Various treatments of fertilization and top dressing of apple trees, cv. Champion Arno, on rootstock MM 106 were under study. It was found out during the years under study that the number of flowers of the apple trees ranged between 378 and 932 pcs./tree, and, to a large extent, it depended on fertilization. Similar to the information about the number of flowers, the load of the trees with fruit took place and it depended on the type and term of the fertilizer application, it also differed within 66 and 185 pcs./tree. In accordance with the intensity of flowering and fruit formation of the apple tree, a significant fluctuation of the yield capacity of the experimental trees was recorded – 21.2 to 33.4 t/ha, depending on the fertilization treatment. On the average in the years under study, the fruit output of the high and first commercial cultivars depended on the studied treatments; it ranged within 73.5–80.3 %. During the research period, the average fruit mass was within 132–153.1g, and it depended on the fertilization treatment considerably.

***Key words**: soil fertilization, top dressing, productivity of plantations, fruiting of trees, marketability of fruits.*

УДК: 634.11:631.542:631.17(477.4)
DOI: 10.32782/2415-8240-2024-104-1-79-87

DIMENSIONS OF CROWNS AND THEIR LEVEL OF PRODUCTIVITY OF APPLE TREES OF THE JONAWELD VARIETY DEPENDING ON THE METHOD AND TERM OF CROWN PRUNING

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Досліджено різні методи та строки обрізання крони яблунь сорту Джонавелд та їх вплив на зміну габітусу крони. Запровадження контурного обрізування з доробкою вручну сприяло формуванню на 25 % меншого об'єму крони. Незалежно від способу обрізування дерев виявлена чітка тенденція, щодо зменшення об'єму крони з відтермінуванням строку обрізування. Рівня питомої продуктивності на об'єм крони в результаті ручного обрізування досліджуваних дерев на 14 % поступалася контурному способу обрізування та на 30 % контурному з доробкою вручну. Поступовому збільшення рівня питомої продуктивності на об'єм крони сприяло відтермінуванням строку вирізування.

***Ключові слова:** яблуня, обрізування, контурне обрізування, об'єм крони, діаметр крони, строк обрізування*

State of the problem. The apple tree is one of the most widespread fruit crops both in Ukraine and in the world, which allows it to be grown in different natural conditions. In the total fruit production in Ukraine, apples occupy a leading position [1]. Recently, there has been a significant shortage of workers in the agricultural sector [2]. The solution to this problem lies in improving modern technologies for growing

intensive apple orchards with the involvement of more mechanized processes, including crown pruning, which allows optimizing the size of the crown, their level of illumination and affecting the fruiting of plantations.

Analysis of the latest research and publications. Pruning is a labor-intensive agricultural measure that accounts for a significant portion of the total costs of growing apples. To solve this problem, several scientists have studied mechanized pruning on fruit trees [3–5]. Mechanical pruning is not a new element of fruit production technology and is widely used in Europe [6, 7]. The timing of pruning appears to be a key factor in the pruning process [8].

The reaction of apple trees to mechanized pruning depends mainly on the time of its implementation. Pruning in winter encourages plants to grow shoots more actively. The best time to shorten the shoots is the period just before the end of their growth and the formation of the apical bud [9]. The strongest shoot growth was observed during winter pruning and one-third less in early summer, with the number of shoots with a generative bud at the end being 48 % and 68 %, respectively [10].

Depending on the region, the optimal time for early summer pruning is when the newly formed shoots have 8–12 leaves. This contributes to the formation of short shoots in summer, the growth of which weakens after several years of summer pruning [11]. M. Sazo & T. Robinson [12] tested summer mechanical pruning on several apple varieties. According to their results, the light distribution in the lower part of the trees improved by 10%, shoot regrowth was short with the formation of a flower bud at the end. According to the research of G. Poldervaart [13], after mechanized pruning of trees, the fruits become smaller by 2–3 mm in diameter over time. Although this is a positive effect for large-fruited triploid varieties.

The purpose of the study is to investigate the effect of contour pruning and its optimal timing on the regulation of growth and yield quality of apple trees.

