

STRUCTURE OF THE VEGETATIVE ASSEMBLY OF APPLE TREES ACCORDING TO AGE AND THE BIOLOGICAL CHARACTERISTICS OF THE VARIETY

Inna BILICI

Technical University of Moldova, 168 Ștefan cel Mare și Sfânt Blvd, Chișinău,
Republic of Moldova

Corresponding author email: biliciinna@gmail.com

Abstract

This work refers to the study of the structure of the vegetative ensemble of apple trees organized in the experimental orchards of SRL "Elit Fruct" and SRL "Prodcar". The apple varieties Granny Smith, Gala Delicious, Gala Buckeye Simmons, Golden Delicious, Golden Delicious Reinders, Red Velox and Fuji Kiku, grafted on M9, intended for the establishment of high density plantations, cultivated in the conditions of the central area of the Republic of Moldova. The vegetative growth of the trees in the apple varieties taken in the study is expressed, quantitatively, by the volume of vegetative growth accumulated annually by the size of the height and width of the crown of the trees, by the size of the surface and volume of the crown, as well as the level of soil coverage of the whole vegetative growth of trees.

Key words: Apple variety, vegetative assembly, tree crown.

INTRODUCTION

The apple is the priority fruit tree species in the country's fruit growing, which provides about 80% of the global fruit production. Obtaining large, constant and high-quality apple productions can only be achieved as a result of the implementation of modern technological links, and in addition to the technological processes applied in the orchard, the fruits must be exploited according to an appropriate technology, which allows maintaining the quality at the highest possible levels raised, from harvesting to delivery to the consumer [Bucarciuc, V. 2008]. The variety represents one of the basic links related to the production technology in apple culture and the exploitation of climatic conditions, being at the same time a mobile element, with continuous possibilities for improvement [Bucarciuc, V. 2008]. The assortment of varieties that are grown in a fruit-growing area is of particular importance, fruit growing being profitable only if the cultivated varieties are able to capitalize on local conditions, giving large, high-quality productions, competitive on the domestic and foreign markets [Babuc, V. 2012]. At the present time, the world assortment of the apple is very rich, representing about 10-12

thousand varieties obtained by man through the empirical selection of the most valuable forms existing in nature, as well as through the activity of research and scientific improvement [Cimpoieș Gh., 2000]. Thus, the large number of varieties is also explained by the fact that, in each apple-producing country, research institutions were opened to improve apple varieties and improve assortments [Bucarciuc, V., 2008]. The analysis of the evolution of the world range of apple culture demonstrates that, in the 21st century, there is a tendency to reduce the number of apple varieties cultivated in accordance with the conditions of environmental exploitation and the requirements of the international market. Today, in the large apple-producing countries, a small number of varieties are grown on huge areas, but with great production potential and quality fruit [Bucarciuc, V., 2008]. The most important cultivars cultivated in the world are those from the Red Delicious, Golden Delicious and Fuji groups [Babuc, V., 2012]. It is observed that, while the surfaces with red varieties remain stable, those with yellow varieties are decreasing, and the surfaces with bicolor varieties are increasing. Vegetative growth and stem development in trees is determined by biological (variety, rootstock, resistance to diseases and pests) and

technological factors (fruit load, provision of food and water), which condition the development of physiological processes [Babuc et al., 2008]. The influence of pedological factors, such as soil structure and fertility, restrictive soil factors, and climatic factors, such as solar energy, temperature, through its maximum and minimum values, but especially through the values recorded in the vegetation period (fruiting phenophases), the amount of precipitation, etc. [Babuc, V. et al., 2013]. From a genetic point of view, the variety is the basic factor in determining the culture system and technology [Bucarciuc, V., 2015].

MATERIALS AND METHODS

Experience 1. The research was carried out at SRL "Elit Fruct" in the village of Coșernița, Criuleni district, during the years 2015-2019. The plantation was founded in 2015, the varieties Red Velox and Golden Delicious Reinders grafted on the M9 rootstock were studied. The distance between rows was 3.2 m, and per row - 0.8 m, which is equivalent to 3900 trees/ha. When planting, the grafting site was placed 15-20 cm above ground level. Until the orchard was planted, the tree support system was installed - monoplane, simple, made of reinforced concrete poles, with a height of about 4.0 m above the ground, and a metal wire installed at a height of 50 cm from the ground level, which it is also used as a support for the irrigation system. In the first year of vegetation, 5 more metal wires were added. The first 2 wires were fixed at 80 cm from the ground and at 80 cm from each other, the following - at 160 cm, 240 cm and 320 cm from the ground, respectively. The experiment was set up in 4 randomized replicates of 8 trees each [Cimpoieș Gh., 2000].

