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Initial Growth and Yield of Skeena, Kordia and Ferrovia Sweet Cherry Varieties on Gisela 5 Rootstock

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Abstract. Evaluation and testing rootstocks for sweet cherry and combinations variety / rootstock began long time ago and the goal was to find those solutions that respond better to the specific climatic and soil conditions in terms of adaptability, precocity, productivity and constancy in the fructification of the varieties in the high-density orchard system. This work addresses to these issues by assessing the behavior of the modern sweet cherry varieties 'Skeena', 'Kordia' and 'Ferrovia' grafted on dwarfing rootstock Gisela 5. The trial has been set up in 2009 and it has placed in Pitesti Maracineni area. The trial includes lot of trees planted at a distance of 4 x 2 meter row and plant distance, high density orchard of 1250 trees with drip irrigation system and individual support for trees and trellis. Observations and measurements made on the growth and fructification particularities of these sweet cherry varieties on rootstock Gisela 5 had revealed 'Kordia' as the most vigorously cultivar comparatively to the other two varieties in terms of increased growth of TCSA and total annual tree growth, the weakest being 'Ferrovia' variety. This variety formed the highest number of spur branches per tree and had the highest percentage of fruit set which lead to the obtaining of a higher yield per tree and per unit area.

Keywords: *Prunus avium* L., cultivar, TCSA, phenology, precocity, fruiting branches

INTRODUCTION

In the last decades, more series of rootstocks were created and evaluated for sweet cherry varieties (Blažková *et al*., 2010; Sitarek and Grzyb, 2010). In particular situations, some inconvenient have been reported such as incompatibility problems (Sitarek, 2006), lower adaptation to the specific soil and clime conditions. Using dwarfing rootstocks such as Gisela 5, Gisela 10, Tabel Edabriz and GM 61/1 in hot climatic conditions of southern Italy conduct to physiological stress of the trees and lower fruit weights (De Salvador, 2001). In Hungary, for light sandy soils, with dry and hot summer and low precipitation, *Prunus mahaleb* is the most suitable and recommended rootstock (Hrotko, 2009), other rootstocks requiring much attention and modern technologies for achieving better results.

Choosing the right cherry rootstock is just as important as choosing the right variety. Similar to M9 for apple, one of the most successful dwarfing rootstocks for sweet cherry varieties in this moment is Gisel5 (Vercammen, 2006). As a decisive advantages compared to conventional cherry rootstocks is the fact that cropping begins already in the 2nd or 3rd year after grafting with large fruit diameters and flat fruiting branches.

In order to find and use the appropriate rootstocks for our environmental and site conditions, an experimental plot was establish in 2009 in Arges region. The main goal is to achieve the best technology practices based on the specific situations and to remark the

behaviour of some valuable cherry varieties on Gisela 5 rootstock as a best answer to reduce the cherry trees height in terms of high productivity and fruits quality.

MATERIALS AND METHODS

The investigations have been carried out at the Research Institute for Fruit Growing Pitesti where the planting system chosen for the experimental plot was 4 m between rows and 2 m between trees within row, a high density orchard with 1250 trees/ha. Spindle trees are trained to central leader with permanent basal branches, provided with individual support and trellis; in the alley way naturally grown grass is managed by mowing. Thebiologicalmaterial was represented by the cultivars 'Kordia', 'Ferrovia' and 'Skeena' grafted on Gisela 5.Three determinations was made on different zones of the trees trunk, in ten replications (upper, under and at the graft level) in order to calculate the trunk cross sectional growth. It was also recorded the number and length of annual increases (long, medium and spur branches) and computed the total length of annual increases. At every tree of experience it was noted the number of inflorescences and flowers blossom on the number of short and long fruiting branches, establishing the total number of flower per tree. After the final fruit set, the number of remaining fruits per trees was counted and the percentage of fruit set was calculated. The estimation of blooming and fruiting phenophases was done according to Fleckinger's method of reference stages (Fleckinger, 1960, Chapman *et al.*, 1976). Quantitative determination of potential production was performed by weighing each tree production (kg/tree) at the optimal harvest time. Fruit weight (g) was determined by weighing 25 fruit samples.Varieties effects on biologic indicators were determined by one-way analyses of variance (ANOVA) following checks for normality and equal variance distributions. Differences between treatment means were separated by the least significant difference (Duncan's multiple range test) at the 95% confidence level ($P > 0.05$) using the SPSS 14 software for Windows.

RESULTS AND DISCUSSION

Data recorded on the increase in thickness of the trunk (Tab. 1) indicates the combination Kordia/Gisela5 with the largest growth increase (13.99 cm^2). Also the biggest difference in thickening was observed in the same version. Instead, Ferrovia/Gisela 5 showed a small increase in force, with 48.1% lower than the experience average and with 67.4% lower than Kordia/Gisela 5.

