

NEW TRAINING SYSTEMS FOR HIGH-DENSITY CHERRY PLANTATIONS

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Abstract. *This research evaluated vegetative growth, yield and fruit quality of different cherry varieties using different crown-forming systems and planting densities. The experimental orchards were established in the central (2015) and northern (2018) areas of the Republic of Moldova, using Black Star, Regina, Summit and Sweet Sharetta varieties, grafted on Gisela 6 rootstock. For each variety- rootstock combination and training system, varying densities were established, ranging from 1250 trees/ha (for thin-stem, cup, Kym Green Bush) to 2500 trees/ha (for thin-stem, improved thin-stem, structured vertical axis). Black Star, grown under the thin-stem system, obtained the highest yields between 9.39 and 10.92 t/ha at the age of 7-10 years, significantly exceeding the values obtained for the crowns cup (8.11-9.67 t/ha) and Kym Green Bush (7.65-8.22 t/ha). For varieties Regina, Summit and Sweet Sharetta planted at 4x1 m spacing, the improved thin spindle crown shape had a modest impact on productivity, but provided important benefits on fruit size uniformity along the entire length of the axis.*

Keywords: *C. avium, rootstock, planting distances, crown forms, yield.*

INTRODUCTION

The crown forms of fruit trees are diverse and depend on the species, variety, pruning and maintenance method, available space, purpose of harvesting and crop management. [In cherry (*C. avium*), the following forms of crowns are used: round stepped crowns with large volume, well distributed and open branches to allow light penetration and air circulation, pyramidal stepped crowns with shorter and well arranged lateral branches for good light exposure, vase shaped

crowns - Spanish Tufa, Improved vase, Late vase with well spaced lateral branches, fusiform type crowns - Super Fuss Axis, Thin Spindle, Super Slender Ax (SSA), Tall Spindle Axe (TSA), Tall Fusiform Axis, i.e. elongated and narrow with well balanced branching, with main and secondary branches arranged in a balanced manner for uniform light exposure, favoring photosynthesis and fruit development [3,4,5].

In all of the fusiform training systems listed, the key feature is that pruning is mainly carried out on 1-3 year old branches, which is an innovative management approach. However, cherry varieties vary in their adaptability to the plantation structure appropriate to training systems in intensively managed high-density orchards. The objective of this research was to compare training systems suitable for high-density orchards in combination with different varieties, grafted on Gisela 6 rootstock, to assess the control on vegetative growth and productivity.

MATERIALS AND METHODS

Research on the realization of modern cherry plantations with a high level of productivity is ongoing (years 2018-2024) in the central fruit-growing area, at Ustia SRL "Staragrogrou", Dubasari rayon, and in the northern area, at Sturzeni, Riscani rayon, Republic of Moldova. This research is carried out in two experiments, using the varieties Black Star, Regina, Summit and Sweet Sharetta, grafted on Gisela 6 rootstock.

Experiment 1 was established in the fall of 2015 and includes the cherry variety Black Star, with trees planted at a spacing of 4x2 m. In this experiment, low-volume crown forms were studied, namely Thin Spindle, Cup and Kym Green Bush. Experiment 2 was initiated in the fall of 2018, with trees planted at a distance of 4x1 m, being managed according to the crown forms V1- Thin Spindle, V2-Ax vertical and V3-Improved Thin Spindle [6]. In both experiments the rows of trees are located in the north-south direction.

Physiological studies of the trees were carried out annually at the end of the growing season. On 32 trees, tree height, crown width and crown length were measured, the yield at fruit maturity was determined for each tree, expressed in kg fruit per tree and reported per hectare. During fruit harvest, fruit distribution (kg/pom) was assessed by tree height at 0-160 cm, 160-240 cm and 240-400 cm from the ground on 8 identical trees of each variety. The fruits were divided into 3 fractions according to their diameter (22-26 mm; 26-30 mm; greater than 30 mm). The results of the study were tested at a significant level of 0.05 using Tukey's test. Soil maintenance, irrigation, fertilization and protection of the trees from diseases and pests were carried out as appropriate [7,8].