Experience 2. The research was carried out at SRL "Prodcar" from Negureni village, Telenești district, during the years 2015-2019. The apple orchard was planted in 2014. In order to establish an assortment of apples intended for sustainable production in the ecopedo-climatic conditions of the central area of the Republic of Moldova, 4 apple varieties recently introduced into the intensive culture system were studied, namely Granny Smith, Gala Buckeye Simmons, Red Velox and Golden Delicious Reinders

grafted onto M9 rootstock at 3.2 x 0.8 m spacing (3900 trees/ha). As a witness served the variety Granny Smith. The trees are driven in the form of a thin improved spindle and planted at a distance of 3.5 x 1 m (2857 trees/ha) in the north-south direction. When planting, the grafting site was placed 20 cm above ground level. Each variant included four repetitions of eight trees each. During the research, the maintenance and phytosanitary protection works of the trees, provided for in the technology of super-intensive apple culture, were applied in the orchard. The soil in the orchard is maintained by weeding and weeding the row of trees

RESULTS AND DISCUSSIONS

Vegetative growth and stem development in trees is determined by biological (variety, rootstock, resistance to diseases and pests) and technological factors (fruit load, provision of food and water), which condition the development of physiological processes [Babuc, V., 2012]. The influence of pedological factors, such as soil structure and fertility, restrictive soil factors, and climatic factors, such as solar energy, temperature, through its maximum and minimum values, but especially through the values recorded in the vegetation period (fruiting phenophases), the amount of precipitation, etc. [Balan, V. et al., 2018]. From the genetic point of view, the variety is the basic factor in determining the culture system and technology.

The vegetative growth of the trees in the apple varieties taken in the study is expressed, quantitatively, by the volume of vegetative growth accumulated annually by the size of the height and width of the crown of the trees, by the size of the surface and volume of the crown, as well as the level of soil coverage of the whole vegetative growth of the trees (Table 1). The height of the crown, in the studied varieties, was 256-282 cm in the 3rd year after planting. The variety Red Velox, of weak vigor, recorded the lowest value (256 cm) of crown height.

The width of the crown at the base recorded maximum values (105-124 cm) admissible in relation to the distance of planting trees in a row (80 cm). The width of the crown at the top depends on the growth vigor of the variety and varied between 25 cm, in the variety Red Velox,

and 65 cm, in the variety Granny Smith (control) of high vigor. The level of soil coverage with the vegetative assembly receiving solar energy has values of 32.8-38.8%. The difference in the use of the

nutrition surface of the trees is insignificant, since the distances between the rows and within the row are optimal for the apple varieties grafted on the M9 rootstock in high density plantations.

Table 1 Structure of the vegetative ensemble of apple trees according to age and the biological characteristics of the variety

Variety	Crown height, cm	Crown width, cm		The level of ground cover with the projection of the crown, %	The lateral surface of the crown, thousand m ² /ha	Crown volume m ³	
		at the base	at the top			tree	ha
year 2017, age of the trees – 3 years							
Granny Smith (control)	282	124	65	38.8	24568	2.6	10155
Gala Buckeye Simmons	270	112	45	35.0	22850	2.1	8202
Red Velox	256	105	25	32.8	20975	1.6	6249
Golden Delicious Reinders	265	115	50	35.9	22654	2.2	8593
Fuji Kiku	265	116	45	36.3	22459	2.1	8202
year 2019, age of the trees – 5 years							
Granny Smith (control)	329	130	75	40.6	28630	3.4	13280
Gala Buckeye Simmons	335	130	65	40.6	28709	3.2	12499
Red Velox	285	130	45	40.6	24021	2.5	9765
Golden Delicious Reinders	333	130	70	40.6	28748	3.3	12889
Fuji Kiku	324	130	65	40.6	27849	3.2	12499

Based on the tree vigor data, the crown volume at the tree level was calculated and reported to the surface unit. The lateral crown surface of 3-year-old apple trees was 20975-24568 m²/ha, and the crown volume was 1.6-2.6 m³/tree and 6249-10155 m³/ha, respectively.

Along with the growth and development of the trees, the parameters of the crown also increase. In 5-year-old trees, the height of the crown is 285-335 cm, depending on the variety, and the width of 130 cm remains constant in all the varieties studied (the distance between rows of 3.2 m does not allow wider crowns) [Balan, V. et al., 2001]. The width of the crown at the top varies from 45 cm, in the trees of the Red Velox variety, to 75 cm, in the Granny Smith variety (control). The soil coverage with the vegetative assembly reached the optimal level possible for the row spacing of 3.2 m and recorded values of 40.6% for all varieties.

The lateral surface of the crown in 2019 (24021-28709 m²/ha) increased significantly compared to 2017 (20975-24568 m²/ha) and achieved optimal values for such orchards. Crown volume, which depends on crown area, also increased significantly, constituting 2.5-3.4 m³/tree and 9765-13280 m³/ha, respectively. In

2019, crown area and volume were greater in Gala Buckeye Simmons, Granny Smith (control), Golden Delicious Reinders and Fuji Kiku varieties compared to Red Velox variety. Thus, in the 5th year of vegetation, the trees of the apple varieties studied achieved an optimal crown surface and volume, which characterizes the productive potential of the plantation. The data related to the structure of the vegetative ensemble of apple trees from SRL "Prodcar" are presented in Table 2. From the data obtained regarding the height of the trees, it follows that the trees of the Red Velox variety have the lowest height both in 2017 (272 cm) and in 2019 (271 cm). The medium to high vigor varieties (Gala Buckeye Simmons, Granny Smith (witness) and Golden Delicious Reinders) exceed the height of the less vigorous trees (Red Velox) by 50-100 cm.

