Thesis of Doctoral (PhD) dissertation

EVALUATION OF GROWING AND FRUIT BEARING CHARACTERISTICS AND FRUIT QUALITY OF NEW APPLE CULTIVARS

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1. INTRODUCTION

Apple is the most important fruit of the temperate zone, as the most cultivated fruit in Hungary. Overall apple production of the world is growing permanently (it reached the 80 million tons in 2013) while the domestic production can be described with the decrease of the cultivated area and the stagnancy of the yield.

Due to the globalization of the fruit trade and to the continually rising concurrency nowadays only those farms can be competitive which can ensure both high quality and quantity required by the market. One of the key factors of the permanently obtained high yields (50-60 tons/hectare) is the question of the applied cultivars. Namely high yields and the adequate quality can be achieved only with cultivars with good productivity and favorable producing characteristics.

Breeding programmes are carried out in many countries of the world in order to find new cultivars which have superior production value compared to the previously used cultivars. The new cultivars/mutants can be described with larger fruit size, higher fruit surface color, better taste, higher genetic stability or resistant ability. Thanks to this they often appear in the cultivar assortment of other countries with huge expectations. However it shouldn't be ignored that cultivars can behave differently under diverse type of ecological conditions compared to their origin place. Their productivity, fruit quality can decrease significantly. Accordingly, it is essential to carry out adaptability studies before the widespread planting of new cultivars originated from abroad.

The data related to yields and fruit quality are well presented in the international studies of the cultivar descriptions but the growing and the producing characteristics of cultivars are given only superficially. The growing habits of the trees, the specialities of the canopy training or the necessity of the specific pruning interventions 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 (tapering dynamics of the central axis, number of the branches, thickness of the branches, etc.), which can ensure useful information for growers during tree training and maintaining.

The aim of this research was to evaluate the vegetative and generative features of new apple cultivars originated from Western-Europe and the USA, which are already judged positively and planted widely in their home country. Regarding the fact that the experimental orchard is located in the Nyírség region representing adequately the ecological conditions of the surrounding areas, our results can be adapted easily also in the largest apple production site of the country, in the Northern Great Plain.

2. OBJECTIVES

Our objectives were to evaluate the vegetative parameters, the bearing characteristics and the fruit quality of new cultivars in a young apple orchard. Based on this it is possible to determine the groups of the cultivars which are suggested definitely, conditionally or not suggested for the Hungarian apple growing, and additionally the group of cultivars which require more examinations.

During this work our specific aims were:

- to describe the growing characteristics in details of the selected apple cultivars and canopies (growth vigour, thickness of the central axis, the number and the thickness of the main branches of the central leader, ramification ability, shoot growing dynamics, cropping parts formation peculiarities),
- to conceive cultivar specific canopy training and maintaining principles based on the vegetative characteristics,
- to determine the available yields of the cultivars,
- to examine the parameters related with fruit quality, fruit appearance, specially focused on the fruit coloration,
- to examine the organoleptic and nutritional values of the fruits and based on this to present the consumers judgments on the cultivars,
- to create a complex cultivar description.

According to the observed growing parameters cultivars were classified, which can make easier the training and maintaining interventions of the canopies. In addition based on the quantity and quality data of the yield advises were given which cultivars can be suitable for Hungarian apple growing.

3. MATERIALS AND METHODS

Experimental site

The experimental orchard is located in Nyírbátor (F.N. Fruit Ltd.), 55 km far from Debrecen in north-east direction. The type of the soil of the plantation is sandy, the Arany-number of heaviness is 25. The pH is 5.3-5.4, so the soil is acid, practically lime free.

Materials

The examined apple cultivars and mutants can be classified into three groups based on their origin sport and resistant ability, while the other cultivars which do not belong to the previous three groups are sorted into the fourth group **(Table 1)**.

Gala sport	Red Delicious sport	Resistant cultivars	Other cultivars
‘Gala Decarli-Fendeca’	'Early Red One'	'Crimson Crisp' (Co-op 39)	'Red Idared'
‘Gala Venus Fengal’	'Jeromine'	'Red Topaz'	‘Fuji September Wonder’
'Galaval'	‘Red Cap Valtod (S)’		‘Wilton’s Red Jonaprince’
'Jugala'			‘Evelina’ (RoHo 3615)
‘Gala Schnitzer (S) Schniga’			

Table 1. Classification of the examined apple cultivars.

The apple cultivars were planted in autumn of 2010 and in spring of 2011, so all the cultivars developed four vegetation period until the end of the examinations. The rootstock of the scions is M.9 ensuring the dwarfing vigour.

The distance between the rows is 3.85 meter. Regarding the plant-to-plant distance in the case of the slender spindle canopies 1 meter was formed, and in the case of the super spindle 0.5 was created. The detailed planting system of the experimental orchard is shown in **Table 2**.

	Year of planting	Planting material	Origin of scion	Root-stock	Planting design	Canopy
'Gala Venus Fengal'	2011 spring	Knipp-tree	Italy	M.9	3.85 m x 1 m	slender spindle
'Gala Decarli-Fendeca'	2011 spring	Knipp-tree	Italy	M.9	3.85 m x 1 m	slender spindle
'Galaval'	2011 spring	Knipp-tree	France	M.9	3.85 m x 1 m	slender spindle
'Jugala'	2011 spring	Knipp-tree	France	M.9	3.85 m x 1 m	slender spindle
'Gala Schnitzer (S) Schniga'	2010 autumn	tree with branches	Hungary	M.9	3.85 m x 1 m	slender spindle
'Red Cap Valtod (S)'	2011 spring	Knipp-tree	Italy	M.9	3.85 m x 0.5 m	super spindle
'Early Red One'	2011 spring	Knipp-tree	Italy	M.9	3.85 m x 0.5 m	super spindle
'Jeromine'	2010 autumn	Knipp-tree	Italy	M.9	3.85 m x 1 m	slender spindle
'Crimson Crisp' (Co-op 39)	2011 spring	Knipp-tree	France	M.9	3.85 m x 1 m	slender spindle
'Red Topaz'	2011 spring	Knipp-tree	Italy	M.9	3.85 m x 0.5 m	super spindle
'Wilton's Red Jonaprince'	2011 spring	tree with branches	Netherland	M.9	3.85 m x 0.5 m	super spindle
'Red Idared'	2010 autumn	tree with branches	Hungary	M.9	3.85 m x 1 m	slender spindle
'Fuji September Wonder'	2011 spring	Knipp-tree	France	M.9	3.85 m x 1 m	slender spindle
'Evelina' (RoHo 3615)	2010 autumn	tree with branches	Hungary	M.9	3.85 m x 1 m	slender spindle

Table 2. Planting system of the experimental orchard.

Methods of the examinations

In the beginning of the experiments 7 trees were signed per each cultivar for the research purposes. Concerning the tree labeling the similar general condition of the trees was an important aspect.

Measurement methods of the vegetative parameters of the trees

The thickness of the trunk, as the complex index of the vegetative accomplishment and the thickness of central leader is expressed in cm^2 values. The Zahn-indexes (the ratio of the trunk thickness and the basic branches) was used to study the growing balance of the trees. The number and the thickness of the main branches of the central axis were used to describe the ramification ability of the cultivars. The height of the trees is related with the size of the cropping surface. The number of the different type of cropping parts compared to the branch thickness shows the flower bud formation characteristics of the cultivars.

Measurement methods of the generative parameters of the trees

At harvest time the fruit number (number/tree) and the fruit amount (kg/tree) were measured, which data were used to calculate the yield/ha. For the better comparability of the yields

of the trees the fruit numbers and the fruit amount were compared also to the trunk thickness (number/cm^2; kg/cm^2).

Measurement methods of the fruit quality

The diameter and the height of the fruits were measured. The shape index was calculated from the ratio of these two parameters. The fruit surface color was determined with visual estimation in percentage form. The intensity (darkness) of the fruit surface color was evaluated with similar method on a scale ranging from 1-5. The fruit appearance was judged with a scale ranging from 1-10.

4. RESULTS AND DISCUSSION

Figure 1 shows the complex index of the vegetative accomplishment, the trunk cross sectional area.

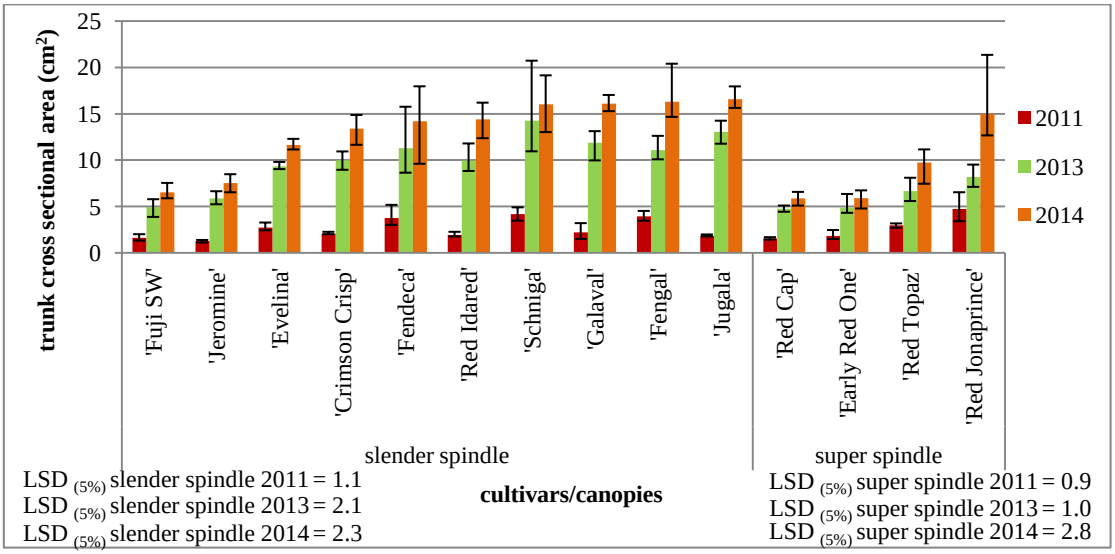

Figure 1. Trunk cross sectional area of the apple cultivars (cm^2) (Nyírbátor, 2011-2014).

