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STUDIES ON THE DEVELOPMENT OF SOME STRATEGIES FOR SWEET CHERRY TREE PLANTING DISTANCE AND MANAGEMENT

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ABSTRACT

This papers presents the growth and fruiting of the Valerii Chkalov, Record, Ferrovia, Kordia, Regina, Stella, Skeena, Bigarreau Burlat, Lapins, Early Star, Samba and Black Star varieties, grafted on the Cerasus mahaleb, L., MaxMa 14 and Gisela-6 rootstocks in different combinations and planted at different distances, which are grown in the southern and central area of the Republic of Moldova have been investigated. The sweet cherry trees with an age between 9 to 14 years that had been grafted on Cerasus mahaleb, L. showed a stronger growth as compared to the trees with an age between 4 to 10 years that had been grafted on Gisela 6, and the tees with an age between 8 to 10 years which had been grafted on MaxMa 14. High vigour trees are grown on non-irrigated soils; the sweet cherry trees, grafted on Gisela 6 and MaxMa 14 rootstocks are grown on fertile well-irrigated soils. The studied associations of varieties and rootstocks turned out to be suitable for cultivation in terms of the soil and climatic conditions of the area.

INTRODUCTION

In recent years, consumers in Europe have been concerned about food quality and safety. For that reason, in the Moldovan fruit growing sector, sustainable, integrated cultivation systems are being studied and successfully applied (Babuc 2012, Balan 2015, Cimpoieș 2018). In fruit growing, the development of future cultivation systems is based on the results obtained in theoretical and practical research on biological material, tree pruning, crown formation, etc. The varying strength of rootstock-varietal associations makes it possible to use all types of cultivation and crown formation systems, as well as to adapt the orchards to less fertile soils.

In modern pomiculture, the sweet cherry trees are grown in classical orchards in which the trees are grafted on vigorous rootstocks (*Cerasus avium* seedlings, Colt, SL 64) and planted at a distance of 6-7x5-6 m, in intensive orchards in which the trees are grafted on vegetative semi vigorous rootstocks (Colt, CAB 6P) and moderate vigorous rootstocks (MaxMa 14) and planted at a distance of 5-6x2.5-5m, and in super-intensive orchards in which the trees are grafted on moderate vigorous rootstocks (MaxMa 14, Piku 1, Piku 4), semi vigorous rootstocks (Gisella 6, P-HL-C, Krymsk 6) and semi dwarfing rootstocks (Gisella 5, Krymsk 6) and planted at a distance of 3-4.5x0.5-2.5 m (Vercammen 2002, Şarban & Balan 2021).

The numerous cv-rootstock associations offer the opportunity to use all types of sweet cherry tree cultivation and crown formation systems. Nevertheless, it

is necessary to identify the theoretical elements that determine the system of culture, the effectiveness of the orchard and how the relationship between them develops (Babuc 2012, Bujdosó & Hrotkó 2012, Aglar et al. 2019.). The purpose of this research was to increase the productivity of sweet cherry (*Cerasus avium L*.) orchards by developing strategies on sweet cherry tree crown shaping and pruning in the Republic of Moldova.

