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Growing characteristics of apple cultivars in environmentally friendly growing systems

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Summary: Nowadays the condition of the good saleability of the fruit is the application of controlled environmentally friendly technologies. Success of the growing is basically influenced by the production value of the cultivars, and their flexibility to the different technologies. In our examinations the effect of the integrated and organic farming system has been evaluated on the growing characteristics of the apple cultivars. According to our results the trunk thickness of the trees both in the initial and both in the later bearing period is higher in the integrated production compared to the organic farming system. This differences most likely caused by the variance of the crop load.

Keywords: *integrated farming system, organic farming system, apple cultivars, growing characteristics*

Inroduction

The fundamentals of environmentally friendly production technology have been widely spread in the integrated production. This resulted in great interest on quality product (optimal size, colouring, shape, flavour etc.) with lower chemical use or almost completely chemical free production technology. Other form of the environmentally friendly technology is the organic farming system which ensures higher priority to the ecological aspects, however the profitability of producing is much lower (Holb, 2009; Dremák, 2015).

One of the key elements of the environmentally friendly technologies is the applied cultivar. In the integrated and organic farming systems it is worthwhile to plant resistant, tolerant or less sensitive cultivars or to use non-chemical control methods in order to achieve better protection against the pathogens (Holb et al., 2006; Holb, 2000, 2009). Namely the utilization of these cultivars or control methods allows the reduction of the used pesticides, which means lower production costs and lower pollution (Janick et al., 1996; Earles et al., 1999; Fischer & Fischer, 1996, 2004; Holb, 2008, 2009).

Production value of the cultivars is determined by the growing and the fruit bearing characteristics and the fruit quality in a complex way. The data related to yields and fruit quality are well presented in the studies of the cultivar descriptions or of the technological experiments but the growing characteristics of cultivars are given only superficially. The growing habits of the trees or the specialties of the canopy training are not detailed, although these factors can determine the success of the production too. However, thanks to the intensification of fruit trees by using more simple canopy structures, there are more possibilities to compare the vegetative parameters of the trees in various crown forms which can ensure useful information for growers during tree training and maintaining (Csihon, 2015; Csihon et al. 2015).

A shape of the canopies is determined by the production site, the rootstock, the cultivar and the production technology. The conical shape is an essential criterion of the optimal crown form, that is the thickness and the length of the branches decreases from the bottom to the up. This state can ensure the best illumination of the trees under the domestic circumstances (Gonda 1995, 2005). This kind of crown form can be compared mostly to the mezotonic trees, in contrast with the basitonic and acrotonic canopies (Lespinasse, 1977; 1980).

The aim of our researches was to evaluate the effect of two production systems (integrated and organic) on the growing characteristics of worldwide known-, resistant- and historical Hungarian apple cultivars.

Materials and methods

The experiments were carried out at the University of Debrecen, Pallag Experimental Station of Horticulture. The apple cultivar collections was planted in spring of 1997 on rootstock M26 with 4.0 × 1.5 m spacing distances. The canopy of the trees is free spindle.

The cultivar collection consisted of 39 apple cultivars and was grouped to three classes as worldwide known-, resistant- and historical Hungarian apple cultivars *(Table 1)*.

Table 1. Classification of the apple cultivars (Debrecen – Pallag, 2010)

Worldwide known cultivars	Resistant cultivars	Historical Hungarian cultivars
Gala Must	Pilot	Batul
Golden Reinders	Reka	Mosolygós batul
Csányi Jonathan	Relinda	Nyári fontos
Ozark Gold	Renora	Téli aranyparmen
Elstar	Reglindis	Téli banán
Mutsu	Releika	Téli piros pogácsa
Jonagold	Rewena	Darusóvári
Golden Orange	Retina	Fertődi téli
Ruby Gala	Remo	Francia renet
Idared	Liberty	London pepin
Granny Smith	Reanda	Gravensteini
Pinova	Resi	Téli fehér kálvil
Topaz	Faw 7262	Húsvéti rozmaring

The growing parameters have been compared to each other by the thickness of the trunk and central axis (cm^2). Thickness of trunk has been considered as a basic parameter, which has been measured on a certain point between ground level and on the lower first branch. The same approach has been used for the axis thickness at 1.0 and 1.5 meter high. 5-5 trees have been examined per each cultivar.

