

Influence of the Method And Degree of Apple-Tree Cyclic Pruning on Photosynthesis Productivity

**Ikramova Makhbuba Latipovna^{1*}, Yunusov Rustam², Rakhmatov Baxtiyor Nimatovich¹,
Maxsudov Saidumar Isaevich³, Karimova Madina Faxritdinovna²**

¹Deputy Director of the Scientific Research Institute for Seed Breeding and Agricultural Technology of Cotton Growing, Bukhara Scientific Experimental Station, Uzbekistan.

²Associate Professor of the Department of Biotechnology and Food Safety, Bukhara State University, st. M. Iqbol 11, Uzbekistan.

³Master of Bukhara State University, Department of Biotechnology and Food Safety, st. M. Iqbol 11, Uzbekistan.

*Corresponding author: Ikramova Makhbuba Latipovna.

Abstract

The article provides data on how, in the saline soils of the Bukhara region of the Republic of Uzbekistan, it is possible to carry out 3-4 summer cyclic rejuvenating pruning on overgrown branches, fruiting branches, grafted grafts and combinations of perennial different varieties of apple trees, tree formation, and the influence of methods and degrees of cyclic pruning on the illumination of the crown, leaf surface, dry weight and photosynthesis productivity of the apple tree. Four-year studies have shown that with 3-4-year cyclic rejuvenating pruning on overgrown branches, fruit-bearing branches, the total leaf area of the studied varieties decreased by 16-23%, but the size of each leaf plate increased by 21-32%. The highest net productivity of photosynthesis was noted in the leaves located in the upper part of the tree trunk, and the lowest - in the leaves located in the central part of the tree trunk, and increased to 0.10-1.25 g compared to the control. The average yield of fruit-bearing branches in 3 varieties of apple trees during the rejuvenation of branches according to a 3-4-year cycle is 4-16 eyes, an additional yield is obtained, respectively: 0.1-4.0 c/ha 0.9-3.5 c/ha; 0.6-3.1 q/ha.

Keywords: leaf surface; crown illumination; photosynthesis productivity; method and degree of pruning; replacement pruning of fruiting branches with a 3-4-year cycle; productivity

Introduction

The most necessary condition for increasing the productivity of fruit trees is the intensive use of solar radiation and an increase in the leaf surface. The size of an apple leaf section is often determined by grafted grafts and cultivar combinations, tree pruning and shaping, and tree density. The growth biomass of a plant organism, including useful economic crop biomass, is a product of photosynthesis. All leaves work with different productivity. This means that depending on how they are located on a branch of a tree trunk and how they are provided with solar radiation, the process of photosynthesis will change, which means that the productivity of photosynthesis will also change accordingly[1-4]. The task of gardeners is to increase the productivity of photosynthesis by monitoring the degree of formation and pruning of trees, as well as correctly placing leaf surfaces in the tiers of branches of each tree. The optimal level of such general illumination in open areas is about 50-70%. Due to the simultaneous increase or decrease in the optimal level of radiation, the process of photosynthesis proceeds under the best conditions[1-4].

Methods

The main goal of the research is to ensure a stable and consistent increase in fruit yield of fruiting branches in intensive orchards through the use of the most effective anti-aging and replacement methods and the degree of periodic pruning on productive branches. And also, by studying the recommended methods and degree of pruning, to significantly increase the annual fruiting of apple trees, by shortening the method and degree of pruning on fruiting branches, in order to increase the efficiency of fruiting and issue recommendations for production based on the most positive results obtained. Object of study. The studies were carried out in 2019-2022. on the experimental plot of the farm "Amin Hayot bogi" in the Bukhara region on 3 different varieties of apple trees Golden Delicious, Renet Simirenko and Firstborn of Samarkand grafted on medium-sized rootstocks MM-106 with a tree planting scheme of 6x4 m, formed with a semi-compressed crown shape, with an irrigation rate 3200-3500 m³/3. Watering was carried out during the year 4-5 times. The depth of groundwater is located at 2.5-2.7 meters above sea level. In the experiment, the determination of the methods and degree of pruning on

fruiting branches was studied according to a three- and four-year cyclic alternation of the method of rejuvenating and normalizing pruning on growing branches of an apple tree. As a control option, the methods of pruning an apple tree existing in the farm were used, which consists in removing dry, diseased and interfering branches of trees. Against the background of the method of pruning (control) used under production conditions, by alternating 3-year cyclic pruning, 3 growing, productive branches of each apple tree are annually rejuvenated, leaving 2-3 fruitful shoots to obtain new growing branches.

