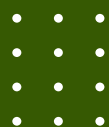


Edited by S. Stankevych, O. Mandych

MODERN TRENDS IN AGRICULTURE SCIENCE: PROBLEMS AND SOLUTIONS



 **TEADMUS**
SERVICE FOR SCIENTISTS

2023

**MODERN TRENDS
IN AGRICULTURAL SCIENCE:
PROBLEMS AND SOLUTIONS**

Edited by S. Stankevych, O. Mandych

**Tallinn
Teadmus
2023**

UDC 631.1:338.43:339.9

Modern trends in agricultural science: problems and solutions. Monograph. Edited by S. Stankevych, O. Mandych. – Tallinn: Teadmus OÜ, 2023. 220 p.

ISBN 978-9916-9859-8-4

Reviewers:

Mykola DOLYA, Ph.D., Prof., Head Department of Integrated Plant Protection and Quarantine of National University of Bioresources and Nature Management;

Oleksandr KUTS, Ph.D., leading of science collaboration, Director of the Institute of Vegetable Growing and melon growing of NAAS of Ukraine.

The monograph is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped at 7 sections: Plants protection and quarantine; vegetable growing in open and closed ground; horticulture, fruit growing, viticulture; breeding and seed production; agrochemistry and soil science; agriculture and modern agricultural technologies; management and strategies for future development. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: agriculture, modern technologies, plants protection, quarantine, vegetable growing, horticulture, fruit growing, viticulture, breeding and seed production, agrochemistry, soil, management, strategies, development.

ISBN 978-9916-9859-8-4

© Team of authors

TERMS OF MECHANISED PRUNING OF INTENSIVE APPLE TREES IN THE CONDITIONS OF THE LEFT BANK FOREST STEPPE OF UKRAINE

Vitaliy LEUS

Candidate of Agricultural Sciences, Associate Professor, Professor
Department of Horticulture and Storage of Crop Products, State
Biotechnological University
vitaliyleus79@gmail.com

The research presents the effect of the timing of contour mechanized pruning of apple trees on phytometric indicators and the productivity of plantations in the orchard of Kharkiv Fruit Company LLC. It was established that the use of contour pruning of trees in the pink bouquet phase provides maximum profit regardless of the pomological variety, as well as maximum profitability of apple production. The positive effect of mechanized pruning during the formation of the fruit wall on the growth processes of the tree and indicators of marketable qualities and yield is substantiated.

Key words: *apple tree, pruning terms, mechanized pruning, fruit wall, variety, profitability, quality, productivity.*

In most countries of Western Europe with developed horticulture, there is a tendency to create quick-fruiting, highly productive apple orchards with a dense arrangement of trees while forming low-volume crowns. In intensive plantings of apple trees on weakly growing clonal rootstocks, in order to obtain high and stable yields, it is necessary to constantly manage the processes of growth and fruiting of fruit plants, to influence the duration of the productive period of the use of trees, the quality of the obtained products (Hrynyk I.V., Omelchenko I.K., Lytovchenko O. M., 2012). According to Professor Mika A., in order to obtain stable harvests in intensive plantings of apple trees on clonal rootstocks, the balance between growth and fruiting processes should be constantly maintained (Mika A., 2003). Polish horticulturist scientists claim that this is achieved by a complex of agricultural methods, among which mechanized pruning of fruit-bearing trees in the "pink bouquet" phase of apple tree development takes the main place (Mika A., Buler Z., Treder W., 2016). This method of

PROBLEMS AND PERSPECTIVES PROSPECTS

tree pruning is widely used in the industrial horticulture of Western European countries, while in Ukraine fruit plantations are pruned mainly by hand in the winter-spring period (Chaploutskyi A.M., Melnyk O.V., 2013).

Therefore, the study of the terms and methods of pruning intensive apple plantations in the conditions of the left-bank forest-steppe of Ukraine is an urgent issue and requires additional study.

The purpose of the research was to compare the effectiveness of mechanized pruning of intensive apple plantations with subsequent recommendations for production.