Results and discussion

The complex index of the vegetative accomplishment, the trunk cross sectional area of the 14-years-old apple trees is shown in *Figure 1-2*. It can be seen that there are remarkable differences among the cultivars. In the integrated orchard the difference between the minimum and maximum values is almost eightfold. The cvs. 'Elstar', 'Reglindis' and 'Gravensteini' outstand with their high trunk thickness.

Trunk cross section area was larger in organic production for all cultivars compared to the integrated production exception for the cv 'Gravensteini'. In the organic orchard the highest values were measured in cvs. 'Gravensteini', 'Reglindis' and 'Elstar', while the lowest were observed in cvs. 'Idared' and 'Fertődi téli'. The largest different between the two technologies was occurred in cvs. 'Húsvéti rozmaring' (23%) and 'Francia renet' (16%) in favor of the organic farming system. The smallest differences were measured in cvs. 'Resi', 'Elstar' and 'Téli banán' (4%). Averaging the all cultivars this parameter is about 7,5%. Taking into the consideration the general conditions of the orchards this phenomenon can be considered unusual.

Trunk and the central axis thickness of the younger (four-year-old) replanted trees are presented in *Figure 3*. Trunk cross section area of the examined apple cultivars is also higher in the organic system compared to the integrated system. That result confirms the previously mentioned unusual tendency of the older trees. Regarding the thickness of the central axis the highest values were also measured in the organic farming system. The explanation of this phenomenon can be that in the organic system in spite of the lower initial plant condition the younger trees can reach relative stronger growth and higher trunk thickness because of the lower crop load.

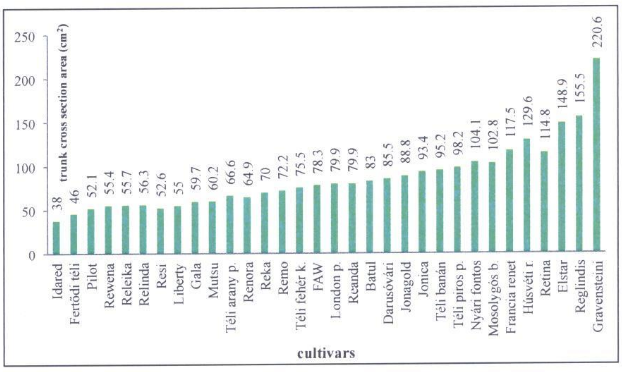

Figure 2. Trunk cross section area of 14-year-old apple trees in organic orchard (Debrecen–Pallag, 2010)

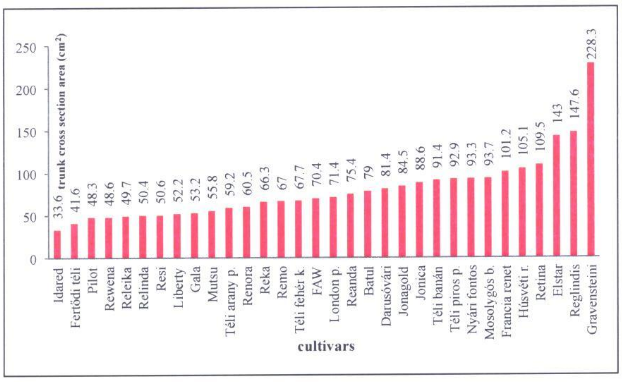

Figure 1. Trunk cross section area of 14-year-old apple trees in integrated orchard (Debrecen–Pallag, 2010)

Concerning the thickening tendency of the axis, it can be seen that the decreasing is stronger in the organic orchard. An exception is the tolerant cv 'Pinova', as the thickness values are higher in the integrated orchards. This cultivar showed more balanced growth which means better plant condition. At a young age the trunk and the axis thickened more in the integrated system compared to the organic system.

