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MODERN CHALLENGES OF AGRARIAN TRANSFORMATIONS IN UKRAINE: AGRICULTURE, FORESTRY AND

MODERN CHALLENGES OF AGRARIAN TRANSFORMATIONS IN UKRAINE: AGRICULTURE, FORESTRY AND HORTICULTURE

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Edited by
Candidate of Economics Sciences, Professor
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The monograph contains the results of research conducted by scientists of Sumy National Agrarian University, Ukrainian Research Institute of Forestry and Agroforestry and Land Reclamation named after GM Vysotsky, Henan Institute of Science and Technology in the framework of the state research "Study of the state of green plantations of populated cities of the North-Eastern part of the Forest-Steppe in order to establish ways to optimize the natural environment "(state registration number 0109U000346);".
The monograph is devoted to the theoretical and practical foundations of modern challenges of agrarian transformation in Ukraine: agriculture, forestry and horticulture, which are formed by integration and globalization challenges. The influence of environmental determinants on the level of sustainable agricultural sector in the short and long term is determined; cost-effective methods of growing planting material of forest and ornamental species of the nursery; improvement of existing and development of new technologies for growing planting material of fruit and ornamental crops.
For researchers, teachers, graduate students and students, business leaders and governing bodies of different levels, entrepreneurs and anyone interested in agriculture, forestry and horticulture speere.

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INTRODUCTION

Agriculture is a branch of economy whose task is to provide the population with food and raw materials for a number of industries. Unlike industry, the technological process in agriculture is closely linked to nature, where land is the main means of production. That is why this industry has a greater impact on the environment than any other sector of the economy.

About half of the world's economically active population is employed in agricultural production. But this figure is not the same in countries with different economic development, namely: in developing countries, this figure is 2/3 or more, while in developed countries - less than 10%, and in the US and some Western European countries it is only 2-3%.

In recent decades, Western agribusiness has been developing rapidly in the West, the core of which is formed by large TNCs that control the production and sale of food. Among the 100 largest - more than 40 American and more than 30 Western European companies.

At the present stage, both new technologies and new methods of management should be actively introduced into the practice of agricultural producers. The only alternative to the current state of domestic agriculture should be considered innovative development. Widespread use of scientific and technical achievements is the most effective and efficient form of sustainable development of the industry, and scientific and technological progress is determined by the possibilities of innovative ways of developing agricultural production

The materials presented in separate sections of the monograph are in one way or another related to the formation of an effective mechanism to support agricultural change in Ukraine in agriculture, forestry and horticulture, reflecting the desire of researchers to harmonize their generalizations with new conditions of the international system. standards of working life and governance in developed countries. From this point of view, the results of the study presented in the monograph are original and important.

The authors do not claim to be exhaustive of their opinions and judgments, as the current challenges of agrarian transformation in Ukraine in the field of agriculture, forestry and horticulture in the country daily make adjustments to the theory and practice of sustainable rural development management.

The monograph combines accessibility and scientific presentation very well. The monograph offers only specific approaches to solving clearly defined problems of improving agricultural transformation in Ukraine in the field of agriculture, forestry and horticulture in Ukraine.

The monograph was prepared based on the results of a study in the framework of the state research topic "Study of the state of green plantations of populated cities of the North-Eastern part of the Forest-Steppe in order to establish ways to optimize the natural environment "(state registration number 0109U000346);" by scientists from Sumy National Agrarian University, Ukrainian Research Institute of Forestry and Agroforestry and Land Reclamation named after GM Vysotsky, Henan Institute of Science and Technology.

We express our sincere gratitude to the reviewers of this publication G.O. Zhatova, Candidate of Agricultural Plants, Professor of the Department of Ecology and Botany of Sumy National Agrarian University; V.I Trotsenko, doctor of Agricultural Sciences, Professor, Head of the Department of Agrotechnology and Soil Science of Sumy National Agrarian University; S.B. Kovalevsky, doctor of biological sciences, Professor of the Botany, Dendrology and Forest Breeding Department, National University of Life and Enviromental sciences of Ukraine.

THE CHLOROPHYLL AND OIL CONTENT OF MUSTARD DEPENDING ON THE USE OF GROWTH REGULATORS WITH ANTI- STRESS ACTION IN THE FOREST STEPPE OF UKRAINE

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Introduction. Mustard is an annual herb of the family *Brassicaceae* and is an important cash crop. *Brassica* includes many crop species that provide edible roots, leaves, stems, buds, flowers and seeds. The seeds and whole grass are used for medicinal purposes, which can reduce phlegm and relieve asthma; mustard can also be used as an excellent honey plant. Mustard is very rich in nutrients and contains a large amount of carotene, potassium, calcium and vitamins. Mustard seed flour is called mustard and is a seasoning (Shekhawat, Rathore, Premi, Kandpal, Chauhan, 2012).

On the other hand, mustard is not only an important fresh vegetable, but also an important agricultural and sideline processing product. Mustard plants are similar to canola in many places, for example, they look like canola, and they are stronger than canola when growing in dry conditions or when exposed to disease. Therefore, mustard is the preferred candidate material to replace rape. Mustard also has a special fragrance, which can increase appetite and help digestion; it also has the health care function of clearing heat and detoxification, antibacterial and detumescence. Mustard has a unique effect on the treatment of blood disorders (Meng Qiufeng, Wang Yuhong, Ren Xiliang, et al., 2006).

Oilseed crops require adequate availability of fertilizers for maximum productivity (Kazemeini, Edalat, Shekoofa, Hamidi, 2010). Nitrogen (N_2), phosphorous (K_2O_5), and potassium (K_2O) (NPK) fertilizers increase crop yield capacity by influencing plant height, the number of flowering/fruiting branches, total plant weight, leaf area index, as well as the number and weight of siliquae and seeds per plant (Siadat, S.A., Sadeghipour, O., Hashemi-dezfouli A. H., 2010. Within the whole growth period of mustard, nitrogen fertilizer was the most needed, followed by potassium and phosphorus. Mustard fertilization should follow the principle of base fertilizer first and top-dressing second. Ternary compound fertilizer (19:19:19) 50 kg/667m^2, spread on the ground is ploughed into the soil.

The application of nitrogen fertilizers substantially increased the seed yield capacity even under diverse and contradicting conditions. Plant height increased with the decrease in planting space and the use of nitrogen fertilizer Mobasser *et al*. Nitrogen rates of 135 and 150 kg ha^{-1} significantly increased harvest index (HI) Kazemeini *et al*. (2010), while it remained unaffected (Danesh-shahraki *et al*., 2008, Rathke G.W., Behrens, T, and Diepenbrock, W., 2006. The 1000-seed weight remained unaffected at various levels of NPK Singh *et al*., (2017) . Rathke *et al*. (2006) reported that fertilizer N rate strongly

influenced rape productivity. They found that rape yield was influenced by various application rates of N fertilizer (Almi, Jannah., 2019). Plant growth compound regulator (PGR) shows prominent effects on plant metabolism, resistance, growth, and productivity (Fang-bo et al., 2017; Rademacher 2015).

Temperature and relative humidity are seemingly the two environmental factors that most immediately influence the performance of foliar nutrients. Besides, the temperature can affect foliar absorption by way of its effect on the drying rate of the applied nutrient spray, the physic chemistry of nutrient solution, as well as its effect on leaf cuticles, and the plant metabolism, ion uptake, and assimilation (Demirer, Ozer, Kocturk, 2004; Melnik, Zherdetska, Ali, Romanko, Makarchuk, Akuaku, 2015). An instant effect of high temperature is reported to increase the drying rate of the spray droplets, which directly diminishes absorption. The ineffectiveness of the applied foliar fertilizers in our research could partly be due to the faster rate of evaporation of the spray solutions deposited onto the leaves. Besides, the temperature seems to directly affect the rate of leaf development and such a way to influence the foliar absorption through effects on leaf phenology and sink: source relations (Fernández et al., 2013). Relatedly, over a brief period, the prevailing temperature during and instantly after the foliar application has different effects based on varieties and mineral elements applied. In pistachio, for example, Zn absorption following the application varied from 9 to 14% as the temperature increased from 8 to 31°C within 24 hours. Within the same temperature range, Zn assimilation in walnut merely increased from 4 to 6%. It is conceivable in the present study, in which the application was done at about 24 °C on sunflower species, there was little or no absorption of mineral elements contained in the applied foliar fertilizers (Vuxal Boron and Spectrum Mo+B), and hence no significant effects.

Materials and Methods. The field research was conducted in the research field of ERPC (educational, research, and production complex) of the Sumy National Agrarian University during 2019-2020 in Ukraine. The experimental plots of Sumy NAU are located within the city of Sumy (latitude 50º52.742N, 34º46.159E Longitude, and 137.7 m above sea level) and belong to the northeastern part of the Forest Steppe. Experiments were carried out on black soil characteristics for the coarse-medium loam.

On the topic of the master's research work, the field research was conducted according to the following scheme.

The scheme of the experiment. Factor A – mustard variety; factor B – seed treatment.

Experiment parameters 1: la = 2, lв= 9; n = 4, the area of the accounting area of 15 m^2. The plots are arranged by the method of organized repetitions in four tiers. The method of sowing is the row method with a row spacing of 15 cm. The seeding rate is 1.5 million pieces of seeds per hectare.

The chlorophyll content in the leaves was determined by preparing a solution in an alcohol extract followed by the determination on a ULAB 102 spectrophotometer. The oil content was determined on the SupNir 2750 infrared analyzer. The statistical analysis of research results was performed using the analysis of variance, correlation, and regression using Exell, Statistica-10 computer programs (DSTU, 2004).

Results. Chlorophyll is the main pigment for photosynthesis in plants. It is a family of lipid-containing pigments located in the membrane. Chlorophyll absorbs most of the red and purple light but reflects green light, so chlorophyll appears green, which plays a central role in the light absorption of photosynthesis. As there is the biosynthetic pathway of chlorophyll in living green plants, chlorophyll can play a role in photosynthesis without photolysis. The seeds were treated with the same growth regulators of Albit, Antistress, Agrinos, Biofoge, Fast Start, Regoplan, Stimulate, and Vermistim D, and the chlorophyll content of the leaves was measured before the plants had matured.

By analyzing Table 1, for Prima, the plants with seeds treated with Biofoge and Vermistim D had the highest fresh weight chlorophyll content – 1.87 mg/g. N-tester: 47.55, 43.50. For Felicia, the plants with Biofoge treated seeds had the highest fresh weight chlorophyll content – 1.26 mg/g. N-tester: 47.60. The chlorophyll content of the plants with seeds treated with the growth regulator of Biofoge increased under the fresh weight of Prima and Felicia leaves.

For the productivity of mustard, the average length of a single pod, the number of seeds per pod, and the seed weight are important factors to measure productivity.

Table 1 - The chlorophyll content of mustard depending on the use of growth regulators with anti-stress action in the forest steppe of Ukraine (2019–2020 yy.)

Factor A	Factor B		
Varieties	Regulators	The content of chlorophylls "a" and "c" in the plant material in fresh weight, mg/g	n-tester
Prima	Control	1.23	42.60
	Albit	1.70	42.15
	Antistress	1.69	48.65
	Agrinos	1.59	46.00
	Biofoge	1.87	47.55
	Fast Start	1.56	45.95
	Regoplan	1.67	44.55
	Stimulate	1.69	45.05
	Vermistim D	1.87	43.50
Average of Prima		1.65	45.11
Felicia	Control	1.16	45.85
	Albit	1.23	47.72
	Antistress	1.20	46.65
	Agrinos	1.15	45.35
	Biofoge	1.26	47.60
	Fast Start	1.13	47.67
	Regoplan	1.24	46.35
	Stimulate	1.14	45.30
	Vermistim D	1.08	50.65
Average of Felicia		1.18	47.02
Duncan test		0.43	6.25

Seeds were treated with the same growth regulators of Albit, Antistress, Agrinos, Biofoge, Fast Start, Regoplan, Stimulate, and Vermistim D, and the average length of individual pods of Prima and Felicia plants, the weight of 25 seeds, the weight of individual pods, and the individual number of pod seeds were measured.

The yield capacity refers to the harvested amount of products needed for cultivation purposes, that is, the harvested amount of grains. The level of output directly affects the economic value. Thousand-grain weight is the weight of one thousand-grain rice in grams, with g as the unit. The index reflects the size and fullness of seeds, it is the content of testing seed quality and crop testing and is an important basis for predicting the yield in the field. For oil crops, the oil content of the seed is an important criterion for measuring the oil yield.

Table 2 - The biological yield capacity and oil content of mustard depending on the use of growth regulators with anti-stress action in the forest steppe of Ukraine (2019–2020 yy.)

Factor A	Factor B			
Varieties	Regulators	Yield, t/ha	Mass 1000 seeds,g	Oil content, %
Prima	Control	1.98	2.60	36.70
	Albit	2.24	2.98	38.46
	Antistress	2.16	2.88	37.42
	Agrinos	2.77	3.69	37.18
	Biofoge	2.92	3.89	39.10
	Fast Start	2.13	2.83	38.91
	Regoplan	3.34	4.45	38.89
	Stimulate	2.25	3.00	37.12
	Vermistim D	2.25	2.99	38.91
Average of Prima		2.45	3.26	38.08
Felicia	Control	2.66	3.55	36.42
	Albit	2.44	3.26	36.92
	Antistress	2.53	3.38	36.57
	Agrinos	2.68	3.57	35.18
	Biofoge	2.56	3.42	38.66
	Fast Start	3.55	4.74	36.69
	Regoplan	2.19	2.91	38.62
	Stimulate	3.84	5.12	36.95
	Vermistim D	2.43	3.24	38.03
Average of Felicia		2.76	3.69	37.12
Duncan test		0.72	1.13	1.38

The plant's yield, thousand-kernel weight, and seed oil content were measured, as shown in Table 2. By analyzing Prima, the plants with Regoplan treated

seeds had the highest biological yield – 3.34 t/ha, and the weight of one thousand seeds was the heaviest – 4.45 g. Plants treated with Biofoge had the highest seed oil content – 39.10%.

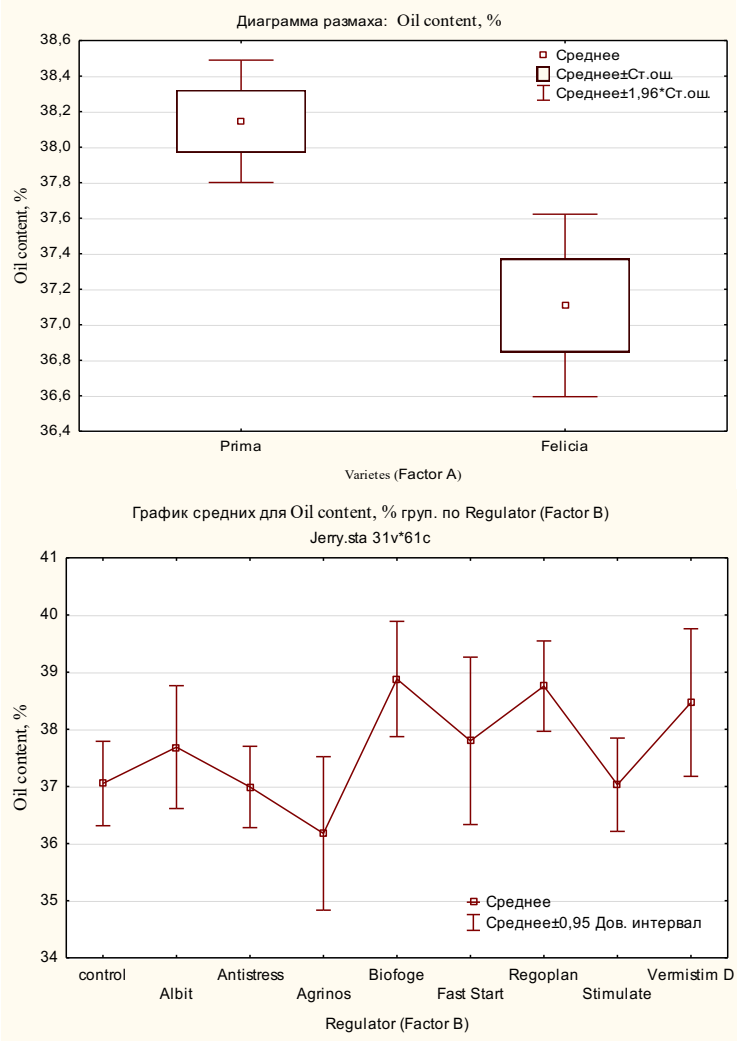

Fig. 1 - Effects of different plant growth regulators on the oil content of mustard seeds (2019–2020 yy.)

For Felicia, the plants with Stimulate treated seeds had the highest yield capacity – 3.84 t/ha, and the weight of one thousand seeds was the heaviest – 5.12

g. Plants treated with Biofoge had the highest seed oil content – 38.66%. The use of Biofoge increased the seed oil content of two varieties of Prima and Felicia.

Conclusions. Based on the results of the research, the following conclusions can be drawn:

1. For Prima, the plants with Regoplan treated seeds had the highest biological yield, 3.34 t/ha, and the weight of one thousand seeds was the heavies – 4.45 g. Plants treated with Biofoge had the highest seed oil content – 39.10 %.

2. For Felicia, the plants with Stimulate treated seeds had the highest yield – 3.84 t/ha, and the weight of one thousand seeds was the heaviest – 5.12 g. Plants treated with Biofoge had the highest seed oil content – 38.66%. The use of Biofoge increased the seed oil content of two varieties of Prima and Felicia.

To obtain the highest yield capacity of brown mustard in the northeastern Forest Steppe of Ukraine. The seeds of Prima variety should be treated with Regoplan growth regulator, the variety of Felicia – with Fast Start or Stimulate growth regulator. To increase the oil content in the seeds, Biofoge growth regulator should be applied.

REFERENCES

1. Danesh-shahraki, A., Kashani, A., Mesgarbashi, M., Nabipour, M. and Koohi-dehkordi, M. (2008). The effect of plant densities and time of nitrogen application on some agronomic characteristic of rapeseed. Pajouhesh&Sazandegi. 79: 10-17.

2. Demirer, T., Ozer, I., Kocturk, O.M., Er., A.Y. (2004). Effects of Different Leaf Fertilizers on Yield and Quality in Sunflower (*Helianthus annuus* L.). Pakistan Journal of Biological Sciences, 7: 384-388. DOI**:** 10.3923/pjbs.2004.384.388

3. Fernández-Martínez, J.M., Pérez-Vich, B., Velasco, L. (2010) Sunflower. In: Oil Crops: Handbook of Plant Breeding 4. New York: Springer; P. 155-232.

4. Kazemeini, S.A., Edalat, M., Shekoofa, A. and Hamidi, R. (2010). Effect of nitrogen and plant density on rapeseed (Brassica napusL.). J. Appl. Sci. 10:1461-1465..

5. Melnik, A. V., Zherdetska, S. V., Ali, S., Romanko, Y. O., Makarchuk, A. V., Akuaku, J. (2015). State and prospects for growing oil crops in Ukraine under the conditions of climate change. Science and World, 1(10), 113−116.