The data showed that the cultivars of the cv 'Gala' sport (cvs 'Jugala', 'Fengal', 'Galaval', 'Schniga' and 'Fendeca') trained to slender spindle reached the highest trunk thickness until the end of 2014. The other cultivars with the same canopy showed 6.5-14 cm^2. The cv 'Red Jonaprince' trained to super spindle displayed similar thick trunk then the cv 'Gala' sport, despite the smaller planting distance. Accordingly a more vigorous apple cultivar planted with smaller planting distance can reach higher trunk thickness despite the higher root competition, than a less vigorous cultivar trained with larger planting distance.

Figure 2 presents the trunk and central leader cross sectional area in different height zones of the canopy.

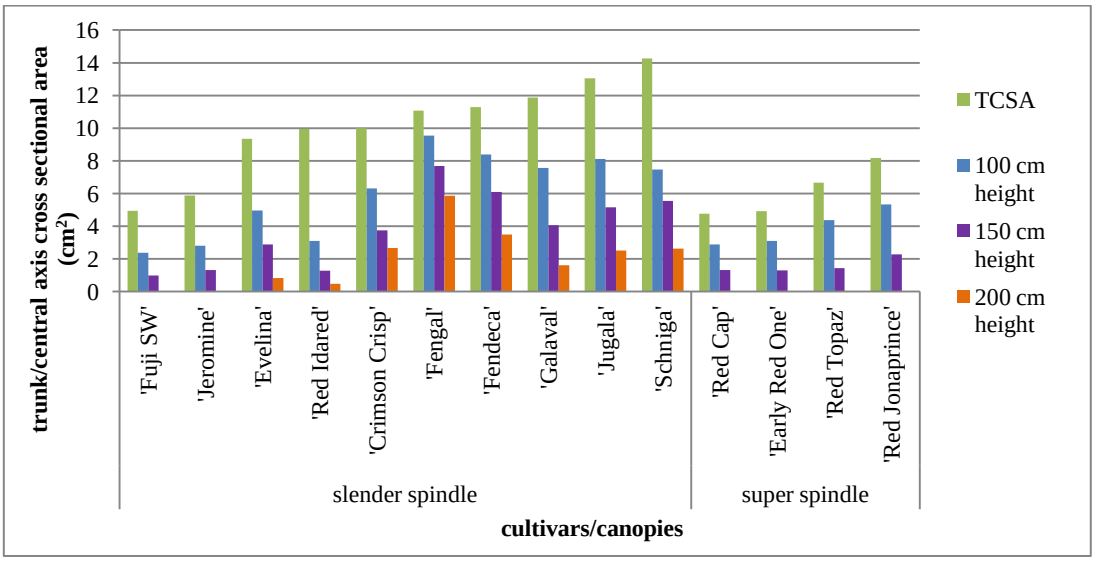

Figure 2. Trunk and central leader cross sectional area in different height zones of the canopy (Nyírbátor, 2013).

The tapering dynamics of the central leader is a critical parameter regarding the maintainability of the canopy. The vigorous cv 'Gala' mutants can be described with high central leader dominance, as above the thick trunk the leader starts to taper slightly. The cv 'Red Idared' displays the opposite phenomenon, namely above the thick trunk the leader starts to taper rapidly.

The height of the trees can be seen in **Figure 3.**

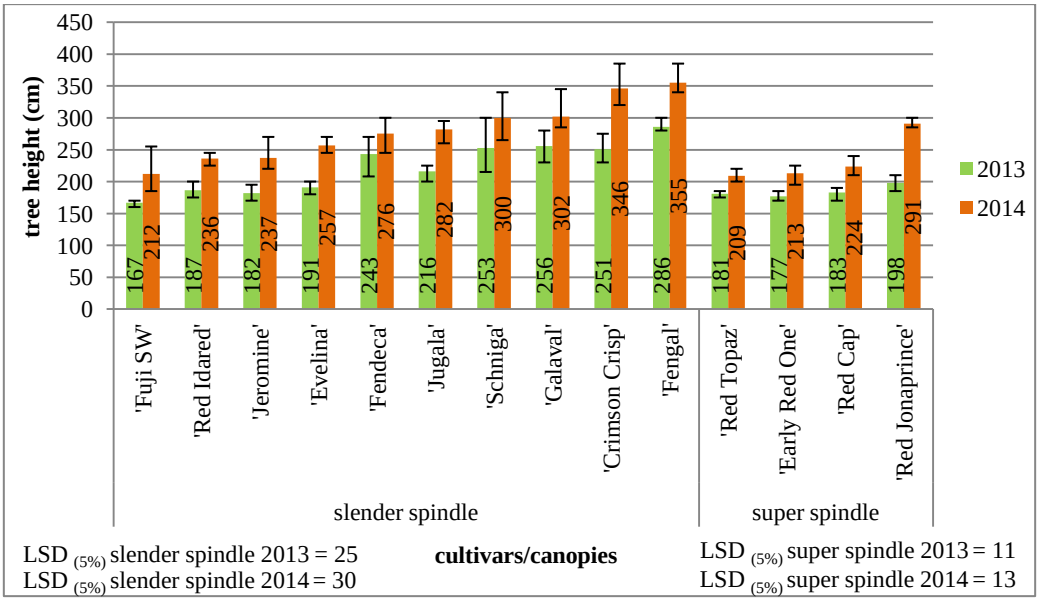

Figure 3. Height of the trees (Nyírbátor, 2013-2014).

The data of the tree height are related with the trunk thickness parameters, as the cv 'Gala' mutants showed the highest values. The four years old cv 'Red Jonaprince' trees with super spindle canopy reached also almost the 3 meter height. Lots of cultivar has not yet achieved the final height of the trees, which determines the available yields in lower level.

Figure 4 shows the Zahn-indexes of the trees (the ratio of the trunk thickness and the basic branches).

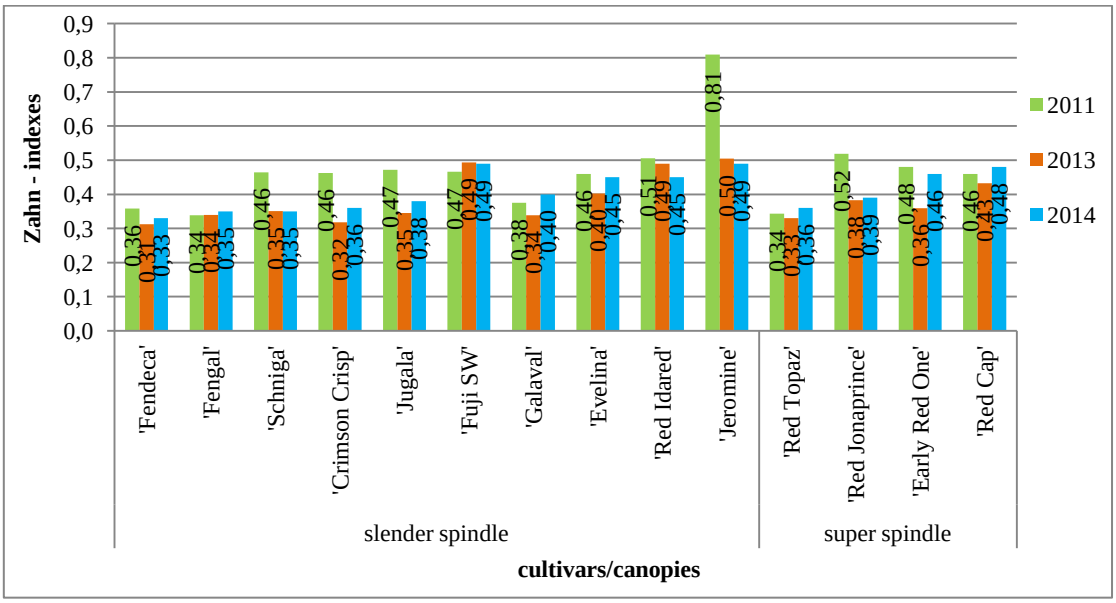

Figure 4. Zahn-indexes of the trees (Nyírbátor, 2011-2014).