Research methodology. The study of different methods and timing of crown pruning began in spring 2014 in an apple orchard with Jonaveld trees. The place of research is the experimental garden of the Uman National University of Horticulture, planting scheme 4 × 1 m, rootstock M.9 T337. The trees were formed with a spindle-shaped crown. The soil retention system in the inter-row was sod-humus, herbicide steam in the trunk strip, and drip irrigation. Trees were pruned in winter, in the phase of pink bud, flowering, in early summer (in the presence of 10 leaves on the growth) and after harvest. Pruning was performed in one of the following ways: manually; contouring with the formation of a fruit wall 80 cm wide in the lower and 50 cm wide in the upper part from the row spacing, annually shortening the growths on the periphery of the crown; and contouring with manual refinement. As a result of manual refinement, fat shoots, thickening in the upper part of the crown, and hanging branches in the stem zone were removed.

Phytometric records were conducted according to the generally accepted recommendations and research methods of Kondratenko P. V. & Bublyk M. O. [14]. All data were analyzed by means of a three-factor analysis of variance using Statistica 10. Values between pairs of variants were compared using the Tukey test ($p = 0.05$). Correlations were determined by comparing annual mean values using the Pearson

method (p = 0.001).

Research results. Analyzing the data of the three-year experiment, a significant effect of both the term of pruning and the method of its implementation on the parameters of the crown of apple trees of the Jonaveld variety was revealed. The studied trees differed significantly in terms of crown diameter. In the orchard plantations with the formation of trees by the type of slender spindle, a more spreading crown was found, which significantly exceeded other variants of the study in terms of its diameter. The pruning of the studied trees by a mechanized method with subsequent manual refinement contributed to significantly less shoot growth and the formation of a more compact crown (Table 1).

Table 1. Crown parameters and productivity level of Jonaweld apple trees depending on the method and time of crown pruning (average 2014-2016)

Method of pruning	Term of pruning	Crown diameter, m	Crown volume, m^3	Specific productivity per crown volume, kg/m^3
Manual	Winter	1,67 ± 0.06 a	3,34 ± 0.28 a	2,42 ± 0.71 g
	Pink bud	1,62 ± 0.09 ab	3,06 ± 0.37 ab	2,76 ± 0.57 fg
	Flowering	1,60 ± 0.01 abc	2,94 ± 0.04 abc	2,73 ± 0.60 fg
	Early summer	1,56 ± 0.02 abcd	2,69 ± 0.06 bce	2,87 ± 0.30 efg
	After harvesting	1,52 ± 0.05 bcde	2,55 ± 0.18 cef	3,22 ± 0.27 cdef
Contour	Winter	1,58 ± 0.03 abc	2,92 ± 0.08 abc	2,88 ± 0.32 efg
	Pink bud	1,50 ± 0.04 cdef	2,66 ± 0.13 bcef	3,17 ± 0.27 cdef
	Flowering	1,52 ± 0.02 bcdef	2,67 ± 0.08 bce	3,17 ± 0.37 cdef
	Early summer	1,44 ± 0.03 efg	2,34 ± 0.11 efgh	3,33 ± 0.31 bcde
	After harvesting	1,41 ± 0.02 efg	2,08 ± 0.07 gh	3,51 ± 0.33 abcd
Contouring with manual refinement	Winter	1,45 ± 0.03 defg	2,39 ± 0.12 efg	3,14 ± 0.27 def
	Pink bud	1,43 ± 0.02 efg	2,38 ± 0.05 efg	3,70 ± 0.44 abc
	Flowering	1,40 ± 0.03 fg	2,22 ± 0.10 fgh	3,54 ± 0.55 abcd
	Early summer	1,38 ± 0.04 g	2,10 ± 0.07 gh	3,83 ± 0.38 ab
	After harvesting	1,35 ± 0.02 g	1,90 ±0.08 h	3,97 ± 0.33 a

*Note: * – Average values (mean ± SD) of indicators, the presence of the same letters in a pair of options indicates the absence of a statistically significant difference according to the Tukey's criterion (p = 0.05).*

At the same time, contour pruning without manual refinement occupied an intermediate position among the studied pruning methods. According to the data presented in Table 1, the trees with manual crown pruning in winter were characterized by the greatest growth and amounted to 1.67 m, while crown pruning mechanized with manual refinement after harvesting provided the most compact crown, which was 20 % smaller in diameter compared to the control.