6. Meng Qiufeng, Wang Yuhong, Ren Xiliang, et al. (2006) Preliminary study on horticultural characters of different varieties of mustard vegetables [J]. Modern agricultural science and technology, №21. 25-26.

7. Mobasser, H.R., Shojaee-ghadikolaee, M., Nasiri, M., Daneshian, J., Barari-tari, D. and Pourkalhor, H. (2008). Effect of nitrogen rates and plant density on the agronomic traits of canola (Brassica napusL.) in paddy field. Asian J. Plant Sci. 7: 233-236.

8. Rathke G., Behrens T, Diepenbrock, W. (2006). Integrated nitrogen management strategies to improve seed yield oil content and nitrogen efficiency of winter oilseed rape (*Brassica napus* L.): a review. Agric. Ecosyst. Environ. 117, 80–108.

9. Seeds of agricultural crops. Methods for determining quality: DSTU 4138–2002. [Effective from 01.01.2004]. Kyiv: State Standard of Ukraine, 2003. 173 p. (National standard of Ukraine).

10. Shekhawat, K., Rathore, S.S., Premi, O.P., Kandpal, B.K., Chauhan, J.S. (2012). Advances in Agronomic Management of Indian Mustard (Brassica juncea(L.) Czern. Cosson): An Overview. Hindawi Publishing Corporation International Journal of Agronomy. Volume 2012, Article ID 408284, 14 pages doi:10.1155/2012/408284.

11. Siadat, S.A., Sadeghipour, O. and Hashemi-dezfouli A.H. (2010). Effect of nitrogen and plant density on yield and yield component of Rapeseed. J. Crop Prod. Res. 2:49-62.

12. Sudirman Almi, Noor Jannah. (2019) Effect of Types and Doses of Compost Fertilizer on Growth and Yield of Sawi Plants (*Brassica juncea* L.). Journal AGRIFOR volume 18 issue 1 on page 145 https://doi.org/10.31293/af.v18i1.4121

GROWING A PEAR WHEN USING AN INTERCALARY INSERT

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About 50 fruit crops are grown in Ukraine, but apple or pear, plum, cherry, etc. predominate in industrial gardens. Soil and climatic conditions of our country are quite favorable for growing deciduous fruit crops. According to information from scientific medical institutions, the total annual consumption of fruit products should be about 100 kg. But Ukraine today does not meet this need, including for pears. The main way to increase the gross fruit harvest is intensification, which is based on the principle of growing orchards from low-growing fast-growing trees with compact low-volume crowns, easy to care for and harvest. The problem of creating modern intensive plantations with fast-fruiting and highly productive trees is solved by growing seedlings in nurseries on dwarf vegetative rootstocks using high-yielding varieties. The concept of intensive garden includes: density (number) of trees per unit area, high-yielding varieties and rootstocks, crown shapes, the presence of supports, irrigation and other technological factors that are constantly changing under the influence of economic factors. Recognizing the undeniable role of increasing the number of trees per unit area as a potential basis for productivity, the concept of intensive gardening should not be considered as synonymous with high-density planting.

Increasing the number of trees per unit area is primarily a means of ensuring the early entry of plantations in the period of commercial fruiting and obtaining a high gross harvest of fruit per unit area. The system of intensive gardening covers a wide range of organizational, economic and technological factors. According to economists, the relationship of the process of intensification in horticulture is the most appropriate to consider in the following sequence: costs - planting land - products. The basis of intensification of the industry is scientific and technological progress, which includes the following groups of factors: biological (rootstock combinations), technological (constructions), technical (mechanization), and organizational ones.

In a market economy, the most important indicators of intensity and perfection of technology are: time of entry of plantations into commercial fruiting, the rate of increase in yield and term of use of plantations, which allows additional income from the use of intensive production technology, and new scientific developments. Therefore, the chosen topic is relevant and has practical significance.

The aim and objectives of the research. The aim of the research is to study and compare the characteristics of growth and development of Williams and Etude pear varieties using intensive and classical production technology.

The object of the research is the productivity of Williams and Etude pear varieties with classical and intensive cultivation technology.

The subject of the research is Williams and Etude pear varieties on seedlings and seedlings with intercalary inserts.

Based on the obtained data, it is possible to establish the efficiency, expediency of using intensive technology of Williams and Etude varieties on seedlings and seedlings with an insert for laying intensive perennials in Sumy district of Sumy region.

At the same time, the transition of Ukrainian horticulture to new technologies, based primarily on new rootstock combinations, the area of industrial use of which is due to climatic conditions, which are characterized by significant differences in Ukraine, determines the need to clarify them.

In addition, new constructions of plantations with a high density of trees per unit area require appropriate retraining of the staff (formation and pruning of trees, irrigation, protection from pests and diseases, etc.).

Assessing the possible risks of commercial fruit production by new technologies, it should be recognized that the greatest risk is not the widespread use of new intensive technologies, but on the contrary, in the case of ignoring these technologies. In that particular situation Ukraine loses the most in economic and social terms (jobs, markets), which makes the country dependent on foreign producers of these products.

For a long time, pear culture around the world has developed extensively. Gardeners followed the rules of obtaining the maximum possible yield from one tree, planting the latter at considerable distances and without limiting the parameters of the crown. The main attention was paid to the formation of durable trees. Early fruiting was seen as a factor in weakening the growth of trees and reducing their longevity, and even provided for the removal of flowers in the first 1-2 years after planting.

Such gardens were grown on vigorous seed rootstocks. Trees were formed on high trunks - 1.5 m or on semi-trunks - 1 m high according to the tier system. Because trees were planted over long distances, the free space between them was used to grow other crops. According to the technology, they were called "inter-row" and were promoted until the late 60's of the last century.

The gardens began to bear fruit at the age of 10-12, entering the period of full fruiting on the 15th-16th year after planting, which is not economically feasible. In addition, this type of plantings had a significant conservatism in changing the range, layout, rootstocks, as the period of their use reached 40-50 years or more.

In this regard, there is no doubt the need to find ways to modernize the technology of cultivation. One of such factors was the revision of the number of trees per unit area in the direction of their increase.

Only in the early 70's of the last century the rectangular system of tree placement was considered more promising, which provided not only reducing the width of rows to 8 m, but also thickened planting of trees in a row - 4 m. Seedlings of resistant cultivars began to be widely used as rootstocks [1,2], and the main type of crown was sparse-tiered. Existing plantations were also compacted [3].

Taking into account the peculiarities of soil and climatic conditions of the regions, in the future the scheme of planting pears on seed rootstocks acquired the following

parameters: distance between rows was 5-7 m, in rows - 3-5 m. Changes in the approaches to the formation and pruning of trees were also determined: the number of main branches, tiers, the height of trees, the size of the crown and even their shape - palmettos - decreased in the crown. Flattening of crowns and reducing their size and skeletal part contributed to improved leaf illumination, increased its photosynthetic activity, and as a result - more rational use of assimilation products for fruiting [4,5].

The new technology has reduced the infertile period to 5-6 years, increased yields and fruit quality, reduction the cost of pruning and especially fruit collection. At the same time, it was found that in intensive pear plantations on seed rootstocks (400-600 trees / ha) the greatest harvest of fruits is achieved in the 3-5th five years from the time of planting, and therefore the period of their cultivation is 25-27 years [6]. In a market economy, the most important indicators of intensity and perfection of technology are: time of entry of plantations into commercial fruiting, the rate of increase in yield and term of plantations use, which allows additional income from the use of new scientific developments.

The research was performed in the educational laboratory of horticulture and viticulture of Sumy National Agrarian University. It is located in the north-western part of Sumy in the north-eastern forest-steppe of Ukraine. The land area of the center stretches from west to east for 3.5 km and from north to south - for 12 km and is a low-wave watershed plateau, which is delimited by beams into a number of local wetland watersheds.

The arable lands of the land use of the center are located on the plains, which allows to grow any crops without the threat of washing away the upper fertile layer of the soil.

The soil of the experimental plot is typical deep low-humus medium-loamy, coarse-grained black soil. It has a reaction close to the neutral one. The humus content is sufficient to obtain high yields of crops.

The lands where the center is located are referred to the second agroclimatic district of Sumy region, which is characterized by temperate, continental climate with warm summers and not very cold winters with thaws. There are no large water basins nearby that affect the climate as a whole or its individual elements. According to average long-term data, the coldest months are January and February, and the warmest one is July. The absolute minimum of air temperatures is observed in January, and the maximum in July. The annual sum of temperatures above 10°C ranges from 2500 to 2650°C. The average annual air temperature is 6.5°C, and the amount of precipitation is 531 mm. Most of them are in summer and autumn. The duration of the frost-free period is 275 days. According to long-term data, the first autumn frosts are observed in the second decade of September, and the last spring frosts end in the third decade of April - at the beginning of the first decade of May.

The hydrothermal coefficient for the period with air temperature above 10°C is 1.1-1.2. 30-35% of annual precipitation falls with snow, which under favorable conditions is absorbed by the soil, creating reserves of productive moisture. The height of the snow cover reaches 15 cm, the distribution of snow is uniform. Agrophysical maturity of soil occurs after the transition of temperature through 5°C, on average in the second decade of April. The number of days with an average daily temperature above 15°C is 110 days.

The growing season, limited by the transition from the average daily air temperature of 5°C in spring (April 10) to its transition of 5°C in autumn (October 26), averages 199 days, among which 156 days (from April 26 to September 29) are quite favorable for the development of crops (with temperatures above 10°C).

Meteorological conditions of the years of our research differed from each other and the average long-term data.

Both years were relatively arid, although the deviation from the average long-term data in 2020 was -23.1 mm, and in the following year rains were more than the average of 108.8 mm, although they fell very unevenly.

With the exception of the third decade, May was wet in 2020. However, almost the entire following period was dry. This was especially true in the first decade of June, the first and the third decades of July and the whole August. In the latter, only 6.9 mm of rain fell during the whole month.

A lot of rain fell in May 2019. In the second decade there were almost 2.5 times more rains than in a number of years, and in the third decade - about 2 times. The first decades of June, July and August were extremely dry, with 1.1-7.2 mm of rain. The second decade of August was very rainy. With an average rainfall of 18 mm, 108.9 mm actually fell, which is 6.1 times more, although the first and the third decades were dry.

The aim of our observations was to identify differences in growth and development, and most importantly in yield of Wiliams and Etiud pear varieties by intensive technology, compared to trees of these varieties using classical technology in the laboratory of horticulture and viticulture of Sumy district, Sumy region. The research was conducted in 2018-2020.

The diameter of a trunk was determined with a pole caliper at a height of 10 cm from the inoculation site.

The width of the crown and the height of the tree were measured with a measuring rail: the width as the average between the two dimensions along and across the row, and the height as the difference between the height of the tree and the height of the trunk. Measurements were performed after harvest [7, 14, 15].

The diameter of the crown was measured by lowering the conditional perpendicular to the ground, two notches along and across the row, measuring the distance between them.

The total length of annual increments was measured at the end of the growing season with a measuring tape, taking into account branches at least 5 cm long.

The average length of annual increments was determined by dividing the total length of branches by their number.

The area of the leaf blade was determined by the method of cuttings, selecting from each repetition of 10 leaf blades and weighing them. Then 20 - 25 cuttings with a total area of at least 10 - 20 cm2 were selected. After weighing, the area of the leaf blade was calculated by the formula:

$$S = \frac{M \times S_1 \times n}{m \times N} \quad (1)$$

where
S is the area of the leaf blade, cm^2;
S_1 - die area (S1 = 0,785 D2, where D is the diameter of the die, cm;
n is the number of cuts;
M - mass of leaves in the party, g;
m - mass of cuts, g;
N - the number of leaves in the party.

The area of the leaf apparatus was determined by multiplying the area of the leaf blade by the number of leaves on the tree. Multiplying the obtained indicator by the number of trees per hectare, we obtained the area of the leaf apparatus (m^2/ha).

The intensity of flowering was determined during its mass phase, counting the number of inflorescences, followed by multiplication by the number of flowers in the inflorescence.

The level of useful ovaries was determined by dividing the number of ovaries left on the tree after June fall by the number of flowers (multiplied by 100).

Yield was calculated by the number of fruits on the tree multiplied by the average weight of the fruit. The latter was determined by weighing 100 apples from each replicate and variant.

Today, in the agricultural sector, it is advisable to use computer technology to process data, calculate and obtain the results of field research, accounting, observation of crop development, and yield. Mathematical processing of the results obtained during the experiments provides an opportunity to perform the calculations we need with considerable accuracy and speed.

The following methods of mathematical statistics were performed during the research: point estimation, interval estimation, one-factor analysis of variance.

Point estimation. An important indicator for point estimation is that the statistical series is characterized by several single summary estimations. The following estimations are used for point estimation of the general population:

μ is the arithmetic mean. It is in the middle of the row and in the ranked row as if dividing it in half.

Σ - standard deviation. It allows you to more or less theoretic frequency to select the area of the ranked statistical series in which there is a particular amount of data. Thus, in the zone ± 1 σ contains 68.26%, in the zone ± 2 σ - 95.45%, and in the zone ± 3 σ - 99.73% of all data.

σ^2 - variance. It is a square of the standard deviation and is convenient in that, if the standard deviation is characterized by standard deviations, it always turns out 0, whatever the variance is, and the variance is always positive (for example, $2^2 = 4$ and $(-2)^2 = 4$) and its absolute value is greater the greater scatter of data is in the statistical series.

In the case where the researcher is dealing with a sample, for convenience, these estimations are replaced by Latin letters:

$\bar{X}$ - sample arithmetic mean;
S-sample standard deviation;
S^2 - sample variance;
$S_{\bar{x}}$ - error of the sample arithmetic mean. One of the main point estimations of the sample is the arithmetic mean. It is based on the formula:

$$\bar{X} = \frac{\sum X_1}{N} \quad (2)$$

where $\bar{X}$ - arithmetic mean,
$\sum X_1$ - the sum of all members of the statistical series;
N - number of members in the statistical series.

One of the main point estimates of the sample is the arithmetic mean. Therefore, to obtain data in our studies, we determined the arithmetic mean of the indicators. There are many requirements for the arithmetic mean in mathematical statistics, and it is very informative. These requirements are as follows:

1. Convincibility, which means that x μ, i.e. the sample mean is approximately equal to the arithmetic mean of the general population. Due to this, when adding new data to the sample, its arithmetic mean almost does not change. On the contrary, such an addition leads to an increasing approximation of the sample average to the general average.

2. Non-bias, which means that the sample mean lies at the very top of the normal distribution curve, dividing it into two equal parts.

3. Efficiency, which assumes that for a given sample the arithmetic mean is such that the variance is minimal, i.e. the scatter of points (values) around the mean is the smallest.

4. Robustness, which means that although the sample deviates slightly from the normal statistical distribution, all estimates for it can be made on the basis of this distribution and will be fair. This feature of the arithmetic mean should be born in mind when interpreting the data.

After performing a series of arithmetic mean calculations in mathematical statistics, we also calculated the standard error of the arithmetic mean.

This indicator was calculated by the formula:

$$S_{\bar{x}} = \frac{S}{\sqrt{n}} \quad (3)$$

Interval evaluation. The method of interval estimation was also used in the calculations, when the statistical series is estimated by some interval "from" and "to", within which are its main typical and statistically significant values. In fact, the arithmetic mean is in the range , $\pm t \cdot S_{\bar{x}}$ where t is the value of the Stiudent's criterion, which depends on the sample size and is tabulated. Confidence estimates were no less informative than point estimates. We illustrated the results of the interval assessment graphically by constructing "mustache boxes".

Also, during data processing we used one-factor analysis of variance, which is one of the most common methods of mathematical statistics in biology and agriculture. It allows you to find the answer to the question whether the influence of a factor is likely. One-way analysis of variance makes it possible to compare several systemically related samples and determine whether there are statistically significant differences between them and what the probability of these differences is.

In all models of analysis of variance the action of some general factor is checked; in our case we use one factor of influence. The factor in the general case is one or another form of influence on the object, as well as the feature or property of the object. When determining the probability of the effect of the presented factor on the object of study, the factor must be divided into types of influence. In analysis of variance as a method of mathematical statistics, these divisions of factors are called levels. Working with one-factor analysis of variance, the accounting procedures of the statistical package automatically selected the correct model from the research data. In general, analysis of variance can only be applied to material that has been properly assembled, and the experiment has been planned in advance for processing by analysis of variance.

It is advisable to lay on the projects in an industrial orchard, regardless of its area, which are developed by garden design and research institutions. The development of the project involves the preparation of feasibility study, careful inspection of land that is planned to be taken under the garden, and survey of the terrain, agrochemical characteristics of soil and subsoil, reclamation works, organization of the garden area, soil preparation, soil selection, selection of species and varieties, their location, garden constructions, 6crowns and their formation, planting, technological maps of the garden and its care before entering into industrial fruiting, estimates for all work [10]. Projects are developed with the aim of the most rational use of land and growing high regular yields of quality fruit based on advanced intensive technologies. When designing an intensive industrial garden, the whole set of organizational, economic, technological and environmental factors is carefully analyzed and evaluated. After all, mistakes made when planting a garden are quite difficult, and often impossible to correct later [7, 8].

Unlike field crop rotations, intensive orchards are planted for up to 20 years, so special care must be taken in site selection and pre-planting soil preparation. First of all, you need to decide on the technology by which you will grow a garden, choose varieties and rootstocks.

The optimal place for planting an orchard is flat or with a slight slope (up to 2-3°) area that has a favorable water regime and is protected from winter winds. Southern exposure of the slope should be avoided, as significant damage to the bark of young trees by sunburn is possible.Iin addition, there is an increased risk of damage to flowers by spring frosts, because the trees develop early in the spring. It is not advisable to plant a garden in the lowlands and valleys, where cold air stagnation is possible. You should begin to prepare the soil for the garden a year before the planned planting. The main task at this stage is to free the area from weeds, increase the content of basic nutrients and create a surface layer with optimal structure.

For planting an orchard, plantation plowing should be carried out to a depth of 45-50 cm to create the optimal water-air regime of the root-containing layer, which is especially important for the growth of young trees. If plantation plowing is not possible, deep plowing should be limited to a plow with a soil deepener [9, 12].

In modern intensive plantations, obtaining an annual harvest with high taste and marketable qualities of fruits is possible only under the conditions of annual active growth processes, during the attenuation of which there is a periodicity of fruiting and deterioration of fruit quality.

The diameter of the trunk.

The trunk circumference or diameter, tree height and crown volume are often used as criteria for tree growth. The growth of trunk diameter is the main indicator of lateral growth of fruit trees, which depends on many factors, including the choice of seedling rootstock. The results of our researches are shown in Table 1. Validation was performed using analysis of variance.

Table 1- The diameter of the trunk of Williams and Etude pear trees depending on the use of the rootstock, mm

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	84	86	68	64	81,0	74,4
2019	87	90	70	69	80,5	76,6
2020	90	93	73	69	81,1	75,5
Average for 3 years	87,0	89,7	70,3	67,3	80,8	75,5

The table shows that with statistical probability the diameter of the trunk on the seedling exceeds this figure on seedlings grown with an insert.