The axis thickness measured at 1.0 meter high is a characteristic parameter of the trees. The values of the trees of the integrated orchard are presented in *Figure 4.* The cultivars showed also significant differences similarly to the trunk thickness. The difference between the extremes is more than tenfold. The cvs. 'Gravensteini' (169.2 cm^2) and 'Reglindis' (110.8 cm^2) has the largest axis thickness at 1.0 meter high, as the cvs. 'Idared' (15.0 cm^2) and the 'Fertődi téli' (18.7 cm^2) presented the lowest values.

Axis thickness parameters of the trees in the organic farming system shows similar tendency compared to the integrated system *(Figure 5).* Among the ranking of the cultivars practically there are no differences. Regarding the values of the cultivars the extremes are smaller, but even can reach more than eightfold difference. The cv. 'Gravensteini' displays outstanding thickness.

Regarding the two technologies the next can be concluded: the trees of the cvs. 'Pilot', 'Téli banán' and 'Idared' can be described with higher trunk and axis thickness in the organic farming system compared to the integrated production. However in the case of the most cultivar the axis thickness at 1.0 meter high is unambiguously lower in the organic orchard than in the integrated one. This difference is about 11-20% in cvs. 'Gravensteini', 'Reglindis', 'Nyári fontos' and 'Húsvéti rozmaring', while in the case of the other cultivar it is less than 10%.

Concerning the axis thickness above 1.5 meter the cv. 'Gravensteini' and 'Reglindis' also outstands *(Figure 6-7).* In the integrated orchard the cv. 'Idared' with the thinner axis reached more than twenty times smaller values compared to the largest one. 11 cultivars displayed lower than 20 cm^2 thickness, other 11 cultivars presented between 20 and 40 cm^2, while 10 cultivars showed more than 40 cm^2.

The ranking between the cultivars does not change in the organic farming system. Accordingly the cvs. 'Gravensteini' (170.8 cm^2) and 'Reglindis' (77.6 cm^2) has the strongest growth similarly to the integrated production. It is worthwhile to mention that the difference between these two cultivars is more than twofold. The weakest growth is presented by cv. 'Idared' (7.5 cm^2), 'Fertődi téli' (8.9 cm^2) and 'Pilot' (10.9 cm^2).

Comparing the two technologies cv 'Gravensteini' displayed similar values in the integrated and organic farming system.

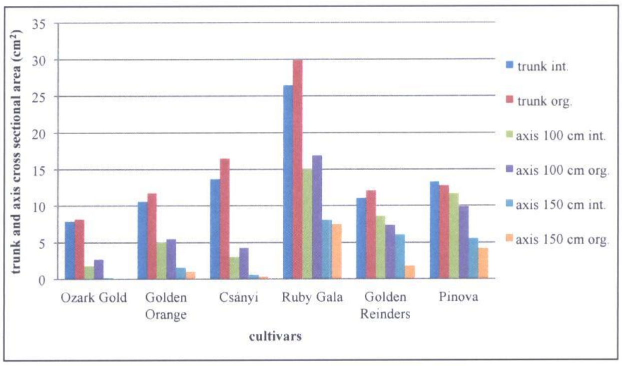

Figure 3. Trunk and axis thickness of 4-year-old apple trees (Debrecen–Pallag, 2010)

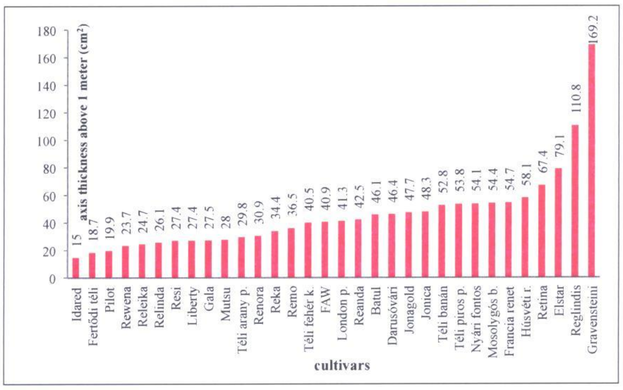

Figure 4. Axis thickness above 1 meter of 14-year-old apple trees in integrated orchard (Debrecen–Pallag, 2010)