MATERIAL AND METHODS

The researches into the cultivation systems were carried out between 2013 and 2021 in the southern (experiment (ex) 2 and central (ex. 1,3,4,5,6) orcharding areas of the Republic of Moldova. The cherry trees, grafted on Gisela 6 and Maxima 14, were formed after the improved natural crown with reduced volume and improved thin spindle. Ex. 1-The orchard was established at the *ProdCa Ltd* in Negureni, the district of Telenesti, in the spring of 2010. It was planted with sweet cherry trees of the Adriana, Ferrovia and Skeena varieties grafted on the Gisela 6 rootstock at a distance of 4x2 m between them. Ex. 2-The orchard was established in the *Terra-Vitis* Ltd in the village of Burlacu, the district of Cahul, in the spring of 2010. It was planted with sweet cherry trees of the Bigarreau Burlat, Ferrovia and Lapins varieties grafted on the vegetative Gisela 6 rootstock with 5x1,5 m, 5x2 m and 5x2,5 m between them. Ex. 3 and 4-The researches were carried out in the sweet cherry orchards of the *Vindex-Agro Ltd* in the village of Malaiesti, the district of Orhei. Ex. 3-The garden was established in 2003 with Valery Chkalov and Record sweet cherry trees grafted onto seedlings of *Cerasus mahaleb, L* with a distance of 6x5 m between them. The trees had naturally improved crowns of large voluminous shape. Ex. 4-The orchard was established in 2011 with sweet cherry trees of the Ferrovia, Kordia and Regina varieties, grafted on the Gisela 6 rootstock, with 4x2,5 m between them. Ex. 5 and 6-The researches were conducted in the central orcharding area of the Republic of Moldova, at the *StarAgroGroop Ltd* in the village of Ustia, the district of Criuleni. Ex. 5 was carried out using the Kordia, Regina, Stella, Ferrovia and Skeena varieties grafted on the Maxima 14 rootstock. Ex. 6 was conducted in the fall of 2015 using the Early Star, Samba and Black Star cherry tree varieties, grafted on the Gisela 6 rootstock, which had 4x2 m space between them.

The research methodology. The experiments were performed according to the multifactorial principle using four groups of eight representative trees each. The interdependence of the planting distance, crown shape, tree pruning system and time, as the basic factors that determine the tree fruiting, yield and fruit quality, was studied. Morphological, physiological and biometric measurements and the statistical processing of results were performed.

RESULTS AND DISCUSSIONS

The research conducted by the State Agricultural University of Moldova, on the increase of efficiency of sweet cherry orchards, by obtaining early bumper qualitative harvests, has led to the use of trees with preformed crowns thickened up to 90-100 cm which are planted more densely, to the development of methods to maintain a balance between growth and fruiting by minimizing pruning in the first years after planting, and to the utilization of inclined branches, irrigation and fertilization (Balan et al. 2018 Ivanov et al. 2019, Şarban & Balan 2021).

The sweet cherry trees of Valerii Chkalov and Record varieties, grafted on the Mahaleb rootstocks with 6x5 m between them, at the age of 9 to 14, reached the

optimum height and diameter of their crowns for such orchards. During the period of full fruiting, the trees of the Valerii Chkalov variety yielded an average output of 15,71 t/ha and the trees of the Record variety yielded an average output of 16,13 t/ha. Analysing the crop capacity of the trees in the tenth to seventeenth year of their vegetation (2012-2019), and comparing it with the data presented by other authors (Bujdosó & Hrotkó 2012, Milošević et al. 2014), it may safely be said that the sweet cherry trees which are grafted on the *Cerasus mahaleb, L.* rootstocks, are semi vigorous, highly productive and can be grown on non-irrigated areas.

In the orchards of the *Vindex Agro* Ltd, the crowns of the sweet cherry trees of Ferrovia, Kordia and Regina varieties 4 to 5 years old, grafted on Gisela 6 rootstocks and planted at the distance of 4x2,5 m, were from 129 to 231 cm long and from 139 to 190 cm wide in the 4th year of the tree vegetation, and up to 235-250 cm in the 6th year of the tree vegetation, but the values are not statistically proved. The tree crown parameters indicate that the distance of 2,5 m between the trees in a row is large, and if the trees will be planted at the distance of 2 m in a row, then the distance between the rows will be optimal, i.e. 4 m (2 m + 2 m). With regard to the distance between trees, it can be noted that the width between the rows will be equal to the sum of the distance between the trees in one row plus 2 m required for the movement of the tractors (Vercammen 2002, Babuc 2012).

Starting with the 3rd year of the tree fruiting, the yield of the Ferrovia, Kordia and Regina varieties, grafted on Gisela 6, increased significantly, namely the harvest of Ferrovia cv amounted to 12,31-13,29 t/ha and the Kordia cv yielded 11,27-12,83 t/ha. During the first seven fruiting years, the average harvest of the Ferrovia cv amounted to 8,19-8,31 t/ha, of the Kordia cv – 7,65-8,31 t/ha, and of the Regina cv – 7,21-7,88 t/ha (tab.1). The crown shape did not have a significant impact on the yield of the studied varieties, because the naturally improved low volume shaped and improved slender spindle shaped crowns are typical for sweet cherry trees grown in a high density system (Long Lynn et al. 2014, Ivanov & Balan 2017, Balan et al. 2018).