The width of the crown in 4-year-old trees varies depending on the variety and is 118-132 cm at the base of the crown and 32-71 cm at its top. In the 6th year of vegetation, these indices increased insignificantly, and the crown of the trees did not exceed the space reserved by the planting distances between rows and per row.

Table 2. The structure of the vegetative ensemble of apple trees according to age and the biological particularities of the variety

Variety	Crown height, cm	Crown width, cm		The level of ground cover with the projection of the crown, %	The lateral surface of the crown, thousand m ² /ha	Crown volume m ³	
		at the base	at the top			Tree	Ha
year 2017, age of the trees – 4 years							
Granny Smith (control)	295	132	70	41.3	25779	2.97	11600
Gala Buckeye Simmons	295	127	60	39.7	25389	2.75	10741
Red Velox	272	118	32	36.9	22498	2.04	7968
Golden Delicious Reinders	285	126	71	39.4	25037	2.80	10936
year 2019, age of the trees – 6 years							
Granny Smith (control)	341	140	75	43.8	29568	3.66	14295
Gala Buckeye Simmons	355	140	75	43.8	30662	3.81	14881
Red Velox	271	140	42	43.8	22811	2.46	9608
Golden Delicious Reinders	338	140	70	43.8	29138	3.55	13866

The level of ground cover with crown projection in 4-year-old trees was 36.9-41.3%, varying slightly from one variety to another. The 6-year-old trees occupied the maximum planting area and reached values of 43.8% for this index.

The lateral area of the crown in the 4th year of vegetation varied from 22498 m²/ha, for the Red Velox variety, to 25779 m²/ha, for the Granny Smith variety (control), and at the age of 6 the trees had a maximum area of the crown of 30662 m²/ha.

The volume of the crown differs both at the level of the tree and at the level of the surface unit. The crown of the trees provides the support structure for the branches, leaves and fruits, and through its structure it must ensure the penetration of solar energy to all skeletal, semi-skeletal and garnishing branches to maintain their coverage with fruit formations and to print a production volume as high as possible. The volume of the crown varies depending on the size of the trees, and these are influenced by the vigor of the variety. The studied varieties form a continuous crown in the direction of the row, which allows receiving no more than 43.8% of solar energy. In 4-year-old trees, the volume of the crown was 7968 m³/ha in the Red Velox variety, increasing considerably in the high-vigor varieties, up to 10741-11600 m³/ha. In 2019, the crown volume of 6-year-old trees reached optimal values and was 9608-14881 m³/ha.

At the tree level, in the 6th year after planting, the recorded crown volume fluctuated quite a lot between varieties - from 2.46 m³/tree, for the Red Velox variety, to 3.81 m³/tree, for the

variety Buckeye Simmons Gala. The crown volume data demonstrate that Gala Buckeye Simmons, Granny Smith (control), Golden Delicious Reinders and Fuji Kiku apple varieties, during the growth and fruiting period, formed an optimal vegetative ensemble for the rational use of solar energy and obtaining a yield enhanced by quality fruit. Similar results regarding the formation of the productive volume in modern orchards were obtained and argued by V. Balan (1997), Gh. Cimpoieş (2000), the data being a function of the size of the crown, the volumetric density coefficient of the lateral surface of the crown and the coefficient of effectiveness of the plantation.

Along with the growth and development of the trees, the parameters of the crown also increase. In 5-year-old trees, the height of the crown is 285-335 cm, depending on the variety, and the width of 130 cm remains constant in all varieties studied (the distance between rows of 3.2 m does not allow wider crowns).

The width of the crown in 4-year-old trees varies depending on the variety and is 118-132 cm at the base of the crown and 32-71 cm at its top. In the 6th year of vegetation, these indices increased insignificantly, and the crown of the trees did not exceed the space reserved by the planting distances between rows and per row.

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CONCLUSIONS

Vegetative growth and stem development in trees is determined by biological (variety, rootstock, resistance to diseases and pests) and technological factors (fruit load, provision of food and water), which condition the development of physiological processes [Babuc, V., 2012]. The influence of pedological factors, such as soil structure and fertility, restrictive soil factors, and climatic factors, such as solar energy, temperature, through its maximum and minimum values, but especially through the values recorded in the vegetation period (fruiting phenophases), the amount of precipitation, etc. [Balan, V. et al., 2018]. From the genetic point of view, the variety is the basic factor in determining the culture system and technology.

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