The research was conducted during 2020-2021 at Kharkiv Fruit Company LLC, located in the village of Korobochkino, Chuguyiv District, Kharkiv Region. An intensive apple orchard with an area of 58.5 hectares was laid according to the 3.2*0.9 scheme in 2017. The soil retention system in the interrows is sod-humus, in the trunk strips - herbicide steam. The entire area of the garden is on a drip irrigation system. The study was conducted with two winter-ripening apple varieties, Renet Simyrenko and Golden Delicious. Tree pruning was carried out with the help of a Fama segment type contour pruner.

Pruning was carried out at three times: at the beginning of the growing season (March), during the pink bouquet phase (April), and after harvesting (October).

Each variant of the experiment was laid out in triplicate. The size of the repetition was 5 accounting trees placed consecutively in a row.

The following observations and records were made in the studies:

- accounting for growth parameters;
- records of fruiting;
- determination of economic indicators.

The diameter of the stem was measured with a measuring tape, stretching it around the stem at a height of 30 cm from the soil surface. Measurements were taken at the end of the growing season. Harvest accounting was carried out by weighing the fruits from each tree and finding the average arithmetic yield, both for repetitions and for the variant as a whole. The yield of the variety in tons per hectare was determined by calculation (3472 trees/ha with a planting scheme of 3.2*0.9 m). The average fruit weight was determined by weighing 100 randomly selected fruits and dividing the result by 100 (P.V. Kondratenko, M.O. Bublyk, 1996).

Pruning of trees was carried out using a contour pruner of the segmental type, forming a fruit wall at a distance of 40 cm from the central conductor in its lower part and 30 cm in its upper part.

According to Professor Melnyk O.V. the diameter of the trunk is one of the indicators that determines the processes of tree growth and affects the level of productivity of trees (Melnyk O. V., Kravtsova Ya. O., 2018). In modern intensive plantations, obtaining an annual harvest with high taste and marketable qualities of fruits is possible only under the conditions of annual provision of active growth processes, during which the periodicity of fruiting and deterioration of fruit quality occurs (Leus V.V., Ivakin O.V., 2014).

Quite often, the girth of the trunk or its diameter is used as a criterion for tree growth. The growth of the trunk diameter is the main indicator of the lateral growth of fruit trees, which depends on many factors, including tree pruning.

According to the results of our research (Table 1), all trees were sufficiently leveled and had good vegetative growth. Thus, in 2020, the diameter of the stem depended to a greater extent on the variety and slightly changed when different pruning periods were used. Trees of the Golden Delicious variety had an average of 10.7 mm larger trunk diameter compared to the Renet Simyrenko variety. In addition, the crown of Golden Delicious trees was more developed compared to the control variety.

Comparing the terms of pruning, an increase in the value of the analyzed indicator is observed when trees are pruned at the beginning of the growing season, regardless of the variety. Thus, for the Renet Simyrenko variety, the difference compared to pruning in the pink bouquet phase and after harvesting was 2.3 and 1.4 mm, respectively. The difference for the Golden Delicious variety was 3.3 and 2.2 mm, respectively.

In the 2021 research year, there is an increase in the diameter of the stem on all variants. The maximum value of the analyzed indicator, regardless of the variety, was recorded on trees pruned at the beginning of the growing season.

On average, over the years of research, trees of the Golden Delicious variety had a significantly larger trunk diameter compared to Renet Simyrenko. The maximum value of the analyzed indicator was noted for trees pruned at the beginning of the growing season, 36.9 mm Renet Simyrenko and 48.0 mm Golden Delicious. The smallest trunk diameter was recorded on trees pruned in the pink bouquet phase. For example, the stem diameter was 33.9 mm for the Renet Simyrenko variety, and 44.3 mm for the Golden Delicious variety.

One of the main indicators of the vegetative growth of apple trees is also the total increase in the length of one-year shoots, which characterizes the processes of shoots and shoot formation of a fruit tree and has a significant

PROBLEMS AND PERSPECTIVES PROSPECTS

impact on the formation of the crop in varieties with a lateral type of fruiting.