Total length of shoots.

The total length of shoots is an important indicator of vegetative growth of trees. The research data were checked for reliability by one-way analysis of variance and are presented in Table 2.

Table 2 - Total length of shoots, m

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	275	269	145	153	52,7	56,9
2019	277	273	139	151	50,2	76,6
2020	274	270	146	150	53,3	75,5
Average for 3 years	275,3	270,7	143,3	151,3	52,1	69,7

On average, the total length of annual shoots was most positively affected by the variant using a seedling rootstock, for which this figure is 275.3 m, which is 52.1% more than the variant using a seedling with an insert.

In 2019, the increase in the total length of Wiliams shoots per seedling, compared to 2018, was 2 m, and for seedlings with intercalary insert - 2.5 m. Thus, both the total length of shoots on the tree and the increase in this indicator per year is higher in seedlings compared to seedlings grown using an intercalary insert.

The average length of an annual shoot on a tree.

The average length of an annual shoot on trees with different rootstocks for the years of observation is shown in Table 3. The results were verified by one-way analysis of variance.

Table 3 - The average length of an annual pear shoot depending on the choice of rootstock, cm

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	55,1	57,8	46,4	48,2	84,2	83,4
2019	54,6	56,3	46,9	46,5	85,9	76,6
2020	55,3	57,2	46,1	46,8	83,4	75,5
Average for 3 years	55,0	57,1	46,5	47,2	84,5	78,5

The results of the study showed that the average length of a shoot per tree is much longer in trees using seedlings - this length is 55.0 cm in Wiliams and 57.1 cm in Etiud. In trees with seedlings with an insert, this figure is 46,5 cm and 47.2, respectively. It is 14.6% and 17.1% more than in seedling trees with an insert.

The height of the trees.

The height of the plants also depends on the type of rootstock chosen. The results are given in Table 4.

Table 4 - Height of plants on seedlings of Wiliams and Eitud varieties and with intercalary insert, m

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	3,67	3,74	3,03	3,38	82,6	90,4
2019	3,82	3,86	3,21	3,49	84,0	76,6
2020	3,97	3,98	3,40	3,65	85,6	75,5
Average for 3 years	3,8	3,9	3,2	3,5	84,1	80,8

According to Table 4 it can be concluded that the height of trees is greatest in control trees, i.e. on the rootstock with intercalary insert - it averages 3.8-3.9 m. Last year the height of trees increased by 12-15 cm. Pears on the intercalary insert have a slightly lower height - on average 3.2 - 3.5 m, the increase in 2020 is 21-16 cm. In percentage correlation trees on seedlings with an insert are less than the control by 16.7% Wiliams and 9.6% Etiud. The reliability of the results was verified by one-way analysis of variance.

Crown width.

The width of the tree crown also depended on the selected rootstock (Table 5). One-factor analysis showed a statistically significant difference between the two variants of the experiment.

Table 5 - The width of the crown of apple trees, depending on the choice of rootstock, m

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	3,21	3,03	2,65	2,44	82,6	80,5
2019	3,34	3,16	2,78	2,65	83,2	76,6
2020	3,41	3,21	2,84	2,73	83,3	75,5
Average for 3 years	3,3	3,1	2,8	2,6	83,0	77,5

The largest width of crown in Wiliams and Etiud pear varieties was in the trees, where a seedling was used. It exceeded the width of the crown of trees with intensive cultivation technology by 17.1% and 17.8%, respectively.

Number of leaves per tree.

The productivity of the pear is ensured not only by the receipt of nutrients from the soil, but also by the synthesis of nutrients in the assimilation organs of the tree - the leaves, which are the energy station of the tree, because it undergoes photosynthesis. It receives 95% of organic matter and only 5% from the root system [10]. The results of studies on the number of leaves are shown in Table 6.

Table 6 - Number of leaves on Wiliams and Etiud pear varieties depending on the choice of cultivation technology, pcs / tree

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	3324	3277	2432	2280	73,2	69,6
2019	3481	3403	2564	2331	73,7	76,6
2020	3421	3347	2503	2314	73,2	75,5
Average for 3 years	3408,7	3342,3	2499,7	2308,3	73,3	73,9

Thus, according to our research, it was found that the initial estimate of the number of leaves contributed to the variant of growing pears on seedlings, which revised this figure on trees with an insert of 26.59% and 30.96%.

Leaf surface area.

No less important indicator of vegetative growth of the tree is the area of the leaf blade Table 7. After all, the larger the photosynthetic surface of the leaves, the better the yield.

Table 7 - The area of the pear leaf blade, depending on the choice of rootstock, cm^2

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	42,1	43,9	41,3	44,7	98,1	101,8
2019	42,4	44,8	42,1	44,9	99,3	76,6
2020	42,9	45,3	42,5	45,6	99,1	75,5
Average for 3 years	42,5	44,7	42,0	45,1	98,8	84,6

The table shows that the largest leaf surface area was in trees using seedlings, which was 45.6 cm in Etiud, in trees grown with ordinary seedlings - 42.9 cm^2 in Williams and 45.3 cm^2 in Etiud.

The total area of the leaf apparatus

The total area of the leaf apparatus of trees Table. 8 depends on the number of leaves Table 6 and leaf surface area of Table 8.

Table 8 - The total area of leaf cover on pears, depending on the choice of rootstock, mI / tree

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	1399,4	1438,6	1004,4	1399,4	71,8	97,3
2019	1455,1	1514,3	1028,2	1455,1	70,7	76,6
2020	1456,1	1515,1	1029,3	1455,8	70,7	75,5
Average for 3 years	1436,9	1489,3	1020,6	1436,8	71,0	83,1

Thus, the use of seedlings for growing Wiliams and Etiud pear varieties in the conditions of this farm provides the highest indicators of the total leaf cover of trees, which is a good prerequisite for the formation of a larger fruit crop. Thus, the total area of the pear leaf apparatus on the rootstock with the insert is 1020.6 m^2 / tree in Wiliams and 1436.8 m^2 / tree in Etiud, while on seedling trees - 1436.9 m^2 / tree and 1489.3 m^2 / tree respectively.

Productivity and development of Williams and Etude pear trees.

Pear yields significantly depend on abiotic and biological environmental factors. In modern intensive gardens the right choice of agricultural techniques for the care of plantations, the choice of planting material in advance have a great influence on fruiting.

One of the ways to pre-determine the yield of pear is to calculate its intensity of flowering trees Tab le9. It is on this indicator that conclusions can be drawn about the formation of generative organs, their damage during adverse winter conditions and the ability of trees to form crops.

Table 9 - The number of flowers on Wiliams and Etiud pear varieties depending on the choice of rootstock, pcs / tree

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	489	476	354	347	72,4	72,9
2019	503	498	378	370	75,1	76,6
2020	507	504	383	379	75,5	75,5
Average for 3 years	499,7	492,7	371,7	365,3	74,4	75,0

The number of flowers on trees using seedlings is slightly higher compared to trees on the intercalary insert. These values are 496 pcs / tree for Wiliams and 487 pcs / tree for Etiud and 366 pcs / tree and 358.5 pcs / tree respectively.

It Is known that Intensive flowering increases the fruit load on trees and, consequently, yields. Tying fruits as the ratio of the number of laid flowers and the number of formed fruits also has some differences between the two variants of the experiment Table 10.

Table 10 – Tying fruit on Wiliams and Etiud pear varieties depending on the choice of rootstock, %

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	18,3	18,8	18	18,6	98,4	98,9
2019	17,8	18,5	19,1	19,3	107,3	76,6
2020	18,3	18,9	18,7	19,4	102,2	75,5
Average for 3 years	18,1	18,7	18,6	19,1	102,6	83,7

On average, in 3 years, the degree of fruit set in apple trees using an intercalary insert exceeded the control (seedling) by 1.63 – 2.83%.

The most important indicator of productivity of pear trees is their yield. Indicators of economic efficiency of fruit growing are calculated on the basis of the yield data [16]. The yield data of fruit trees of the experimental garden are presented in Table 11.

Table 11 - Yields of Wiliams and Etiud trees depending on the choice of rootstock, t / ha

Years	Seedling (K)		Seedling with an insert		Before control,%	
	Wiliams	Etiud	Wiliams	Etiud	Wiliams	Etiud
2018	15,0	13,0	32,0	29,0	213,3	223,1
2019	17,2	16,0	33,0	30,6	191,9	76,6
2020	17,6	16,4	33,1	30,2	188,1	75,5
Average for 3 years	16,6	15,1	32,7	29,9	197,8	125,1

The table shows that there are significant differences between two variants; the yield of pears in both varieties using intensive technology is higher than the control by an average of 213.3% Wiliams and 223.1% Etiud.

Over the years of research, there has been a tendency to increase the yield of pears due to the beginning of the planned entry into fruition.

Conclusions. 1. The growth rates of Wiliams and Etiud plants with intercalary inserts differed from those of seedlings. Stem diameter, leaf area, number of annual shoots, crown width, total number of shoots, length of one annual shoot and plant height were statistically significantly higher in seedlings grown than in intercalary inserts.

2. Indicators of productivity, on the contrary, were higher in plants using seedlings with intercalary. And these are the main indicators of economic feasibility of using a particular cultivation technology.

3. Wiliams and Etiud differed significantly in yield. Seedling yield is much lower.

REFERENCES

1. Matviyenko N.V. (1999) Rootstocks for pears are obtained from seeds. *Gardener*,no.3, pp. 30-31.

2. Zatokovyi F.T., Saiko V.I. (1998) Yield, early fruiting and strength of pear growth depending on the rootstock. *Gardening,* no.47, pp. 199-202.

3. Kuian V.H. (2009) Fruit growing. 478 pp.

4. Verzilin A.V.(2003) Ways of horticulture development in the central black soil zone. *Proceedings of the Scientific and Practical Conference "Increasing the efficiency of gardening in modern conditions",* vol.1, pp. 199-206.

5. Voievodin V.V. (2006) Features of horticulture development in Ukraine. *Gardening news,* no.3, pp.25-26.

6. Matviienko M.V., Matseiko L.M., Kumpan K.D. (1995) Pear on clonal and seed rootstocks. *Gardening*, no.44, pp.57-60.

7. Babina R.D. (2001) Economic and biological assessment of pear varieties in the Crimea. *Gardening*, no.52, pp.37.

8. Oliinyk M.S. (2004) "Secrets" of the queen cell rootstock. *Gardening news,* no.3, pp.6-8.

9. Spriahailo O.A., Kucher R.A. (2004) Biological features of undersized hybrid forms of pear (seed rootstocks) in the Right-Bank Forest-Steppe of Ukraine. *Collection of scientific works of Mliiv Institute of Horticulture named after L.P. Symyrenko and Uman State Agrarian University*, pp.121-126 (50% - part of the experimental work was done, conclusions were made).

10. Kuian V.H. (2004) Special fruit growing. *World*, no.49, pp.5-71.

11. Oliinyk M.S. (2004) "Secrets" of the queen cell rootstock. *Gardening news,* no.3, pp.6-8.

12. Matviienko M.V., Babina R.D., Kondratenko P.V. (2006) Pear in Ukraine (history, present, prospects). 320 p.

13. Pomology: in 5 vol. (1995) Vol.2: Pear and quince. 352 p.

14. Tkachyk S.O. and others (2016) Methods of examination of fruit varieties of fruit, berry, nut, subtropical and grape plants for suitability for distribution in Ukraine. 85 p.

15. Bublyk M.O. and others (2013) Laboratory and field methods for determining the frost resistance of fruit species and crops: guidelines. 26 p.

16. Khodakivska Yu.B., Matviienko M.V. (2016) Biochemical composition and organoleptic evaluation of fruits of promising varieties and elite forms of pear (Pirus communis L.) in the northern part of the Forest-Steppe of Ukraine. *Gardening*, no.71, pp.108-113.

IMPROVEMENT AND LANDSCAPING OF THE TERRITORIES OF PRE-SCHOOL EDUCATIONAL INSTITUTIONS IN KHARKIV, UKRAINE (FOR EXAMPLE, THE COMMUNITY PRE-SCHOOL EDUCATIONAL INSTITUTION CLUB "OKSAMIT")

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Relevance, purpose and significance of the study. As a result of hostilities on the territory of Ukraine in 2022 and in the city of Kharkiv, in particular, many preschools built in 1980-1990 on standard projects were damaged buildings, facilities and landscaping. An urgent issue is their urgent reconstruction and creation of conditions for the resumption of the educational process.

An important point in the modern processes of urbanization of urban areas is the connection of both large and small settlements with the natural ecosystem. Green areas, individual trees and shrubs, features of the terrain, act as part of the organization of the territory, performing a number of functional tasks. They can be located and improve the central part of the settlement or a certain area, delimit the territories by functional zones.

At the same time, green plantations in modern urban planning play an important recreational, architectural-planning, engineering-protective and sanitary-hygienic role. Aesthetic, educational, environmental and educational functions should also be considered. Green plantings on the territory of preschool, educational, educational institutions are used in the educational and upbringing process of children through the manifestation of careful attitude to nature, the formation of their environmental education. In settlements, the territory of the educational institution is also a kind of "pearl" of the neighborhood. Here are solemn events, celebrations and other cultural events. In addition, given the densely built-up areas of large cities, it is a place for walks and recreation of the local population.

Green areas of educational institutions, in addition to their sanitary and protective functions, are also widely used in educational and training processes: landscaped area promotes comfortable recreation and games, develops aesthetic taste, instills a love of nature [1]. Architectural and planning decisions, landscaping and equipment of the institution should be as consistent as possible with its main purpose [2]. On the territory of the institution, children get an idea of nature, so most of the territory is set aside for greenery, except for alleys, driveways, playgrounds and sports grounds.

The urgency of the study is to restore a harmonious, comfortable environment near the restored buildings for children's education and recreation through the creation or reconstruction of greenery and landscaping elements on the territory of the institution. This would meet the recreational, cultural, aesthetic and educational needs of children, parents and employees of these institutions. The aim was to develop a basic project for the reconstruction of landscaping and landscaping of the school, which is important and meets modern requirements and makes the stay of children, staff, local population more comfortable, safe and enjoyable.

The objectives of the study are as follows:

1. Analysis of natural and climatic conditions of the area of their location, the actual state of landscaping and landscaping;
2. Development of project proposals for reconstruction and landscaping elements and landscaping;
3. Selection of species range of trees, shrubs and flowers for landscaping.

The tasks were implemented on the example of pre-school educational institution Club "Oksamit" in Kharkiv on Zubareva street, 33.

Greenery as an important component of modern urban planning

Landscaping of settlements is a set of works on creation and use of green plantings in settlements. Landscaping is part of the overall set of measures for planning, development and improvement of settlements, acting as a so-called "ecological framework" [3], provides a uniform location among the buildings of gardens, parks and other large green areas, connected by boulevards, promenades, green strips, which with suburban forests and reservoirs are a single continuous system. In addition, landscaping in cities is a key element of artistic decoration (alley plantings, green walls, etc.).

Green areas, regardless of their functional purpose, are an organic part of the settlement. Placement in the plans of different categories of greenery depends on their functional purpose: to create comfortable conditions for recreation; for protection against wind, noise, harmful emissions of enterprises; improving microclimatic conditions; aesthetic considerations - landscaping of streets, squares, squares, neighborhoods, etc. [7, 23].

According to the functional purpose, greenery is divided into three types: general use; limited use; special purpose [4].

Public green areas - green areas located on the territory of city and district parks, specialized parks, parks of culture and recreation; in the territories of zoos and botanical gardens, city gardens and gardens of residential areas, inter-quarter residential buildings or their groups; squares, boulevards, plantations on the slopes, embankments, forest parks, meadows, water parks and others that have free access for recreation [4, **Ошибка! Источник ссылки не найден.**]. This type of plantings are located on the territory of the studied object.

The basis of the landscaping system of the modern city is the planting of residential neighborhoods, near educational institutions (kindergartens, schools, colleges, etc.); plantings of city and district importance in parks of culture and rest,

children's, sports and other parks, plantings in squares, boulevards; plantings in industrial areas, as well as reserves, sanitary protection and water protection zones.

The formation of the system of green areas of the city and their standards depend on many factors: geographical location, climatic conditions (rainfall, temperature, wind speed and direction), natural and landscape conditions, size and planning structure of the settlement [**Ошибка! Источник ссылки не найден.**].

The object of landscaping is the land on which the components of the landscape and buildings are interconnected and intended for recreation [4]. In large cities, all elements of the landscaping system are available; a rural settlement, settlement or small town has only a part of them. However, in urban and rural areas, protective greenery is needed between residential buildings and the production area. In large cities with a large share of industrial enterprises, it is important to ensure the aeration of urban development through its dismemberment into large green areas.

In many cases, the vegetation on the site can perform various functions, but depending on the conditions, one of the purposes is the main, others - additional. The main functions of greenery are: sanitary and hygienic (air purification and ionization, phytoncide of plants, protection from noise), recreational, decorative and artistic.

In modern conditions of high anthropogenic loads, landscaping and landscaping of settlements becomes especially important; a prerequisite for the ecological comfort of the settlement is the creation and maintenance of high-quality greenery. At the same time, they play a significant microclimatic role, in particular, on green and shaded streets the temperature can be 4-5 °C lower, and relative humidity 10-15% higher than on unshaded and green areas [8].

Criteria for landscaping of educational institutions

In today's urban environment, it is difficult to overestimate the role of greenery. In addition to the main sanitary and hygienic and environmental functions, they perform equally important recreational and aesthetic, improving physical condition, promoting normal emotional and mental development, so the improvement of educational institutions requires special attention [2]. In addition, the problem of landscaping and landscaping are very relevant for educational institutions that provide not only educational services but also promote education.

According to the state building regulations, the layout and dimensions of educational buildings are determined in accordance with the space standards. Thus, for up to 100 students the norm is 40 m^2 per place, with a total area of 0.2 ha; for 100-350 students - 30-35 m^2, with a total area of 1.2-1.5 ha accordingly.

Secondary school buildings are located no closer than 25 meters to the red line, with a location in the center of the village - 10 meters, subject to sanitary and hygienic standards. The distance between the boundaries of the educational institution to the walls of residential buildings is not less than 10 meters, from the buildings of educational institutions - according to the norms of insolation, natural light and noise protection [11].

A protective green strip of trees, shrubs and lawn frames the entire side of the school. The minimum width of the strip is 1.5 meters, and from the streets - at

least 3 meters. Secondary schools must have a fence 1.2-2 meters high, when placing schools inside residential areas, the use of hedges made of shrubs or trees at least 1 meter high is allowed. On the territory there should be entrances for fire engines to the houses, the possibility of their detour around the buildings, parking for cars on other vehicles. All entrances must be paved.

The functional zoning of the area includes the following functional areas: educational (training and production, training and research), sports, recreational, economic and residential.