Tab. 1

Growth of trunk cross sectional area of the sweet cherries varieties on Gisela 5

Cultivar /Gisela5	TCSA spring 2010 (cm^2)	Trunk Cross Sectional Area (TCSA) spring 2011 (cm^2)				Increased growth in thickness (cm^2)
		Under grafting zone (cm^2)	Graft point (cm^2)	Upper grafting zone (cm^2)	Difference (cm^2)	
	A	B	C	D	D-B	D-A
Kordia	5.70 a*	22.33 [a]	31.62 [a]	19.69 [a]	2.64 [a]	13.99 [a]
Skeena	4.62 b	13.89 [b]	22.46 [b]	12.40 [b]	1.49 [b]	7.78 [b]
Ferrovia	3.88 b	9.34 [c]	13.86 [c]	8.44 [c]	0.90 [c]	4.56 [c]
Mean	*4.73*	*15.19*	*22.65*	*13.51*	*1.68*	*8.78*

** Duncan's multiple range test ($P \leq 0.05$)*

Concerning the trees features, there is a distribution of different types of fruit branches depending on the genetic characteristics of each variety (Tab. 2). Be taken into account that

trees are in the young stage and the growth processes are dominant. The energy growth is directed mainly towards to formation of medium and long types of branches, particularly in the extension of the scaffolds. Still notice a tiebreaker in the share of certain short or long branches in the crown of trees that are inclined to the variety 'Kordia' for long branches (63.15%), to the short branches in 'Ferrovia' (55.91%) and relatively balanced for variety 'Skeena' (45-55%).

Tab. 2

Distribution of branches types and length of annual growth in sweet cherry cultivars grafted on Gisela 5

Cultivar /Gisela5	Number of long branches		Number of spur branches		Total length of growth/tree (cm)		Total annual growth (cm)	Share of the long branches (%)	Share of the spur branches (%)
	Medium branches	Long branches	Spur fruiting branches	Spur vegetative branches	Medium branches	Long branches			
Kordia	4.9 ^{a*}	18.7 ^{a}	10.7 ^{a}	2.9 ^{a}	230 ^{a}	1,475 ^{a}	1,705 ^{a}	63.15 ^{a}	36.84 ^{b}
Skeena	6.6 ^{a}	5.7 ^{b}	8.6 ^{a}	2.2 ^{ab}	298 ^{a}	490 ^{b}	788 ^{b}	54.16 ^{a}	45.83 ^{b}
Ferrovia	5.6 ^{a}	2.6 ^{c}	9.5 ^{a}	0.9 ^{b}	257 ^{a}	199 ^{c}	456 ^{c}	44.08 ^{b}	55.91 ^{a}
Mean	*5.7*	*9.0*	*9.6*	*2.0*	*262*	*721*	*983*	*53.80*	*46.19*

* Duncan's multiple range test ($P \leq 0.05$)

Of the three varieties of cherry, 'Kordia' has formed the largest number of long branches on the tree (18.7) and recorded the biggest increase in the amount of the annual tree length increases (1.705) with significant differences from the other two varieties ('Skeena' 788 cm and 'Ferrovia' 456 cm). The 'Skeena' variety also significantly exceeded 'Ferrovia' both in the number of long branches on the tree (5.7 comparatively to 2.6) and the total length of annual tree branches.

The figure below (Fig. 1) describes the intensity of correlation between total length of the medium and long branches per tree (y) and cross-sectional area of the trunk measured upper the grafting level (x) for each variety of cherry studied separately. In other words, whether and how variation affects the trunk cross-sectional area, total length of the medium and long branches (one of the qualities that characterize the true vigor of trees growing in the first years after planting, foliar surface thereof etc).

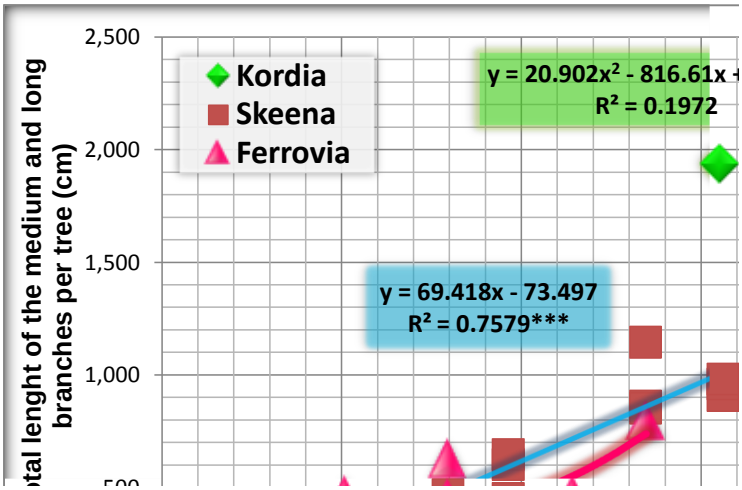

Fig.1. The correlation between the total length of the medium and long branches of the tree and TCSA upper the grafting zone of the sweet cherry varieties