During the experiment, a weakening of crown growth and a decrease in its diameter was observed in the year of the experiment in 2014 (Figure 1), later the values of the indicator slightly increased and did not change significantly over the years.

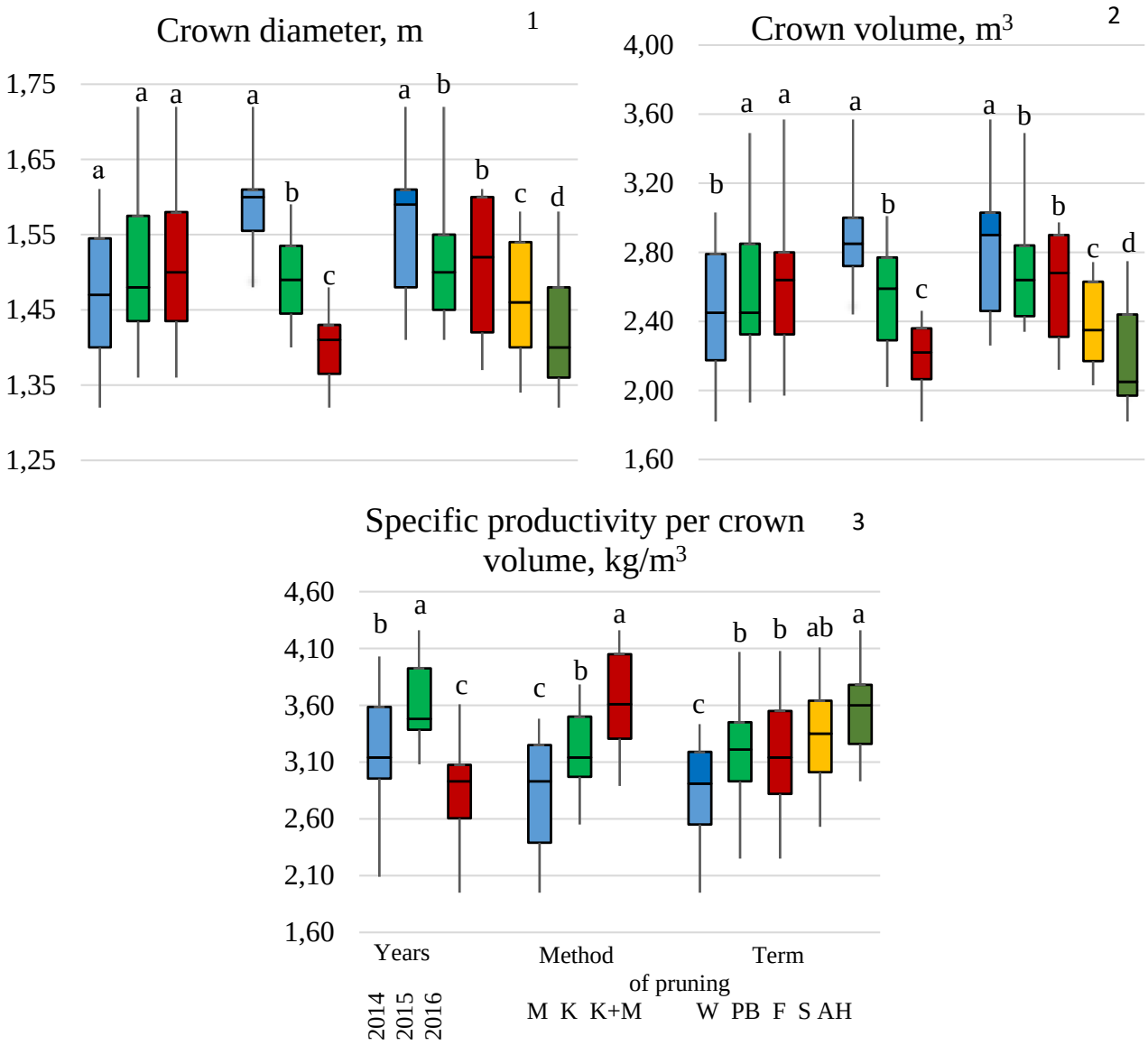

Fig. 1-3. Productivity of Jonaweld apple trees depending on the factors studied: pruning method: M - manual, K - contour, K+P contour with manual refinement; term of pruning: W - winter, PB - pink bud phase, F - flowering, S - early summer, AH - after harvest.