Table 1

The diameter of the trunk of trees depending on the terms of pruning, mm

Pomological variety	Crop lines	2020	2021	Average over the years of research
Renet Simyrenko	At the beginning of the growing season (k)	32,4	41,3	36,9
	Pink bouquet phase	30,1	37,6	33,9
	After harvesting	30,7	38,1	34,4
Golden Delicious	At the beginning of the growing season (k)	43,7	52,2	48,0
	Pink bouquet phase	40,4	48,1	44,3
	After harvesting	41,5	48,6	45,0

According to scientist Ryl K. of intensive apple plantations, one-year growths should be about 30-40 cm long, stronger growths will thicken the crown, thereby creating a negative phytosanitary condition of the trees. With this length of shoots, the crown of a fruit tree does not thicken, and shoots of this length form an optimal assimilation surface, which has a rather positive effect on the vegetative growth of fruit trees (Ryl K., 2015).

Table 2

The length of one-year shoots depends on the timing of pruning, see

Pomological variety (A)	Crop lines (B)	2020	2021	Average over the years of research
Renet Simyrenko	At the beginning of the growing season (k)	52,3	58,2	52,2
	Pink bouquet phase	43,1	40,2	41,7
	After harvesting	44,2	47,3	45,8
Golden Delicious	At the beginning of the growing season (k)	44,2	45,1	44,7
	Pink bouquet phase	31,3	30,6	30,1
	After harvesting	33,1	33,8	33,5
<i>SSD₀₅ A</i>		3,4	3,2	
<i>SSD₀₅ B</i>		4,3	3,9	
<i>SSD₀₅ AB</i>		6,0	5,5	

Based on the results of our research, in 2020 there is a fairly strong

growth of trees, especially of the Renet Simyrenko variety. Trees of the Golden Delicious variety had an optimal shoot length of 30.3-33.1 cm only in the variants, with tree pruning in the pink bouquet phase and after harvest. Regardless of the variety, pruning trees at the beginning of the growing season leads to an increase in the average length of the shoots, which negatively affects the size of the trees.

A similar trend is observed in the next year of research. It is worth noting that on both research varieties of 2021, on the variants with the application of pruning trees in the pink bouquet phase, a decrease in the analyzed indicator was obtained compared to 2020. With other options for pruning, an increase in the length of the shoots is observed.

On average, over the years of research, pruning in the traditional period (at the beginning of the growing season) increases annual growth, thereby influencing crown thickening. Thus, for the Renet Simyrenko variety, the one-year shoots on the control variant were 52.2 cm long, and on the trees of the Golden Delicious variety 44.7 cm. It is worth noting that, regardless of the period of pruning, the trees of the Golden Delicious variety had a significantly shorter length of shoots, which indicates a greater the suitability of this variety for planting intensive apple plantations. Shoots of trees pruned in the phase of pink bouquet had the shortest length, 41.7 and 30.1 cm. Pruning, which was carried out after harvesting, also had a positive effect on the length of one-year shoots, reducing it. Thus, compared to the control on the Renet Simyrenko variety, this difference was 6.4 cm, and for the Golden Delicious variety it was 11.7 cm.

Thus, the application of tree pruning in an intensive garden in the pink bouquet phase significantly reduces the length of annual shoots, especially for trees of the Golden Delicious variety.

One of the main indicators that determines the intensity of tree flowering is the presence of clusters of flowers. The intensity of flowering will depend on the number of clusters, and therefore the degree of fruit set. The more clusters on the tree, the greater the probability of successful flowering, and in the future, more even placement of fruits in the crown of the tree, which will directly affect the marketable quality of the fruits, especially their size.

In 2020, the third year after the garden was planted, the trees had quite a good flowering. Trees cut at the beginning of the growing season had the smallest number of clusters. On the trees of the Renet Simyrenko variety, their number was 68.3 pcs/tree, and on the Golden Delicious variety 74.8 pcs/tree. This can be explained that some of the clusters were removed

PROBLEMS AND PERSPECTIVES PROSPECTS

during pruning. The trees of the Renet Simyrenko and Golden Delicious varieties had the highest value of the analyzed indicator, 97.4 and 90.3 pcs/tree, when pruned in the pink bouquet phase. It is important to note that the phase of the pink bouquet makes it possible to properly assess the level of flowering and, if necessary, to adjust the degree of tree pruning, which cannot be done during other periods of pruning.