Table 1

Sweet cherry yield, t/ha.

Cv	Years							Average yield (2014-2020)
	2014	2015	2016	2017	2018	2019	2020	
Naturally improved low volume crown								
Ferrovia	0,50	5,00	12,31	7,90	10,88	13,73	7,03	8,19
Kordia	0,40	4,60	11,27	7,50	7,60	13,81	8,37	7,65
Regina	0,50	4,80	10,38	7,80	7,60	12,37	7,01	7,21
Improved slender spindle crown								
Ferrovia	0,50	4,90	13,29	7,93	11,78	12,94	6,82	8,31
Kordia	0,40	4,70	12,83	8,88	8,94	13,32	9,12	8,31
Regina	0,40	5,00	11,89	7,57	11,29	11,99	6,99	7,88
DL, 5%	-	0,845	0,529	0,82	0,675	0,315	0,783	-

The researches carried out at the *ProdCar* Ltd demonstrated that the characteristics of the Adriana, Ferrovia and Skeena sweet cherry tree varieties, grafted on Gisela 6 with 4x2 m space between them, reached the optimum level during the fruiting and growth periods. With an increase in the age of trees, the fruit yield increased, and in

2015 it amounted to 11,87-13 t/ha in the Adriana cv, the Ferrovia cv yielded 13,25-14,12 t/ha, and the Skeena cv – 16 t/ha. During the 7th year after the trees had been planted, the sweet cherry harvest doubled as compared to the previous year, namely, the Adriana cv produced 21,87-22,50 t/ha, and the Skeena cv – 26,25-28 t/ha (tab.2). Between 2017 and 2020, the fruit yield was 9,31-18,98 t/ha, with Ferrovia and Skeena being the most prolific varieties, which is an average for sweet cherries grafted on Gisela 6 (Long Lynn et al. 2014). The sweet cherry trees with slender spindle shaped crowns yielded a higher crop, namely, the Skeena cv – 14,58 t/ha, followed by the Ferrovia cv which produced 12,93 t/ha.

Table 2

Sweet cherry harvest, t/ha

Cv	Years								Average harvest (2013-2020)
	2013	2014	2015	2016	2017	2018	2019	2020	
Naturally improved low volume crown									
Adriana	0,62	4,37	11,87	21,88	10,87	12,96	13,38	9,32	10,66
Ferrovia	1,12	4,87	13,25	24,75	15,75	15,22	10,79	14,28	12,51
Skeena	0,63	4,25	16,00	26,25	16,88	17,58	17,04	16,65	14,41
Improved slender spindle crown									
Adriana	0,87	4,50	13,00	22,50	10,75	14,82	13,13	10,82	11,29
Ferrovia	1,56	5,00	14,13	24,50	12,70	15,39	13,54	16,64	12,93
Skeena	0,38	4,38	16,00	28,00	14,00	17,50	17,42	18,99	14,58
DL, 5%	-	0,435	0,971	1,315	1,429	1,423	2,305	1,314	-

The data analysis of the research undertaken at the *Terra-Vitis* Ltd showed that the density of trees in the first years of their vegetation did not affect the length and width of the crowns. It was determined that, during the growing period, the crowns of the sweet cherry trees of the Bigarreau Burlat, Ferrovia and Lapins varieties, grafted on Gisela 6 rootstock, had a length of 125-265 cm regardless of the planting distance. In the third fruiting year, the harvest of the sweet cherry trees amounted to 8,0-12,86 t/ha, and in the fourth year – 14,62-20,07 t/ha. During the period of full fruiting, the yield increased, but not in direct proportion to the number of trees per one ha; sweet cherry yields were higher and statistically assured at shorter tree planting distances. Regarding the productivity of the varieties, it has to be mentioned that the largest harvest was produced by the trees of the Ferrovia cv that had been panted at the distance of 5x1,5 m, namely 18,94-20,07 t/ha, in their 7th year of vegetation. The trees that had been planted at the distance of 5x2,5 m, produced the smallest harvest, namely 15,63-16,90 t/ha. The disparity in the crops can be explained by the difference in the number of trees per hectare.