According to the results of the analysis of variance, a significant impact on the change in the values of the indicator was caused by the factor "method of pruning" – the influence of the factor is 60.5 % (Figure 4), with the predominance of manual pruning. Postponement of pruning to a later date, regardless of the method of pruning the crown, contributed to a decrease in the value of their diameter (factor influence of 24 %). However, there was no statistically significant difference between the pruning options in the pink bud and flowering phase. The value of the crown diameter directly correlates with the crown volume, crown projection area, and utilization of the feeding area, but an inverse correlation was found with the specific productivity per crown volume, the number of fruits, their weight, and yield.

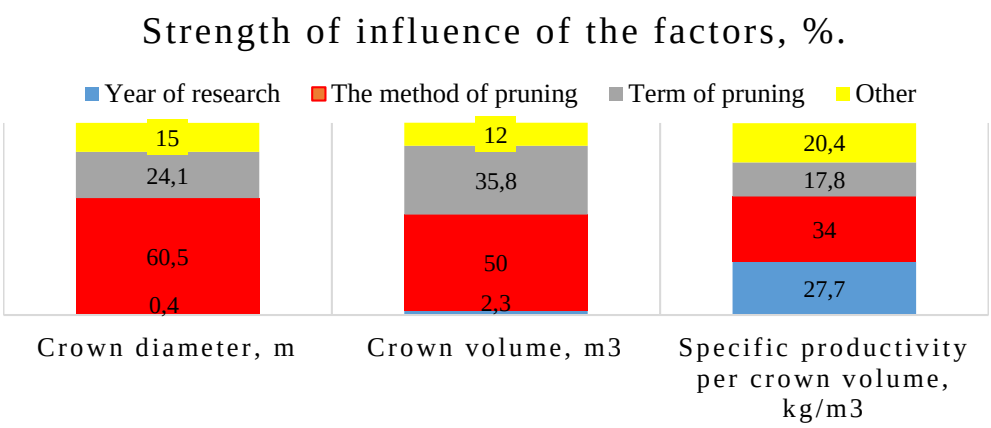

Fig. 4. Strength of influence of the studied factors on the change in the values of the indicators

A similar effect of the studied agricultural measures was manifested in the change in crown volume. Encouraging more active growth and increasing the overall habitus of the crown contributed to the implementation of manual pruning, in particular in winter, which provided a value of 3.34 m³. As a result of contour pruning, and especially contour pruning with manual refinement, a decrease in crown volume was observed. The lowest value of the indicator was found in the plantation with contour pruning with manual refinement after harvesting (1.9 m³). Regardless of the method of tree pruning, there was a clear tendency to reduce the volume of the crown with the delay of pruning. According to the results of the analysis of variance (Figure 2), contour pruning contributed to the formation of the largest crown size (influence of the factor 50 %). The introduction of contour pruning with manual refinement contributed to the formation of a 25 % smaller crown volume and greater control of growth processes. A clear dependence on the decrease in the values of the studied indicator with the delay of the pruning period was also revealed. Thus, the smallest crown size was formed as a result of pruning after harvest. Also, no significant difference was found between the variants of pruning in the phase of pink bud and flowering (the influence of the factor "pruning time" was 36 % (Figure 3).

A direct correlation of crown volume was observed with its diameter and projection area. Also, an inverse correlation was found with the indicator of specific productivity per feeding area, the number of fruits by weight, yield and specific productivity per cross-sectional area of the stem.

An inverse relationship was observed with the value of the specific product per crown volume, indicating a significant increase in yield and the formation of more compact crowns. The implementation of contour pruning with manual refinement provided an increase in productivity while reducing crown volume. There is also a clear dependence on the increase in the level of crown productivity and the decrease in their habitus as a result of delaying the pruning period. The predominance of the indicator values was obtained as a result of contour pruning after harvesting (67 % increase compared to the control).

