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Fruit bearing shoot characteristics of apricot and sweet cherry cultivars in Hungary

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Summary: Our study was carried out on 23 apricot and 9 sweet cherry cultivars in February 2005. Fruiting laterals were classified into four groups (0–10 cm, 10–20 cm, 20–40 cm and >40 cm) and then the density and setting of flower buds were evaluated and expressed as bud/cm. The flower bud density of four types of fruit bearing shoots and the changes in the frost resistance were studied. Shoots were collected from a young orchard in Gönc (apricot), Siófok (sweet cherry) and Nagykutas (sweet cherry). There were significant differences among the cultivars in the density of flower buds. The number of flower buds/cm shoot length ranged between 0.91 and 2.20 in the average of the different fruit bearing shoot types on apricot. Based on the results, the bud density of shorter shoots is generally higher on apricot, but this is not valid for all cultivars. For cvs. Magyarkajszi and Ceglédi biborkajszi, the highest flower bud density was detected on shoots of medium length (10–40 cm). There were fivefold and almost twofold (1.85) differences in bud density among cultivars on shoots shorter than 10 cm length and longer than 40 cm length, respectively. The ratio of the bud densities of the different types of shoots also ranged between wide boundaries. For cvs. Bayoto, Toyesi and Toyiba this ratio was 2.5–3.5, while for cv. Magyarkajszi it was 1.3.
In the average of fruit bearing shoots on sweet cherry, cv. Bigarreau Burlat (1.10 bud/cm) and cv. Germersdorfi 45 (0.61 bud/cm) had the largest and the lowest flower bud density, respectively. Among the fruit bearing shoots, the largest flower bud density was in the group of 0–10 cm fruiting laterals. Among cultivars, cv. Bigarreau Burlat had the largest bud density. In the groups of 0–10 cm, 10–20 cm, 20–30 cm and 30–40 cm fruiting laterals, the lowest flower bud density was for cv. Linda, cv. Germersdorfi 45, cv. Ferrovia and cv. Sunburst, respectively. On cvs. Van and Bigarreau Burlat, large numbers of double-set flower buds were observed on the fruit bearing shoots longer than 20 cm. Fruit setting differed on the different types of fruit bearing shoots, with the lowest value measured on above 40 cm shoots. The highest fruit setting was observed on cv. Katalin, while the lowest value was measured on cv. Germersdorfi 3.

Key words: apricot, sweet cherry, bud density, frost injury, fruit set, bearing shoot

Introduction

In fruit growing the apricot is one of the most frost-tender species in Hungary. In the northern border of its cultivation it is growable safely only on territories with less frost-danger (crest, hillside) (*Szabó*, 1997). The most important part of fruit security is to moderate winter- spring frost damage. There are several possibilities to reduce frost-danger besides habitat selection.

Frost-resistance is a dynamically changing characteristic of the plant and is influenced by genetic and environmental effects (*Proebsting*, 1970; *Nyujtó* & *Surányi*, 1981; *Szalay*, 2001). Flower buds are the most endangered parts of apricot trees and at the same time the basics of fruit production. The flower buds have the best frost-resistance in December and in Hungary this feature begins the decrease from January depending on the variety and the year-effect. The flower buds have been classified in three groups according to their frost-tenderness by *Szabó* & *Nyéki* (1998).

During the objective analysis of frost-damage the number of flower buds on the trees must be taken into consideration. Both between the species and between cultivars of one species there are multiple differences in the number of flower buds per shoot length (cm). There are differences in bud density according the length of fruit bearing shoots. Several authors give accounts of the fact that shorter shoots have greater bud density and bud ratio (*Brózik*, 1960; *Mohácsy* et al., 1959). Bud density is a significant characteristic of the cultivar, but the condition of the tree and the year-effect (*Alburquerque* & *Egea*, 2004; *Szabó* et al, 2003; *Werner* et al, 1988) has an influence, too. In habitats threatened by frost it is recommended to choose cultivars with high bud density, while on secure habitats varieties with small-medium bud density are better. According to *Pedryc* (1992) the bloom time of varieties and between the frost tolerance of flower there are not correlate.