In the case of the majority of the cultivars the ratio of the trunk thickness and the basic branches was under or around the critical 0.5 value. One year after the planting the cv 'Jeromine' presented very high, 0.8 value. On the 3-4 years old trees the cv 'Red Idared', the cv 'Fuji SW' and the cv 'Jeromine' approached or reached the 0.5 value.

In **Figure 5** the number of the main branches of the central leader in different height zones is presented.

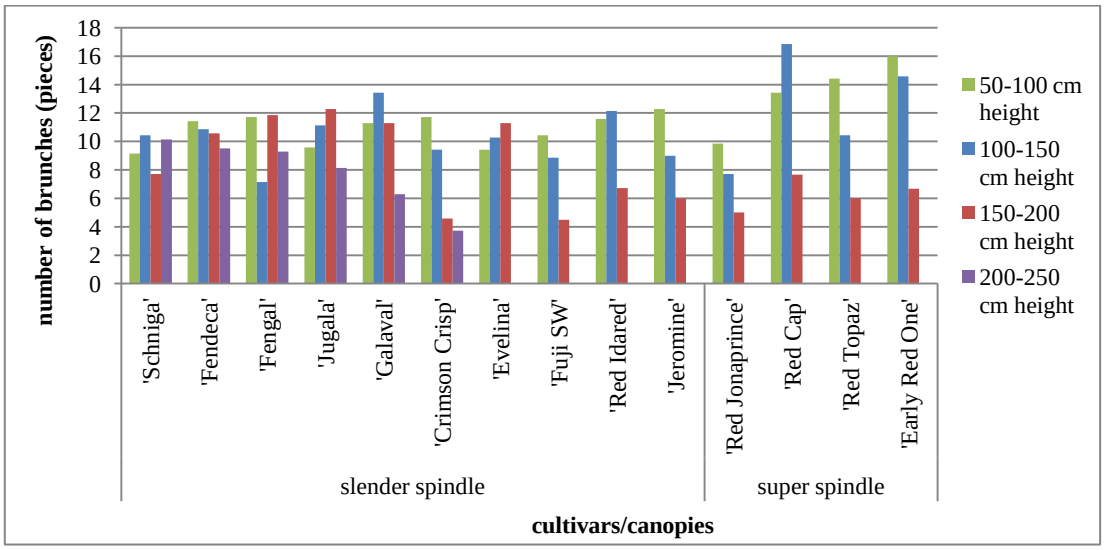

Figure 5. Number of the main branches of the central leader in different height zones (Nyírbátor, 2013).

Regarding the number of the main branches of the central leader the majority of the cultivars shows decreasing tendency from the upper to the higher regions (cvs ‘Fendeca’, ‘Crimson Crisp’, ‘Fuji SW’, ‘Jeromine’, ‘Red Jonaprince’, ‘Red Topaz’ and ‘Early Red One’). In the case of the cv 'Crimson Crisp' and the cv 'Red Jonaprince' the weaker ramification ability of the higher regions can be considered as negative characteristics.

Figure 6 displays the thickness of the main branches of the central leader in different height zones.

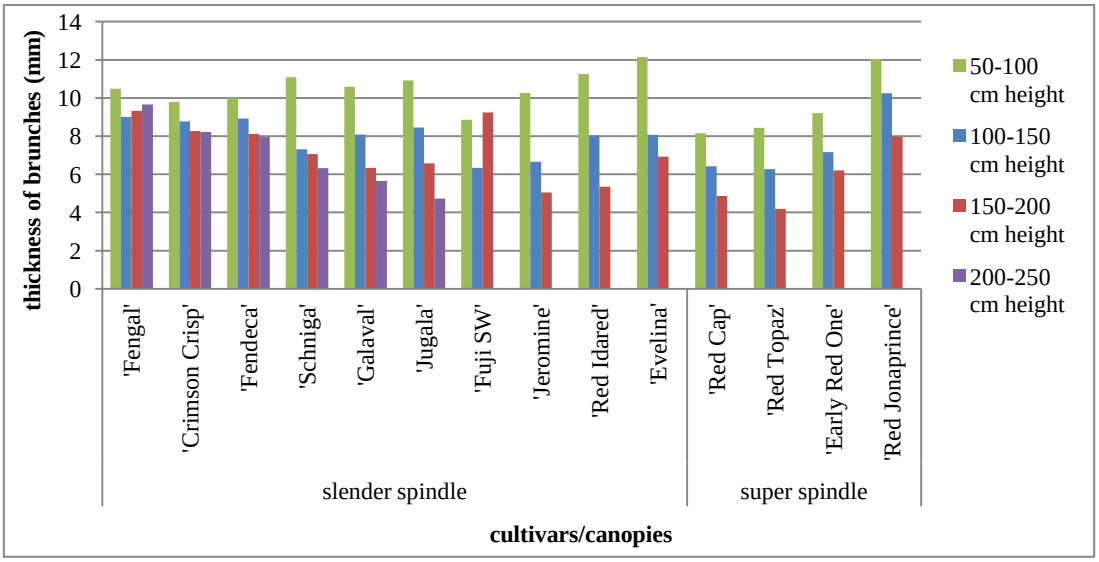

Figure 6. Thickness of the main branches of the central leader in different height zones (Nyírbátor, 2013).

Most of the cultivars showed the peculiarity of the spindle canopies, that is the thickness of the main branches is decreasing from the upper region to the higher parts. Two cultivars presented different tendency. The higher and the middle zone (150-250 cm) of the cv 'Fengal' canopy is built up with similar thick branches. Besides in the higher parts of the cv 'Red Jonaprince' trees the branches can be too thick.

Figures 7-8 show the relationship between the tapering dynamics of the central axis and the thickness of the main branches in slender and super spindle canopies.

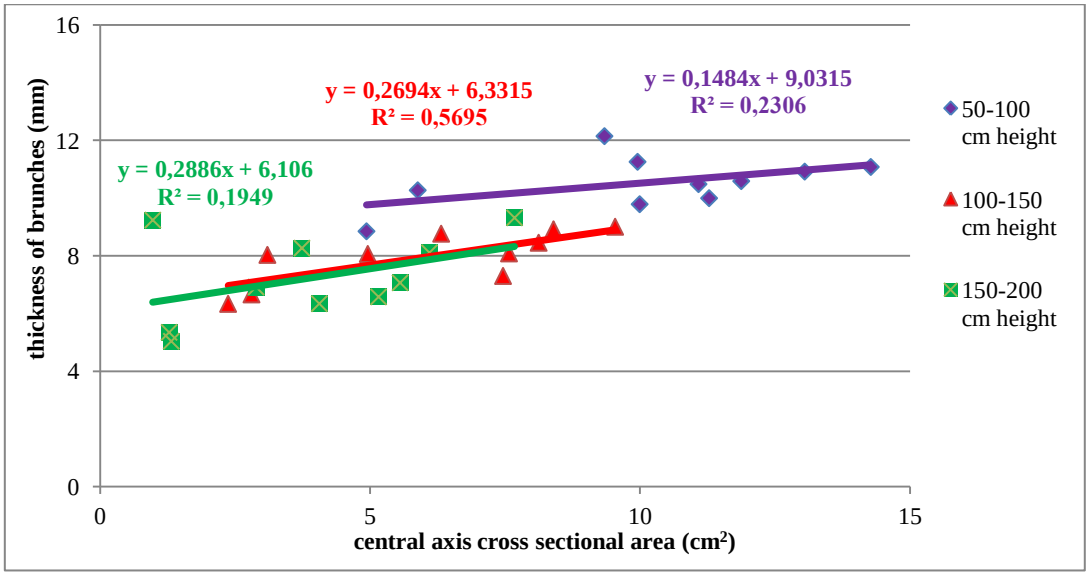

Figure 7. The relationship between the tapering dynamics of the central axis and the thickness of the main branches in slender spindle canopies (Nyírbátor, 2013).

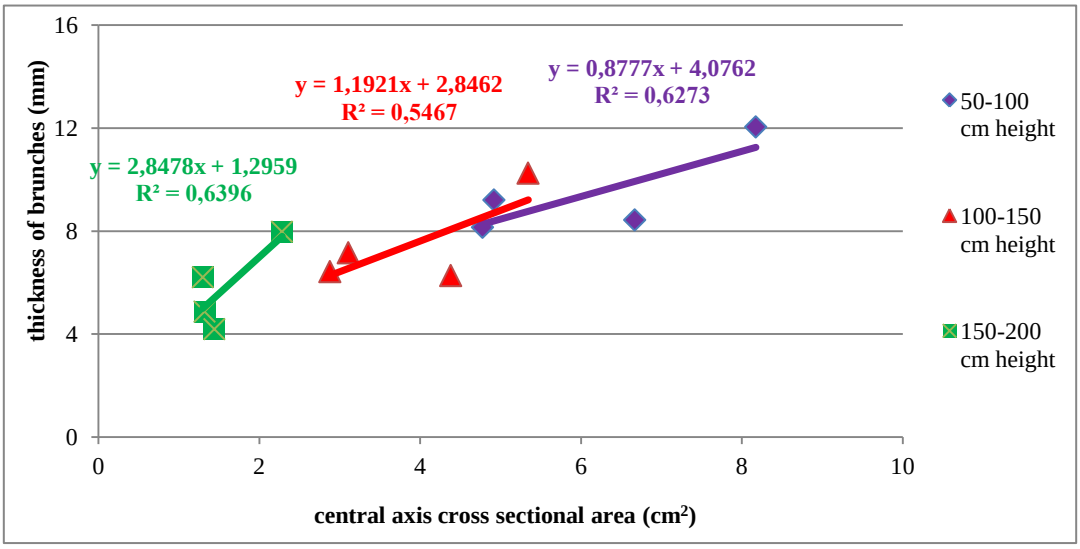

Figure 8. The relationship between the tapering dynamics of the central axis and the thickness of the main branches in super spindle canopies (Nyírbátor, 2013).