In the 'Ferrovia' and 'Skeena' case, correlation is significantly positive (R^2 = 0.542 ** at Ferrovia and increased at Skeena variety R^2 = 0.7579 ***). Referring to the variety 'Ferrovia' we can say that 54.2% of the variation in total length of the medium and long branches can be attributed to differences in cross-sectional area of the tree trunk above the graft point. The trunk section area was more higher, between 5.10 to 13.46 cm^2 limits, as the total length of medium and long branches increased, between 260 and 610 cm per tree, after a 2^{nd} degree polynomial curve. However, for both varieties analyzed, the limits between which oscillate these two indicators are much lower than the 'Skeena', where the correlation between the total length of branches and trunk section area above the grafting point was insignificant.

The variety 'Ferrovia' noted a very significant positive correlation between total length of the medium and long tree branches and the trunk cross sectional area at the point of grafting (R^2 = 0.6805***) (Fig. 2) and insignificant (R^2 = 0.3265) (Fig. 3) for the trunk section below the grafting zone.

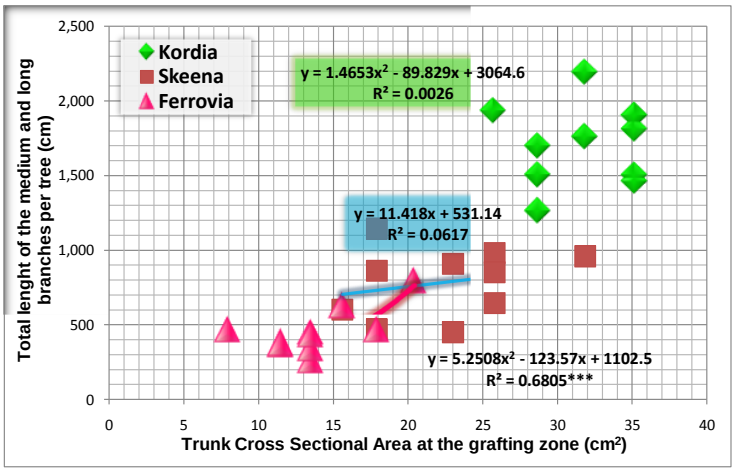

Fig. 2. The correlation between the length of the medium and long branches of the tree and TCSA at the grafting zone of the sweet cherry varieties

At the 'Kordia' variety, the only significant correlation (R^2 = 0.4457*) (fig. 3) was between the total length of the medium and long branches on the tree with the sectional area of trunk under the grafting point.

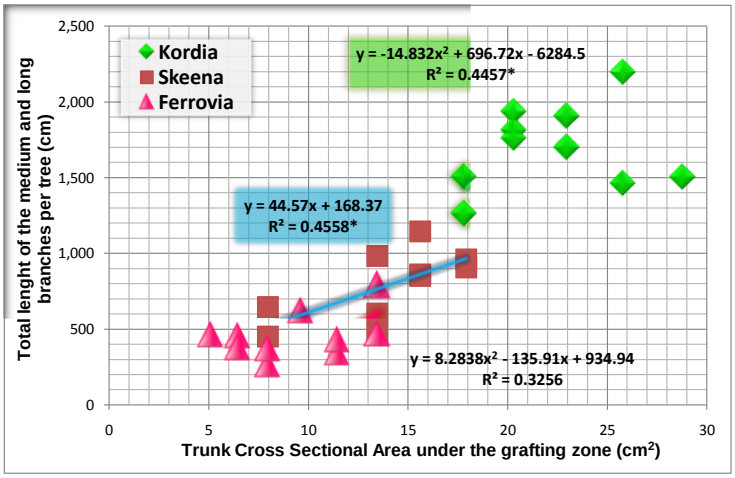

Fig. 3. The correlation between the total length of the medium and long branches of the tree and TCSA under the grafting zone of the sweet cherry varieties

Regarding the specifics of fructification of the sweet cherry varieties analyzed, we remarked a significant growing in terms of total number of inflorescences from the medium fruiting branches appeared to variant Kordia/Gisela 5 (17,3) comparatively to 'Skeena' (5,33) and 'Ferrovia' (4,0). The largest number of fruit per tree was recorded by 'Ferrovia' variety, which had the highest percentage of fruit set, the differences between this variety and the others being statistically assured.