The number of flower and leaf buds is different among the sweet cherry cultivars, which has a large influence on fruit setting. In addition to that, differences can be detected in

the fruit quality of fruits from the different types of fruit bearing shoots. The density of flower buds is dependent upon the type of the fruit bearing shoot, the age, the nutrient supply and the general condition of the tree and the cultivar. In intensive cherry production, the most important cultivar-specific characters determining the formation of the required productive surface are vigour of growth, branching potential and quality and quantity of the buds (*Király & Gonda*, 2004; *Gonda & Király*, 2005). Besides the cultivar, the rootstock also plays an important role in the formation of fruit bearing shoots and in determining the number, location and quality of short fruit bearing shoots (*Maguylo* et al., 2001). Most of the flower buds are situated on the short fruit bearing shoots of long life (10–12 years), a smaller number of buds can be found on two-year-old and older shoots and on the basal part of one-year-old shoots (*Hrotkó*, 2003). Based on earlier studies, it has been stated that the formation of flower buds in the different cultivars is determined genetically, and the exterior conditions or the rootstock can have only a minor infuence on it. In similar studies performed in apple, great differences were found among the cultivars in the number of flower buds on one-year-old shoots (*Friedrich*, 2000). In sweet cherry, the largest density of flower buds can be observed on 0.3–25 cm fruit bearing shoots (*Feucht*, 1982).

Materials and methods

The objective of our studies was to compare the frost-resistance ability of varieties and to analyze the effects of influential factors. The researches have been performed during the winter of 2004/2005 on the field of a village in Northeast Hungary's apricot growing territory, Boldogkőváralja. The orchard was irrigable, the trees were in good condition.

The experimental orchard was near 60 hectares, where besides 5 traditional, mainly Hungarian cultivars, 18 new, foreign cultivars and cultivar-candidate can be found. The trees take up 3 X 5 meters, the shape of the trees is a compact vase. The fruit bearing shoots have been gathered after the falling of the leaves, in mid December and in four size categories as follows: <10 cm, 10–20 cm, 20–40 cm and 40 cm< for the experiments. The parameters of 10–10 shoots in each fruit bearing shoot type were registered. First, the length of the shoots was measured than the width at the basal and top parts. After that in each bud the number of flower and sprout buds were determined.

The sweet cherry examinations were performed at two commercial orchards at Siófok (near Lake Balaton, 7 year-old trees) and at Nagykutas (Western-Hungary, 2 year-old trees). One-year-old fruit bearing shoots of different length (0–10 cm, 10–20 cm, 20–40 cm and above 40 cm) were collected for the assessment from dormant trees. Nine cultivars were examined, four Hungarian (Germersdorfi 3 and 45, Katalin, Linda), two Canadian (Sunburst, Van), one Czech (Kordia), one French (Bigarreau Burlat) and one Italian (Ferrovia). The same rootstock (*Prunus mahaleb*) was used in both orchards. The trees were six years old and pruned to a slender spindle shape. Samples were collected from 1.5–2 m height. Fruit bearing shoots of each type were examined for each cultivar. Leaf bud and flower bud densities were determined by calculation. Leaf and flower buds were examined separately. Bud density values were determined as number of buds/cm, The fruit bearing shoots were frozen in a dormant stage in February 2005 on two cultivars (Katalin, Linda). For the assessment of fruit setting, 10-10 fruit bearing shoots of the above sizes were selected on each cultivar and the number of flower buds, flowers and fruits were recorded. Based on these data, it could be determined whether there is a difference in the fruit setting of the different types of fruit bearing shoots or not.

The frost-resistance of the cultivars was examined with artificial freezing during four months (December-March) in SANYO Atmos Chamber MTH-4400 type climate-chamber. The shoots were treated on three temperatures. The samples spent four hours on the given temperatures. During the evaluation from 10–10 fruit bearing shoots two hundred flower buds were cut in half. The bud, which pistil was brown or got brown, was declared damaged.

The frost-resistance differences between fruit bearing types were examined in February. In seven cultivars in four size categories with 10–10 shoots' 200 flower buds natural frost-damage were assessed.

Results and discussion

Apricot

There were significant differences between the varieties' flower bud bedding-in. The data expressed in flower buds (piece) per shoot length (cm) ranged between 0,9 and 2,2 on average. The highest value resulted form Robada, the lowest from Magyarkajszi C235. Parallel to that the number of sprout buds and basal bud was one of the lowest exactly on Robada, especially on the shorter shoots. It is a characteristic of the cultivar that it has four flower bud per basal bud, but higher results can occur frequently.

It is noticeable from the results that the bud density of shorter shoots are higher on average, but this tendency is not valid in certain species. It is typical of the Magyarkajszi and Ceglédi bíborkajszi cultivars that the flower bud density is highest on middle-long (10–40 cm) fruit bearing shoots. The differences between the bud density of varieties in the case of fruit bearing shoots that are shorter than 10 cm were more than fivefold, while in the case of shoots longer than 40 cm nearly twofold (1,85).