In variants of cyclic replacement with 4-year pruning, where every year 4-year-old branches are rejuvenated, and 2-3-fruit buds are left for replacement to obtain new growing and productive branches next year. In the process of rejuvenation of the branches of the apple tree, in order to leave the required number of fruit buds on the fruit-bearing branches, the branches are shortened, leaving 4-8, 8-12 and 12-16 fruit buds, and in the control variant, the branches are not shortened for comparison with other tested variants. The experimental scheme of the experiment is presented in Table 1.

Table 1: Scheme of experience

Options for anti-aging pruning on growing branches, fruiting shoots	The number of fruit buds on the left branches (pcs.)
Recommended pruning method used in the production environment (control)	Without shortening
Three-year cyclic anti-aging pruning method	4-8
	8-12
	12-16
	Without shortening
Four-year cyclic rejuvenation pruning method	4-8
	8-12
	12-16
	Without shortening

Table 2: Variants of the second experiment.

Variants of the second experiment
1. Pruning of branches leaving 2-3 fruit-bearing and growing shoots in order to rejuvenate the resulting branches;
2. Trimmings of fruiting branches, 10-12 cm long on unawakened shoots;
3. Shortening branches, in order to obtain new branches from the main trunk of the tree.

In all the experimental variants studied, pruning of branches growing on the side of the central conductive branches was shortened to a height of 3.0–3.2 m, and this figure was maintained at the same height by further pruning. The variants of the experiment consisted of three repetitions, while the number of trees for accounting in the variant was 8-10, and in 3 repetitions - 24-30 trees. The variants were placed in a block, sequentially according to the method of randomization. Research and accounting were carried out developed at the All-Union Research Institute of Horticulture [5-7] from the generally accepted methodological manuals, phytometric indicators of apple trees, illumination, leaf surface, dry weight, photosynthetic productivity and yield and its quality indicators were studied. Calculations were made to study the thickness of the aerial part of the apple tree - trunk - the thickness of the trunk, the average and total annual growth of branches, the size of the branches. Annually, at the beginning and end of the year, metric measurements were made on the registered trees. At the

same time, the length and thickness of the branches obtained in the process of pruning were measured, and the number of shoots in them was also determined. And on the leaf surface and the accumulation of dry matter of apple varieties on ordinary trees, they were determined by the Nichiporovich “cutting” method [8]. The distribution of sunlight over parts of the tree branches was measured using a Yu-16 luxmeter, that is, during the period when the illumination level was optimal for the leaves, i.e. 15.06 during the day at 800, 1200, 1500, 1800 hours compared to the open area. The productivity of photosynthesis was determined by the method of A. S. Ovsyannikov [9] on 3 accounting trees. The dynamics of crop formation was studied by the variety study method (All-Union Research Institute of Horticulture) [5-7]. In apple trees, the productivity indicators of each remaining tree were studied for all calculations, the average indicator was calculated per 1 ha. The photosynthetic productivity of leaves on branches was determined per 1m², 1m³, and 1cm².

Statistical processing of all obtained experimental results was carried out according to the method of B. A. Dospekhov [10].

The economic efficiency of growing apple trees was determined on the basis of methodological manuals [11], published at the Department of Economics, Bukhara State University.

Results and discussions

The efficiency of the leaf and the productivity of photosynthesis depend on the location of the branches of the leaf, the time of its formation, the size of the leaf surface, structure, age, the presence of acceptors - organs or tissues, and it is shown that this depends on the intensive participation of assimilators in the intensive construction of their organism, in the implementation of physiological processes or in the winter-spring period.

The intensity of photosynthesis is also determined by the influence of the environment and external factors. They depend on illumination, temperature, carbon dioxide concentration, air mixing in the leaf, humidity and the amount of mineral nutrients, and soil salinity. It cannot be said that the productivity of an apple tree can be increased by bringing the leaf surface area to an optimal level. All leaves can be fertile or infertile depending on where they are located on the branch and how much light and how nutrients are distributed on the branch. Practical differences in increasing the productivity of work on a sheet surface are very large [2], [12-25]. The conducted studies showed that during the periods of growth and development of fifteen-year-old apple trees, the leaf surface area reached an acceptable level, and this figure ranged from 20.0 m²/ha to 24.0 m²/ha in variants of different apple tree varieties. The results of a 4-year study showed that with a 3-4-year cyclic rejuvenating, replacing pruning on growing branches, fruit-bearing branches, the total leaf area of the studied varieties decreased by 16-23%, but the size of each leaf plate increased by 21-32%. As a result, it was noticed that its productivity increased due to a sharp increase in the illumination of the branches and the intensity of the photosynthesis process in the leaves.