The educational zone includes academic buildings, separate buildings and the areas around them. The production and research areas include production workshops, laboratories, testing grounds, research areas and other facilities. Production and other facilities of service purpose are located in accordance with the requirements of regulations. Training grounds and research farms are not included in the territory, they are placed outside the area, if possible, co-operating with the appropriate enterprises.

The physical education and sports area is represented by sports facilities and playgrounds, open and closed type. The types and number of sports facilities are determined according to the standard requirements for sports facilities, taking into account the approximate age and number of students.

The sports area may be located adjacent to the study area, but not on the side of windows of rooms, elementary classrooms, classrooms or library rooms, or if there are noise abatement measures in place.

Playgrounds for playing with the ball, throwing sports equipment are located at least 25 meters from the academic building, if there is a fence of at least 3 meters in height, other sports grounds - at a distance of at least 10 meters.

The recreational area includes playgrounds for quiet and active recreation. Active recreation areas can be attached to the sports area, located near the entrances and exits of the territory, etc. Parks for quiet relaxation are located afternoons away, on the "wing" of the territory, often combining them with greening. Maidens for children of different age groups are isolated from one another by living planes or fences; for protection from noise and insolation, trees with dense crowns (oaks, limes, chestnuts) or high mantles are planted on the eastern side at 0.5-1.0 metres from the edge of the maiden.

Group playgrounds are envisaged for toddlers and children, their sizes depending on the age groups of the children: 100 m2 for children 1-2 years old, 150 m^2 for 2-3 years old and 180 m^2 for 3-4 years old. Thematic and activity-specific playgrounds (transport, theatrical, fitness) of 200-220 m^2 are being built for pre-school children.

All playgrounds must be equipped with handy and safe garden furniture, the territory must have a sufficient number of lighters and lamps for illumination in the dark hours of the day, and waste bins.

An important consideration is the interplay of the outside and the inside of the grounds. This is achieved through the design of inner courtyards, playgrounds, differently designed outdoor and indoor spaces that can be used as play areas or places for recreation.

The proportion of the territory to be landscaped in educational institutions is very high: pre-schools - up to 60% and schools - up to 50% of the total area of the institutions [22], including green spaces for recreation, shelter strips and perimeter planting, areas for growing vegetables and berries, fruit and vegetable gardens, etc. When adjacent to the green areas, the area of the green zone may be reduced by no more than 30-40%. Distances from the building of the educational building for tall trees are at least 10 meters, for shrubs - 5 meters, 2 meters from the underground communications and 10 meters from the edge of the road.

Features of landscaping of educational institutions

The landscaping in a pre-school must meet certain requirements [21]. The landscaping must be diverse, highly decorative and aesthetically pleasing, consisting mainly of native species or successfully introduced ones. The scale of plants and their useful properties should also be taken into account when designing the landscaping of the preschool area.

Scale is manifested in the use of second- and third-order trees. Trees of the first order - the common oak, the common chestnut, the linden and the birch - are used in limited numbers. Given the scale of children's perception, it is best to use low, closely spaced plants. Decorativeness is ensured by the use of beautifully shaped plants with decorative leaves, fruits or bark texture. The cinnamoniness lies in the rational use of the plants' tonic and ionising properties. The use of conifers (around 40 % of the total number of trees) is recommended. Phytoncid plants such as juniper, spruce and pine are also useful.

The park area should be designed as an arboretum where students can learn about ornamental and local flora. If there is free space in the school garden, a 'nature park' can be created. Choose a quiet place, away from the group playgrounds and sports fields. Install a bird and squirrel feeder and bird houses in the centre.

Use hedges to enclose the perimeter of the grounds, various courtyards, homesteads, etc. Low and border plants look good on the façade of a building, near central corridors and in the square.

The walls of buildings, parks, pavillions, alcoves, pillars can be used as supports for vertical design; trellises for hanging plants, pergolas over borders and other structures can also be placed in the area. This is done by using plants with elongated stems and ornamental leaves (grapes, clematis, actinidia, honeysuckle, climbing roses).

When selecting the range for landscaping of the educational institution must take into account the content of toxic substances in plants [9].Under no circumstances should plants with thorns and poisonous fruits be used: Sophora japonica L., Daphne mezereum, Prunus spinosa L., Gleditsia triacanthos, Robinia pseudoacacia L., blackberry (Eubatus L.), sea buckthorn (Hippophae rhamnoides L.), dog rose (Rosa canina L.), hawthorn (Crataegus monogyna Jacq.). Herbaceous plants such as black ash (Hyoscyamus niger), ash (Dictamnus albus L.), datura (Datura), cicuta (Cicuta virosa), foxglove (Digitalis), autumnberry (Sternbergia colchiciflora W), Euphorbia), poison lettuce (Lactuca virosa) and some others are also prohibited. Also undesirable are species that, during flowering or fruiting, saturate the surrounding area (poplars (Populus L.), willows (Salix L.) and increase

allergic sensitivity in humans or attract large numbers of insects (mulberry (Morus L.)).

The assortment of trees recommended for planting on the territory of pre-school children's educational institution should include the following: maple (sharply-leaved, riverine, Tartar), small-leaved linden (Tilia cordata Mill.), birch (Betula pubescens L.) and bearded birch (Betula pendula L.), European larch (Larix decidua Mill.), spruce (Picea abies L.), mountain ash (Sorbus aucuparia L.), oak (Quercus L.), ash (Fraxinus L.); shrubs - common lilac (Syringa vulgaris L.) and Hungarian (Syringa Josikaea L.), garden jasmine (Philadelphus L.) or chubushnik, various types of spirea (Spiraea L.), silver loch (Elaeagnus argentea Pursh.), acacia gum (Caragana arborescens Lam.). High ornamental value have such species of shrubs as hydrangea (Hydrangea L.), guelder rose (Viburnum opulus L.). Shrubs resistant to the lack of light can be planted in the shade: birch birch (Euonymus verrucosus Scop.), irgu (Amelanchier medik.), snowberry (Symphoricarpus L.) [6, 12, 19, 20].

Floral decoration should be concentrated in the main viewpoints: at the entrance, in front of the facade of the building, in places where parents expect their parents. A variety of annual and perennial, round, bulbous and other herbaceous plants can be used for flower beds of various decorative qualities (shape, height, color of flowers, duration of flowering). At the main entrance, along the main paths are usually arranged flower beds of light-growing perennials (lilies, phlox, irises); annual flower beds are usually laid out along the paths so that children can water and watch. Perennials are placed farther from the paths on the lawns in the form of free groups [10] or in combination with low-growing trees and shrubs. Flower beds on the territory can occupy up to 2% of the total plot area. Preference is given to long-flowering plants that do not require special care (cosmea, marigolds).

Flower beds on the territory of educational institutions are arranged in a regular style with strict compositional lines, or in a looser landscape, where plants are placed more "naturally", there is no symmetry and linearity. Regular flower beds are more often arranged on the front parts, while landscape flower beds are arranged in the depths of the territory, near the recreation area.

The most common types of floral decoration used in floral decoration of educational institutions:

Rabatka - a narrow (1-3 meters) flower garden of regular type, located along roads, around monuments, ponds. There are two types of borders: one-sided - low plants are located in the foreground, followed by medium height and high; bilateral - when the tallest plants are located in the center of the flower bed, along the contours - low.

Flowerbed - a regular flower garden of strict geometric shape (rectangular, round, square, rhombic), with an area of 4 to 30 m2.Plants of different heights, colors and textures are combined in the flowerbed in order to obtain a finished composition. A characteristic feature is the raised center, which allows you to view such a flower garden from all sides. Flat variants are also allowed, but then taller plants (peonies, aquilegia, delphinium, dahlias, etc.) are planted in the central part. On the edges of the desired border of densely planted low-growing plants (host, marigolds, stonecrops, phlox, alissum) or lawn border of about 20 cm

Arabesque - a complex large flower garden with original ornaments. At the heart of arabesque are low-growing flowering plants (ageratum, lobelia, fuchsia, begonia) or ground cover (coleus, stachys, pyrethrum, sedum, echeverria, etc.).

When choosing plants should take into account their vital needs, otherwise the stronger will grow and suppress the less adapted, and the decorative arabesque will suffer.

Border - solid strips of low-growing plants planted for edging. They are created to highlight any boundaries (paths, garden areas, etc.). Suitable for this pillow or creeping, necessarily compact plants (gatsania, alissum, verbena, pansies, stonecrops, marigolds, etc.), close together when growing. The flower border is made from 10 cm to 40 cm wide, from 20 cm to 35 cm high. There can be up to 5 rows of plants in the border. The decoration of the edging should be different from the main flower garden. In wide borders it is possible to use evergreen or ornamental shrubs that tolerate haircuts to maintain shape. In long borders smooth or contrasting transition of one color of flowers in another is allowed.

Mixborder is an elongated flower garden in which multi-group and multi-row mixed plantings of ornamental plants (perennials, biennials and annuals) are located in the form of natural groups near walls, houses, on the edge of higher plantings [13]. For mixborders, the plants are selected in such an assortment that they bloom from early spring until frost. The height of the plants should gradually increase from the viewing point from low to higher. The edge of the mixborder is surrounded by a border. Light-loving plants are planted in mixborders, which often occupy a sunny location. If the mixborder is limited on one side by a road (path) and on the other by a wall (fence), then low-growing plants are planted along the road, and the tallest - along the wall (the highest may also be vines that surround the wall); plants in the center have an intermediate height.

Location of the object of research and characteristics of the territory

The "Oksamit" Club pre-school educational institution is located at the following address: 61000, Kharkiv city, Industrialny district, 33 Zubareva Street, located on the territory of Rogan housing estate.

The residential area of Rogan (also known as Yuzhny Pyatykhatki) is an industrial and residential area in the south-east of the city. Nearby is the settlement of Rogan and the village of Malaya Rogan in Kharkiv Oblast [14]. The central axis of the massif and its main traffic artery is Rohan Street, perpendicular to it - Gritsivets Street. The pre-school educational institution is located at a safe distance (170 metres) from the central streets of the housing estate 759-A of the residential area, and Kharkiv specialised school No. 85 is located nearby.

The city of Kharkiv is characterized by a temperate-continental climate, with moderately cold winters and dry, hot summers. The average annual temperature is 8.1 °C. The average annual rainfall is 515 mm.

The city is located almost on the border of forest-steppe and steppe zones, evaporation significantly exceeds precipitation, especially in summer. The wettest monththere is July (67 mm of precipitation), which is due to summer rains. From August to January, 35-45 mm of precipitation falls. The driest months are February, March and April. The least precipitation falls in March, about 27 mm. [15].

Winter is characterized by extremely changeable weather: together with low temperatures of -20 ...- 25 °C there are thaws up to +4 ... + 5 °C. There are icebergs.

The height of the snow cover does not exceed 18-20 cm on average, the maximum is 67 cm. The depth of soil freezing is on average 65 cm, the minimum is 48 cm, and the maximum is 95 cm.

Analysis of the state of landscaping and landscaping of the object

The territory of the educational institution is about 0.96 hectares and is an almost flat area of land (there are slight slopes on the north side). The total area of the club building is 1541 m^2. This is a two-storey building with attached one-storey pavilions. Along the perimeter the territory is fenced, asphalted paths and platforms are arranged. There are greenery, flower beds, lawn cover is partially present, but in poor condition.

In addition to the club building, there are outbuildings, a parking lot for vehicles, pavilions for recreation; there are plantings of fruit (common apricot), ornamental (pointed maple, spherical shape, black poplar, pyramidal shape) and other species (spruce, thuja western, mountain ash, birch hung, ash), flower beds. The perimeter of the territory is fenced with a low (up to 1 meter) fence, the integrity of which is violated, there are large holes, a few meters are absent, which leads to entering the territory in places not intended for this purpose people and animals.

The road network on the territory is irrational and is in a careless state. Asphalt pavement is partially broken, there are large cracks, in need of major repair or replacement; this also applies to the coverage of sites. Dirt paths (paths) are arbitrarily trodden by the local population and do not correspond to the original project.

The results of the survey are shown in table 1.

Table 1 - Balance of the territory of the Club "Oksamit"

№	Territory	Area, m^2	%
1	Buildings and structures	2097,0	21.8
	Buildings	1541,0	16.0
	Outbuildings	90.0	0.9
	Pavilions	466.0	4.8
2	Tracks and platforms	2401.0	25.0
3	Landscaping	5116.0	53.2
	Trees	450.0	4.7
	Brush	2.0	0.0
	Flower beds	95.4	1.0
	Lawn	4568.6	47.5
4	Total area	9614.0	100.0

The recreation pavilions are currently in an emergency condition (broken walls, partially or completely missing roof) and therefore need to be dismantled and replaced with more modern ones. Sports facilities (swings, slides) are also subject to repair or replacement. There are no benches or lanterns on the territory; the number of garbage cans is insufficient.

The range of woody and shrubby plants on the territory is represented by 15 species (see table 2); flower beds are represented by flower beds of annuals and perennials. The lawn is significantly damaged and needs to be completely replaced. Some plantations need to be removed due to their emergency, sanitary condition and low decorative value. Flower beds are in poor condition, with single flowers (marigolds (Tagetes L.). Flower design requires a complete change.

Table 2 - The range of plants that grow in the area

№	Breed	Latin name	Number	Sanitary condition *
1	Common apricot	Prunus armeniaca	3	1
2	Birch	Betula pendula	5	1
3	Birch (up to 10 years old)	Betula pendula	1	2
4	Lilac	Syringa vulgaris	1	3
5	Garden elder	Home sorbet	1	1
6	Common elder	Sorbus aucuparia	4	1
7	Common elder	Sorbus aucuparia	4	2
8	Common elder	Sorbus aucuparia	5	3
9	Horse chestnut	Aesculus hippocastanum	2	1
10	Norway maple	Acer platanoides	3	1
11	Norway maple	Acer platanoides	1	2
12	Norway maple v. globular	Acer platanoides "globosa"	1	1
13	Field maple	Acer campestre	1	3
14	Field maple	Acer campestre	1	1
15	Tatar maple	Acer tatricum	1	2
16	Small-leaved linden	Tilia cordata	1	2
17	Small-leaved linden	Tilia cordata	1	1
18	White poplar v. pyramidal	Populus alba	28	1

19	White poplar v. pyramidally	Populus alba	8	2
20	White poplar v. pyramidally	Populus alba	1	3
21	Thuja westerly	Thuja occidentalis	2	1
22	White silkwood	Morus alba	1	1
23	European spruce	Picea abies	6	1
24	European spruce	Picea abies	1	2
25	European spruce v. dwarf	Picea abies	6	3
26	Ash	Fraxinus excelsior	1	3

** - Sanitary index: 1 - good, 2 - satisfactory, 3 - unsatisfactory (dried up).*

Based on the results of the survey, the following trees are proposed to remain: common apricot - 3 pcs, warty birch - 4 pcs, mountain ash (common and garden) - 1 pc, horse chestnut - 2 pcs, norway maple - 2 pcs, globular norway maple - 1 pc, field maple - 2 pcs, small-leaved lime - 1 pc, western Thuja - 2 pcs, common fir – 5 pcs. A total of 67 trees are proposed for removal.

As a result of the landscaping analysis, it can be concluded that the area has been neglected for a long time, as a result of which the functional purpose of the area is disturbed, the landscaping elements do not comply with norms and regulations and are potentially hazardous. In order to improve the situation it is proposed to make significant changes in the area planning structure, to optimise the area distribution by functional zones, to remove and dismantle potentially dangerous structures, trees; to choose typical projects of pavilions, sports, children's and other playgrounds that comply with the current regulations.

Suggestions for the species range of plants and landscaping elements

Landscaping and landscaping reconstruction works include a set of planning, engineering, landscaping and other works aimed at improving the functional, aesthetic and decorative condition of the territory, landscaping elements, greenery. Reconstruction works are preceded by a survey of the territory, during which the general condition of the territory and its individual elements (paths, sites, buildings, landscaping, etc.) are determined, the main goals and objectives of the work are determined.

After the inspection of the territory of the object, the main tasks of the reconstruction works were determined: 1. To carry out the functional zoning of the territory, as now the territory of the institution by functional purpose does not meet the requirements; 2. Develop a project of landscaping and landscaping, taking into account the possibilities and location; 3. Choose a range of plants that will meet the conditions of the site and the requirements for it.

Changes in the planning structure of the territory. By analysing the network of roads, paths and tracks, it can be concluded that the area was often used not only for walks and recreation by local residents, but also for transit traffic (as a shorter route). It is therefore planned to increase the number of entrances to the site from two to four. Additional entrances are proposed on the north and south sides and the perimeter of the site will be fenced. Trees will be planted on the north, east and west sides to provide protection from wind, noise and dust and the site is bordered by a multi-storey building on the south side.

According to the *functional purpose*, it is proposed to allocate the following zones: educational, physical culture and sports, zones of short-term and long-term recreation for different age groups, orchard, economic zone.

Training area consists of the main educational building and the surrounding area. The project proposes the demolition of the pavilions adjacent to the main building, as they do not fulfill any functional purpose and are potentially dangerous due to their emergency condition. This will allow you to use the free space to create a short rest area. The area around the educational building has a solid asphalt surface of satisfactory condition. There are 2 symmetrical rosaries on the east side of the building, the green areas on the south side remain unchanged.

Short-term recreation area is located on the right side of the school, adjacent to it. The area covers the area from one of the entrances to the orchard, includes 2 playgrounds with equipped seating areas, a stage for ceremonial events.

Site I is made in a landscape style, made of a winding path of natural stone, decorated on both sides with arrays of chrysanthemums, a group of rhododendrons and perfectly inscribed in the landscape style weeping crowns of weeping willow and hanging birch "Jungi". The choice of plants is emphasized by the fact that the willow will visually separate the site from the path, create comfort, shade and coolness in summer; dwarf birch "Jungi" will look harmonious against the background of chrysanthemums and rhododendrons. The perimeter of the site is lined with a single-row hedge of evergreen boxwood. Next to the willow there is a swing for children, comfortable garden benches and trash cans.

Site II is arranged in a regular style, with clear straight lines, as opposed to the first. The perimeter is also framed by boxwood hedges, benches and dumps, the compositional center of the site is a solitary planting of weeping willow surrounded by hedges.

The sites are separated from each other by a green area decorated with ordinary plantings of Sulange magnolias. In spring, the magnolia will decorate the facade, and the hedge will mask unattractive hatches. Between the second platform and the orchard there is a stage for ceremonial events, gathering of students and similar purposes. On the side of the site is a hedge, a place to rest.

The *area of the orchard* behind the stage can be considered as a kind of buffer between the residential area and the educational building. In addition, this area is also suitable for walks, recreation, you can hold environmental classes with children, instill in them a love of nature.

Sports area is located in the eastern part of the territory, between the zone of short-term recreation (site I) and the contour of the site. The functional area is a specially equipped area for sports games, physical education and other activities.

The site is surrounded on all sides by a high fence, it is separated from the sites by a green wall of apricot (site I), plantings of maple and ample lawn space (playground).

