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Effect of different flower thinning techniques on annual fluctuation of macro and micronutrients in sweet cherries (*Prunus avium* l.)

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Summary: The seasonal dynamic of macro- and micronutrients uptake of a sweet cherry cultivar cv. 'Katalin' (*Prunus avium* L.) was studied according to apply different flower thinning techniques. Beside control treatment, three thinning treatments were performed: (1) thinning for 1 flower/inflorescence, (2) thinning for 2 flower/inflorescence, (3) thinning for 3 flower/inflorescence. Soil examination was carried out to establish the growing conditions of orchard site. Moreover, for studying the temporal dynamic of nutrient uptake plant analytical examination was performed four times per year based on leaf collecting according to the phenological phases. It was found that the macro- and micronutrients contents of leaves were showed significant differences between treatments before ripening, at ripening and after ripening stage. It was found that thinning has influence on mineral composition of leaf. Flower removal unbalanced the equilibrium of generative and vegetative processes. The applied manual flower thinning treatment resulted improving vegetative processes like nutrient uptake and storage.

Key words: nutrient uptake, fruit quality, manual thinning

Introduction

Although in the last two decades there has been an increasing attention to environmental friendly and effective growing systems, many publishers pay keen attention to examine the effects of new chemical agents, pesticides, growth regulators and hormones, but the topic of mineral nutrition has become stagnant. The main cause of it that nutrition practise is little seems to change from year to year.

As, the importance of manual thinning is improving in organic orchards nowadays we should focus on the nutritional aspects of manual thinning in this study.

The modern orchard management unimaginable without proper fertilization practices because high yield and fruit quality are so important to the successful marketing of fruits.

Many authors have pointed out that proper thinning technique have significant effect on nutrient uptake and fruit quality as well (*Bünemann* et al., 1980; *Bowling*, 1980).

Although the connection between thinning and nutrient status has well explored there are only a few information about it among Hungarian conditions.

The main goal of this paper is to study different level of manual thinning on the annual fluctuation of macro- and micronutrient uptake of sweet cherry *(Prunus avium L.)*.

Materials and methods

The study was conducted during 2005–2006 in West Hungary on cv. 'Katalin' grafted on *Prunus mahaleb* rootstock. Trees were planted in the spring of 2003. Trees spaced 4 × 1 m, and growing in a slightly acidic brown forest soil at Nagykutas in West-Hungary. Orchard was not irrigated in 2005 and 2006. For the purpose of the experiment, 10 trees were randomly selected from a population of trees with uniform characteristics.

In the orchard, beside control treatment (C), three thinning treatments were performed: (1) thinning for 1 flower/inflorescence, (2) thinning for 2 flowers/ inflorescence, (3) thinning for 3 flowers/inflorescence.

Soil sampling and preparation

Soil samples were collected from three layers (0-20, 20-40 and 40–60 cm) of orchard 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 at the beginning of the vegetation period in March 2005. Sample preparation of the soil samples was performed according to Hungarian guideline (*MSZ-08 0202-77*). The following parameters were measured: pH, K_A, content of humus, KCl soluble nitrate and ammonium, AL soluble P and K and micronutrients according to Hungarian guidelines (*MSZ 20135:1999*).

Plant sampling and preparation

Plant (leaf) samples were taken, from May to September (14 May, 1 June, 2 July and 10 September) in 2005and 2006. Leaves were taken from all trees according to international conception and Hungarian sampling guidelines (*MI-08 0468-81*) and *Stiles & Reid* (1966).

Nitrogen content of leaves was determined from homogenized samples directly using the dry combustion method according to *Nagy* et al. (2006).

For determining phosphorus and potassium contents of leaves, first homogenized leaf samples (0.5 g each sample) were digested with cc. 5 ml H_2SO_4 and 5 ml H_2O_2 in a heating block digestor, at 220 C for 2 hrs. Then phosphorus was quantified by colorimetrically with phosphomolybdovanadate method. Potassium content was determined by flame atom emission spectrophotometry.

For leaf B analysis 1 g plant sample was ashed in a muffle furnace at 450 °C. Ash was dissolved in 5 ml of a 1M HCl at room temperature, mixed, and measured by colorimetrically with Azomethin-H method using a spectrophotometer (Metertech VIS SP-850 Plus; Metertech Inc., Taipei, Taiwan).

For determining manganese, copper and zinc contents of leaves, first homogenized leaf samples (0.5 g each sample) were digested with cc. 5 ml HNO_3 and 5 ml H_2O_2 while the digestation became complete. Then manganese, copper and zinc were determined by flame atom absorption spectrophotometry.