It can be seen that the relationship between the two factors was different on the two types of canopy. In the case of the slender spindle it was weaker (R^2= 0.19 - R^2=0.56), than on super spindle (R^2= 0.54 - R^2=0.63). Based on this the next tendency is stronger on the super spindle canopies, than on the super spindle trees: the thickness of the branches decreases in proportion to the tapering dynamics of the central leader by going from the upper regions to the higher zones.

The yields of the cultivars (kg/tree) are presented in **Figure 9**.

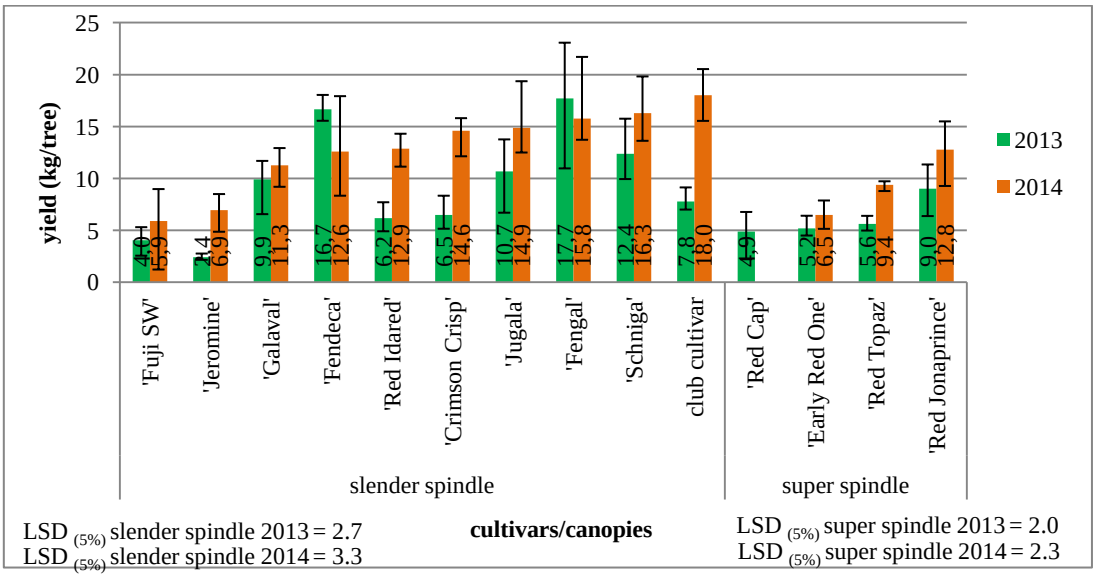

Figure 9. Yields of the cultivars (kg/tree) (Nyírbátor, 2013-2014).

Most of the cultivars reached higher yields in 2014. Two cv 'Gala' mutants, the cv 'Fengal' and the cv 'Fendeca' produced outstanding yields (17-18 kg/tree) on the three years old trees in 2013, thus these two cultivars showed lower values in 2014. Compared to the other cultivars the cv 'Fuji SW' and the cv 'Jeromine' produced lower yields. It is related with the trunk thickness, namely that two cultivars showed also the weakest vegetative accomplishment. The 9-13 kg/tree yield of the cv 'Red Jonaprince' trained to super spindle can be considered as an excellent result.

Fruit number per tree is displayed in **Figure 10**.

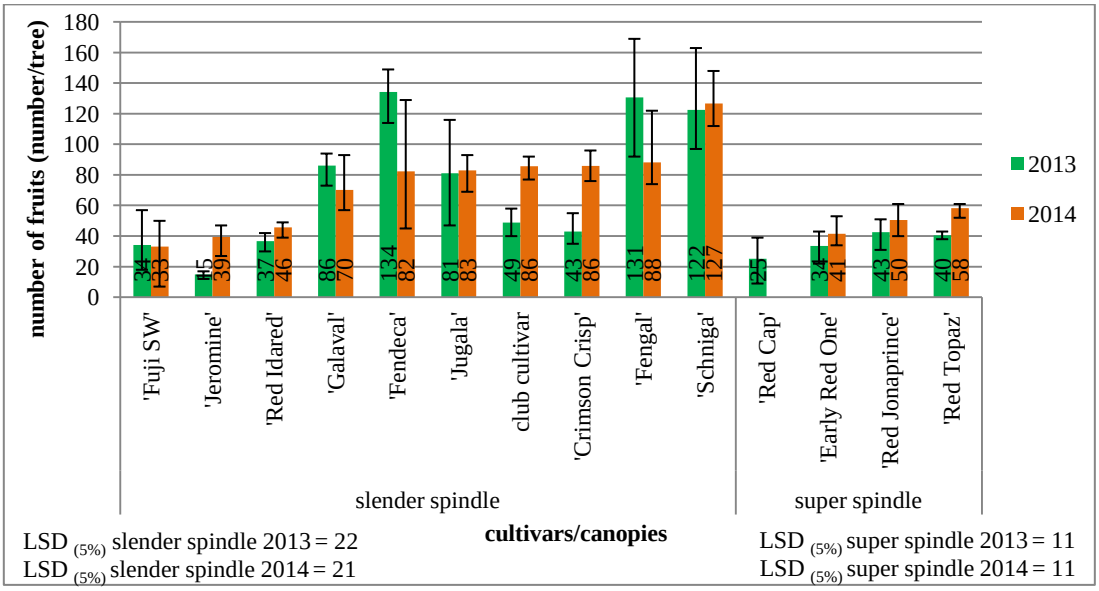

Figure 10. Fruit number per tree (Nyírbátor, 2013-2014).

Regarding the fruit number of the trees and the training systems it can be stated, that the higher fruit numbers of the slender spindles canopies are well visible (120-130 number/tree), but a cultivar with weaker growth trained to slender spindle (cv 'Fuji SW' and cv 'Jeromine') can be described with a similar lower value than a cultivar trained to super spindle (40-50 number/tree). It shows, that in terms of the fruit numbers of the trees the characteristics of the cultivar are more dominant then the differences of the training systems.

In **Figure 11-12** the yield/tree and the trunk cross sectional area were compared.

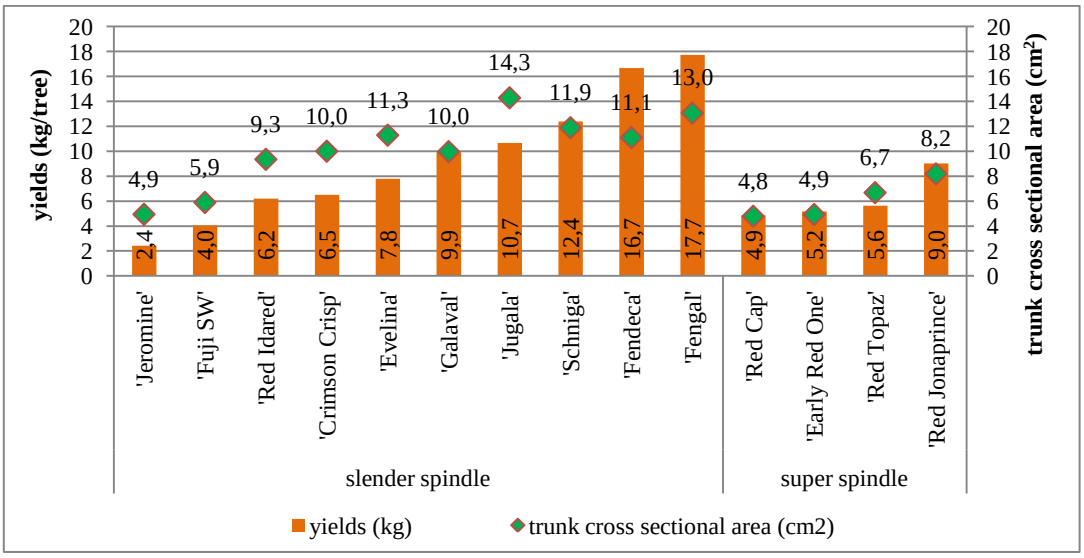

Figure 11. Yields/tree and trunk cross sectional area of the cultivars (Nyírbátor, 2013).

It can be seen, that in the case of the most of the cultivars the higher vegetative accomplishment resulted in higher yields. Compared to the trunk thickness the cv ‘Red Idared’, the cv ‘Crimson Crisp’ and the cv ‘Jeromine’ achieved relative lower values in 2013. In turn the cv 'Fengal' and the cv 'Fendeca' produced very high yields compared to the trunk thickness. That shows their early productivity.