In 2021, there is a significant increase in the number of clusters on all variants of the experiment. This is explained by the fact that 2021 is the fourth year of vegetation and the trees are still increasing their productivity. As in the previous year, the maximum number of clusters was obtained by pruning trees in the pink bouquet phase, 162.3 pcs/tree on trees of the Renet Simyrenko variety and 178.2 pcs/tree. Golden Delicious. Trees pruned after harvesting had a slightly higher number of clusters compared to the control. So, for the Renet Simyrenko variety, this difference was 1.8, and for Golden Delicious it was 10.3 pcs/tree.

Table 3

The number of clusters of flowers depending on the terms of pruning, pcs

Pomological variety	Crop lines	2020	2021	Average over the years of research
Renet Simyrenko	At the beginning of the growing season (k)	68,3	135,4	101,9
	Pink bouquet phase	97,4	162,3	129,8
	After harvesting	70,2	137,2	103,1
Golden Delicious	At the beginning of the growing season (k)	74,8	130,5	102,6
	Pink bouquet phase	90,3	178,2	134,2
	After harvesting	75,4	140,8	108,1

On average, quite intensive flowering is observed over the years of research. Analyzing the varieties, the number of clusters on the trees practically did not differ. An increase in the value of the analyzed indicator is observed for the Golden Delicious variety. The timing of pruning had a significant impact on the number of clusters on apple trees. Thus, the maximum number of clusters was obtained on trees pruned in the pink bouquet phase, 129.8 pcs/tree for the Renet Simyrenko variety, which is 27.9 more compared to the control, and 134.2 pcs/tree for the Golden Delicious variety, which is 31.6 pcs/tree more than control. It is worth noting a slight increase in clusters on options with tree pruning after harvest

compared to the traditional pruning period.

So, pruning trees in intensive apple plantations in the pink bouquet phase increases the number of clusters per tree by 21.5% for the Renet Simyrenko variety and 23.5% for the Golden Delicious variety.

The average weight of the fruit is an indicator that directly affects the productivity of plantations (table 4). Its value primarily depends on the number of fruits and the nature of their placement on the tree. Since we thinned the ovary and left the same number of fruits on each tree, one in a cluster, the first place was the placement of fruits on the tree from each other. With the greatest distance, it was possible to place fruits on trees with a larger number of clusters.

Table 4

The average weight of fruits depending on the period of pruning, g

Pomological variety (A)	Crop lines (B)	2020	2021	Average over the years of research
Renet Simyrenko	At the beginning of the growing season (k)	170,3	168,4	169,4
	Pink bouquet phase	187,4	197,3	192,4
	After harvesting	176,2	180,4	178,3
Golden Delicious	At the beginning of the growing season (k)	190,7	192,7	191,7
	Pink bouquet phase	211,2	218,4	214,8
	After harvesting	195,4	200,3	197,9
<i>SSD₀₅ A</i>		23,7	9,4	
<i>SSD₀₅ B</i>		29,1	11,6	
<i>SSD₀₅ AB</i>		41,1	16,4	

According to the results of our research, in 2020, the fruits of the Golden Delicious variety had a higher average weight compared to the Renet Simyrenko variety by 21.2 g. As well as the number of clusters on the trees, the trees pruned in the pink bouquet phase had the maximum average fruit weight of 187.4 g for the Renet variety Simyrenko, which is 10% more compared to the control and 211.2 g for the Golden Delicious variety, which is 10.7% more compared to the traditional pruning period.

A similar trend is observed in the next year of research. It is worth noting that in 2021 the fruits had a slightly higher average weight compared to 2020 in all variants of the experiment. This was influenced by the larger

PROBLEMS AND PERSPECTIVES PROSPECTS

dimensions of the tree, as the trees are still forming, which made it possible to place the fruits at a greater distance from each other. On the trees of the Renet Simyrenko variety, the maximum average weight was obtained at the level of 197.3 g, and the trees of the Golden Delicious variety had fruits weighing 218.4 g.