Long rest area extended from east to south, conditionally divided into Zone I and Zone II. Long-stay zone I is intended for parents with children, holidaymakers; it includes recreation rooms and a children's playground located directly behind the sports area. Further up to the entrance, zone II starts and is intended for young people. This layout is based on the fact that the recreation area is designed for different age groups, taking into account the proximity of the area to the housing estate.

The *recreation area* is surrounded on all sides by trees, bushes and hedges. Comfort and coolness here are created by planting apricots, at the entrance there are groups of spirea and lilac. All pavilions are equipped with benches, trash cans, lighting elements, safe and reliable coverage for the sites.

Economic area occupies the southwestern part of the territory. It includes a parking lot, outbuildings. It is separated from the residential area and the orchard by large-sized (sharp-leaved maple, small-leaved linden) trees.

Landscaping. The functional purpose of greenery on the territory depends on the nature of land use, the functional purpose of sites and structures on it. Green plantations create favorable conditions on the territory, perform a protective function, enhance the aesthetics of the site.

When planning the range of wood species for landscaping, first of all select local, most common or successfully introduced plant species. Trees and shrubs can be located in alley and row plantings, singly, in groups, small arrays. Solitary plantings or compositions of trees and shrubs look good in the open space, single specimens and groups of shrubs are often arranged near sites, at the intersection of paths [17]. Hedges are arranged to separate the sites along the paths. Floral decoration should be located near the facades, in the central points and near places of rest.

For the needs of landscaping, there are 123 trees, 365 shrubs, of which: conifers - 13, fruit - 22 pcs. Large trees on the territory are planned to be used for protective and fencing purposes. Thus, along the perimeter of the territory it is planned to plant a single-row strip of small-leaved linden; sharp-leaved maple is used to separate the economic zone from the orchard. The full range of plants is shown in table 3.

Table 3 - Species range of trees and shrubs for landscaping

№	Ukrainian name	Latin name	The need for material, pcs. *	Total number, pcs **
Trees				
1	Apricot tree	Prunus armeniaca	4	7
2	Birch wartwood	Betula pendula	10	14
3	Birch "Yungi"	Betula pendula "Youngi"	1	1

4	White willow	Salix babylonica	2	2
5	Garden elder	Sorbus domestica	-	1
6	Common mountain elder	Sorbus aucuparia	-	1
7	Horse chestnut	Aesculus hippocastanum	-	2
8	Norway maple	Acer platanoides	2	4
9	Globe-shaped maple	Acer platanoides "globosa"	26	27
10	Field maple	Acer campestre	-	2
11	Small-leaved linden	Tilia cordata	46	47
12	Magnolia Sullanja "Big Pink"	Magnolia soulangeana "big pink"	3	3
13	Thuja westerly	Thuja occidentalis	-	2
14	Apple tree	Malus domestica	18	18
15	Common spruce	Picea abies	-	5
16	Spruce "Glaucous"	Picea pungens "glauca"	11	11
Brush				
17	Common lilac 'Vestalka'	Syringa vulgaris "vestalka"	8	8
18	White Currant	Cornus alba	5	5
19	Rhododendron "Atumnus Embers"	Rhododendron "autumn embers"	5	5
20	Box evergreen	Buxus sempervirens	242	242
21	Spirea Bummalda 'Goldflame'	Spiraea bumalda "goldflame"	9	9
22	Spiraea Vangutta	Spiraea vanhouttei	23	23
23	Rose floribunda 'Black Cherry'	Rosa floribunda "black cherry"	64	64
24	Thuja westerly 'Danica	Thuja occidentalis "danica"	2	2
25	Medium Forsythia	Forsythia intermedia	7	7

** - must be purchased, pcs. ** - projected quantity on the territory, total pcs.*

Alley and row planting. The rows of plants on the grounds are of purely decorative value. On the north side, for example, symmetrical rows of glaucous spruce and western Danica have been planted, decorating the entrance to the courtyard; and along the path connecting the utility area and the long leisure area. Given the existing specimens of hanging birch and holly maple "globos" there, it was decided to complement them and create a row of plantings. The globular-shaped shrub maple was also used at the entrance to the long resting area, in groups of 2-3 specimens in 'green pockets' formed by the hedgerow.

Compositions of coniferous and deciduous trees, shrubs. The most decorative part of the territory is the composition near the eastern building of the main building. It is represented by a group of prickly spruce and birch hanging in the first tier, and symmetrically located white and middle forsythia.

Shrubs on the territory are used mostly in the design of entrances, in groups along paths, playgrounds. The southern entrance to the area will be decorated with lilac bushes. Bumalda and Vangutta spiers are used near the sports ground and long-term recreation areas, respectively. Deren and middle forsythia - near the economic zone.

Landscaping of the short-term recreation area is represented by weeping (weeping willow, hanging birch) and beautifully flowering forms (Sulandzha magnolia) and tree species, beautifully flowering shrubs (rhododendrons). Evergreen boxwood is used as a hedge.

Fruit trees are used for the formation of the orchard (home apple tree), as well as in the design of playgrounds and recreation areas (common apricot).

Floral decoration of the territory. Along the eastern part of the building are symmetrical rosaries with bright red floribunda roses (Black Cherry variety), along the paths - landscape groups of garden chrysanthemums. The range of flowers used for floral decoration of the territory is given in table 4.

Table 4 - Assortment of flowering plants

№	Type, variety	Color	Terms of flowering	Number		
				pcs / m	m2	total, pcs.
1	Garden chrysanthemum	Violet	September October	25	29.29	732
2	Black Cherry Floribunda Rose	Red	June-October	2	30	61

The area of the rosary is 40 m2, flower beds occupy 29.29 m2.

Lawn. Grass cover on the territory of educational institutions must meet certain requirements. It must be dense, strong, resistant to trampling and mechanical damage, tolerate shading, and so on. As a lawn covering it is offered to use a grass mix "Universal". Decorative grass mixture when sowing forms a beautiful and dense grass, resistant to trampling and mechanical stress, adverse weather conditions and

shading. The mixture includes25% red oatmeal, Roland variety; 25% red oatmeal, Rufilla variety; 20% pasture ryegrass, Henrietta variety; 20% pasture ryegrass, Talgo variety; 10% meadow poa, variety Balin (Balin) [16].

For sowing of this grass mix on the area of 3001,8 m^2 105 kg of mix from which: red fescue, Roland variety - 26 kg; red fescue, Rufilla variety - 26 kg; pasture ryegrass, Henrietta variety - 21; pasture ryegrass, Talgo variety - 21 kg; meadow poa, grade Balin (Balin) - 11 kg. Calculations of the number of seeds for the grass mixture are given in table 5.

Table 5-List of lawn grasses

Lawn category	Plant species	Seeding rate grams per m^2 pure	The content of the mixture,%	Seeding rate in the mixture, kg	The required number of seeds for lawn arrangement, kg
Landscape sports	Red fescue, Roland variety	40	25	0.25	26
	Red fescue, Rufilla variety	40	25	0.25	26
	Pasture ryegrass, Henrietta variety	25	20	0.2	21
	Pasture ryegrass, Talgo variety	25	20	0.2	21
	Meadow poa, Balin variety	20	10	0.1	11

A separate decorative element of the area is the installation of **decorative dumping**. The most common materials for dumping are crushed bark, pebbles, colored stones, crushed remnants of trunks, and other materials. It prevents the growth of weeds, improves the aesthetic appearance, retains moisture.

It is suggested to use bark shedding for maple trees, near the main entrance under the preserved specimens of western thuja and spruce. The total area of the dump is 16.5 m^2.

Landscaping. The project proposes to replace the asphalt pavement of paths and areas, in addition to the training area, with more modern - paving slabs and natural stone (in areas of short-term and long-term recreation).

To create comfortable conditions on the territory, in the areas of short-term and long-term recreation it is proposed to install garden benches, garbage cans; garden lanterns in the central points of the territory (near the entrances, at the intersections of paths, near the platforms, the main building). For children's and sports grounds, other landscaping, it

is proposed to use standard projects "Children's swing", "Children's playground" 33.5 m^2, "Sports ground" 146 m^2, "Garden pavilion".

The full list of used buildings, equipment, small architectural forms, taking into account the amount and materials is given in table 6.

The organization of landscaping and landscaping of the pre-school educational institution Club "Oksamit" was carried out on a total area of 0.96 hectares. Most of the territory is occupied by buildings and farm buildings (about 17%).

Landscaping accounts for 4,054 meters (42.2% of the total area), most of which is lawn (31%). Compared to the current situation, the area of paths and sites has significantly increased (up to 40%); functional zoning was carried out and territories were allocated for specialized functional areas, play areas, recreation areas. Typical projects for functional areas, 2 large garden pavilions, 23 garden benches, 11 waste bins and 72 lanterns were used for landscaping.

Table 6 - List of buildings, equipment, small architectural forms for landscaping

№	Item name	Material	Quantity, items.
1	Swing for children	A typical project	1
2	Playground	A typical project	1
3	Sports ground	A typical project	1
4	Garden pavilion	A typical project	2
5	Garden bench	Wood, metal	23
6	Waste bins	Metal	11
7	Lantern	Metal, glass	72

The results of design decisions on landscaping and landscaping are shown in table 7.

Table 7 - Balance of the reconstructed territory of the "Oksamit" Club.

№	Territory	m2	%
1	**Buildings**	**1541,0**	**16.0**
2	**Outbuildings**	90.0	0.9
3	**Pavilions**	33.8	0.4
4	**Paths and Grounds**	**3895,0**	**40.5**
	Asphalt driveways and areas	1381,57	14.4
	Tiled Driveways	1976.6	20.6
	Natural stone walkways	244.7	2.5
	Sports Ground	146.0	1.5

	Playground for children	33.5	0.3
	Recreation Grounds	112.6	1.2
5	**Landscaping**	**4054.2**	**42.2**
	Trees	732	7.6
	Bushes	193	2.0
	Hedges	51.61	0.5
	Rosarium	40	0.42
	Flowerbeds	29.29	0.3
	Bark bed	16.5	0.2
	Lawn	3001.8	31.1
6	**Total area**	**9614.0**	**100.0**

The master plan of the territory is made in the program AutoCAD 2009, visualization elements are created with the help of Realtime Landscape Architect and are added to the working project. The calculation of the estimated cost and other organizational and technical indicators should be carried out at the time of the start of work on the project.

REFERENCES

1. Chernyak VM Landscaping of the school site. Ternopil: Bogdan, 2010. 392 p.
2. Kowalski LN Architecture of educational buildings. K .: "Builder", 1983. 143 p.
3. Shevchenko LS Ecological aspects of urban landscape design. Problems of urban environment development: scientific and technical. collection. Iss. 3. K., NAU. 2010. Pp. 190-193.
4. About the statement of Rules of the maintenance of green plantings in settlements of Ukraine: Order of the Ministry of Construction of Ukraine dated April 10, 2006 № 105.
5. Belous V.I. Garden and park art. A Brief History of Development and Methods of Creating Artistic Gardens. K.: Nauk. Svit, 2001. 299 p.
6. Kucheryawy V. P. Greening of populated areas. Lviv: Svit, 2005. 456 p.
7. Mashinsky VA, Zlogina EG Designing landscaping of residential areas. M .: Stroyizdat, 1978. 84 p.
8. Gudak VA Landscape design of the modern natural environment. Bulletin of the Kharkiv State Academy of Design and Arts. 2008. № 11. Pp. 46–55.

9. Sovgira SV, Goncharenko GE, Lyulenko SO, Podzerey RV New promising crops for recreational use in landscaping. Collection of scientific articles "III All-Ukrainian Congress of Ecologists with International Participation". Volume 1. Vinnytsia, 2011. Pp. 261-264.

10. Nikitsky Yu.I. Floral design techniques. M .: Rosselkhozizdat, 1985. 235 p.

11. Buildings and structures of children's preschool institutions: State building codes of Ukraine (BSI B.2.2-4-97). Kyiv, 199 p. Access mode: http://specteh.dn.ua/images/stories/normativnye _dokumenty /dbn_v.2.2-4-97.budinki_sporudi_dityach.pdf.

12. Ornamental plants. Hand. aut. count. V.F. Paw. K .: Higher school, 1981. 232 p.

13. Tips for running a homestead. Ed. F. Ya. Popovich. K .: Urozhay, 1985. 664 p.

14. Yuzhny Pyatikhatki - [Electronic resource] - https://uk.wikipedia.org/wiki/Південні_П%27ятихатки.

15. Climatic conditions of Kharkiv region - [Electronic resource] - http://www.pogodaiklimat.ru.

16. Assortment of grass mixtures of lawn grasses - [Electronic resource] - https://ukrsemena.com/ua/trava-gazonnaya-universalnaya-german-grass-1-kg-42343/.

17. Aksenova NA, Frolova NA Trees for gardening and landscaping. M .: MSU, 1989. 155 p.

18. Zalesskaya LS Course of landscape architecture. M .: Stroyizdat, 1964. 184 p.

19. Zayachuk V.Ya. Dendrology. Lviv: Apriori, 2008. 656 p.

20. Ivanova Z.Ya. Ornamental woody plants (trees, shrubs, vines) and methods of their reproduction. Simferopol: Tavriya, 2003. 208 p.

21. A brief guide to the architect. Landscape architecture. Ed. Rodichkina ID K .: Budivelnyk, 1990. 336 p.

22. Крижановская Н.Я. Basics of landscape design. Kharkiv: Konstanta, 2002. 214 p.

23. Levon F.M. Creation of green plantations in the conditions of the urban environment: requirements, limiting factors, ways of optimization. Scientific Bulletin of the Ukrainian State Forestry University. 2003. Iss. 13.5. Pp. 157-162.

AGROTECHNIQUE OF GROWING ROOT PLANTED PLANTING MATERIAL OF DECORATIVE SPECIES OF PLANTS

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Green plantings are one of the main factors in the landscape organization of the territory, in its sanitary and hygienic improvement, which gives originality to the salinity points. They are an integral part of settlements' landscaping, provided by development projects [1, 3, 7].

In their vast majority various forms of greenery are used in landscaping.

Green plantations can perform a number of functions, among which the most important are improving microclimatic conditions, cleaning and humidifying the air and enriching it with oxygen, high volatile activity, improving the architectural and artistic appearance of new buildings, preventing adverse climatic factors [2, 6].

Relevance of the issue. The introduction of ornamental plants in the improvement and landscaping of settlements, requires improvement of growing methods. At the same time, an extremely important problem is the development of new and improvement of existing technologies for growing of planting material of ornamental plants. This will create conditions for increasing the species diversity of garden phytocenoses and for the increase of their resistance to adverse environmental factors.

Analysis of recent research and publications. With the increasing demand for planting material of ornamental plants, the need to improve existing seedling technologies, taking into account biological characteristics, arises. A number of elements of technology for growing rooted seedlings of ornamental species are still insufficiently studied.

Materials and methods of research. Experimental work was performed in 2020-2021 in the "Landscape Design" training laboratory of the Department of Horticulture and Forestry.

The research was conducted in eight experiments:

1. To analyze the influence of the time of grafting (*Ligustrum vulgare*) on the rhizogenic activity of micro-shoots (cuttings).

2. To identify the effect of substrate on the rhizogenic ability of *Tahis bassata* cuttings.

3. To determine the effect of the reaction of the soil environment on the regenerative capacity of *T. baccata* stem cuttings.

4. To identify the influence of metamerism of cuttings on rhizogenic ability and quality of planting material (*L. vulgare and Spiraea vanhouttei*).

5. To consider the influence of micropod planting scheme on the growth and development of *L. vulgare* plants.

6. To study the influence of the time of soil mixture usage on the process of coregenesis in cuttings and other biometric indicators of *L. vulgare* plants.

7. To identify the influence of exogenous auxin-like compounds on the rooting process of microshoots of *L. vulgare and S. vanhouttei*.

8. To analyze the influence of the transplantation time of rooted cuttings (*T. baccata*) on their survival.

Factor A - grafting time: 1) control (10.04); 2) 10.07; 3) 10.09. Factor B - substrate type: 1) control (peat + humus (1: 1)); 2) peat + sand + humus (1: 1: 1); 3) peat + sand (1: 1). Factor C - the reaction of the soil: 1) control + sand + peat (pH 4.0), 2) sand + peat (pH 6.0). Factor D - metamerism of cuttings: 1) control (single-node or single-bud); 2) two-node or two- bud; 3) three-node or three-bud micro shoots. Factor E - planting scheme: 1) control (15 X 10 cm); 2) 8 X 4 cm. Factor F - soil mixtures of differentusage term: 1) control (single use); 2) reusable. Factor G - auxin compounds: 1) control (water); 2) *Ukorzeniacz DDS*; 3) *Stekpoeder pokon*; 4) topsin-M; 5) *Rhizopon AA* powder; 6) charkor. Factor H - terms of transplanting plants: 1) control (20.09), 2) 25.04.

Micro-shoots were harvested from 7-8-year-old mother plants growing on the territory of the university (Fig. 1).

Fig. 1. Procurement of cuttings of L. vulgare [Own photo]

A greenhouse box covered with glass 4 mm thick was used for rooting cuttings. It housed ridges 0.8 m wide and 6.0 m long.

Soil mixture for rooting cuttings included peat "*DOMOFLOR*" (pH 6.0) and river sand.

Experimental work to improve the technology of growing planting material was carried out in accordance with the method of reproduction of ornamental trees of the Botanical Garden of NULES of Ukraine [5].

Research results and their discussion. The intensification of the system for the production of planting material is especially important due to the high demand

for planting material. The results of research by Ukrainian and foreign scientists prove that harvesting micro-shoots in optimal periods creates the conditions for managing vital processes occurring in the plant body, as well as significantly affect the efficiency of root production of planting material [10, 17].

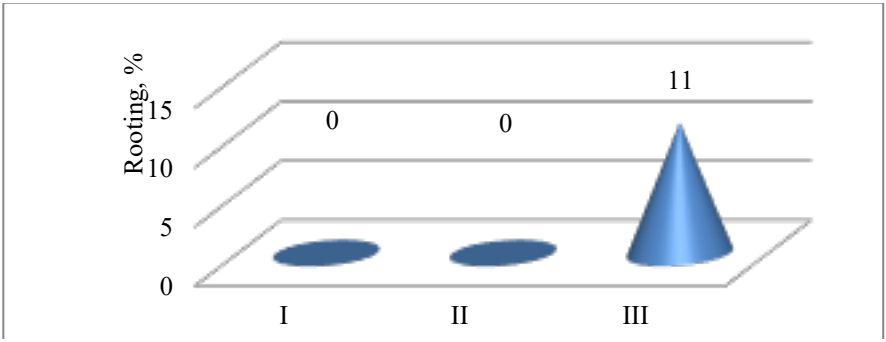
Table 1. Influence of the period of *L. vulgare* grafting on the reproductive capacity of micro-shoots

Harvest time of micro-shoots	Reproducibility,%	± to control
10.07	0	- 98
10.09	12	- 86
Control (10.04)	98	-
SSD (the smallest significant difference) $_{05}$	7.38	

The results of laboratory studies (Table 1) convincingly show that the highest rate of reproductive capacity (rooting makes 98 %) is observed when harvesting *L. vulgare* micro-shoots in April. Harvesting of micro shoots of this taxon after swelling and flowering buds provides low rates of rooting.