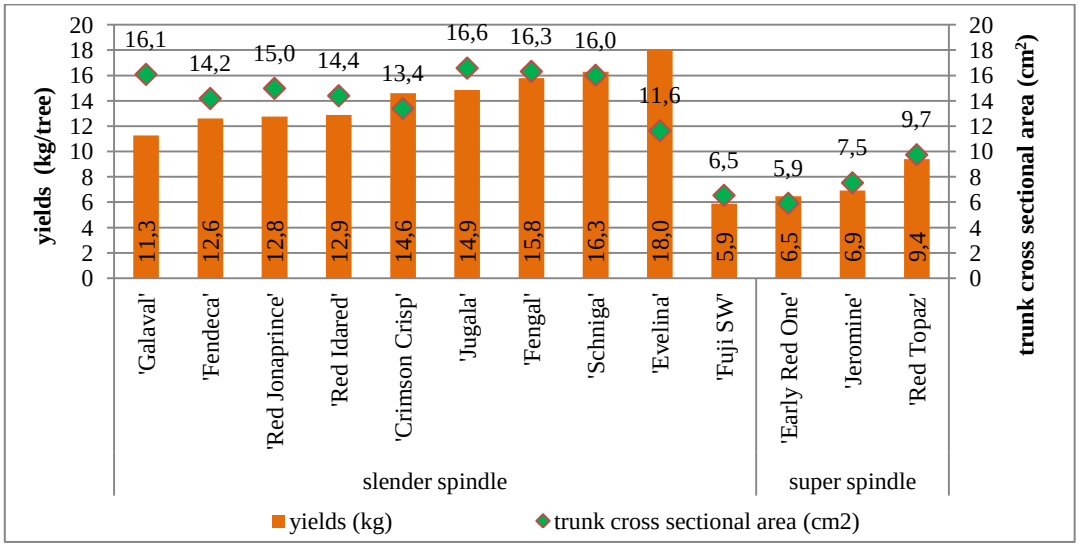

Figure 12. Yileds/tree and trunk cross sectional area of the cultivars (Nyírbátor, 2014).

Concerning the year 2014, the cv 'Galaval' produced less yields as the trunk parameters would have allowed. The cv 'Evelina' contrary to this, showed higher fruit amount. The other cultivars showed harmonic yields to the trunk thickness. This relationship is confirmed also by the correlation coefficient (**Figure 13.**).

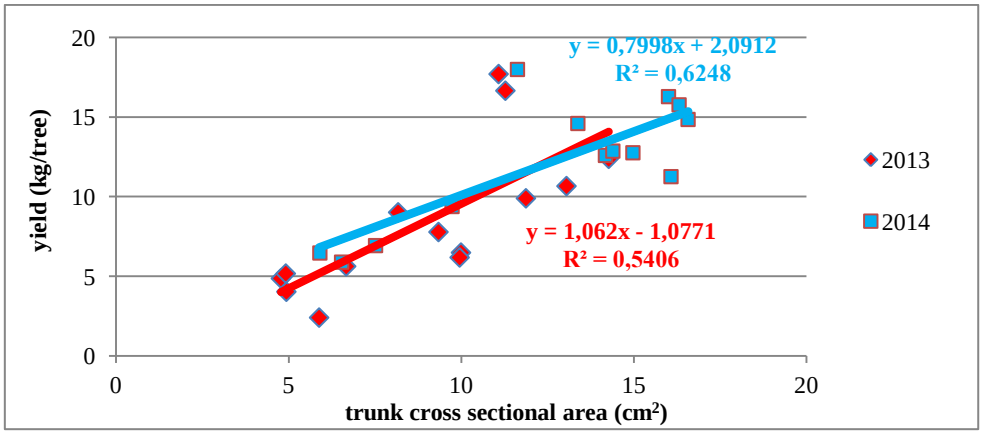

Figure 13. Relationship between the yields and the trunk cross sectional area (Nyírbátor, 2013-2014).

Based on the figure, most of the cultivars achieved proportional yields to the trunk thickness. Accordingly in the case of the cultivars with low yields/tree, the main reason of the low fruit amount is the weaker vegetative accomplishment and the smaller cropping surface, not the insufficient productivity.

The crop load (fruit number per trunk cross sectional area) can be seen in **Figure 14**.

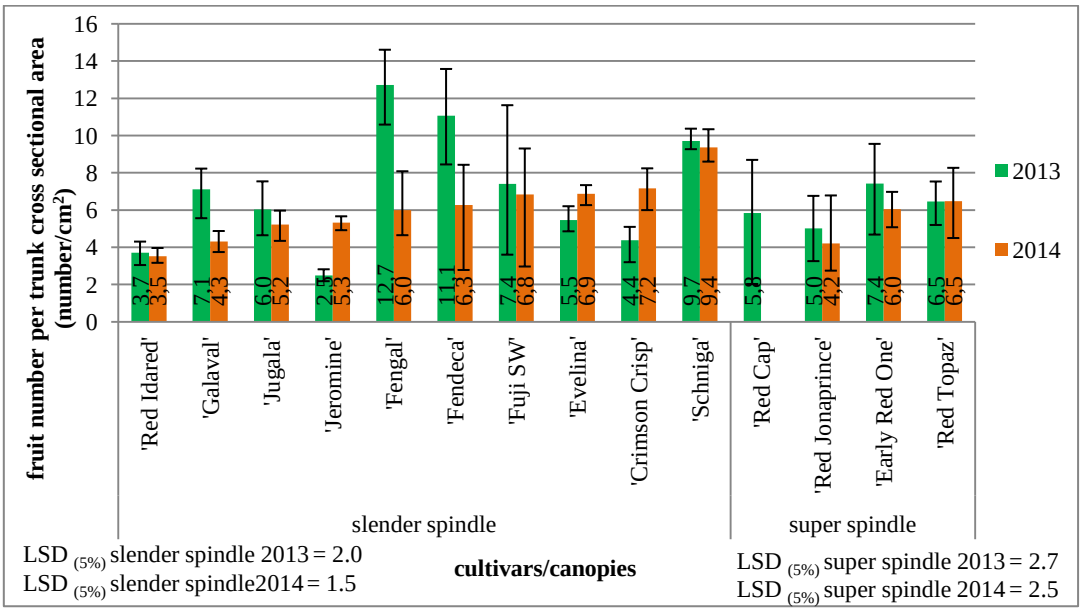

Figure 14. Crop load of the cultivars (Nyírbátor, 2013-2014).

Concerning the crop load among the cultivars the cv 'Schniga', the cv 'Fendeca' and the cv 'Fengal' outstand with the value 9.7-12.7 number/cm^2 in 2013. The data also show that the lower fruit number/tree of the super spindle trees means similar or higher crop load, than the crop load of the slender spindle canopies.

The **Figure 15** shows the yield (t/ha) of the cultivars.

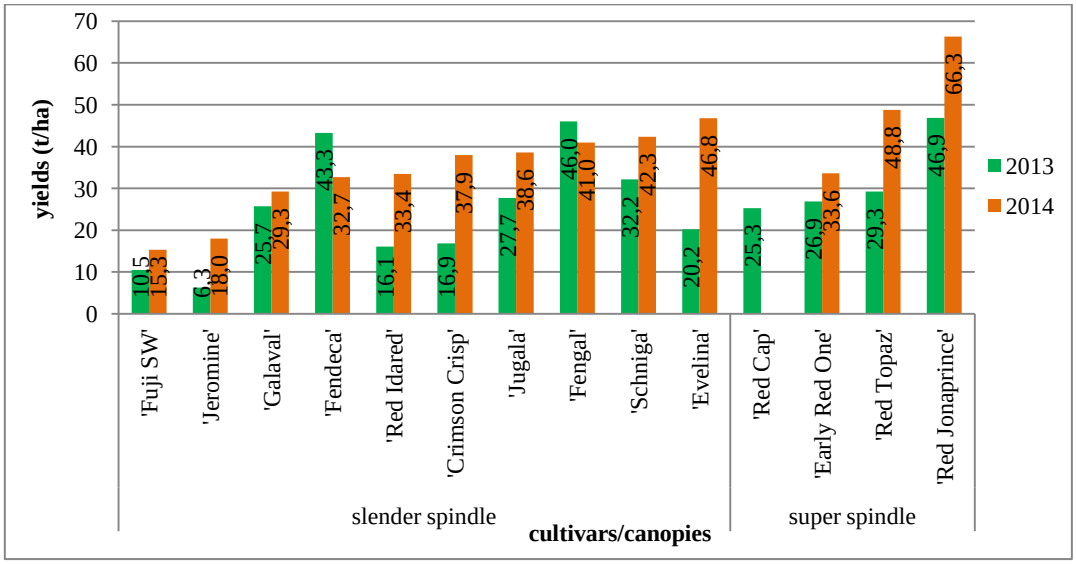

Figure 15. Yield (t/ha) of the cultivars (Nyírbátor, 2013-2014).

It can be seen, that in 2013 (three years after the planting) the cv 'Fengal' and the cv 'Fendeca' trained to slender spindle, and the cv 'Red Jonaprince' trained to super spindle exceeded notably the 40 tons/hectare yields. Comparing the cultivars and the training systems the cv 'Red Jonaprince' with super spindle reached the highest values in both years (47 and 63 tons/hectare).