Results

Soil analysis

The orchard soil type is weakly acidic brown forest soil. The soil of orchard site is mainly homogeneous. The upper layer of soil (0–60 cm) is characterized as follows (*Table 1*).

The soil plasticity index according to Arany is 35. From soil analysis it can be established that the humus content of soil is low. The N supply of soil is low. The easily soluble N forms are in mainly nitrate form. Its amount decreases dramatically from the upper layer to deeper layers. The amount of ammonium form is negligible.

Available P and K supply of soil is the following: medium for P and good for K. The contents of micronutrients correspond to the type of soil. The measured values are low. The micronutrients contents increase according to layers.

Plant analysis

Nitrogen concentration was varied between 4.22 and 2.30% of dry matter in leaves, during vegetation period. It

Table 1. The main characteristics of orchard soil (n=7)

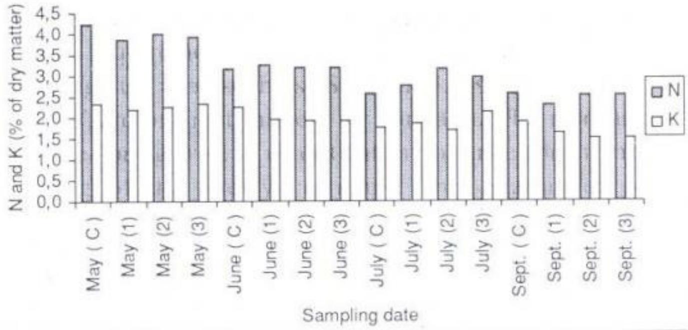
	Depth (cm)			
Soil parameter	**0–20**	**20–40**	**40–60**	***0–60***
pH (KCl)	5.98	5.94	5.93	***5.95***
pH (H_2O)	6.45	6.46	6.45	***6.45***
$CaCO_3$%	<0.1	<0.1	<0.1	***<0.1***
K_A	35	36	34	***35***
H%	1.13	1.11	1.03	***1.09***
NO_3–N (mg/kg)	23.86	12.08	7.20	***14.38***
NH_4^+–N (mg/kg)	1.28	1.46	1.39	***1.38***
P_2O_5 (mg/kg)	136	192	153	***160***
K_2O (mg/kg)	157	274	269	***233***
Mg (mg/kg)	154	170	184	***169***
Mn (mg/kg)	141.3	192.3	190.9	***174.8***
Cu (mg/kg)	2.10	1.80	2.70	***2.20***
Zn (mg/kg)	1.40	1.70	2.40	***1.83***

For determine of P and K so called AL (ammonium-lactate) solution was used, while nitate, Mn, Zn, and Cu content of soil was measured in 1M KCl solution.

continuously decreased during examined period in every treatment. But the degree of decrease was different according to the treatments (*Figure 1*).

In May, the N content of leaf was the highest in the control. Later, higher N contents were measured in the thinning treatments than the control. The most important data of growing season is the time of ripening. Because, the determination of nutrient supply level of the different elements in cherry leaves are based on the data of July (at ripening) all over the world (*Failla*, 1992). Based on the data of ripening, the leaf N contains varied between 2.58 and 3.18% of dry matter. The lowest leaf N was measured in the control.

In all treatments, these values were in the optimal range (*Mills & Jones*, 1996).



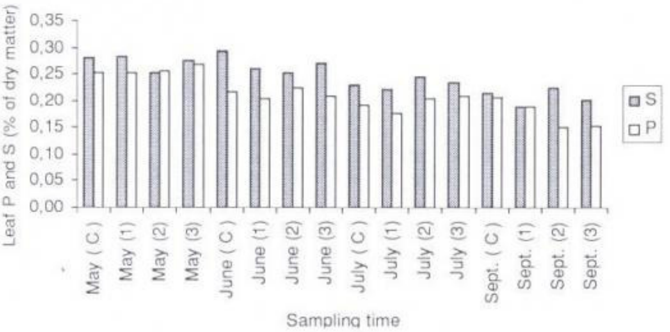
		May	June	July	September
$LSD_{5\%}$	N	0.15	0.04	0.25	0.12
	K	0.07	0.15	0.18	0.19

– the code of treatments in parentheses

Figure 1. Effect of thinning treatments on annual fluctuation of leaf N and K

Similar tendency was observed relate to leaf K. It continuously decreased during examined period in every treatment. But the degree of decrease was different according to the treatments (*Figure 1*)

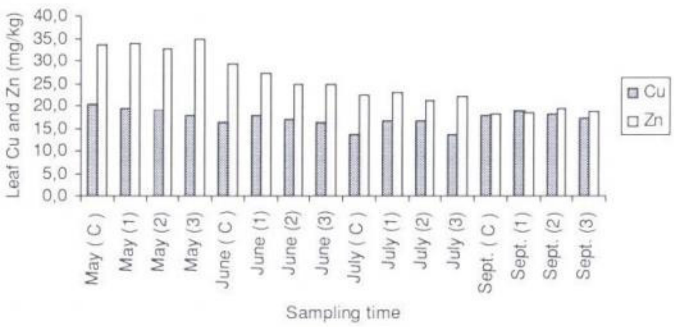
At the beginning of our observation the K content of leaves was higher in the control compared to the thinning treatments.