To obtain a homogeneous planting material rootstock propagation by stem grafting is widely used [8].

During the vegetative propagation of ornamental plants and their forms, *T. baccata* in particular, it is advisable to create conditions for the processes of callus and cargenesis [10]. An important condition for the intensive root-forming ability of cuttings is the soil mixture with optimal agrophysical and agrochemical properties (Fig. 2).



I - peat + humus, II - peat + sand + humus, III - sand + peat

Fig. 2. The effect of substrate on the root-forming ability of cuttings

At the stage of rooting cuttings do not absorb nutrients from the substrate. However, they are very sensitive to both the lack and excessive concentration of cations of hydrogen, aluminum, iron, manganese, sodium in the soil solution.

One of the important factors in the effective regeneration of the root system is the optimally selected acidity of the soil mixture. In this case, the inconsistency of the reaction of the soil environment to the characteristics of the species adversely affects the process of reproductive capacity of stem cuttings (Table 2).

Table 2. Influence of reaction of environment on rhizogenic activity of stem cuttings

Substrate type	A variant of the experiment	*T. baccata*	
		Rooting, %	± to control
Control (sand + peat) (pH 3.5)	Water	0	-
	Ukorzeniacz DDS	1	+ 1
Sand + peat (pH 6.0)	Water	8	-
	Ukorzeniacz DDS	35	+ 27

According to the results of experimental work, it was found that the root-forming ability of cuttings (*T. baccata*) is influenced by the acidity of the soil environment. At the same time, in the control the reproductive capacity of stem cuttings was minimal, and at the acidity of the substrate pH 6.0, it was 8-35 %.

In the course of the study it was convincingly proved that the concentration of hydrogen ions and other elements in the soil mixture can significantly affect the processes of adventitious rhizogenesis in the *T. baccata* stem cuttings. In addition, we found out that in the case of root reproduction of the mentioned species, it is best to use peat with a weakly acidic or neutral reaction of the soil environment.

The obtained results provided the proof for a significant effect of substrate acidity on the rate of adventitious rhizogenesis in *T. baccata* stem cuttings.

Thus, for the optimal root-forming ability of cuttings, it is important to create and maintain the appropriate concentration of hydrogen and aluminum ions in the nutrient medium, which meets the biological requirements of the species under study.

In production conditions, grafting is used in order to grow large volumes of rootstock planting material. Vegetative propagation of plants by micro-shoots (cuttings) is a fairly simple and affordable way. This method creates the preconditions for obtaining planting material that identically retains the phenotypic characteristics and properties of the parent forms [8, 10. 12].

The rhizogenic capacity of *S. vanhouttei* micro-shoots depends on the metamerism of the cuttings (Table 3).

The yield of planting material from single-bud micro-shoots, which were harvested from the apical part, was 1 %, which is 2-3 times less compared to the medial and basal micro-shoots.

The use of double-bud cuttings influenced the process of their rooting (the percentage of rooted micro-shoots increased compared to single-bud ones). The yield of rooted double-bud cuttings from the medial part of the shoot was 12 %, and single-bud ones made 3 %.

Table 3. Influence of metamerism of cuttings on rooting and indicators of root system development

Part of the shoot	Number of buds, pieces	Yield of rooted cuttings,%.	In anticipation of a cutting	
			number of roots, pieces	length of roots, cm
Apical	1(control)	1	1.2	2.1
	2	4	2.0	4.3
	3	8	3.0	5.1
Medial	1(control)	3	1.9	2.5
	2	7	3.3	5.2
	3	12	3.8	6.3
Basal	1(control)	2	1.4	2.4
	2	6	1.9	4.2
	3	9	3.2	5.9

Rooting of three-bud cuttings dominated significantly, regardless of the part of the shoot which they were harvested from. Rooting of cuttings from the apical part of the shoot was 8 %, which was 1.5 and 1.12 times less compared to the medial and basal ones.

In the experimental variants, the number of roots formed in two- and three-bud cuttings was significantly higher compared to the control (single-bud one). For example, three-bud cuttings from the apical part of the shoot formed 3.0-pieces roots, which is 250 % more than single-bud ones.

The maximum number of roots was formed on the cutting material from the medial part of the shoot.

The total length of roots in single-bud apical cuttings was 2.1 cm, while in double-buds this figure was 4.3 cm. The length of roots was the smallest on cuttings from the apical part of the shoot. It was found that the maximum number and total length of roots is characteristic of three-bud cuttings.

The results of the influence of shoot type on some morphometric parameters of planting material are shown in Fig. 3 and 4.

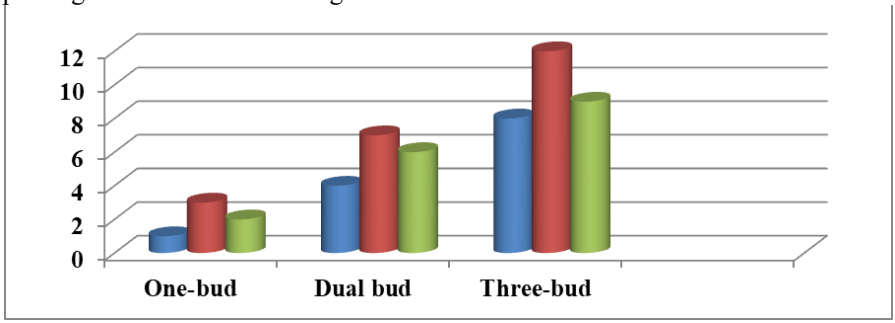


Fig. 3. The dependence of the rooting rate of S. vanhouttei microshoots on the number of buds on cuttings,%

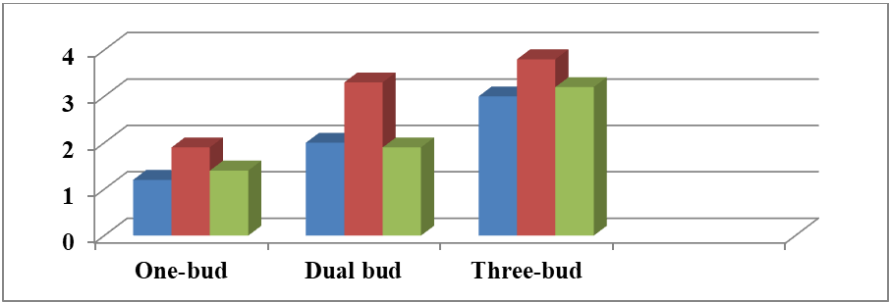


Fig. 4. The average number of roots formed on the micro-shoots depending on the number of buds on the cuttings, pcs.

In the course of experimental research it was proved that the type of the shoot significantly affects not only the rhizogenic ability of microshoots, but also the number of roots formed on them. The number of roots formed on the cuttings of the control variants was smaller compared to the experimental variants. The results of research convincingly show that with root propagation of *S. vanhouttei,* it is desirable to harvest cuttings from the medial and basal part of the shoot, and the cuttings should have at least 2-3 buds.

The production of standard seedlings is the final stage of the agro-technological process of cultivation (Table 4).

There was a significant difference in the reproducibility of the cuttings. The highest rate of regenerative capacity was observed under the conditions of using two and three-node cuttings, and the lowest - in the control.

Table. 4. Influence of metamerism of micro shoots on qualitative indicators of planting material

Experimental variant	Regenerative capacity,%	Plant height, cm	± to control
Single-node (control)	89	12.3	-
Dual nodes	100	23.9	+ 11.6
Three-node	100	42.1	+ 29.8
SSD (the smallest significant difference) $_{05}$	4.45	3.85	

The length of plants in the first variant was 12.3 cm, which is 11.6 and 29.8 cm less than in other variants (SSD_{05} was 4.45).

During the laboratory tests, a significant difference was found in the options (SSD_{05} 4.45 and 3.85). Under the conditions of scientific work, we found out that in the experimental variants the planting material has better biometric performance than in the control one.

Experimentally, it was found that the metamerism of the shoot affects not only the root productivity of cuttings and *L. vulgare* plant height, but also the formation of phytomass (mass of the aboveground part and root system) (Table 5 and Fig. 5).

Table 5. Influence of metamerism of micro shoots on the mass of planting material

A variant of the experiment	Mass, g			
	aboveground part	± to control	the root system	± to control
Single node	6.8	-	19.5	-
Dual nodes	14.1	+ 7.3	31.5	+ 12.0
Three-node	21.5	+ 14.7	43.2	+ 23.7
SSD_{05}		1.22		1.98

Fig. 5. The influence of metamerism of cuttings on the growth of the root system [Own photo].

The mass of the aboveground part of plants formed in single-node micro-shoots was 6.8 g, which was 7.3 and 14.7 g less than in the experimental variants, where two- and three-node cuttings were used. Mathematical processing of the obtained indicators proved a significant difference between the options ($SSD_{0,5}$ was 1.22).

The weight of the root system of plants ranged from 19.5 to 43.2 g ($SSD_{0,5}$ was 2.48). The highest value of this indicator was observed in the experimental version, which used three-node cuttings and was 43.2 g.

In particular, it was found out that the number of nodes on the micro-shoots significantly affects the further growth and development of the studied cultivar. Thus, 2- and 3-node micro shoots had the opportunity to form a more branched root system.

In the process of performing the tasks of scientific work, attention was paid to the influence of the scheme of planting cuttings on the morphometric parameters of planting material (Table 6).

Table 6. Biometric indicators of *L. vulgare* rooted microshoots

Version of experiment	Length of growth, cm	± to control	Weight, g	
			root system	± to control
Control (15 X 10)	9	-	1.4	-
8 X 4	5	- 4	0.6	- 0.8

The increase in the experimental variant was 5 cm, which was 166.7 % less than in the control variant. In particular, the increase in the feeding area of micro-shoots had a positive effect not only on the height of planting material, but also on the weight of the root system.

In the experimental work, we drew attention to the relationship between the service life of the soil mixture and some biometric indicators of planting material (Table 7).

Table 7. Influence of the term of soil mixture use on plant quality indicators

Version of experiment	Reproducibility, %	Length gain, cm	Weight, g	
			aboveground part	± to control
Control (disposable)	100	11	3,91	-
Reusable	63	6	2,72	- 1,19

The regenerative capacity of micro-shoots in the experimental variants was 63 %, which was 37 % less than in the other variant.

In the variant where a single use of the substrate was performed, the length of growth was 11 cm, which was 1.83 times longer than with repeated use.

The results of laboratory studies show that the duration of use of the soil mixture can affect not only the height of the plants, but also the peculiarities of the formation of the aboveground part.

In laboratory studies, the weight of the aboveground part of plants was in the range of 2.72 - 3.91 g.

It was found out that the highest morphometric indicators of *L. vulgare* plants are characteristic of the variant where the substrate was used only once. Probably, these data can be explained by the fact that plants have the ability to emit toxic substances (colenes), which adversely affect the growth and development of plants in the future.

Recently, in the industrial nursery of ornamental plant species, one of the main methods of reproduction has bedome asexual one. At the same time stimulants of rooting have been used actively. Exogenous phytohormonal compounds are used to improve the regenerative ability of cuttings of ornamental plants that are relatively poorly rooted [13, 17-18].

The effectiveness of growth and development stimulants significantly depends on: the physiological state of the micro-shoot during harvesting, as well as the concentration of the active solution and the exposure of cuttings soaked in it [11].

The results of studies on the influence of exogenous regulators of growth and development of plants on the process of reproduction of the root system in *S. vanhouttei* cuttings are given in table. 8.

Table 8. Influence of exogenous growth stimulators on morphometric parameters of plants

Version	Recovery capacity,%.	Number roots of the 1st order, pcs.	Length of roots, cm.
Control (water)	12	3.8	6.3
Topsin - M	23	4.5	7.7
Rhizopon AA poeder	89	6.4	11.9
Charcor	35	5.1	9.1
SSD_{05}	4.8	0.4	0.6

The use of some exogenous growth regulators had a positive effect on the process of root system reproduction in *S. vanhouttei* cuttings. The indicator of rhizogenic ability in the experimental variants was in the range of 23-89 %, and in the control one it was 12 %. When using *Rhizopon AA poeder*, the percentage of rooting cuttings was 89, and in the control version, this figure was 7.4 times lower. Some physiologically active substances affected not only the process of rooting cuttings, but also the number of roots formed on cuttings. The number of roots of the 1st order in the control variant was 3.8 pcs. And in the experimental variants, this figure ranged from 4.5 to 6.4 pcs.

The total length of the roots of the 1st order when using topsin - M made 7.7 cm, which was 1.4 cm more compared to the control variant.

In the variant using charkor, the total length of the roots was 9.1 cm, which was 1.4 times more than in the control variant.

In the laboratory, studies were conducted on the effect of the timing of harvesting micro-shoots on the regenerative capacity of *S. vanhouttei* cuttings (Table 9).

Table 9. Influence of growth regulators on the process of rooting *S. vanhouttei* woody cuttings

Experimental variant	Grafting time		
	control	20.06	20.07
	Rooting,%		
Control (water)	8	12	10
Topsin - M	13	23	18
Rhizopon AA poeder	48	89	81
SSD_{05}	3.23	4.75	4.12

Preparation of micro-shoots for the phase of swelling and flowering buds negatively affected the process of their rooting (the minimum value of regenerative capacity was recorded in the control variant and was 8 %). The use of exogenous compounds provided an increase in the production of planting material.

Grafting *Spiraea* after the flowering phase has a positive effect on the rooting process of micro-shoots. In the control variant, the percentage of rooting made 12 %, which was 1.5 times more than in the first period of grafting (before the swelling phase of the buds). The highest rate of rhizogenic activity was observed in the variant where *Rhizopon AA poeder* was used and it made 89 %.

The analysis of the results showed that the studied compounds have different effects on the processes of callus and choregenesis in micro-shoots. Treatment of cuttings with auxin-like compounds provides a more significant increase in its regenerative capacity than grafting without their use. Harvesting of *S. vanhouttei* micro-shoots should be carried out after the flowering phase of plants.

The influence of exogenous biologically active substance provides the planted cuttings with prerequisites for laying and differentiation of somatic cells, which are necessary for root system regeneration and its further growth and formation, which will ultimately affect the growth and development of the aerial part of the rooted micro-shoot in a positive way (Table 10).

Table 10. Influence of physiologically active substances on the reproduction of the root system in *L. vulgare* cuttings

Experimental variant	Rhizogenic ability,%	± to control
Control (water)	95	-
Stekpoeder Pokon	93	- 2
Ukorzeniacz DDS	98	+ 3
SSD_{05}		2.64

The analysis of experimental work showed that some exogenous compounds can significantly affect the regenerative capacity of *L. vulgare* micro-shoots. Of the studied substances, the best results were obtained using *Ukorzeniacz DDS*.

In the version with *Ukorzeniacz DDS*, the rooting rate made 98 %, which was 3 % higher than in the control one. For *Stekpoeder Pokon* cuttings, the above figure was 93 %.

Changes in the phytohormonal balance of cuttings (*L. vulgare*) under the action of certain exogenous auxin-like compounds did not affect the reproductive capacity more significantly than the cultivation of planting material without treatment with these substances.

The course of physiological and biochemical processes in plant organisms is controlled by 13 groups of hormonal compounds, in particular: salicylic, bird cherry and abscisic acids, auxin, cytokinin, ethylene, brassine and others. They have a variety of functions, control the basic physiological and biochemical processes in plants, as well as the restoration of the root system [4, 15-16].

The main role in the process of callus- and choregenesis belongs to auxins. The processes of callus- and cargenesis are significantly influenced by the ratio in plant tissues of both inhibitors and substances of auxin-like nature. The regenerative ability of micro-shoots (cuttings) is improved by stimulators of root formation, which provide better rooting of ornamental species cuttings and plant forms [9, 11].

Treatment of cuttings (*L. vulgare*) with exogenous growth regulator (*Ukorzeniacz DDS*) creates conditions for the management of regenerative processes (Table 11).

Table 11. Influence of exogenous compound on choregenesis in semi-woody cuttings of *L. vulgare*

Experimental variant	Indicator of rhizogenic ability,%	± to control
Control (water)	2	-
Ukorzeniacz DDS	49	+ 47
SSD_{05}		4.27

The results of laboratory studies convincingly show that the auxin-like substance affects certain reactions that occur in cuttings, and in particular in the version with *Ukorzeniacz DDS* treatment, the rhizogenic capacity was 49 %, which was 24.5 times more than in the control. The minimum value of rooting of micro-shoots of ornamental species was noted in the control, and it made 2 %.

In the course of laboratory studies it was found out that as a result of exposure to exogenous auxin-like compound (*Ukorzeniacz DDS*) the phytohormonal balance of *L. vulgare* micro-shoots has been changed which significantly affects the shaping processes (reproduction of the root system). Thus, the rational use of *Ukorzeniacz DDS* under the conditions of root propagation of the studied species by grafting, creates conditions for efficient cultivation of planting material.

Mathematical processing of qualitative indicators shows a significant difference between the experimental variant and control one ($SSD_{0,5}$ was 4.27).

Introduction into the production process of various techniques and measures, advanced achievements of science and practice necessitates the calculation of economic efficiency.

Estimation of economic efficiency of use of the perspective rooting stimulator is given in tab. 12.

Table 12. Efficiency of production of *S. vanhouttei* planting material

Types of costs	Control (water)	*Rhizopon AA poeder*
Costs (material), UAH	4204.83	7114.93
Remuneration, UAH	6419.4	7959.4
Salary accruals, UAH	2432.9	3016.6
Total costs, UAH	13057.13	18090.63
Yield of rooted cuttings, pcs.	1200	8900
Unit cost, UAH	5.0	5.0
The cost of a rooted micro-shoot, UAH	10.88	2.03
Profitability index,%	-54.04	146.1

The cost of rooted micro-shoots in the experimental version is UAH 2.03, which is UAH 8.85. less than the control. The level of profitability in the experimental version was 146.1 %. Production efficiency indicators convincingly prove that it is advisable to use exogenous auxin compound (*Rhizopon AA poeder*) for root cultivation of *S. vanhouttei*.

The set of agro-technical measures for growing the same type of planting material involves transplanting rooted cuttings for further growth. Rooted micro-shoots with a well-formed root system are transplanted in late July - early August. In the year of grafting it is advisable to transplant some ornamental species, in particular: *Cornus alba, Juniperus, Thuja*. Rooted cuttings of most breeds should be left in cultivation facilities for winter [10].

Table 13. Influence of transplantation time on the process of plant survival

Experimental variant	Survival,%	± to control
Control (25.04)	98	-
25.09	10	- 88
SSD_{05}	4.49	

According to the results of research (Table 13), the survival rate of planting material in the control was 98 %. At the same time, the minimum value of survival was recorded when transplanting was carried out in September (25.09).

In the experimental work, a probable difference in variants was noted ($SSD_{0,5}$ 4.49). At the same time, it was found out that the process of transplanting plants of the studied species should be carried out in April.