Figure 16 presents the fruit size of the cultivars.

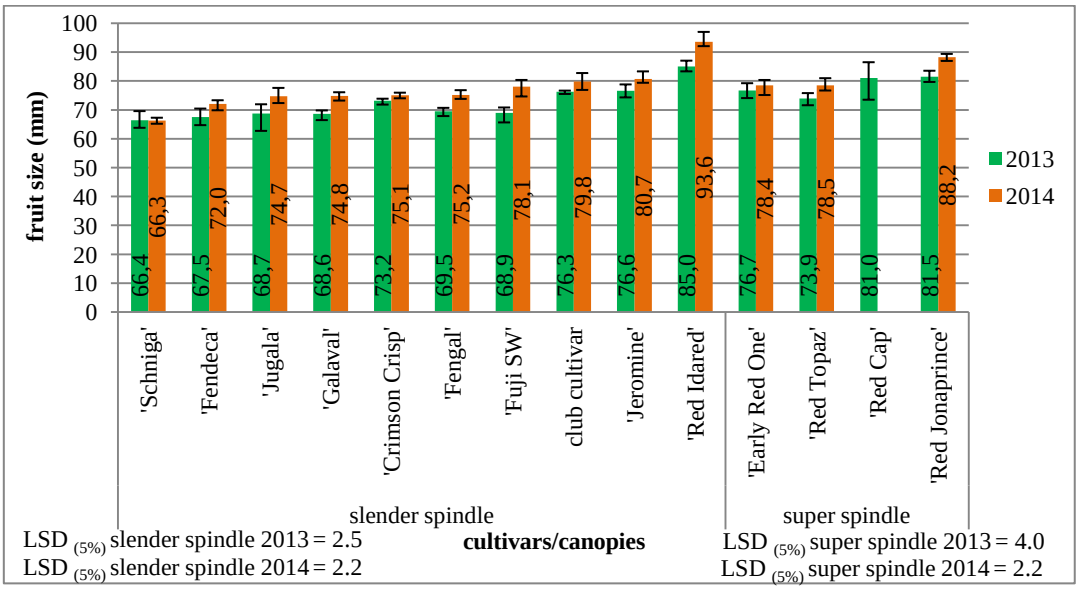

Figure 16. Fruit size of the cultivars (Nyírbátor, 2013-2014).

In term of the fruit size all the cultivars achieved the required diameter which makes possible the fresh market consumption. The size of the cv 'Gala' mutants (above 70 mm) can be considered as an excellent result. The cv 'Red Jonaprince' (81 and 88 mm) and the cv 'Red Idared' (85 and 94 mm) showed huge fruits in both years. In the latter case the diameter over 90 mm can be judged excessive, which can result in negative effects (packing, storage).

In **Figure 17** the shape index (ratio of the fruit diameter and height) can be seen.

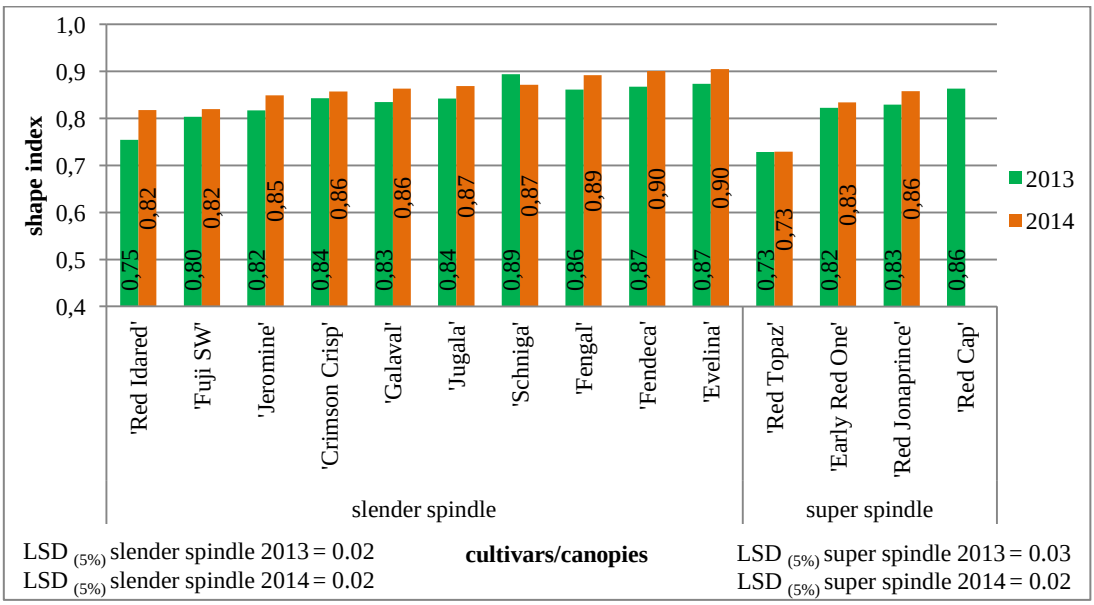

Figure 17. Shape index of the fruits (Nyírbátor, 2013-2014).

The ratio of the fruit diameter and height shows that most of the cultivars can be described with standard 0.8-0.9 values. Two cultivars, the cv 'Red Topaz' and the cv 'Red Idared' presented different, flat shape. The members of the cv 'Red Delicious' sport, the cv 'Jeromine', the cv 'Early Red One', and the cv 'Red Cap' displayed 0.82-0.86 shape index, so neither of them developed the typical elongated shape on the 3-4 years old trees.

Figure 18 shows the surface color of the fruits.

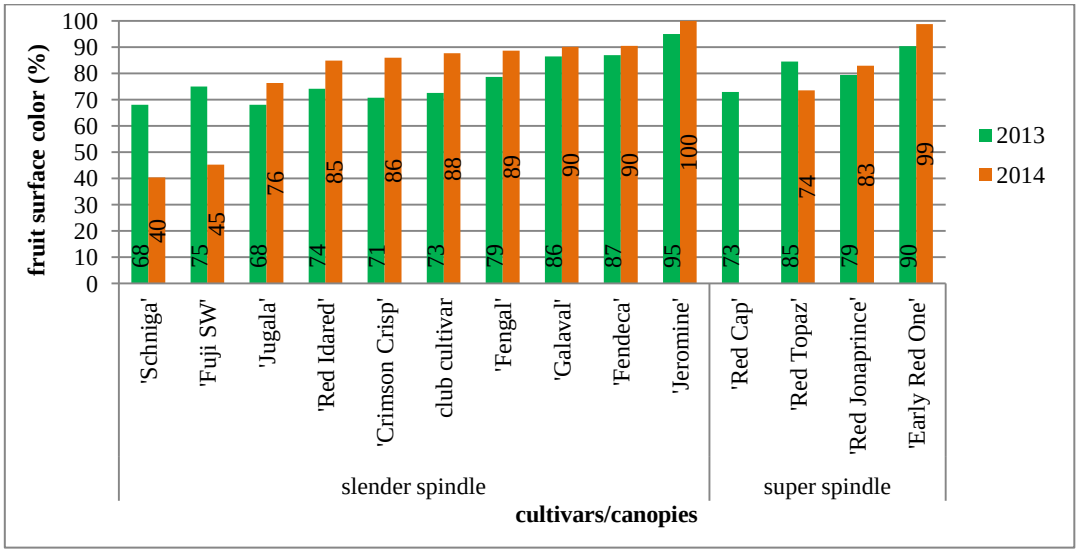

Figure 18. Fruit surface color (Nyírbátor, 2013-2014).

The data of the fruit surface color shows that the majority of the cultivars reached excellent values (80-100%). Thanks to this we had the possibility to harvest the fruits with one pick (excluding the cv 'Schniga').

In **Figure 19** the color intensity (darkness) of the fruits is shown.

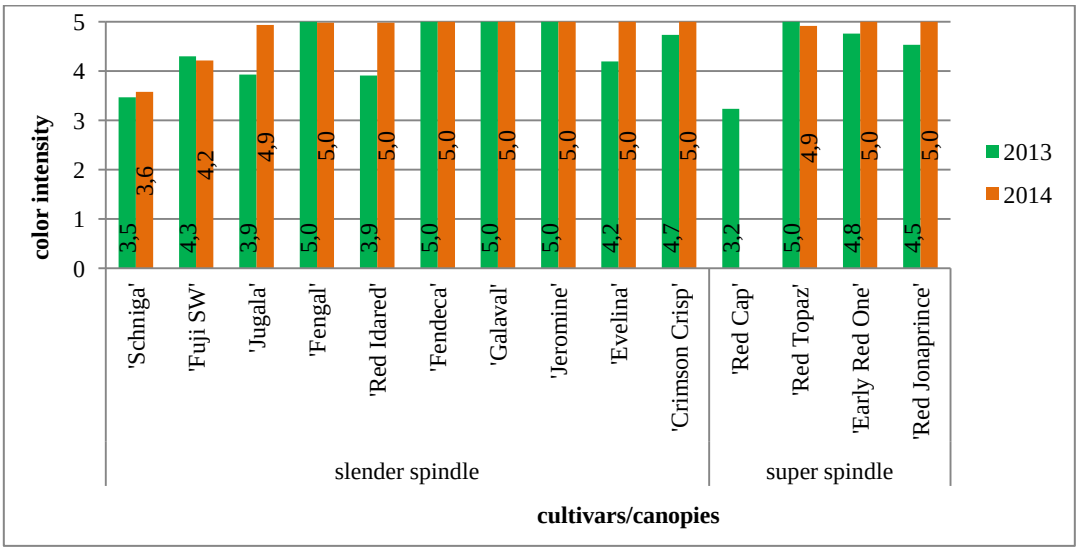

Figure 19. Color intensity of the fruits (Nyírbátor, 2013-2014).