With an unstable level of yield over the years, there was a significant change in

specific productivity per unit volume of the crown (the influence of the factor "year of research" 28 %).

The lowest value of the level of specific productivity per crown volume (Figure 3) was found as a result of manual pruning of the studied trees, which was 14 % lower than the contour pruning method and 30 % lower than the contour pruning method with manual refinement. A gradual increase in the level of specific productivity per crown volume was observed with the delay of the cutting period. There was no significant difference between the variants when pruning in the phase of pink bud, flowering and early summer, as well as between the variants of the experiment when pruning in the early summer and after harvesting, where the maximum value of the indicator was obtained (the influence of the factor "pruning time" was 18 %).

A direct correlation between specific productivity and crown volume was found with the yield, tree fruit load, and fruit weight. An inverse correlation was observed with the crown volume, projection area, and utilization of the feeding area.

Conclusions. The paper presents the results of experimental studies with theoretical substantiation of the influence of the term and method of crown pruning on the change in the habitus of the crown of Jonaveld apple trees on a dwarf rootstock. As a result of contour pruning with manual refinement, a decrease in crown diameter by 12.5 %, crown volume by 25 %, and an increase in specific productivity per crown volume by 30 % were observed. There is a clear tendency to reduce the value of crown diameter by 9 % and crown volume by 24 % with the delay in the term of pruning to a later date after harvesting, but pruning in the fall after harvesting contributes to an increase in specific productivity per crown volume by 26 %.

Література:

1. Чиж О. Д., Фільов В. В., Гаврилюк О. М., Чухіль С. М. Інтенсивні сади яблуні. Київ: Аграрна наука. 2008. 244 с.

2. Eurostat. Farm structure statistics. Retrieved from 2018. Режим доступу: http://ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics#The_farm_labour_force.

3. Krueger W. H., Niederholzer F. J. A., Fichtner E. Investigation of pruning strategies for dried plums including hand, mechanical and combinations. *Acta Hortic*. 2013. № 985. P. 201–207. doi.org/10.17660/ActaHortic.2013.985.25

4. Mika A., Buler Z., Treder W., Mechanical pruning of apple trees as an alternative to manual pruning. *Acta Scientiarum Polonorum – Hortorum Cultus*. 2016. № 15 (1). P. 113–121.

5. Чаплоуцький А. М., Мельник О. В. Формування продуктивності насадженьяблуні залежно від способу і строку обрізування. *Збірник наукових праць УНУС*. 2019. Вип 95. Ч. 1. С. 199–206. URL: doi.org/10.3195/2415-8240-2019-95-1-199-206.

6. Warner G. Washington grower-packer foresees multiple benefits from mechanical pruning // 2015 August 26, URL: https://www.goodfruit.com/hedging-to-improve-quality/.

7. Zeng H., Yang J., Yang N., Huang J., Long H., Chen Y. A Review of the Research Progress of Pruning Robots. *IEEE 2nd International Conference on Data Science and Computer Application (ICDSCA)*, Dalian, China, 2022. P. 1069–1073. doi: 10.1109/ICDSCA56264.2022.9988192.

8. Chaploutskyi A., Polunina O., Kucher I., Chetskyi B., Borysenko V. Zabolotny O. The Growth Activity and Productivity of Apple Trees Depending on the Form of the Crown and the Time of Pruning. *Journal of Horticultural Research*. 2023. vol. 31 (2). doi.org/10.2478/johr-2023-0027.

9. Conesa M. R., Martínez-López L., Conejero W., Vera J., Ruiz-Sánchez M. C. Summer pruning of early-maturing. Prunus persica: Water implications. *Scientia Horticulturae.* 2019. № 256. doi: 10.1016/j.scienta.2019.05.066.

10. Albarracín V., Hall A. J., Searles P. S., Rousseaux M. C. Responses of vegetative growth and fruit yield to winter and summer mechanical pruning in olive trees. *Sci. Hortic*. 2017. № 225. P. 185–194. doi.org/10.1016/j.scienta.2017.07.005.