The habitat affects the flower bud bedding-in, too. The bud density on the shoots of the typical bifurcate ending of the twigs of Bergeron (20–40 cm fruit bearing shoots) was 1,1 piece/cm in Boldogkőváralja and 0,8 piece/cm in Sóskút.

The fruit security and in relation of yield not only the flower buds per shoot length, but their distribution play an important role. The number of flower buds per one knot and one basal bud plays an important role mainly on long fruit bearing shoots, because during thinning normally one fruit is left. The number of basal buds per one unit of shoot length

was around 0,5-0,8 pieces. This value on the Bergeron which is a cultivar with low bud density was 0,8, while on Robada with high bud density was 0,7.

Within one cultivar the bud density of fruit bearing shoots compared to each other show a diversified picture. In the cultivars of Bayoto, Bergeron, Toyesi, Toyiba the ratio is more than twofold and nearly fourfold (2.5–3.5), while in Magyarkajszi it is 1,3.

Although in every examined cultivar the unaffected frost-damage was little (1–16%), the frost analysis of fruit bearing shoot types shows that the flower buds of 10–20 cm shoots suffer the smallest damage. There was no significant difference according to the statistical analysis on $SD_{5\%}$ level. The further sequence and ratio of damage of fruit bearing shoots were different in each variety.

The change of frost-resistance ability of the varieties was followed with artificial freezing. In December on -19 °C the buds suffered little damage, but on -20 °C more than 80% of the buds of the varieties of Toyiba, Toyuda, while on Magyarkajszi only 2.2% perished. The values in *Table 1* are the results of the treatments on -19 °C. The level of damage grew from month to month in different ratio in most of the varieties.

Sweet cherry

Table 1 Flower bud density of four types fruit bearing shoots of apricot varieties in Gönc region

Varieties	Bud density of different type of bearing shoots (db/cm)			
	<10cm	10–20cm	20–40cm	40cm<
Robada	**3.01**	**2.34**	**1.96**	**1.49**
Toyuda	**2.74**	**1.81**	**1.61**	**1.52**
Toyiba	**2.43**	**1.93**	**1.85**	**1.03**
Zebra	**2.32**	**1.79**	**1.52**	**1.16**
Toyesi	**3.03**	**2.11**	**1.72**	**1.16**
Bayoto	**2.11**	**1.64**	**1.27**	**0.68**
Priboto 10	**1.61**	**1.56**	**1.30**	**0.60**
Pannónia	**1.95**	**1.66**	**0.91**	**0.81**
Magyarkajszi C. 235	**0.81**	**1.05**	**0.98**	**0.80**
Ceglédi bíbor kajszi	**1.13**	**1.26**	**1.22**	**0.67**
Bergeron	**1.92**	**1.53**	**0.82**	**0.56**

The smallest flower bud density on the fruit bearing shoots of 0–10 cm length was detected on cvs. Germersdorfi 45 and Linda, while the largest value was measured on cv. Bigarreau Burlat. In the 10–20 cm category, the highest flower bud density was observed also on Bigarreau Burlat , while the second highest on cv. Kordia. The lowest value was for cv. Germersdorfi 45 also in this category. In the 20–40 cm category, the highest and lowest number of flower buds was observed on cv. Bigarreau Burlat and Ferrovia, respectively. On shoots longer than 40 cm, the number of buds per cm for cv. Bigarreau Burlat was twice as high compared to the other cultivars, the lowest flower bud densities were detected on cvs. Ferrovia, Kordia and Sunburst. When comparing the number of leaf buds, absolutely different results were obtained. Flower bud density of cv. Kordia was only 0.28/cm in the 0-10 cm category, while the highest density was measured in cv. Germersdorfi 45 (0.58/cm). The differences between the cultivars were even more definite in the 10–20 cm category. The highest value was observed on cv. Van with 0.43 buds/cm. In contrast, the density of cv. Katalin was only 0.16 buds/cm. In the 20–40 cm category, cv. Kordia had an outstanding leaf bud density of 0.37 buds/cm, while the number of buds per cm shoot was only half of that on cv. Linda. In the category of shoots longer than 40 cm, the highest number of leaf buds was measured on cvs. Van and Kordia, while the smallest number was detected on Sunburst.

When comparing the different types of fruit bearing shoots, it can be started that the highest relative flower bud density can be observed on shoots of 0–10 cm length. In the average of the cultivars examined it was 2.25 flower buds in one cm. On the shoots of 10–20 cm length, the relative flower bud density was considerably lower. In this category, only 0.55 flower buds can be found in one cm. On the fruit bearing shoots of 20–40 cm length, the number of flower buds was slightly smaller than that with 0.26 buds/cm. The average of 0.11 buds/cm obtained on fruit bearing shoots longer than 40 cm demonstrates that sweet cherry produces fruit mainly on the shorter fruit bearing shoots (*Table 2*).