The majority of the cultivars developed excellent color intensity (on a scale ranging from 1-5). The cvs 'Fengal', 'Fendeca', 'Galaval', 'Jeromine', 'Red Topaz', 'Early Red One', 'Crimson Crisp' and the 'Red Jonaprince' showed maximal or near to maximal values in both years.

Figure 20 presents the relationship between the fruit surface color and the color intensity.

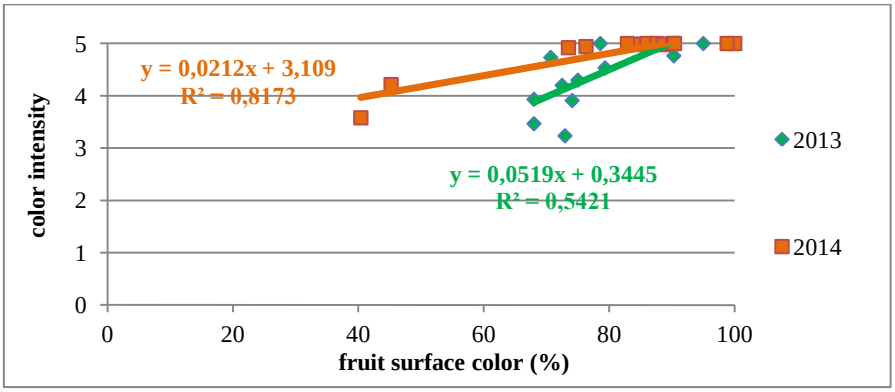

Figure 20. Relationship between the fruit surface color and the color intensity (Nyírbátor, 2013-2014).

It can be seen that the higher surface color of the examined cultivars means also higher color intensity. This relationship was stronger with increased surface color.

In **Figure 21** the relationship between the fruit surface color and the fruit appearance is presented.

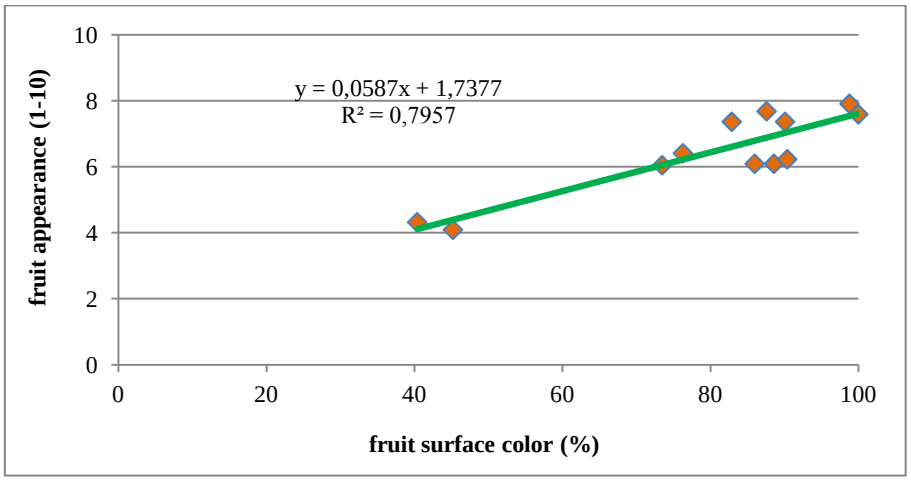

Figure 21. Relationship between the fruit surface color and the fruit appearance (Debrecen, 2014).

According to the data of the fruit surface color and the fruit appearance it can be stated that the cultivars with higher coloration were more attractive for the consumers. That fact presents well the value of the examined new cultivars.

5. SUMMARY

The world apple production grew greater in the last years, then the increase of the consumption. Due to the sales problem the production can only be economical if we ensure both high quantity and excellent quality at the same time. To satisfy the criteria of the high yields and the adequate quality is only possible if cultivars with good productivity and favorable producing characteristics are used.

In our study apple cultivars originated from abroad were studied, which are judged positively in their home country and are planted expansively in Western-European apple orchards. During our work, growing characteristics in details were also described beyond the fruit bearing characteristics and fruit quality of the cultivars. Namely, the previous one is usually handled superficially both in the domestic and foreign studies.

The differences in the growing vigour of the cultivars through the size of the cropping surface basically determined the available yields. Tree size of the cultivars with slender and super spindle canopies proved that the smaller planting distance between the trees not always means smaller tree size and lower fruit amount.

Results also proved that the yields per trunk cross section area (kg/cm^2, fruit number/cm^2) on trees pruned to super spindle were equal or higher than that of pruned to slender spindle.

Based on two years (2013-2014) data set, the available yields and fruit quality of the 3-4 years old trees were determined. Regarding the yields the cv ‘Gala’ mutants trained to slender spindle achieved the highest values. From them the cv ‘Gala Venus Fengal’ and the cv ‘Gala Decarli-Fendeca’ produced more than 40 t/ha on the three years old trees. The cv ‘Wilton’s Red Jonaprince’ trained to super spindle showed very high, 66 t/ha in the four years old orchard.

The organoleptic and the visual evaluations proved that the cultivars with high surface color are more preferred by the consumers. That means a better opportunity for purchasing of these new cultivars.

6. NEW AND NOVEL SCIENTIFIC RESULTS

1. We stated that there is a relationship between the tapering dynamics of the central axis and the thickness of the main branches. This relationship was stronger in super spindle canopies (R^2=0.54-0.63), than in slender spindle crown forms (R^2=0.19-0.56).
2. We confirmed that a more vigorous apple cultivar planted in smaller planting distance (0.5 m) can reach higher trunk thickness, than a less vigorous cultivar trained with larger planting distance (1.0 m). In terms of the space utilization the characteristics of the cultivar are more dominant despite the higher root competition then the differences of the training systems.
3. Based on our results the lower fruit number/tree of the super spindle trees with smaller cropping surface means similar or higher crop load (fruit number compared to the trunk thickness, which can be considered as the complex index of the vegetative accomplishment), than the crop load of the slender spindle canopies.
4. We stated that under domestic circumstances on the 3-4 year old trees the 9.7-12.7 number/cm^2 crop load (fruit number/trunk cross sectional area) of the high productivity 'Gala' cultivars can't be considered excessive. Namely the decrease of the fruit size and fruit surface color have not achieved the level which would exclude the possibility of the fresh market sale or the optimal high yields of the next year.
5. According to our results we determined the group of the cultivars which can be suggested definitely and unambiguously for the Hungarian apple production: cvs ‘Gala Decarli-Fendeca’, ’Galaval’, ’Red Idared’, ‘Wilton’s Red Jonaprince’, ‘Evelina’ and 'Crimson Crisp'. Proposed optionally to produce: cvs ‘Gala Venus Fengal’ and ’Red Topaz’. Not recommended to produce: cvs ’Jugala’, ‘Gala Schnitzer Schniga’ and ‘Fuji September Wonder’. Further examinations are required: cvs ’Early Red One’, ‘Red Cap Valtod’ and ’Jeromine’.

7. PRACTICALLY USEFUL RESULTS

1. Based on our results the next cultivars reached optimal vigour grafted on rootstock M.9: cvs ‘Gala Venus Fengal’, ‘Gala Decarli-Fendeca’, ‘Galaval’, ‘Jugala’, ‘Gala Schnitzer (S) Schniga’, ‘Jeromine’, ‘Crimson Crisp’, ‘Red Topaz’, ‘Wilton’s Red Jonaprince’, ‘Red Idared’ and ‘Evelina’. Stronger rootstocks are required (M.26, MM.106): cvs 'Early Red One', 'Red Cap Valtod' and 'Fuji September Wonder'.
2. The main branches of the trunk and the central leader tend to overthickening: cvs 'Red Idared', 'Wilton’s Red Jonaprince', 'Fuji SW' and 'Jeromine'. To prevent this negative phenomenon, thus maintain the branches specific fitotechnical interventions (bending down, cambering, cracking) are suggested to carry out during the training of the canopy.
3. The density of the branches of certain parts of the canopy can be too low: cvs 'Crimson Crisp', 'Wilton’s Red Jonaprince', 'Fuji September Wonder' and 'Red Idared'. In the case of these cultivars the increasement of the budding is required by pruning and other fitotechnical interventions (nicking above the bud).
4. The density of the branches of certain parts of the canopy can be too high: cvs ‘Gala Venus Fengal’, 'Wilton’s Red Jonaprince' and 'Red Cap Valtod'. The optimal density and light penetration of the canopy must be created with regular thinning pruning.
5. The next cultivars can be described with early productivity and high crop load and yield: cvs ‘Gala Venus Fengal’, ‘Gala Decarli-Fendeca’, ‘Gala Schnitzer (S) Schniga’ and 'Wilton’s Red Jonaprince'. The productivity is low in the first years: cvs ’Jeromine’ and ’Fuji September Wonder’.
6. All the cultivar reached the fruit size which makes possible the optimal fresh market sale. From them the cv ‘Gala Schnitzer Schniga’ achieved lower (66 mm), the cv 'Wilton’s Red Jonaprince' (81-88 mm) and the cv 'Red Idared' (85-94 mm) larger fruits.
7. Most of the cultivars can be described with high (80-100%) fruit surface color, which is accompanied by excellent color intensity. That means better opportunity for venting these new cultivars.