According to the analysis, depending on the same type of tree formation and the density of tree bushes (416 trees/ha), by increasing the degree with the method of a three-four-year cycle of rejuvenating pruning, a decrease in the size of the assimilation surface of the leaves was observed. Then, when recalculating the level of the leaf surface per tree, their number decreases until 4 to 16 fruit-bearing shoots appear, and when calculated per hectare, on the contrary, the assimilation surface of the leaves increases.

Also, according to the results of a long-term study, it was found that with an increase in the degree of pruning in apple trees, the leaf surface of each bush decreased by 18-

21%, and by 1 ha, an increase in the area of the leaf plate was observed.

The area of the leaf plate increased from 15-20% to 23-38% in the variants where replacement rejuvenating and periodic pruning methods and degrees were used to reduce overgrown branches.

As a result of the research, it was also found that the assimilation surface of the leaf is mainly influenced by the biological characteristics of the variety, the method and degree of standard pruning, and the duration of cyclic replacement by growing branches.

The area of the leaf surface of the branches of the Golden Delicious apple tree is 11.8-13.0 m²/tree, for the Renet Simirenko variety - 12.4-14.0 m²/tree, for the Pervenets Samarkandsky variety - 11.2-12.4 m²/tree. These indicators have been confirmed by other scientific results obtained during intensive care of apple orchards. Also, a decrease in the projection area of a tree trunk and the size of a leaf plate depends on the biological characteristics of the studied varieties.

Thus, it was found that, when used in variants with replacement, rejuvenating and normalizing methods and with an increase in the degree of pruning during a three-four-year cycle, the volume of the leaf blade decreased by 7.0-20.0% compared to the control. Also in the control variant, the distribution of the leaf surface area of the branches located on the tree trunk was almost the same size, and the leaf surface area was up to 34% in the lower tier, in the middle tier - up to 39%, in variants using the rejuvenating, replacing and normalized method and the degree of pruning of regrown branches, and in the upper tier it was set to -27%.

Thus, during the fruiting period for a full harvest of apple trees, following the degree of rejuvenating replacement branches and normalizing pruning of regrown branches, that is, pruning branches leaving 8-16 fruit buds separately, the area of the leaf blade, on the contrary, increased to a noticeable extent.

In observations, a number of researchers noted that the leaves of the branches of a fruit tree are not equally illuminated. This can be seen in the deeper part of the trunk and branches of the tree and on the sides, where light falls and allow more solar radiation to penetrate into the interior than other varieties with a dense leaf surface. Depending on the age of the tree, the size of its crown and the biomass of nutrients, as well as the growth of the leaf surface, the nature of the distribution of solar radiation changes differently.

The best indicator of the high level of foliage and the simultaneous degree of daylight illumination of its location in terms of the density of branches among the 3 studied apple varieties was observed in the variants of rejuvenating and replacing 3-4-year cyclic methods and the degree of pruning on the growing branch.

In this variant, when 8-16 fruit buds were left on the branches of the plant, they were given the opportunity to

develop well, and the degree of daylight illumination of apple trees was 18-26% less than the equipment of the open field in the main center, which is quite enough for the normal activity of photosynthesis. In the control variant, this figure was 31-44 m² per tree in 2022, depending on the variety. Giving the trees the correct shape, shortening according to the method and degree of pruning has a positive effect on their growth and development, high-quality and fast fruiting, including the efficient use of solar energy scattered over distances, low consumption in terms of area and unit of production, the cost of grown product, yield and quality of fruits are improved, the viability of trees is increased, production costs are reduced.

According to Gurin A.V., Nikitina O.V. [26], on the study of the crown of an apple tree, depending on the height of the fall of the tree, as well as the influence of the level of illumination on the quality of the fruit. When the crown was reduced to 3m, the level of illumination in the center of the crown was 61.5%, which is favorable for the laying of fruit buds and good quality.