It is also worth noting that the average yield over the years is not the most important indicator that reflects the efficiency of the cultivation system. The most important thing is to get early high yields of high quality and competitive fruit in order to recoup the initial investment spent on creating an orchard (Long Lynn et al. 2014, Cimpoieș 2018). The data obtained indicate that sweet cherry trees grafted onto the Gisela 6 rootstock and planted at a high density allow obtaining medium-sized crowns, stimulate early fruiting, increase pruning productivity and make it possible to gather fruit from the ground; planting density is limited by the economic law of diminishing marginal productivity (Sumedrea et al. 2014).

Thus, in 2018 the sweet cherry trees of Ferrovia, Kordia, Regina, Skeena and Stella varieties, grafted on the MaxMa 14 rootstock, yielded from 4.18 t/ha to 15.70 t/ha. The Early Star and Black Star varieties, grafted on the Gisela 6 rootstock and planted at the distance of 4x2 m, started to bear fruit (2,9-3,7 t/ha) in the 4th year of the tree vegetation, and the Samba cv – in the 5th year of its vegetation (tab. 3).

Table 3

Sweet cherry harvest, t/ha

Cv	Year 2018	Year 2019	Year 2020	Average harvest (2018-2020)
Early Star	2.945	7.012	4.463	4.807
Samba	3.667	16.820	3.625	8.037
Black Star	0	10.750	9.875	6.875
DL, 5%	0.992	0.874	1013	-

In the 2nd year of tree fruiting, a higher yield was noted in the Samba (16,82 t/ha) and the Black Star (10,75 t/ha) varieties, and the poorest crop was produced by the Early Star (7,01 t/ha). On average, over 3 years, the Samba cv turned out to be the most productive, yielding 8,04 t/ha.

When designing modern sweet cherry orchards, it is necessary to identify the biotic and abiotic factors that define the cultivation system, which corresponds to the biological crop capacity of the orchard and to economic interest. The development of an orchard project should be based on the following principles: geographical conditions, the degree of natural soil fertility, the relative vigour of the cv-rootstock association, planting density, early high harvests; simple crowns easily adaptable to partial mechanization. Nowadays, there are rootstocks of dissimilar vigour and many varieties of sweet cherry trees. The modern orchards can be adapted to less fertile soils and planted on sloping land. All types of systems can be used to grow cherry trees in them and form crowns of various shapes (Babuc 2012, Sumedrea et al. 2014, Musacchi et al. 2015, Cimpoieș 2018).

In modern pomiculture, the sweet cherry tree cultivation system assumes the utilization of semi dwarfing rootstocks (Gisella 5, Krymsk 6), moderate vigorous rootstocks (MaxMa 14, Piku 1, Piku 4) and semi vigorous rootstocks (Gisella 6, P-HL-C, Krymsk 6). It also assumes simple crown shapes, which would fully use the nutritional space offered to the tree, early fruiting, high crops of qualitative fruit, the mechanization of technological processes and increasing labour productivity in orchard maintenance and fruit harvesting.

In conclusion, it should be noted that the cherry orchards of the future should have simple narrow crowns with a thickness of no more than 1,2 m, which will ensure good distribution of light over all areas of the crown, produce uniform high quality fruit, be suitable for mechanized pruning, have a high efficiency when harvesting fruit from the ground and from tractor-assisted platforms.

CONCLUSIONS

In modern fruit growing, the concept of shaping and pruning of cherry tree crowns is contradictory. However, in order to obtain sustainable yield, it is necessary to identify the biotic and abiotic factors that define the orchard of the future. The key objective of sweet cherry trees cultivation is to promote sustainable cultivation systems that would produce qualitative and healthy fruit. To meet these requirements, all sustainable integrated cultivation systems, based on geographical conditions, the degree of natural soil fertility, the relative vigour of the cv-rootstock

association, planting density, simple crowns, early and high harvests are successfully utilized in order to achieve great economic efficiency.

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