For two cultivars (Katalin and Linda), the frost resistance of the fruit bearing shoots was studied. The results of freezing in a climate chamber indicated that the shorter fruit bearing shoots were more sensitive to frost in the case of cv. Katalin, at -22°C almost 50% of the flower buds were damaged, while in the case of cv. Linda, only the shoots longer than 40 cm were damaged significantly (39%). For cv. Katalin, there was a definite difference in the frost resistance of shoots longer and shorter than 20 cm. While frost damage was as high as 45% for shorter shoots, the maximum value was only 16,7% for the longer shoots.

Conclusions

In Hungary, the flower buds of apricot varieties often are killed by the low temperature in winter and spring. The number of the buds on the trees, and the bud density are very important flavor of the varieties. We have compared 23 apricot cultivars. There were great differences among the cultivars and different type of bearing shoots in flower bud density. The highest flower bud density showed the cv. Robada, the lowest the cv. Magyarkajszi. We experienced, the shorter bearing shoots have higher bud density, so it is inversely proportional with the length of the shoot. Some varieties behaved different. We examined the frost resistance of these bearing shoots as well. Analyze the rate of natural frost injury we observed, that the shoots of 10–20 cm length were the least damaged. During the winter we resumed artificial freezing treatments. The varieties, that had higher bud density often sustained higher frost injury too.

By the sweet cherry cultivars there were great differences among the cultivars in flower bud density. The difference was higher than 50% between some cultivars. The highest flower bud density was measured on cv. Bigarreau Burlat. There

Table 2 The average relative bud, flower and fruit densities of the studied cultivars

Cultivar	Size category	buds/cm	flower buds/cm	Leaf buds/cm
Bigarreau Burlat	0–10 cm	3.38	3.06	0.32
	10–20 cm	1.00	0.76	0.24
	20–40 cm	0.63	0.35	0.27
	over 40 cm	0.49	0.21	0.28
Ferrovia	0–10 cm	3.27	2.79	0.48
	10–20 cm	0.79	0.46	0.32
	20–40 cm	0.44	0.16	0.28
	over 40 cm	0.30	0.09	0.21
Katalin	0–10 cm	3.94	2.38	0.50
	10–20 cm	0.70	0.54	0.16
	20–40 cm	0.54	0.26	0.27
	over 40 cm	0.36	0.11	0.25
Kordia	0–10 cm	2.22	1.94	0.28
	10–20 cm	1.03	0.72	0.30
	20–40 cm	0.67	0.30	0.37
	over 40 cm	0.37	0.08	0.29
Linda	0–10 cm	2.05	1.74	0.31
	10–20 cm	0.69	0.49	0.19
	20–40 cm	0.42	0.23	0.19
	over 40 cm	0.35	0.13	0.22
Germersdorfi 3	0–10 cm	2.52	2.02	0.51
	10–20 cm	0.84	0.45	0.39
	20–40 cm	0.54	0.25	0.29
	over 40 cm	0.36	0.10	0.26
Germersdorfi 45	0–10 cm	2.34	1.76	0.58
	10–20 cm	0.58	0.31	0.28
	20–40 cm	0.50	0.24	0.26
	over 40 cm	0.40	0.13	0.28
Sunburst	0–10 cm	2.25	1.82	0.43
	10–20 cm	0.97	0.67	0.30
	20–40 cm	0.56	0.26	0.33
	over 40 cm	0.29	0.08	0.20
Van	0–10 cm	3.24	2.74	0.50
	10–20 cm	1.02	0.59	0.43
	20–40 cm	0.62	0.28	0.34
	over 40 cm	0.39	0.10	0.29
LSD 5%		0.16	0.17	0.15

were also considerabble differences among the different types of fruit bearing shoots. It can be concluded that the shorter the fruit bearing shoot is, the higher the relative number of flower buds is, that is the number of flower buds per cm is inversely proportional with the length of the shoot. Since the formation of the fruit bearing shoots of different length can be regulated well by pruning, the grower should aim to help the formation of shoots of 10–20 cm length, since on these shoots a large number of flower buds can be found besides a satisfactory number of leaf buds. Consequently, fruit setting is the most favourable on these shoots for quality production. There has been limited research on this topic, therefore, we aimed to provide researchers and practical experts with new information in this field.

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