11. Chaploutskyi A., Butsyk R., Polunina O. Features of creating and maintaining a fruit wall in apple orchard: Literature review. *Scientific Horizons*. 2021. № 24(9). P. 93–99. doi.org/10.48077/scihor.24(9).2021.93-99.

12. Sazo M., Robinson T. L., Recent advances of mechanization for the tall spindle orchard system in New York state. *New York Fruit Quarterl.* 2013. № 21(1), P. 15–20.

13. Poldervaart G. Apple varieteis and mechanical pruning. *European Fruit Magazine*. 2011. № 9. P. 12–13

14. Кондратенко П. В., Бублик М. О. Методика проведення польових досліджень з плодовими культурами. Київ. 1996. 95 с.

References:

1. Chizh, O. D., Filov, V. V., Gavrilyuk, O. M., Chukhil, S. M. (2008). Intensive apple orchards. Kyiv: Agrarian Science. [in Ukrainian].

2. Eurostat. (2018) Farm structure statistics. Retrieved from 2018. URL: http://ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics#The_farm_labour_force.

3. Krueger, W. H., Niederholzer, F. J. A., Fichtner, E. (2013). Investigation of pruning strategies for dried plums including hand, mechanical and combinations. *Acta Hortic*., no. (985), pp. 201–207. doi.org/10.17660/ActaHortic.2013.985.25

4. Mika, A., Buler, Z., Treder, W., (2016) Mechanical pruning of apple trees as an alternative to manual pruning. *Acta Scientiarum Polonorum – Hortorum Cultus*, no. 15 (1), pp. 113–121.

5. Chaploutskyi, A., Melnyk, O. (2019). Formation of productivity of apple plantations depending on the method and term of pruning. *Collection of scientific works of UNUS*, issue 95, part 1, pp. 199–206. doi.org/10.3195/2415-8240-2019-95-1-199-206. [in Ukrainian].

6. Warner, G. (2015). Washington grower-packer foresees multiple benefits from mechanical pruning // August 26, URL: https://www.goodfruit.com/hedging-to-improve-quality/.

7. Zeng, H., Yang, J., Yang, N., Huang, J., Long, H., Chen, Y. (2022). A Review of the Research Progress of Pruning Robots. *IEEE 2nd International Conference on Data Science and Computer Application (ICDSCA)*, Dalian, China, pp. 1069–1073. doi: 10.1109/ICDSCA56264.2022.9988192.

8. Chaploutskyi, A., Polunina, O., Kucher, I., Chetskyi, B., Borysenko, V., Zabolotny, O. (2023). The Growth Activity and Productivity of Apple Trees Depending on the Form of the Crown and the Time of Pruning. *Journal of Horticultural Research*, vol.31, no.2. doi.org/10.2478/johr-2023-0027.

9. Conesa, M. R., Martínez-López, L., Conejero W., Vera, J., Ruiz-

Sánchez, M. C. (2019). Summer pruning of early-maturing. Prunus persica: Water implications. *Scientia Horticulturae,* no. 256. doi: 10.1016/j.scienta.2019.05.066.

10. Albarracín, V., Hall, A. J., Searles, P. S., Rousseaux, M. C. (2017). Responses of vegetative growth and fruit yield to winter and summer mechanical pruning in olive trees. *Sci. Hortic*., no. 225, pp. 185–194. doi.org/10.1016/j.scienta.2017.07.005.

11. Chaploutskyi, A., Butsyk, R., Polunina, O. (2021). Features of creating and maintaining a fruit wall in apple orchard: Literature review. *Scientific Horizons*, no. 24(9), pp. 93–99. doi.org/10.48077/scihor.24(9).2021.93-99.

12. Sazo, M., Robinson, T. L., (2013). Recent advances of mechanization for the tall spindle orchard system in New York state. *New York Fruit Quarterly,* no. 21(1), pp. 15–20.

13. Poldervaart, G. (2011). Apple varieteis and mechanical pruning. *European Fruit Magazine,* no. 9, pp. 12–13.

14. Kondratenko, P. V., Bublyk, M. O. (1996). Methods of conducting field research with fruit crops. Kyiv. 95 p. [in Ukrainian].