One of the main indicators of the productivity of an apple tree is the distribution and illumination of solar radiation throughout the tree. The increase in apple fruit, the improvement in the quality of the crop, energy, and the activity of photosynthesis depend on how much it is illuminated by the sun's rays. The lighting mode of the near-stem circle of a fruit tree is one of the most important factors, it directly depends on the width of the site, the exposure of the site, the time of year and the degree of cloudiness of the weather at night, the number of shoots, the apple tree variety, the size and shape of the tree trunk. We found that the activity of a leaf formed under conditions of constant shade is low, even if it is provided with a sufficient amount of light energy, there is a weak development of cellular organelles in the process of photosynthesis. A low level of illumination is one of the main reasons for the weakening of the growth and development of photosynthetic organs without deepening their tissue differentiation. Lighting is also a factor that regulates flowering and fruiting.

At the end of the period of growth and fruiting in the studied varieties Golden Delicious, Renet Simirenko, Firstborn of Samarkand in the fifteenth year after planting trees, in the control, the height of the tree, respectively, was 5.1 m. and 3.8 m. The diameter of the cross-section of tree trunks (in the direction of the row) in the control variant was 2.2 m, respectively, and according to the method used and the degree of pruning, it was 3.5 m. and the diameter of each was 3.8-4.0 m. Due to the application of the method of rejuvenating pruning on growing branches, sprouted shoots by variety, the size of the tree trunk decreased and the density decreased, and an improvement in the degree of illumination was also established. Regardless of the method and degree of pruning, it was noted that the penetration of the radiation flux into the

branches of the tree trunk increased in the middle of the day and gradually decreased in the afternoon.

Throughout the day, the weakest illumination was observed at the base of the tree trunk, but even here it was sufficient for the normal level of photosynthetic activity of the leaves, differentiation of flower buds and the formation of a high yield, because. illumination compared to the open area was 30-50%. The productivity of solar radiation was higher on the inner side of the branches of the tree trunk compared to the control variant for all varieties and variants of methods and degree of pruning.

On average, for one day, the number of branches located in the central part of the tree trunk, in 3 studied apple varieties, the illumination did not exceed 36-38% in the control variant, and in the method and degree of pruning, respectively, were: 41.5 compared to the illuminated open 43.0% of the area in the used variants was achieved.

It should be noted that at 50% illumination, the process of photosynthesis takes place in the leaves at a satisfactory level. Less than 30% of light reduces the efficiency of photosynthesis. Under the influence of low light, the fruits become smaller and show negative indicators that are not characteristic of the variety. [4,12-13].

The studies noted that the productivity of photosynthesis was 1.1-1.2 times higher as a result of improved illumination of the inner part of the branches of the tree trunk in variants where methods and degrees of rejuvenating pruning were used in the growing branches. Thus, as a result of applying the correct and scientifically based pruning method, the illumination in the inner parts of the branches of the fruit tree trunk is significantly improved, resulting in an increase in the productivity of photosynthesis, productivity and quality of the crop, as a result of which the mass of apple fruits increases.

Among the external factors for plants, light is one of the most necessary and labile factors. Often, it is the level of illumination of the leaves that determines the intensity and productivity of photosynthesis. In the early morning and evening hours, as well as in cloudy weather, the leaves feel a lack of light energy and absorb carbon dioxide much less. In the middle of the day, on cloudless days, when the rays of light fall directly on the leaves, they receive an excess of light energy. An extreme excess of light inhibits the rate of photosynthesis in both situations, as does a lack of light, although the reasons for the decrease in the rate of absorption (assimilation) of carbon dioxide are different here.

The intensity of photosynthesis is determined by the proportion of environmental factors that respond to external environmental influences. These include the following factors: light, temperature, carbon dioxide concentration, air exchange in the leaves, humidity and the amount of nutrients.

Chlorophyll particles are the most important substance in the intensity and productivity of photosynthesis. The intensity and productivity of photosynthesis can be

explained by the following data of visual experience, depending on how light falls on the branches (leaves) of a tree trunk.

The data presented in Table 3 show that in all three-four-year cycles of rejuvenating and normalizing pruning of overgrown branches of the 3 studied apple tree varieties, the net productivity of photosynthesis changes depending

on the location of the branches on the tree trunk, and the number of fruit-bearing shoots on different parts of the tree is different. . The highest net productivity of photosynthesis was noted in the leaves located in the upper part of the tree trunk, and the lowest - in the leaves located in the central part of the tree trunk, and increased to 0.10-1.25 g compared to the control.