LSD5%		May	June	July	September
	P	0.01	0.01	0.01	0.03
	S	0.01	0.02	0.01	0.01

– the code of treatments in parentheses

Figure 2. Effect of thinning treatments on annual fluctuation of leaf P and S



LSD5%		May	June	July	September
	Cu	1.06	0.69	1.67	0.66
	Zn	0.85	2.12	0.66	0.57

– the code of treatments in parentheses

Figure 3. Effect of thinning treatments on annual fluctuation of leaf Cu and Zn

The results the content of leaf P and S can be seen in *Figure 2*. Similarly the result of N and K, the P and S content of leaves was the highest in the control till July. After that, in July the leaf P and S were declined in the control. In autumn, the measured nutrients were the highest again in the control compared to the thinned treatments.

Zinc concentration of leaves continuously decreased during examined period while copper contain of leaves decreased till July and then it increased slightly again in every treatment. Obtained seasonal dynamic of Zn and Cu uptake was corresponded in the reference curves of literature (*Figure 3*).

The leaf Zn was mostly higher in the control than in thinned treatments till ripening. After that, its amount not showed significant differences between treatments.

Regarding leaf Cu, it was found that the Cu content of leaves the highest in the control but only in May. Later, its amount was the lowest in the control sample. From June, the highest leaf Cu was measured in the (1) treatment.

Based on the data of ripening, the leaf Zn varied between 21.33 and 22.95 mg/kg and leaf Cu varied between 6.60 and 13.75 mg/kg of dry matter, respectively.

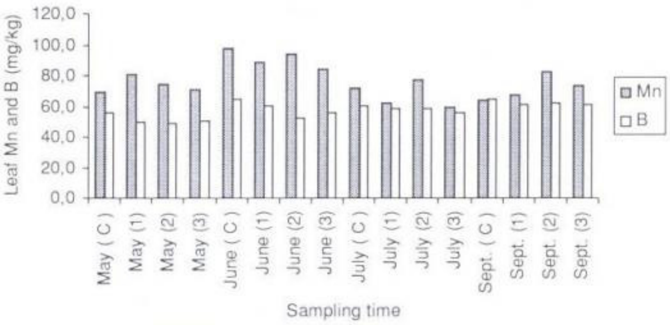
Based on the data of ripening values of leaf Zn and Cu were in the low stage of optimal range in all treatments (*Mills & Jones*, 1996).

Manganese content of leaf was increased till June and then its amount significantly dropped in the ripening stage of July. Later it increased again toward September (*Figure 4*).

From July the highest leaf Mn was measured in the (2) treatment. A continuous increase was observed of leaf boron in the whole examined period independently of the treatments (*Figure 4*). Based on the data of ripening, the leaf Mn contains varied between 59.60 and 77.75 mg/kg and B varied between 56.09 and 60.88 mg/kg of dry matter, respectively.

Regarding leaf B, it was observed that the highest leaf B content was measured in the control samples at every sampling time (*Figure 4*).

There were not significant differences between leaf B content of thinning treatments. Furthermore, significant higher leaf B content was measured in the control samples the whole studied period. It can be explained by the flower removal. Moreover, our observations confirm the conception that B is more mobile than previously thought. Removed flowers caused a remarkable B loss which had an effect on boron movement from leaf to flower.



LSD5%		May	June	July	September
	Mn	5.00	5.69	8.36	8.33
	B	2.99	5.28	1.93	1.62

– the code of treatments in parentheses

Figure 4. Effect of thinning treatments on annual fluctuation of leaf Mn and B

From our results it was evident that thinning has influence on mineral composition of leaf. Flower removal unbalanced the equilibrium of generative and vegetative processes. In the cases of flower removal the vegetative development processes can be dominant, like leaf development. Thus, those nutrients which are important for flower and fruit development (e.g. B, K) are lower content in thinned treatments compare to the control.

The higher degree of thinning resulted improving vegetative processes like nutrient uptake and storage.

As the ripening processes become dominant and the transport of took up nutrients from leaves to fruit can be more and more intensive the contents of nutrients of control treatment are decreased.

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