RESULTS AND DISCUSSION

Vegetative growth of Black Star cherry variety was studied in dynamics (Table 1). So, the Black Star variety, during the growing and fruiting period, recorded the height of the trees of 375-400 cm, which corresponds to the optimal parameters for cherry orchards with trees grafted on low vigor rootstock, planted at the row spacing of 4 m [9,10]. The crown width of cherry trees shows that with the advancement of the trees in age the crown width increased, reaching optimal sizes in the 6-7 years after planting being 210-240 cm. In the following years the crown width depended on the distance between the rows and the height of the trees and remained at about 250 cm, regardless of the crown shape. As the crown length (200-250 cm) is a basic index in tree formation, it is clear that at the age of 6-7 years after planting the crowns of Black Star trees have joined the rows of trees and formed continuous rows.

Table 1. Phytometric indicators of Black Star cherry trees according to crown shape (planting distance 4x2 m, tree age 6-7 years)

Crown shape	Tree height, cm		Crown width, cm		Crown length, cm	
	Year 2020	Year 2021	Year 2020	Year 2021	Year 2020	Year 2021
Thin spindle	400	400	220	240	215	245
Cup	375	400	210	241	200	250
Kym Green Bush	380	400	236	241	229	250

Based on morphological indicators of the crown, the level of ground cover with crown projection, lateral area and crown volume were calculated (Table 2). The trees of Black Star variety at the age of 7 years use more than 60% of the area reserved for the tree, form a lateral crown area of 21650-22025 thousand m²/ha, being higher in the case of the crown form Kym Green Bush. The volume of the crown, as a summary indicator of the parameters of the orchard plantation, was 15483-19318 m³/ha. The trees formed after the cup and Kym Green Bush crown system formed the highest values with 14.6-24.7% compared to the thin spindle crown form. In conclusion we mention that the structure of the vegetative assembly of the Black Star cherry plantation, grafted on Gisela 6, planted at a distance of 4x2 m provides a continuous crown volume in the direction of the row, which at the age of 7 years receives more than 60% of solar energy.

Table 2. Structure of the vegetative set in Black Star cherry trees according to crown shape (planting distance 4x2 m, age of trees 7 years)

Crown shape	Ground cover, %	Lateral crown area, thousand m ² /ha	Crown volume, m ³	
			tree	ha
Thin spindle	60,0	21650	12,3	15483
Cup	60,2	21700	14,2	17744
Kym Green Bush	60,2	22025	15,4	19318

The technology of cherry cultivation, including the crown management system and orchard management determines the solar energy conversion, earliness, consistent yield and quality of fruit competitive in the market [3,4,7,11,12]. The fruit yield of Black Star cherry trees grafted on Gisela 6 rootstock, planted at 4x2 m spacing, differs by year and crown shape (Table 3). The presented data show that the yield in 2021 was low (2.99-4.40 kg/pom) due to climatic conditions during flowering, and in the following years the yield was 6.12-7.97 kg/pom or 7.96-10.92 t/ha, being significantly higher in trees formed after thin spindle crown. Thus, in the Black Star variety it can be observed that the thin spindle crown during the fruiting period of the trees has the highest distinctly significant values (9.39-10.92 t/ha) compared to the cup (8.11-9.67 t/ha) and Kym Green Bush (7.65-8.22 t/ha) crowns.

Table 3. Fruit yield of Black Star cherry trees by crown shape (planting distance 4x2 m, age of trees 7-10 years)

Crown shape	Kg/tree				t/ha			
	Year 2021	Year 2022	Year 2023	Year 2024	Year 2021	Year 2022	Year 2023	Year 2024
Thin spindle	4,40	7,51	7,97	8,72	5,50	9,39	9,96	10,92
Cup	2,99	7,04	6,49	7,74	3,73	8,81	8,11	9,67
Kym Green Bush	3,12	6,37	6,12	6,58	3,90	7,96	7,65	8,22
DL 5%	0,39	0,28	1,17	1,34	0,39	0,28	1,17	1,34

The fruit yield (Table 4) in high density plantations was 4.56-4.76 kg/inch for Regina and 6.43-6.97 kg/inch for Sweet Sharetta and Summit with insignificant increase in the crown shape thin spindle compared to vertical axis and improved thin spindle. If we refer to the yield per hectare, compared to the data presented by other authors [13,14], it can be mentioned that the yield of the varieties taken in the study are averages of those considered normal.