Table 3: Net photosynthetic productivity of the apple tree by method and degree of pruning (2022)

Options for anti-aging pruning on growing branches that have finished fruiting	The number of fruit buds on the left branches (pcs.)	Productivity of pure photosynthesis in longline branches, g		
		lower	middle	upper
Apple varieties Golden Delicious				
Control	No shortening	5.67	4.25	8.02
3-year cycle	4-8	6.75	5.15	9.55
	8-12	6.55	5.02	8.95
	12-16	6.75	4.75	8.75
	No shortening	5.90	4.50	8.45
4-year cycle	4-8	6.45	4.97	9.25
	8-12	6.25	4.8	8.7
	12-16	5	4.5	8
	No shortening	5.75	4.4	7.5
Apple varieties Renet Simirenko				
Control	No shortening	4.35	3.85	7.45
3-year cycle	4-8	5.5	5	9
	8-12	5.2	4.85	9.75
	12-16	5.12	4.5	8.25
	No shortening	5	4.15	7.9
4-year cycle	4-8	5.25	4.9	8.9
	8-12	5.05	4.75	8.5
	12-16	4.9	4.3	8.05
	No shortening	4.6	4.05	7.7
Apple varieties Pervenets Samarkanda				
Control	No shortening	4.25	3.35	7.15
3-year cycle	4-8	5.2	4.85	8.75
	8-12	5.05	4.4	8.35
	12-16	4.85	4.25	7.95
	No shortening	4.5	3.97	7.5
4-year cycle	4-8	5.05	4.5	8.5
	8-12	4.9	4.25	8.05
	12-16	4.5	4	7.7
	No shortening	4.4	3.55	7.5

Thus, in variants where methods and degrees of pruning are used, the productivity of photosynthesis increases depending on the improvement in illumination and the increase in the degree of shortening of the branches left for fruiting, and as a result, provides an increase in the yield of the apple tree.

As a result of the application of methods and degrees of pruning in fruit trees, which positively affect their growth and development, all physiological processes are successfully carried out: metabolism, the intensity and

productivity of photosynthesis, transpiration processes, as a result of which it becomes possible to increase productivity and its quality.

If the extra branches of fruit trees are pruned when they are young, they will start harvesting early. During the harvest period, when this agro-measure is not applied, fruit trees will bear fruit until a certain period (maturity), and then when they reach a certain stage of growth and development, they will continuously produce, the fruiting order is disturbed. During the ripening period, together with the

formation of buds that bear fruit for this year, during the growth period, it ensures the formation of flower buds on the branches for the next year. The frequency of fruiting begins in apple varieties with a large load remaining on their branches, with a decrease in growth and development. The fruits become smaller, the appearance and marketability of the crop deteriorates, and the quality decreases. In this case, it is necessary to pay attention to the method of pruning and the levels of reduction in such gardens.

As a result of the research, it was found that over 3-4 years of studying 3 different varieties of apple trees, the number of flowers in the variants left for fruiting without shortening the branches left for rejuvenation was 12.3% for the Golden Delicious variety, and 12.3% for the Renet Simirenko variety. 11.8%, and Firstborn in Samarkand, it was 13.0%, on branches shortened leaving 4-8, 8-12, 12-16 fruit buds, the yield for apple varieties was 11.5-12.8 % above the control.

Conclusion

From the above data, it has been established that the use of the method and degree of rejuvenating pruning of branches in a 3-4-year cycle had a positive effect on tree fruiting.

Thus, in order to rejuvenate the given and grown branches, the studied varieties have a high percentage of useful pollination, the number of flowers is reduced, and in the variants that leave 4-8, 8-12 and 12-16, the number of flowers is reduced. Fruit shedding of fruit buds on three-four-year-old branches is reduced.

When applying the methods and degrees of pruning old trees, their general condition improves, the number of extra flower buds decreases, the level of illumination, leaf canopy, dry weight and photosynthesis productivity, productivity, and fruit quality improve significantly.

Over the years of research, the average yield of fruit-bearing branches in the Golden Delicious variety during the rejuvenation of the branches according to a 3-4-year cycle was 4-16 eyes, an additional yield was 0.1-4.0 c/ha, in the Renet Simirenko variety 0.9- 3.5 c/ha, in the variety Pervenets Samarkand 0.6-3.1 c/ha compared with the control variant. The best results were obtained on variants that left 8-16 buds on fruit-bearing branches against the background of 3-4-year rejuvenation of fruit-bearing branches.

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