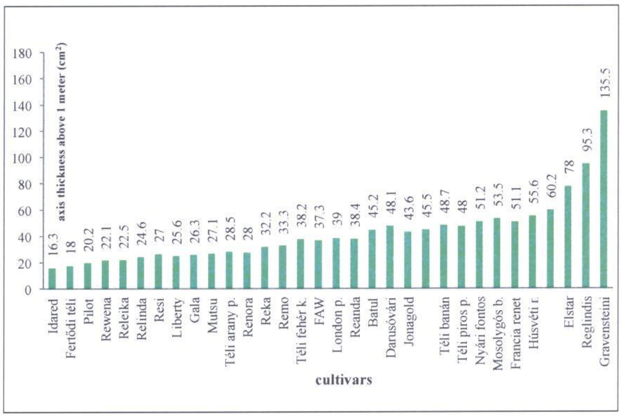

Figure 5. Axis thickness above 1 meter of 14-year-old apple trees in organic orchard (Debrecen–Pallag, 2010)

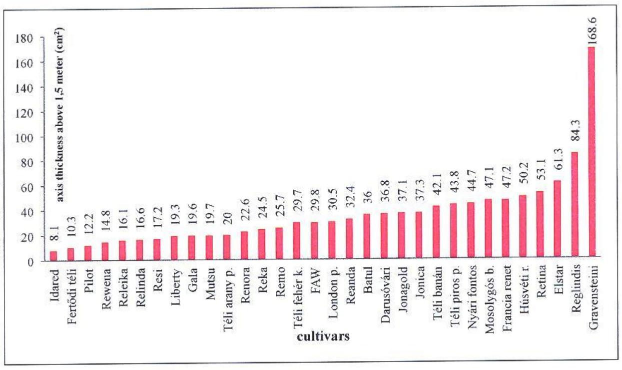

Figure 6. Axis thickness above 1.5 meter of 14-year-old apple trees in integrated orchard (Debrecen–Pallag, 2010)

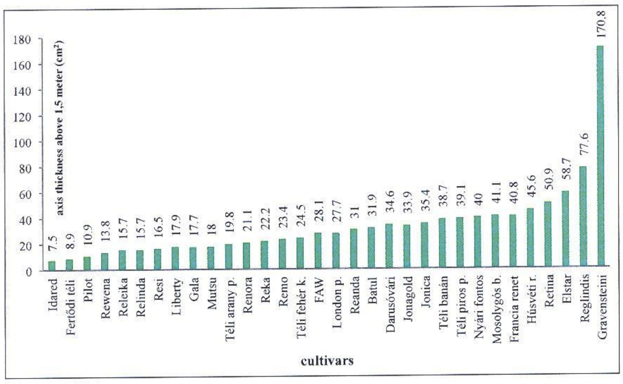

Figure 7. Axis thickness above 1.5 meter of 14-year-old apple trees in organic orchard (Debrecen–Pallag, 2010)

In the case of the other cultivar the difference is larger. Specially cvs. 'Francia renet' and 'Mosolygós batul' showed larger differences between the farming systems, as their axis thickness at 1.5 m height is much more smaller in the organic orchard.

Conclusions and recommendations

Based on the data of the trunk and central axis thickness the next conclusions can be stated:

- Initial trunk thickening is clearly stronger in the organic farming system compared to the integrated system. The explanation for this may be that fewer fruit is left on the smaller (younger) trees in the initial bearing period. In addition thanks to the difficulties of the plant protection partial or total yield loss can be occurred in more years. Accordingly the lack of the optimal crop load has significant effect (in a diverse way) on the initial growing characteristics in both farming system.
- Later in the bearing period the thickening of the trunk and the central axis are equalized or are turn round. In several cases this can be experienced for axis thickness above 1 meter in integrated production. The tendency is more conspicuous in axis measured above 150 cm as trees were thicker in all cases in integrated production while thickness was more moderate in organic production.

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