Furthermore, there was significant difference in the K content of leaves between the control and the foliar fertilized treatments.

The seasonal pattern of leaf Ca and Mg content corresponded to the reference curves of literature. Based on the data of the end of June the content of leaf Ca and Mg is in the excess supply category in every treatment (*Figure 1*) (*Mills & Jones*, 1996). It can be explained by the high carbonate content of soil (*Table 3*). Moreover, it was found that there was significant difference in leaf Ca and Mg content between the control, the Damisol treatment and the Benefit treatment.

Table 4. Macronutrients contents of cherry leaf during examined period

N	May 14	May 30	June 30	Sept. 10
Control	3.66	2.94	2.31	2.15
BPZ	3.73	3.07	2.68	2.19
DK	3.96	3.08	2.54	1.94
$LSD_{5\%}$	0.17	0.09	0.21	0.16
P				
Control	0.25	0.17	0.14	0.20
BPZ	0.25	0.25	0.15	0.13
DK	0.29	0.20	0.17	0.16
$LSD_{5\%}$	0.03	0.05	0.02	0.04
K				
Control	1.80	1.43	0.68	1.09
BPZ	1.95	1.84	1.50	1.09
DK	2.09	1.71	1.23	0.82
$LSD_{5\%}$	0.16	0.24	0.47	0.18

Results of fruit analysis

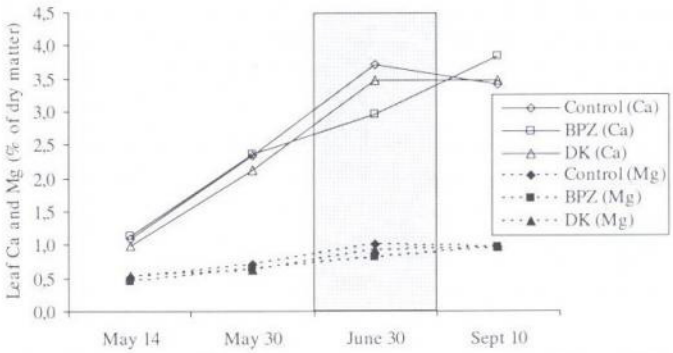

Figure 1 Effect of applied foliar treatments on contents of leaf Ca and Mg

Some measured important fruit parameters for the consumers, for nutritional aspects and eating quality were showed in *Table 5*. As can see from *Table 5*, the fruit weight was increased significantly by applying Benefit PZ. The best results for fruit cracking observed at Benefit treatment too. It can be explained the effect of Benefit on cell-division and extension. Due to biostimulators the turgor status of cell was improved. The better conditions of cells resulted lower difference between osmotic potential of cell and outer surface water of peel.

Table 5 Measured fruit parameters of cherry

Treatments	Fruit weight (g)	Fruit cracking (%)	Fruit density*	Maturity*
Control	8.15	16.87	6.5	6.5
BPZ	8.54	6.49	8.0	7.5
DK	8.01	12.18	8.5	8
$LSD_{5\%}$	**0.31**	**5.88**	**1.18**	**0.86**

* This parameter was given a number on a subjective scale from 1 to 9 as mentioned above.

The best result for fruit density was observed at Damisol treatment. Both applied foliar treatments significantly increased the number of fruits per tree. Same observation was achieved for maturity. Foliar treatments significantly increased the degree of ripening (*Table 5*).

Our results for the soluble solids were varied between 15 and 15.9. Significantly lower value was obtained applying Benefit PZ, while there was not difference between the control and the Damisol treatment. Obtained, lower soluble solids content in Benefit treatment is correlation with the measured higher fruit weight in this treatment.

Significantly lower fructose and glucose content was measured in the Benefit treatment than other treatments also. Our results were varied between 7.6 and 8.0 for fructose and 7.55 and 7.93 for glucose (*Figure 2*).

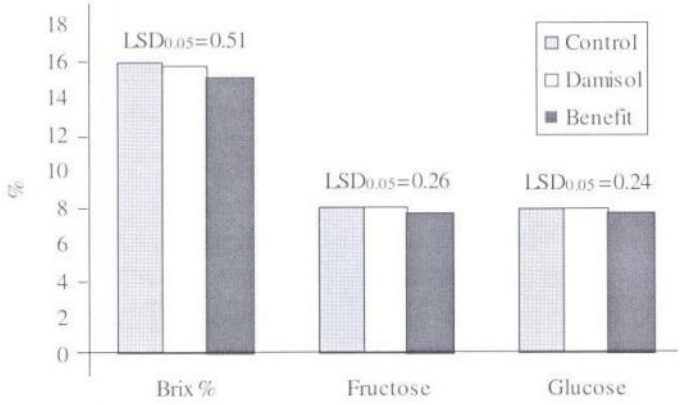

Figure 2 Effect of applied foliar treatments on contents of soluble solids and sugars (g/100g of fresh weight)

Obtained results can be explained by the effect of Benefit. It means that higher fruit weight and size can be reached by applying different biostimulators but it causes more intensive cell-division and reproduction simultaneously which has a dilute effect on the inner parameters.

Our results for the monosaccharides investigated are similar to those reviewed by *Wrolstad & Schallenberger* (1981) who reported mean values for a large variety of cherries as glucose 7.78 g/100 g; fructose 7.09 g/100 g and *Gardiner* et al. (1993) who reported the content of glucose is 7.025 g/100 g and fructose is 6.7 g/100 g approximately. Our values are also comparable to those obtained by *Wills* et al. (1987) for Australian cherries and *Dolenc & Štampar* (1998) in Slovenia. Sucrose was not detected in the unprocessed cherries, which is consistent with the findings of *Wrolstad & Schallenberger* (1981) who reported the absence of sucrose in some cultivars (e.g. cherries) and only low concentrations in others. No attempt was made to inactivate invertase in the unprocessed cherries as it is unlikely that this would be done in a commercial situation.

Furthermore, our results confirmed those earlier results as the content of glucose and fructose is present in approximately equal amounts in most fruit nectar (*Van Handel* et al.,1972).

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