On average, over the years of research, the fruits of the Golden Delicious variety had a higher average weight by 11.2% compared to the Renet Simyrenko variety. Pruning trees in the phase of pink bouquet, regardless of the variety, increases the average weight of the fruit compared to the control. Thus, the fruits of the Renet Simyrenko variety were heavier by 13.6%, and the Golden Delicious variety by 12%. This increase occurred primarily due to the fact that when pruning a tree at the beginning of its growing season, a significant part of nutrients is directed to the restoration of the above-ground part (growth processes), and when pruning in the phase of a pink bouquet, tree nutrients are directed to clusters. Due to this, the future flowers receive more nutrients, they become stronger, as a result of which the fruits that are formed from them have a stronger growth energy. It is worth noting that pruning trees after harvesting also has a positive effect on increasing the average weight of the fruit.

Yield is an indicator that determines the economic efficiency of growing apple trees. According to the results of our research in 2020, trees of the Golden Delicious variety had a higher yield compared to the Renet Simyrenko variety. Pruning the trees in the phase of the pink bouquet ensures the maximum yield for both test varieties. Thus, the trees of the Renet Simyrenko variety had a 2.3 t/ha higher yield compared to the control, and the Golden Delicious variety by 2.0 t/ha. It is worth noting that post-harvest pruning of trees also increases yield compared to control.

In 2021, research is following a similar trend. It is worth noting that for all options, a higher yield was obtained in 2021 compared to 2020. This is explained by the fact that the trees have not yet reached full productivity and the yield is increasing.

On average, over the years of research, regardless of the method of tree pruning, the Golden Delicious variety had a higher total yield compared to the Renet Simyrenko variety. Regardless of the variety, pruning trees in the phase of a pink bouquet significantly increases the total yield of trees. Thus, applying tree pruning in the current term, the Renet Simyrenko variety had a 7.4 t/ha higher yield compared to the control, and the Golden Delicious variety had a 7.3 t/ha yield. Pruning trees after harvest also increases yields compared to traditional pruning.

Therefore, in order to obtain the maximum yield, it is necessary to prune apple trees in intensive plantations in the pink bouquet phase.

Table 5

Productivity depending on the period of pruning, t/ha

Pomological variety (A)	Crop lines (B)	2020	2021	Average over the years of research
Renet Simyrenko	At the beginning of the growing season (k)	23,7	29,2	52,9
	Pink bouquet phase	26,0	34,3	60,3
	After harvesting	24,5	31,3	55,8
Golden Delicious	At the beginning of the growing season (k)	26,5	33,5	59,9
	Pink bouquet phase	29,3	39,9	69,2
	After harvesting	27,1	34,8	61,9
<i>SSD₀₅ A</i>		1,9	2,2	
<i>SSD₀₅ B</i>		2,3	2,7	
<i>SSD₀₅ AB</i>		3,3	3,8	

The criterion of economic efficiency is the level and rate of growth of gross production, cash receipts, gross and net income, profit per hectare of land, reduction of unit cost of production, increase in labor productivity, profitability.

Gross production represents the entire mass of raw materials produced in a given year (measured in hundredweights, tons). Profit is the difference between the revenue for the sold products and the costs of its production (table 6). The volume of production costs per unit of production is its cost price. When additional costs are added to it, the full cost price is created. Profitability is the ratio of net income or profit to the sum of material and monetary costs associated with the production and sale of products.

The average selling price of apples of the Renet Simyrenko variety was at the level of UAH 11.5 per kilogram, and of the Golden Delicious variety at UAH 13.0/kg. Thus, the market value of the Golden Delicious variety was higher by UAH 1.5/kg compared to the Renet Simyrenko variety. Trees pruned in the phase of pink bouquet had the maximum value of production, regardless of the variety. So, for the Renet Simyrenko variety, the cost of production was at the level of 346.1 thousand hryvnias, and for the Golden Delicious variety, it was 436.8 thousand hryvnias. It is worth noting that the cultivation of the Golden Delicious variety provides a higher

PROBLEMS AND PERSPECTIVES PROSPECTS

cost of production compared to the Renet Simyrenko variety. The difference was at the level of UAH 85.25-90.65 thousand.