We have convincingly proved that transplanting rooted cuttings in favorable periods creates the conditions for optimizing agricultural production of *T. baccata* seedlings, as well as improving the efficiency of planting material.

Conclusions and prospects for further research.

1.The optimal substrate for plant propagation (*T. baccata*) by grafting is a mixture of sand and peat (pH 6.0) in a ratio of 1 : 1.

2. The corregenic ability of *L. vulgare* micro shoots is determined by the period of grafting. The optimal time for harvesting micro-shoots is the period before swelling and flowering buds (recovery rate is 98 %).

3. When root-own planting material (*S. vanhouttei*) is available, it is advisable to harvest micro-shoots with 2-3 buds.

4. Treatment of cuttings (*S. vanhouttei*) with auxin-like substances provides a greater effect than grafting without their use. *Rhizopon AA poeder* is a highly effective compound that stimulates the process of callus- and choregenesis in micro-shoots (cuttings) of *S. vanhouttei*. The rate of regenerative capacity in the experimental variant was 89 %, and in the control one – 12 %.

5. *L. vulgare* is desirable to propagate by root-own method (semi-woody micro-shoots) using *Ukorzeniacz DDS*. Treatment of micro-shoots (cuttings) with this compound creates conditions for the reproduction of the root system (rhizogenic capacity was 49 %).

6. The feeding area of micro-shoots (*L. vulgare*) in the cultivation facility significantly affects the quality of planting material. The optimal feeding area of rooted cuttings is 15 X 10 cm.

7. At root reproduction of *L. vulgare* in the conditions of the closed soil one-time use of soil mix is expedient.

8. The cost of planting material (*S. vanhouttei*) in the experimental variant (*Rhizopon AA poeder*) was UAH 2.03, which was 5.36 times less than in the control. The profitability of planting material production was 146.1%.

9. Transplantation of *T. baccata* rooted cuttings is best done in late April (survival rate was 98 %).

10. The use of plants of the studied taxa will create stable phytocenoses.

REFERENCES

1. Aksyonov, Ye.S. & Aksyonov, N.A. (2000). *Decorative garden plants*. Moskva : ABF [in Russian].

2. Alexander, R. M., Batstone, K. A. (2006). *Dizain sada: professionalnyi podkhod*. Moskva : Kladez-Books [in Russian].

3. Ihnatenko, O. P. (2012). *Blahoustrii terytorii naselenyh punktiv*. Kyiv [in Ukrainian].

4. Kobyletska, M. S., Terek, O. I. (2017). *Biokhimiya roslyn.* Lviv: LNU im. Ivana Franka [in Ukrainian].

5. Kolesnichenko, O. V., Slusar, S. I., Yakobchuk, O. M. (2008). *Metodychni recomendatsii z rozmnozgennya derevnyh dekoratyvnyh roslyn Botanichnogo sadu NUBiP Ukrayiny*. Kyiv [in Ukrainian].

6. Klueva, I. V. (2010). *Landshaftnyi dizain*. Kharkiv: Vesta [in Ukrainian].

7. Kutcheryavyi, V. S. (2000, 2019). *Landshaftna arkhitektura*. Kyiv: Hovyi Svit [in Ukrainian].

8. Hordiyenko, M. I., Guz, M. M., Derbrynyuk, Дебринюк, Yu. M. et al. (2005). *Lisovi kultury.* Lviv: Kamula [in Ukrainian].

9. Manankov, M. K., Musiyenko, N. N., Manankova, O. P. (2002). *Regulyatory rosta rastenii i practika ih primeneniya.* Kyiv : Fitosotsiozentr [in Russian].

10. Maurer, V. M., Pinchuk, A. P., Boboshko-Bardin, I. M. et al. (2019). *Dekoratyvne rozsadnytstvo.* Kyiv : Profkniga [in Ukrainian].

11. Polikarpova, F. Ya., Pilyugina, B. B. (1991). *Vyraschivaniye posadochnogo materiala zelyonym cherenkovaniyem.* Moskva : Rospromizdat [in Russian].

12. Reva, M. L. (2007). *Vegetatyvne rozmnozgennya derevnyh ta chagarnykovyh roslyn v pryrodnyh umovah*. Kyiv : Naukova dumka [in Ukrainian].

13. Yavorsk, V. K., Dragovoz, I. V., Kryuchkova, L. O. et al. (2006). *Regulyatory rostu na osnovi pryrodnoyi syrovyny ta yih zastosuvannya v roslynnytstvi*. Kyiv : Logos [in Ukrainian].

14. Spirin, A. S. (2019). *Molekulyarnaya biologiya*. Moskva : Laboratoriya znaniy [in Russian].

15. Tarasenko, S. A. (2017). *Fiziologiya i biokhimiya rasteniy*. Moskva : Foton [in Russian].

16. Talor, D., Green, N., Stout, U. (2019). *Biologiya*. Moskva : Laboratoriya znaniy [in Russian].

17. Tokman, V. S., Zakharchenko Ye. A. (2019). Vplyv substratu ta stymulyatoriv koreneutvorennya na vkoribennta zhyvtsiv Taxus ваccata L. v umovah NNVK Sumskogo NAU. *Visnyk Kharkivskogo natsionalnogo agrarnogo universytetu im. V. V. Dokutchayeva. Seriya «Gruntoznavstvo, agrokhimiya, zemlerobstvo, lisove gospodarstvo».* Kharkiv: HNAU, 108-119 [in Ukrainian].

18. Torchyk, V. I., Kelko, A. F. , Holopuk, G. A. (2017). *Rizogenez u dekoratyvnyh sadovyh form hvoinyh rasteniy i sposoby yego intensifikatsii*. Minsk : Belaruskaya navuka [in Russian].

PRE-COMMERCIAL METHOD OF THINNING IN THE STATE ENTERPRISE "SHOSTKA FORESTRY UNIT"

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Actuality of theme. Thinning are a generally accepted system for the purposeful formation of economically valuable foreststands with the desired composition, structure and productivity [1; 3; 4; 8; 9]. In the conditions of the SE "Shostka forestry unit" system of thinning are carried out periodically, part of trees is cut down in foreststands for the purpose of improvement of conditions of development for those trees which remained for the further growth. Due to the system of thinning, wood is harvested, which over time can be a natural waste. Thus, due to timely and high-quality thinning, the composition and structure of stands are improved, as well as the yield of liquid wood per unit area is increased, and the time for growing technically mature wood is reduced. In general, system of thinning contributes to the rational use of forest resources [1; 3; 4; 8; 9]. Of great importance is the presence of a set of standards governing their implementation [2; 4-6]. In 2020, SE "Shostka forestry unit" planned to take measures to improve the sanitary condition of forests on an area of 736.4 hectares. In Voronezh forestry subdivision, 212.6 ha were allocated for the system of thinning, including 85.1 ha for pre-commercial thinning.

The purpose of the research is to reveal the peculiarities of pre-commercial thinning in foreststands in the conditions of the specified enterprise. The object of study - the process of formation of foreststands by care felling. The subject of research is the specifics of the use of through pre-commercial thinning in pine foreststands of the specified enterprise.

The following research methods were used: monographic; silvicultural and forest inventory (for laying experimantal plots in order to establish silvicultural and forest inventory's indicators of forest stands); silvicultural and ecological (to provide typological characteristics of forest stands).

The scientific novelty of the research is the generalization of scientific approaches and the study of practical experience in conducting system of thinning in forest stands in the enterprise. The results of the research have practical application in the field of system of thinning, will improve the conduct of transitional felling in the study area.

SE "Shostka forestry unit" with an area of 27074.7 hectares is located in the north-western part of Sumy region in the Krolevets and Shostka administrative districts and the city of Shostka. The administrative and organizational structure of the enterprise includes 4 forestries: Myronivske (5743.7 ha), Sobytske (7366.6 ha), Shostkynske (5731.8 ha) and Voronezhke (8232.6 ha) [6]. According to forest zoning, the territory of the forestry belongs to the Kyiv-Chernihiv (Eastern Polissya) forestry district, the forest vegetation zone of Polissya. The climate of the forestry area is temperate-continental with long continental summers, sufficient rainfall and

relatively short mild winters. Among the climatic factors that negatively affect the growth and development of forest stands should be noted the presence of late spring and early autumn frosts, dry winds of the south-eastern and eastern directions. The territory of the forestry by the nature of the relief is a slightly undulating plain without sharp rises with elevations not exceeding 50-200 m above sea level and intersects the valleys of the left tributaries of the Desna River. The main types and kinds of soils: sod-podzolic (sod hidden-podzolic sandy or slightly humus, sod-slightly podzolic, sandy, clay-sandy, light and medium sandy, as well as sod-medium podzolic - 98%; peat-podzolic and peat-gley - 2%. Erosion processes are poorly developed. According to the degree of humidity, most soils are fresh and moist. Forest areas with excessive moisture account for 4.6% of the area covered with forest vegetation. The swamps cover an area of 234.5 hectares. Natural conditions are favorable for the growth and development of major forest species.

Research methods. During the collection of material for the planned research were used materials of forest management of the enterprise, reporting data on formation and rehabilitation of forests. Experimental plots were laid in the most common types of forest conditions in the most typical place of the site and placed at a certain distance from the road, clearings, meadows - not closer than 30 m (not closer to a distance equal to 2-3 tree heights). During the establishing of experimental plots in young stands, the requirements for involving the entire cycle of mixing of species were observed, in pure stands there should be at least 5 rows of the main breed in pure ones. The longer side of the trial area is located along the rows. The description of experimental areas is provided according to methods that are generally accepted in forestry and forest inventory: location of test area (name of enterprise, forestry, № quarter), undergrowth, soil type, relief. The forest typological description of all components of the forest stand was given, according to which the type of forest vegetation conditions was established [8; 10].

A list of trees was measured on the trial area with the measurement of the diameters of all trees at a height of 1.3 m from the soil surface: at the age of the clearing - 4 cm thick. Diameters and heights of 12-15 model trees are measured from the central degrees of thickness (to plot the height and establish the height category). The average diameter of the stand is determined by the cross-sectional area and the number of trees. The average height of the stand was determined by the height curve, which is built according to model trees [7; 8]. The quality of the forest stands was established on the scale of Professor M. M. Orlov. The stock of a stand is established by means of assortment tables of the corresponding forest tree species and the category of heights [2].

Intensity of forestry at the enterprise. The leading branch of the national economy of Ukraine is agriculture with the cultivation of cereals and livestock. The forest cover of the administrative districts on the territory of which the forestry is located is: Krolevets district - 29.7%, Shostka district - 29.3%. The economic activity of the forestry is aimed at the rational and efficient use of forest resources, improving soil protection, sanitation, health, aesthetic and other useful functions of the forest.

The intensity of forestry is high, as evidenced by key indicators. The annual volume of forest use (liquid) under the current forest management project is 81.7 thousand m^3, including 56.24 thousand m^3 from the commercial fellings. The average volume of forest use from 1 ha of forested forest areas is 3.2 m^3. Annual volume of forest reproduction works: creation of forest crops - 109.5 ha, promotion of natural regeneration - 40 ha.

The list of measures to improve the sanitary condition of forests for 2020 is planned: in Myronivske forestry subdivision - an area of 316 hectares, in Voronezhke forestry subdivision - 213.2 hectares, in Sobytske forestry subdivision - 207.2 hectares.

In Voronezhke forestry subdivision, the plan for the removal of commercial felling of Scots pine was assigned in 2019 - an area of 31.0 hectares with a liquid reserve of 11,073 m^3, in 2020 - 30.9 hectares and 11,332 m^3. The plan of system of thinning in Voronezh forestry for 2020 included (forest plantations with a predominance of Scots pine) for felling: for lighting - 36.0 hectares, clearing - 44.8 hectares, thinning - 46.7 hectares, precommersial felling - 85.1 hectares.

The existing organization of forestry works in the forestry unit is as follows: development of logging places of the commersial fellings, partial (up to 20%) care of plantations is carried out by contractors who enter into contracts with the forestry. All other forestry works, including timber removal, are carried out by specialized forestry brigades [6].

Characteristics of experimental plots. In the forest plantations of Voronezhke forestry subdivision 4 test areas have been laid in order to establish forestry inventory's indicators of stands and organizational-technical indicators of precommersial felling.

The purpose of precommersial fellings is to increase the growth of the best trees and increase the marketability of stands. Passage fellings are carried out in pine plantations from 41 years and older. Trees are divided into three categories: I - the best, II - auxiliary, III - undesirable. The intensity of care felling is set depending on the composition, age, quality class, structure, condition of plantations.

The provisions set out in the following normative documents were used to lay down temporary test plots for precommersial fellings and during the calculation of changes in forestry and tax indicators, the provisions of such normative documents as "Projects of organization and development of forestry" [6], in handbooks on forest inventory [2], "Rules for improving the quality of forests" [4], etc. were used.

Experimantal plot № 1 is laid in the quarter № 65, with an area of 11.5 hectares in Voronezhke forestry subdivision. The assessment description of the experimantal plot № 1 is given in table 1.

Table 1 - The assessment description of the experimantal plot № 1

Composition of forest tree species	Number trunks, pcs. * ha^{-1}	Average figures		The sum of cross-sectional areas, m^2* ha^{-1}	The density of standing trees	Stock of wood, m^3* ha^{-1}
		H, m	D, cm			
Before the precommersial felling						
100% *Pinus sylvestris* L.	1578	15,8	16,2	27,6	0,79	201
After the precommersial felling						
100% *Pinus sylvestris* L.	1351	15,3	15,8	24,2	0,69	176

The size of the experimantal plot is 0.5 ha. The composition of forest tree species before precommersial felling - 100% *Pinus sylvestris* L. Origin - artificial. Type of forest vegetation conditions - B_3. Forest site (quality class) - I. The density of standing trees - 0.79. Stock of wood - 201 m^3* ha^{-1}. Living ground cover - raspberries, forest lilies, strawberries. Soil type - sod-slightly podzolic sandy. The relief is flat. Age - 41 years. Type of felling - precommersial felling. The degree of liquefaction is 12.3%. The felled wood stock is 24.8 m^3* ha^{-1}: business wood– 3,6 м^3 m^3* ha^{-1}, firewood – 17.2 m^3* ha^{-1}, illiquid firewood - 0.4 m^3* ha^{-1}, bushes - 3.6 m^3* ha^{-1}.

Experimantal plot № 2 is laid in the quarter № 7, with an area of 2.6 hectares in Voronezhke forestry subdivision. The assessment description of the experimantal plot № 2 is given in table 2.

Table 2 - The assessment description of the experimantal plot № 2

Composition of forest tree species	Number trunks, pcs. * ha^{-1}	Average figures		The sum of cross-sectional areas, m^2* ha^{-1}	The density of standing trees	Stock of wood, m^3* ha^{-1}
		H, m	D, cm			
Before the precommersial felling						
100% *Pinus sylvestris* L.	370	29,9	36,2	38,0	0,81	507
After the precommersial felling						
100% *Pinus sylvestris* L.	329	28,9	35,8	33,8	0,72	451

The size of the experimantal plot is 0.5 ha. The composition of forest tree species before precommersial felling - 100% *Pinus sylvestris* L. Origin - artificial. Type of forest vegetation conditions - B_3. Forest site (quality class) - I. The density of standing trees - 0.81. Stock of wood - 507 m^3* ha^{-1}. Living ground cover - lily of the valley, heather, ortilia unilateral. Soil type - soda-slippery podzolits sandy scrap. The relief is flat. Age - 110 years. Type of felling - precommersial felling. The degree

of liquefaction is 11.0%. The felled wood stock is 56 m^3* ha^{-1}: business wood– 5,8 м^3 m^3* ha^{-1}, firewood – 43.8 m^3* ha^{-1}, liquid from the crown - 1.1 m^3* ha^{-1}, bushes - 5.1 m^3* ha^{-1}.

Experimantal plot № 3 is laid in the quarter № 36, with an area of 4.0 hectares in Voronezhke forestry subdivision. The assessment description of the experimantal plot № 3 is given in table 3.

Table 3 - The assessment description of the experimantal plot № 3

Composition of forest tree species	Number trunks, pcs. * ha^{-1}	Average figures		The sum of cross-sectional areas, m^2* ha^{-1}	The density of standing trees	Stock of wood, m^3* ha^{-1}
		H, m	D, cm			
Before the precommersial felling						
100% *Pinus sylvestris* L.	692	22,5	24,1	31,7	0,76	327
After the precommersial felling						
100% *Pinus sylvestris* L.	612	22,0	23,5	26,0	0,62	268

The size of the experimantal plot is 1.0 ha. The composition of forest tree species before precommersial felling - 100% *Pinus sylvestris* L.. Origin - artificial. Type of forest vegetation conditions - B_3. Forest site (quality class) - IA. The density of standing trees - 0.76. Stock of wood - 327 m^3* ha^{-1}. Living ground cover - forest lily of the valley, blueberries.. Soil type - soda-slippery podzolits sandy scrap. The relief is flat. Age - 63 years.

Type of felling - precommersial felling. The degree of liquefaction is 18.1%. The felled wood stock is 59.2 m^3* ha^{-1}: firewood - 32 m^3* ha^{-1}, liquid from the crown - 0.5 m^3* ha^{-1}, illiquid firewood - 3.5 m^3* ha^{-1}, bushes - 23.2 m^3* ha^{-1}.

Experimantal plot № 4 is laid in the quarter № 36, with an area of 2.5 hectares in Voronezhke forestry subdivision. The assessment description of the experimantal plot № 4 is given in table 4.

Table 4 - The assessment description of the experimantal plot № 4

Composition of forest tree species	Number trunks, pcs. * ha^{-1}	Average figures		The sum of cross-sectional areas, m^2* ha^{-1}	The density of standing trees	Stock of wood, m^3* ha^{-1}
		H, m	D, cm			
Before the precommersial felling						
100% *Pinus sylvestris* L.	510	26,5	28,3	36,0	0,80	425
After the precommersial felling						
100% *Pinus sylvestris* L.	458	25,8	29,5	32,9	0,73	389

The size of the experimantal plot is 1.0 ha. The composition of forest tree species before precommersial felling - 100% *Pinus sylvestris* L. Origin - artificial. Type of forest vegetation conditions - B_3. Forest site (quality class) - IA. The density of standing trees - 0.8. Stock of wood - 425 m^3* ha^{-1}. Living ground cover - raspberries, lilies of the valley, strawberries. Soil type - sod-slightly podzolic sandy. The relief is flat. Age - 83 years.

Type of felling - precommersial felling. The degree of liquefaction is 8.5%. The felled wood stock is 36 m^3* ha^{-1}: firewood - 29.6 m^3* ha^{-1}, liquid from the crown - 0.3 m^3* ha^{-1}, illiquid firewood - 2.5 m^3* ha^{-1}, bushes - 3.6 m^3* ha^{-1}.

Analysis of research results. Forestry approaches to the use of precommersial fellings with the laying of experimental plots were developed on the example of pure pine plantations. Experimental forest stands grow in conditions of moist soil moisture. Forest stands grow in high quality classes, most of them are high-density or close to such.