Table 4. Fruit yield of cherry trees by variety and crown shape, mm (Planting distance 4x1 m, year 2024)

Crown shape	Regina variety		Sweet Sharetta variety		Summit variety	
	Kg/tree	t/ha	Kg/tree	t/ha	Kg/tree	t/ha
V1	4,76	11,91	6,9	17,25	6,8	17
V2	4,56	11,41	6,63	16,58	6,43	16,08
V3	4,63	11,58	6,97	17,40	6,43	16,08
DL 5%	1,39	1,85	1,39	1,85	1,39	1,85

During the harvest, the distribution of fruits by tree height was evaluated on the sectors of ground distance 0-160 cm, 160-240 cm and 240-400 cm (Table 5). In the case of thin spindle crown shape at ground distance 0-160 cm the diameter of fruits of 22-26 mm constituted 32.8%, 26-30 mm - 48.8% and larger than 30 mm were only 18.4%. In

the central part of the crown (160-240 cm) the number of fruits with the diameter of 26-30 mm (50.03%) and larger than 30 mm (26.43%) increased. In the upper third of the crown the number of fruits with the diameter of more than 30 mm increased significantly and reached 38.03%. The proportion of fruits in the vertical axis system practically changed identically to the thin crown, with 45.52% of fruits with a diameter of 26-30 mm.

Table 5. Distribution of fruits on Regina cherry trees by crown shape, mm
(Planting distance 4x1 m, year 2024)

Crown shape	Distance from ground, cm	Fruit diameter		
		22-26 mm	26-30 mm	Greater than 30 mm
		Fruit weight, %		
Thin spindle	0-160	32,8	48,8	18,4
	160-240	23,53	50,03	26,43
	240-400	21,36	40,6	38,03
	Average	25,90	46,48	27,62
Ax vertical	0-160	33,34	45,82	20,84
	160-240	24,54	49,13	26,33
	240-400	19,45	41,62	38,93
	Average	25,78	45,52	28,7
Improved thin spindle	0-160	22,53	39,06	38,4
	160-240	15,03	46,8	38,16
	240-400	24,43	39,96	35,6
	Average	20,66	41,94	37,39

The distribution of fruit on the improved thin-stemmed Fus crown is essentially different compared to the thin-stemmed and vertical axis crowns, with a percentage of fruit larger than 30 mm in size per tree height. Thus, at the distance from the ground 0-160 cm the proportion of fruit larger than 30 mm was 38.4%, at 160-240 cm - 38.16% and 35.6% in the upper part of the crown.

CONCLUSIONS

The thin spindle crown form used on Black Star cherry, grafted on Gisela 6 rootstock and planted at 4x2 m spacing, proved to be the most effective for ensuring higher yield and continuous crown volume in the direction of the row, which, at 7 years of age, captures more than 60% of the available solar energy.

For the varieties Regina, Summit and Sweet Sharetta, grafted on Gisela 6 and planted at a density of 2500 trees/ha, the improved thin spindle crown shape had a modest impact on productivity. However, it provided important benefits in fruit size uniformity along the entire length of the axis, facilitating more efficient harvesting and marketing.

The thin-spindle and ax vertical crown forms were less effective in

distributing the fruit evenly on the spindle than the improved form. In conclusion, the improved thin-spindle crown shape is recommended for cherry crops grafted on Gisela 6 rootstock, as it provides an optimal balance between productivity and quality and is a suitable choice for high quality and high yielding crops.

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