Tab. 3

Yield efficiency and fruiting characteristics of sweet cherry varieties on Gisela 5

Sweet cherry variety/ Gisela 5	No of total inflorescences from spur branches /tree	No of total inflorescences from medium branches /tree	No of flowers /spur branches inflorescence	No of flowers /medium branches inflorescence	Total no of flowers /tree	Total no of fruits /tree	Fruit set (%)	Fruit weight (g)	Yield (g/pom)	Yield (kg/ha)	Crop load (fruits/ TCSA)
Kordia	15.0 ^{a*}	17.3 ^{a}	2.1 ^{a}	1.87 ^{a}	65.77 ^{a}	13.0 ^{b}	19.77 ^{b}	10.20 ^{a}	132.6 ^{b}	165.8 ^{b}	0.61 ^{b}
Skeena	8.67 ^{a}	5.33 ^{b}	1.55 ^{b}	1.86 ^{a}	23.18 ^{a}	11.50 ^{b}	49.60 ^{ab}	7.90 ^{c}	90.85 ^{b}	113.6 ^{b}	1.06 ^{b}
Ferrovia	10.0 ^{a}	4.0 ^{b}	2.2 ^{a}	2.09 ^{a}	30.15 ^{a}	25.00 ^{a}	82.93 ^{a}	9.9 ^{b}	247.5 ^{a}	309.4 ^{a}	2.91 ^{a}

** Duncan's multiple range test ($P \leq 0.05$)*

Fruits with the highest weight were obtained by 'Kordia' variety (10.2 g, compared to 9.9 g at 'Ferrovia' and 7.9 g at 'Skeena') but the highest production was observed at 'Ferrovia' (165.8 kg/ha) which showed an increased precocity and productivity than 'Kordia' and 'Skeena' (165.8 kg/ha, respectively 113.6 kg/ha). Ratio between the number of fruits obtained per tree and TCSA above the grafting point highlights Ferrovia with a higher index (2.91 fruits/cm^2) than the other two varieties. 'Skeena' manages a higher than 1 index value (1.06), higher with 57.54 % than the most vigorous variety 'Kordia', but the difference is not statistically assured.

Tab. 4

The main phenophases of sweet cherry varieties on Gisela 5 in 2011

Cultivar/ rootstock	Swelling of the floral buds	Swelling of the vegetative buds	Bud burst stage	First Blossom	The blossom intensity	End of petal fall	Fruit ripening date
Ferovia/ Gisella 5	25.03	4.04	9.04	20.04	5	3.05	20.06
Skeena/ Gisella 5	24.03	1.04	5.04	19.04	3	1.05	24.06
Kordia/ Gisella 5	26.03	7.04	10.04	22.04	5	1.05	22.06

Concerning the phenology of the trial, we can see that in the 2011 year conditions, differences between varieties were relatively small in terms of swelling of the floral buds but these are gradually tie at the swelling of the vegetative buds and bud burst stages. Thus, we observed that 'Skeena' was the first variety of which the buds has been broken (April 5) and the latest 'Kordia' (April10). Blossom stage has performed during 12 days at the Skeena and 'Ferrovia' variety and 9 days at 'Kordia'. The highest blossom intensity has recorded by 'Ferrovia' and 'Kordia'. The first fruits that reached harvest maturity were of 'Ferrovia' variety on June 20 followed by 'Kordia' on June 22 and 'Skeena' on June 24.

CONCLUSIONS

The largest share of production was achieved on long and medium branches. On spur branches 'Ferrovia' has obtained the highest yield and has been remarked with a high percentage of fruits/tree and therefore with a higher productivity.

After first three years from planting, 'Kordia' proved to be most vigorously than 'Skeena' and 'Ferrovia' variety considering TCSA and the total length of the medium and long branches per tree. 'Skeena' variety also significantly exceeded 'Ferrovia' in terms of the annual growth and vigor.

The total length of the medium and long branches has been significant positive correlated with TCSA measured upper the grafting level at the weaker vigorous varieties ('Ferrovia' and 'Skeena') and with TCSA measured under the grafting zone at the most vigorous variety 'Kordia'.

Although the number of the inflorescences from medium branches was bigger at 'Kordia' variety however the highest number of fruits per tree at the harvest time was achieved by 'Ferrovia' due to a much lower fruit set percentage of the 'Skeena' and especially 'Kordia' variety.

Even though the yield obtained from 'Skeena' variety was lower than the other two varieties, the average weight of a fruit at ripening date was only 7.9 g, significantly lower than the varieties 'Ferrovia' (9.9 g) and 'Kordia' (10.2 g).

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