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List of publications related to the dissertation

Hungarian scientific article(s) in Hungarian journal(s) (6)

1. **Csihon Á.**: Vegetatív és generatív sajátosságok vizsgálata a 'Gala' almafajta néhány változatánál. *Agrártud. Közl. 64*, 15-20, 2015. ISSN: 1587-1282.

2. Szabó A., **Csihon Á.**, Balla-Kovács A., Gonda I., Vágó I.: Komposztkijuttatás hatása az ökológiai módon termesztett almafák (Malus domestica Borkh.) levelének szárazanyag- és Ca-tartalmára. *Agrokém. talajt. 63* (2), 315-328, 2014. ISSN: 0002-1873.

3. Szabó A., **Csihon Á.**, Vágó I.: Komposztkezelések hatása a bio/öko és integrált termesztésű almafák (Malus domestica Borkh.) egy folyóméter-hajtásra jutó levélfelületének alakulására. *Agrártud. közl. 56*, 111-116, 2014. ISSN: 1587-1282.

4. **Csihon Á.**: Új almafajták vegetatív és generatív teljesítményének vizsgálata. *Agrártud. közl. 56*, 29-34, 2014. ISSN: 1587-1282.

5. **Csihon Á.**: Eltérő fajtaösszetételű almaültetvények és az ATS (ammónium-tioszulfát) gyümölcsritkító hatásának összefüggései. *Agrártud. közl. 52*, 35-38, 2013. ISSN: 1587-1282.

6. **Csihon Á.**, Illés A., Szabó A., Bicskei D.K.: Biostimulátor készítmények összehasonlító vizsgálata intenzív almaültetvényben. *Kertgazdaság. 45* (4), 20-27, 2013. ISSN: 1419-2713.

Foreign language scientific article(s) in Hungarian journal(s) (4)

7. **Csihon, Á.**, Holb, I., Gonda, I.: Growing characteristics of apple cultivars and canopies. *Int. J. Hortic. Sci. 21* (1-2), 7-10, 2015. ISSN: 1585-0404.

8. **Csihon, Á.**, Holb, I., Gonda, I.: Evaluation of generative accomplishment of new apple cultivars in Hungary. *Int. J. Hortic. Sci. 21* (1-2), 11-15, 2015. ISSN: 1585-0404.

9. **Csihon, Á.**: Evaluation of the vegetative and generative performance of new apple cultivars in the Nyírség region. *Int. j. hortic. sci. 20* (3-4), 39-44, 2014. ISSN: 1585-0404.

10. **Csihon, Á.**, Holb, I., Gonda, I.: The relationship of the plant protection and the applied technology in the integrated apple production. *Int. j. hortic. sci. 19* (3-4), 11-14, 2013. ISSN: 1585-0404.

Hungarian conference proceeding(s) (2)

11. Gonda I., **Csihon Á.**: Az integrált almatermesztés növényvédelmének közvetett elemei. In: Integrált termesztés a kertészeti és szántóföldi kultúrákban, XXX. : Budapest, 2013. november 27. Szerk.: Hochbaum Tamás, Novák Róbert, Ripka Géza, Magyar Növényvédelmi Társaság, [Budapest], 35-46, [2013]. ISBN: 9789638969019

12. Szabó A., **Csihon Á.**, Bákonyi N., Kátai J., Vágó I.: Komposzt alkalmazása Pinova és Golden Delicious almaültetvényben. In: Újabb kutatási eredmények a növénytudományokban. Szerk.: Sándor Zsolt, Szabó András, DE AGTC MÉK Hankóczy J. Doktori Isk., Debrecen, 47-53, 2013. ISBN: 9786155183409

Informational/educational article(s) (9)

13. **Csihon Á.**: Red Jonaprince, egy nagy reményű almafajta. *Kertész. Szőlész. 64* (30), 18-20, 2015. ISSN: 0023-0677.

14. **Csihon Á.**, Gonda I.: Az almafák magasításának lehetőségei és korlátai. *Agrofórum Extra. 58*, 52-55, 2015. ISSN: 1788-7380.

15. **Csihon Á.**: A népszerű Gala és változatai.
Kertész. Szőlész. 64 (8), 12-14, 2015. ISSN: 0023-0677.

16. **Csihon Á.**: Almaművelési rendszerek.
Kertészet és Szőlészet 63 (47), 16-19, 2014. ISSN: 0023-0677.

17. **Csihon Á.**: Perspektivikus új almafajták III..
Őstermelő. 18 (2), 70, 2014. ISSN: 1418-088X.

18. **Csihon Á.**: Perspektivikus új almafajták II..
Őstermelő. 18 (1), 94-95, 2014. ISSN: 1418-088X.

19. **Csihon Á.**: Perspektivikus új almafajták.
Őstermelő. 17 (6), 48-49, 2013. ISSN: 1418-088X.

20. **Csihon Á.**: Kutatás felsőfokon.
Kertész. szőlész. 67 (37), 17-19, 2013. ISSN: 0023-0677.

21. **Csihon Á.**: Őszi gyümölcsfa telepítés: A termőhely befolyása a gyümölcsfák tápláltságára.
Értékálló aranykorona. 12 (8), 4-5, 2012. ISSN: 1586-9652.

List of other publications

Foreign language scientific article(s) in Hungarian journal(s) (1)

22. Szőke, S., **Csihon, Á.**: Comparison of the growing habit of peach varieties trained to caldron and slender spindle crowns.
Int. J. Hortic. Sci. 16 (3), 55-59, 2010. ISSN: 1585-0404.

Hungarian conference proceeding(s) (5)

23. Riczu P., **Csihon Á.**, Nagy A., Nagy G., Elshal A.M., Tamás J., Gonda I.: Intenzív almaültetvény strukturális paramétereinek vizsgálata 3D lézerszkenneres adatok alapján.
In: Gazdálkodás és menedzsment Tudományos konferencia I. köt. Környezettudatos gazdálkodás és menedzsment. Szerk.: Ferencz Árpád, Kecskeméti Főiskola, Kecskemét, 198-202, 2013. ISBN: 9786155192203

24. Balla Z., **Csihon Á.**, Kaszás L., Puskás A., Zsembeli J.: Néhány termesztett kultúrnövényünk érzékenységének vizsgálata és biológiai alapjainak fejlesztése a kedvezőtlen ökológiai körülményekhez való alkalmazkodás vonatkozásában.
In: Az ismeretszerzéstől az ismeretátadásig : a Kerpely Kálmán Szakollégium gyakorlatorientált kutatási projektjeinek bemutatása az agrártudományok területéről. Szerk.: Balla Zoltán, Juhász Csaba, Zsembeli József, Debreceni Egyetem Agrár- és Gazdálkodástudományok Centruma Kerpely Kálmán Szakkollégium, Debrecen, 41-53, 2012. ISBN: 9786155183201

25. **Csihon Á.**: Eltérő alanyú és fajtaösszetételű almaültetvények és az ATS (ammónium-tioszulfát) gyümölcsritkító hatásának összefüggései: Előzetes eredmények.
In: Az ismeretszerzéstől az ismeretátadásig : a Kerpely Kálmán Szakollégium gyakorlatorientált kutatási projektjeinek bemutatása az agrártudományok területéről. Szerk.: Balla Zoltán, Juhász Csaba, Zsembeli József, Debreceni Egyetem Agrár- és Gazdálkodástudományok Centruma Kerpely Kálmán Szakkollégium, Debrecen, 88-99, 2012. ISBN: 9786155183201

26. **Csihon Á.**, Szőke S.: Katlan és karcsú orsó koronaformájú őszibarack fajták növekedési tulajdonságainak összehasonlítása =Comparison of growth characteristics of oeach cultivars with caldron and slender spindle crown form.
In: XXX. Jubileumi OTDK Agrártudományi Szekció. Pannon Egyetem Georgikon Kar, Keszthely, 43-52, 2011.

27. **Csihon Á.**: Katlan és karcsú orsó koronaformájú őszibarack fajták vegetatív teljesítményének összehasonlítása.
In: XXX. Jubileumi OTDK Agrártudományi Szekció. Pannon Egyetem Georgikon Kar, Keszthely, 174, 2011.

Informational/educational article(s) (2)

28. **Csihon Á.**: Csonthéjas gyümölcsűek betakarítása és áruvá készítése.
Értékálló aranykorona. *13* (4), 18-19, 2013. ISSN: 1586-9652.

29. **Csihon Á.**: Az alma tárolhatósága és tápanyagellátása közötti összefüggés.
Értékálló aranykorona. *13* (3), 13-14, 2013. ISSN: 1586-9652.

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