Annotation

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Dimensions of crowns and their level of productivity of apple trees of the Jonaweld variety depending on the method and term of crown pruning

In this experiment, different methods and terms of crown pruning of Jonaveld apple trees and their influence on the change in crown habitus were investigated. The experiments were conducted at the educational and production department of the Uman National University of Horticulture in the city of Uman, Cherkasy region, for three years from 2014 to 2016.

The studied trees were grown on the rootstock M.9 T337 and were formed with a spindle-shaped crown. They were planted according to the 4x1 m scheme in 1995. The experimental plot is represented by podzolized black soil. The research scheme included the study of the effect of three pruning methods: the traditional method of manual pruning, the contour method of forming a fruit wall of the crown 80 cm wide in the lower part and 50 cm wide in the upper part from the row spacing with annual contour pruning of growths on the periphery of the crown and the contour method with manual modification, which consisted in removing fattening shoots, too thick branches and hanging branches in the stem zone. Crown pruning was performed at five different times: in winter (during winter dormancy), during the pink bud phase, during flowering, in early summer (with 10 leaves on the growth), and after harvest.

In the orchard plantations with the formation of trees by the type of slender spindle by hand, a more spreading crown was formed, which significantly exceeded the other variants of the study in terms of its diameter. A significant impact on the change in the values of the indicator was caused by the factor "method of pruning" – with the predominance of manual pruning. Also, the influence of postponing the term of pruning to a later date, regardless of the method of pruning the crown, on reducing the value of their diameter was revealed.

As a result of contour pruning, in particular contour pruning with manual refinement, a decrease in crown volume was observed. The introduction of contour pruning with manual refinement contributed to the formation of 25 % less crown

volume. Regardless of the method of tree pruning, a clear tendency to reduce crown volume with the delay of pruning was revealed.

The level of specific productivity per crown volume as a result of manual pruning of the studied trees was 14 % lower than the contour pruning method and 30% lower than the contour pruning method with manual refinement. The gradual increase in the level of specific productivity per crown volume was facilitated by the delay in the cutting period.

***Key words**: apple tree, pruning, contour pruning, crown volume, crown diameter, pruning period*

УДК: 633.111.1:631.53.027]001.891.53
DOI: 10.32782/2415-8240-2024-104-1-87-96

ВПЛИВ РІЗНИХ ДОЗ БІОПРЕПАРАТІВ НА ПРОРОСТАННЯ НАСІННЯ ПШЕНИЦІ М'ЯКОЇ ОЗИМОЇ В ЛАБОРАТОРНИХ УМОВАХ

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Стаття висвітлює результати вивчення впливу передпосівної обробки насіння пшениці м'якої озимої сорту Дума одеська біологічними препаратами на енергію проростання, лабораторну схожість та біометричні показники проростків. Встановлено, що, для стимуляції енергії проростання та лабораторної схожості оптимальними є біопрепарати Азотофіт-р у дозі 0,5 л/т та Гуміфренд у дозі 1,0 л/т. Обробка насіння біопрепаратом Мікофренд у дозі 1,0 л/т була ефективнішою для стимуляції росту первинних корінців, а для приросту колеоптиле – біопрепаратом Азотофіт-р у дозі 0,8 л/т. Найоптимальнішим для обробки насіння пшениці озимої сорту Дума одеська визначено біопрепарат Азотофіт-р у дозі 0,5 л/т, що забезпечує приріст енергії проростання на 4,0 %, лабораторної схожості – на 2,0 %, довжини головного кореня – на 8,5 %, колеоптиле – на 24,1 %.

***Ключові слова**: пшениця м'яка озима, дози біопрепаратів, енергія проростання, лабораторна схожість, довжина первинних коренів, довжина колеоптиле*

Постановка проблеми. Пшениця озима є головною зерновою культурою Півдня України, але часто її генетичний потенціал продуктивності не вдається повністю розкрити. Однією з основних причин формування низької врожайності культури, особливо на Півдні України є строкатість та нерівномірність сходів в осінній період, що впливає на формування густоти рослин пшениці озимої [1].

На польову схожість насіння пшениці впливають багато факторів, основними з яких є: вологість ґрунту, середньодобова температура повітря, лабораторна схожість насіння, попередники, строки сівби, норми висіву тощо