Table 6

The economic efficiency of growing apples depending on the timing of mechanized tree pruning in an intensive orchard per 1 hectare (on average for 2020-2021)

Pomological variety	Crop lines	Productivity, t/ha	Product cost, thousand UAH	Production costs, thousand UAH	Cost, thousand UAH	Profit, thousand UAH	Profitability, %
Renet Simyrenko	At the beginning of the growing season (k)	26,5	304,7	90,0	3,39	214,75	238,6
	Pink bouquet phase	30,1	346,1	90,0	2,99	256,15	284,6
	After harvesting	27,9	320,8	90,0	3,22	230,85	256,2
Golden Delicious	At the beginning of the growing season (k)	30,0	390,0	90,0	3,00	300,0	333,3
	Pink bouquet phase	33,6	436,8	90,0	2,67	346,8	385,3
	After harvesting	31,0	403,0	90,0	2,90	313,0	347,7

Production costs consisted mainly of chemical protection of plantations, fertilizing, tree pruning, harvesting and employee wages. On average, production costs over the years of research amounted to about UAH 90,000 per year.

The main indicator of the economic efficiency of apple cultivation is the profitability of the varieties or agricultural measures used. According to the results of our research, the Golden Delicious variety, regardless of the timing of pruning, had a significantly higher profitability than the Renet

Simyrenko variety. Analyzing the timing of pruning, the maximum profitability was provided by trees that were pruned in the pink bouquet phase.

Thus, for the Renet Simyrenko variety, the value of the analyzed indicator was at the level of 284.6%, and for the Golden Delicious variety - 385.3%. Trees pruned at the traditional time - at the beginning of the growing season - had the lowest profitability. A slightly higher level of profitability was recorded compared to the control period for trees pruned in the fall after harvest.

Summing up certain results, we can say that the application of pruning in the phase of the pink bouquet provides the maximum profit regardless of the pomological variety, and therefore the highest profitability of apple production. Cultivation of the Golden Delicious variety is more profitable, and therefore this variety is better suited for planting intensive apple plantations.

Thus, in the soil and climatic conditions of the left-bank forest-steppe of Ukraine, it is advisable to use the Fama contour pruner for pruning intensive apple plantations in the phase of a pink bouquet, which provides the maximum yield per unit area, as well as the highest level of profit and profitability. For varieties with insufficient growth, pruning should be carried out at the beginning of the growing season in order to stimulate growth processes.

References

1. Hrynyk, I. V., Omelchenko, I. K., Lytovchenko, O. M. (2012). Ways to solve problems in the development of horticulture in Ukraine. *Horticulture*. Vol. 65, 5–19 http://nbuv.gov.ua/UJRN/sadiv_2012_65_3 (in Ukrainian).
2. Mika, A. (2003). Ciecie jabloni w sadach intensywnych. *Owoce, Warzywa, Kwiaty*, № 3, 7–8 (in Polish).
3. Mika, A., Buler, Z., Treder, W. (2016). Mechanical pruning of apple trees as an Alternative to manual pruning. *Acta Scientiarum Polonorum Hortorum Cultus*, Vol. 15 (1), 113–121 (in Polish).
4. Chaploutskyi, A. M., Melnyk, O. V. (2013). Contour trimming: experience and introduction. *Gardening news*, № 4, 9–11 (in Ukrainian).
5. Kondratenko, P.V., Bublyk, M.O. (1996). Methods of field research with fruit crops. *Agrarian science*, 95. (in Ukrainian).
6. Melnyk, O. V., Kravtsova, Ya. O. (2018). The habit of the crown of apple trees depending on the period and method of pruning. *Collection of*

PROBLEMS AND PERSPECTIVES PROSPECTS

scientific works of the Uman National University of Horticulture, Vol.93 (1), 126–135. DOI: 10.31395/2415-8240-2018-93-1-126-135 (in Ukrainian).

7. Leus, V.V., Ivakin, O.V. (2014). Ways of pruning apple trees in the conditions of the left-bank forest-steppe of Ukraine. *Materials of the final scientific conference of professors and teaching staff, graduate students and graduates of the Faculty of Agronomy, the Faculty of Plant Protection, Agronomy and Soil Science, Forestry, Kharkiv National Agrarian University, Part II*, 104–105 (in Ukrainian).

8. Ryl, K. (2015). Ciecie mechaniczne jabloni zalety i wady. *Sad Nowoczesny*, № 1, 9–10 (in Polish).