When assigning organizational and technical indicators of precommersial felling, the light-loving nature of Scots pine was taken into account. It is known that at the age of lighting and clearing pine quickly drowns out deciduous trees and shrubs, at the age of thinning - needs to adjust enough light in crowns, and at the age of clearings - the corresponding area of nutrition in the soil.

It is known that in research conditions (fresh and wet stands), especially for pine stands of artificial origin, the formation of the assortment structure of stands with the use of weak degrees of liquefaction may be unsatisfactory due to the initial excessive density of stands [7-9]. The latter can lead to damage to pine stands by snowstorms.

The precommersial felling at the experimental plot № 1 was assigned in a 41-year-old stand with a composition of *Pinus sylvestris* L. (100%) with a weak degree of liquefaction (12% in stock, completeness reduced from 0.79 to 0.69). The average volume of wood whip was 0.2 m^3. The felling was carried out by a combined method with a selection of pine trees: damaged trees, those that lagged behind in growth, in groups with excessive density. The composition of the stand is already economically feasible. The purpose of felling was to continue the care of the shape of the crown and trunk of the best pine trees, as well as the beginning of the care of trees for soil-light growth (increase in thickness). The next reception of through felling should be carried out in 7-8 years with a weak degree of liquefaction.

The precommersial felling at the experimental plot № 2 is planned in a 100-year-old forest stand with a composition of of *Pinus sylvestris* L. (100%) with a weak degree of liquefaction (11% in stock, completeness reduced from 0.81 to 0.72). The average volume of wood whip was 1.05 m^3. The purpose of felling was to create optimal conditions for the growth of the best trees in thickness, as well as for seed formation. The next reception of through felling should be carried out in 10 years with a weak degree of liquefaction.

The precommersial felling at the experimental plot № 3 was assigned to a 63-year-old stand with a composition of *Pinus sylvestris* L. (100%) with a liquefaction intensity of 18.1%, while the completeness was reduced from 0.76 to 0.62. The average volume of wood whip was 0.4 m^3. 80 pine trees are intended for felling per 1 ha.

The precommersial felling at the experimental plot № 4 is assigned in an 83-year-old stand with a composition of *Pinus sylvestris* L. (100%) with a liquefaction intensity of 18.1%, while the completeness is reduced from 0.8 to 0.73. The average volume of wood whip - 0.58 m^3. 31 pine trees are assigned for felling per 1 ha.

Conclusions. The vast majority of Scots pine stands are characterized by high growth rates, so they need constant silvicultural care to prevent natural tree loss. The company pays considerable attention to silvicultural care of stands – the system of thinning is carried out in a timely manner and in sufficient quantities.

When taking pine trees to precommersial fellings, a combined method of care felling was used: from the upper part of the canopy pine trees with defects were selected, and from the lower part - pine trees that lagged behind in growth, and thickened pine tree groups were thinned. In addition, the formation of large windows, which can lead to the appearance of grass vegetation, was avoided.

With a careful silvicultural approach to the formation of the spatial-parametric structure of forest stands from the moment of closing the crowns in young stands to the age of natural maturity, you can increase the productivity of forest stands and their biological stability.

The average apiary technology with an apiary width of 50 m is used for works during precommersial fellings. The felling of the forest takes place with the help of gasoline-powered saws "Husqvarna", "Shtil" and others. The felling of felled trees takes place in the apiary. Skidding of assortments takes place on skidding drags is carried out by the MTZ-82 tractor with the hydraulic capture. Sorting and stacking of assortments is carried out in the upper warehouse.

Compliance with the requirements of current regulations and taking into account the results of research cited in the literature will allow in the future through through felling in these studies, as well as in general all measures for forest formation and rehabilitation, grow valuable forest stands in appropriate types of forest conditions, forest areas and forest categories.

REFERENCES

1. Atrokhin V. G. (1985) System of thinning and intermediate forest management / V. G. Atrokhin, I. K. Ievin. M.: Agropromizdat, 255 p. (in Russian)

2. Forest inventory handbook (2013) / Responsible for the issue: S. M. Kashpor, A. A. Strochinsky. - Kyiv: Vinichenko Publishing House, 496 p. (in Ukrainian)

3. Izyumsky P. P. (1969) System of thinning / P. P. Izyumsky. M.: Forest industry. 152 p. (in Russian)

4. On approval of the Rules for improving the quality of forests: Resolution of the Cabinet of Ministers of Ukraine of 12.05.2007 № 724. 8 p. (in Ukrainian)

5. Practical economics of forest ecosystem management: the case of the Ukrainian Carpathians (2009) / L. Irland, E. Kremenetska, pp. 180-200. In: Ecological economics and sustainable forest management: developing a transdisciplinary approach for the Carpathian Mountains. Edited by I.P. Soloviy, W.S.Keeton. Lviv: Ukrainian National Forestry University Press, Liga-Press.

6. Project of organization and development of forestry of the state enterprise "Shostkinse forestry unit" of Sumy regional management of forestry and hunting of the State agency of forest resources of Ukraine (2018). Explanatory note. Irpin: Ukrainian State Project Forest Management Production Association "Ukrderzhlisproekt", 172 p. (in Ukrainian)

7. Svyrydenko V. E. (2006) Dependence of productivity and quality of pine trees on the spatial-parametric structure in the age of precommersial felling / V. E. Svyrydenko, L. S. Kyrychok, V. V. Babenko / Scientific Bulletin of the National Agrarian University (in Ukrainian)

8. Svyrydenko V. E. (2008) Forestry: Textbook / V. E. Svyrydenko, O. G. Babich, L. S. Kyrychok / Ed. V. E. Svyrydenko. Kyiv: Aristey, 544 p. (in Ukrainian)

9. Silvicultural systems and multiple service forestry (2013). In book: Integrative approaches as an opportunity for the conservation of forest biodiversity, Chapter: 1.5, Publisher: European Forest Institute, Editors: Kraus D., Krumm F., pp. 64-73.

10.Vorobiev D. V. (1967) Methods of typological research / D. V. Vorobiev. K .: Urozhay, 388 p. (in Russian)

SYMBIOTIC ACTIVITY AND PRODUCTIVITY OF SOYBEAN PLANTS FOR TREATMENTS WITH GROWTH REGULATORS WITH ANTI-STRESS ACTION

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Introduction. Soybeans are one of the most valuable crops in world agriculture. The universality of the culture is due to the unique chemical composition, which combines 38−42% protein, 18−23% oil, 25−30% carbohydrates, enzymes, vitamins, minerals. It is impossible to overestimate its importance in the biologization of agriculture. Growing soybeans has a positive effect on humification processes, physical and physicochemical properties of soils, water and nutrient regimes, improves the nitrogen balance of crop rotation and increases the yield of other crops (Babych, 2004; Kolisnyk. 2009).

The latest trends in climate change, scientists are faced with the task of developing cultivation technologies that can increase yields and improve quality. An important component of increasing the yield and improving the quality of soybean seeds is the use of optimal nutrition, the use of modern highly effective plant growth regulators (Melnyk, Akuaku, Makarchuk, 2018; Mikheev, 2019). The mechanism of the effect of foliar feeding with growth regulators with anti-stress effect on photosynthetic, symbiotic activity and productivity of plants has not been studied, which makes research in this area relevant.

An important feature of plants is the ability to symbiotic nitrogen fixation. Among field crops, legumes have the highest potential for nitrogen fixation. World and domestic studies have shown that legumes in symbiosis with nodule bacteria are able to fix a large amount of nitrogen: clover - 180-670 kg/ha, alfalfa - 200-460, beans - 100-550, soybeans - 90-240, peas - 70 -160, lupines - 150-450, pastures with legumes - 100-260 kg/ha (Franche, 2008; Kalenska, 2009). Soybeans with a grain yield of more than 3.0 t/ha are absorbed by no more than 6.0 t/ha of nitrogen. At the same time, with such a grain harvest, plants use twice as much nitrogen from the soil for its formation, ie such crops do not create a positive balance of this element in the soil (Drobitko, 2001; Melnyk, Romanko, 2015).

Materials and Methods. The task of the experiment is to identify the effect of growth regulators with anti-stress effect on the productivity of soybean plants. The field research was conducted in the research field of ERPC (educational, research, and production complex) of the Sumy National Agrarian University during 2018–2020 in Ukraine. The experimental plots of Sumy NAU are located within the city of Sumy (latitude 50º52.742N, 34º46.159E Longitude, and 137.7 m above sea

level) and belong to the northeastern part of the Forest Steppe. Experiments were carried out on black soil characteristics for the coarse-medium loam.

On the topic of the master's research work, the field research was conducted according to the following scheme.

Experimental scheme Factor A - application period: in the microstage of development according to BBCH (61, 69 and 61 + 69). Factor B - the use of growth regulators with anti-stress effect: control (without regulators), Albite TPS (40 ml/ha); X-site (1.5 l/ha); Atonic Plus (0.2 l/ha); Megafol (1.0 l/ha); Bioforge (1.5 l/ha); Vermistim D (6.0 l/ha); Stimulate (0.75 l/ha).

Experiment parameters 1: la = 3, lв= 8; n = 4, the area of the accounting area of 30 m^2. The plots are arranged by the method of organized repetitions in four tiers. The method of sowing is the row method with a row spacing of 45 cm. The seeding rate is 0.5 million pieces of seeds per hectare.

Assessment of photosynthetic activity was performed on the following indicators: leaf surface area was determined by phases of soybean development by the method of cuttings and calculated by the formula. Also used the analytical method of determining the leaf surface area of soybean plants, which was developed by Babich A. O. and Makarov O.V. by one-parameter equations. The duration of general and active symbiosis and the number and mass of nodules on soybean roots were calculated on 20 plants according to the method of G. S. Posipanov.

Results. To identify the influence of the application phase and the type of growth regulators with anti-stress effect on symbiotic activity, the number and weight of nodules on the studied soybean plants were determined (Table 1).

It was found that for the introduction of PPP in the 61st microstage , maximum value received for use Atonic Plus (499 pcs. bubbles general weighing 31.04 d) that on 193 pcs. and 15.14 g more than in the control . High efficiency also detected by processing Megafol (444 pcs. bubbles weighing 24.05 d) that almost 30% more comparatively with control. Decrease symbiotic activity plants soybeans was determined for making X-site (273.5 pieces of bubbles weighing 11.18 g), which is 11% less than in the control . Calculated mass one nodules averaged 0.053 g and varied from 0.041 to 0.062 g. For making plant growth regulators in BBCH 69 in on average was formed less in number bubbles comparatively with processing in phase 61 (297.06 pcs.) and insignificant increase their general mass up to 19.72 g (Duncan test = 2.05 g).

Table 1 - Symbiotic activity of soybean plants depending on the phase of application and the type of growth regulators with anti-stress effect (average for 2018-2020 yy.)

Phase for BBCH (factor A)	Options for treating plants with growth regulators (factor B)	The number of bubbles, pcs.	Mass of bubbles, d	Average weight 1 bubble, d
BBCH 61	Control	306.5	15.90	0.052
	Albite TPS	329.9	17.32	0.053
	X-site	273.5	11.18	0.041
	Atonic Plus	499.0	31.04	0.062
	Megafol	444.0	24.05	0.054
	Bioforge	302.0	17.34	0.057
	Vermistim D	334.0	17.91	0.054
	Stimulate	378.0	17.50	0.048
	Average	***358.4***	***19.03***	***0.053***
BBCH 69	Control	282.5	21.36	0.076
	Albite TPS	242.5	16.30	0.067
	X-site	251.5	15.20	0.060
	Atonic Plus	394.0	29.60	0.075
	Megafol	243.5	18.67	0.077
	Bioforge	284.0	18.33	0.065
	Vermistim D	332.5	17.81	0.054
	Stimulate	346.0	20.52	0.059
	Average	***297.1***	***19.72***	***0.066***
BBCH 61 +69	Control	307.5	16.50	0.054
	Albite TPS	357.0	18.81	0.053
	X-site	300.5	16.18	0.054
	Atonic Plus	423.0	32.50	0.077
	Megafol	397.5	29.80	0.075
	Bioforge	357.0	18.87	0.053
	Vermistim D	298.5	18.22	0.060
	Stimulate	369.8	18.40	0.050
	Average	***348.7***	***21.55***	***0.060***
Duncan test $_{0.05}$		**22.54**	**2.05**	**0.006**

In incision growth regulators identified growth symbiotic activity plants soybeans for use Atonic Plus (394 pcs. bubbles weighing 29.6 g), Stimulant (346 pieces of bubbles) weighing 20.5 g) and Vermistim D (332.5 pieces of bubbles) weighing 17.8 g). Available inhibitory effect on symbiotic activity from making Albite TPS (242.5 pieces of bubbles weighing 16.3 g) that lower by 14% compared to control em . Trace to note weight gain one nodules for use regulators for more

late 69th BBCH microstage . Calculated mass one nodules on average by factor A was 0.066 g and varied from 0.054 to 0.077 g

Double foliar feeding with plant growth regulators in the 61st and 69th microstages led to the formation of the same number of tubers as in a single application in the 61st phase. The average factor A factor (348.7 units) was higher than the use of growth regulators in phase 69 (297.1 units). At the same time, it should be noted the increase in the total mass of nodules. On average, for BBCH $_{61 + 69}$ this indicator was at the level of 21.55 g, which is significantly higher than for a single application in BBCH $_{61}$ (19.03 g) and BBCH $_{69}$ (19.72 g). The above indicators led to the formation of bubbles weighing from 0.050 to 0.077 g. Factor B revealed the greatest manifestation of symbiotic activity when applying Megafol and Atonic (397.5-423.0 pieces of bubbles weighing 29.8-32.5 g, respectively), which with control by 22.7–27.4%. The average weight of the tubers was also the maximum and was 0.075–0.077 g. A positive effect was also obtained with the introduction of Bioforge and Stimulate (557.0 - 397.5 g of tubers weighing 18.4 - 18.87 g).

The main indicators of individual productivity are the number of beans, the number and weight of grain. The above indicators directly determine the realization of the biological potential of the crop and affect the formation of yields (Table 2).

On average, according to the research options, the maximum number of fruits (15.74 pcs.) By factor A (term of application) was detected by double use of growth regulators in the 61st and 69th microstages according to BBCH. On the variants for the introduction of PPP in BBCH 61 an average of 14.78 pieces were formed, and in BBCH 69 - 13.14 pieces. beans. According to factor B, the greatest effectiveness was found with the introduction of Megafol and Stimulate. On average, 15.14–15.15 pieces were formed on the above-mentioned variants. fruits . It should be noted the significant influence of growth regulators with anti-stress action, which provided the formation of more than 14.6 pieces. beans (Duncan test = 0.32 pcs.), except for Albite TPN, where only 13.61 pcs. fruits.

According to the indicator of grain weight from one plant in relation to the influence of application terms, the maximum parameters were found for application in BBCH 61 and double application of BBCH 61 + BBCH 69 . Another important indicator of plant productivity Is the amount of grain from one plant. According to the results of research, it was found that a greater impact on this indicator (28.33 pcs.) Was obtained with the use of growth regulators in the early phase of BBCH 61 (table. 3).

Treatment of plants in the next phase of BBCH 69 provided an average of 26.47 pieces. grains from plants. On the variants with double use of drugs, an average of 26.67 pieces were obtained. grains from plants. Factor B revealed a significant difference in the options for the use of growth regulators (over 26.88 units) compared to the control (24.6 units).

Table 2 - Number of beans and grain weight per soybean plant depending on the application phase and type of growth regulators with anti-stress effect (average for 2018-2020 yy.)

Phase for BBCH (factor A)	Options for treating plants with growth regulators (B)	Number of beans, pcs.	Mass of grain from the plant, g
BBCH 61	Control	13.70	4.29
	Albite TPS	13.95	4.51
	X-site	14.81	4.91
	Atonic Plus	15.03	5.25
	Megafol	15.50	5.17
	Bioforge	14.97	4.68
	Vermistim D	14.92	5.00
	Stimulate	15.40	4.95
	Average	*14.78*	*4.85*
BBCH 69	Control	12.16	4.26
	Albite TPS	12.36	4.48
	X-site	13.33	4.82
	Atonic Plus	13.37	4.56
	Megafol	13.55	5.10
	Bioforge	13.50	4.42
	Vermistim D	13.06	4.89
	Stimulate	13.78	4.89
	Average	*13.14*	*4.74*
BBCH 61 +69	Control	14.26	4.31
	Albite TPS	14.52	4.66
	X-site	15.67	5.03
	Atonic Plus	15.74	5.29
	Megafol	16.38	5.18
	Bioforge	15.84	4.83
	Vermistim D	15.77	4.72
	Stimulate	16.28	4.99
	Average	*15.74*	*4.87*
Duncan test $_{0.05}$	***AND***	***0.19***	***0.09***
	IN	***0.32***	***0.15***
	AB	***0.55***	***0.26***

The weight of 1000 grains is an important indicator of both the structure of the crop and its quality. It characterizes the grain size and is mainly a varietal trait. At the same time, elements of technology, in particular plant nutrition, have an impact on this parameter. It is quite logical that a well-developed plant, characterized

by high photosynthetic and symbiotic activity, is able to form a well-filled grain with a high weight of 1000 pcs. seeds.

Table 3 - Quantity and weight of 1000 pcs. seeds depending on the phase of application and the type of growth regulators with anti-stress effect (average for 2018 - 2020 yy.)

Phase for BBCH (factor A)	Options for treating plants with growth regulators (factor B)	Number of grains, pcs.	Weight 1000 pcs. seeds, g
BBCH 61	Control	25.39	168.93
	Albite TPS	26.48	170.96
	X-site	29.12	168.97
	Atonic Plus	29.53	178.10
	Megafol	29.85	173.51
	Bioforge	28.04	166.90
	Vermistim D	28.93	173.39
	Stimulate	29.26	169.93
	Average	*28.33*	*171.34*
BBCH 69	Control	24.62	173.39
	Albite TPS	25.10	179.08
	X-site	27.65	174.34
	Atonic Plus	25.56	179.17
	Megafol	28.80	177.61
	Bioforge	25.88	171.08
	Vermistim D	27.19	180.04
	Stimulate	26.94	181.39
	Average	*26.47*	*177.01*
BBCH 61 +69	Control	23.79	181.22
	Albite TPS	25.17	184.95
	X-site	27.93	180.05
	Atonic Plus	28.81	183.52
	Megafol	28.11	184,70
	Bioforge	26.73	181.19
	Vermistim D	25.74	183.74
	Stimulate	27.12	184.28
	Average	*26.67*	*183,20*
Duncan test $_{0.05}$	***AND***	***0.51***	***2.05***
	IN	***0.83***	***3.35***
	AB	***1.44***	***5.81***

According to the results of our calculations, it was found that the most effective influence on the formation of the mass of 1000 pcs. grains (183.20 g) were obtained by double treatment of plants in BBCH $_{61}$ and BBCH $_{69}$. The average value

(177.01 g) was calculated for treatments in the 69th microstage by BBCH. Early application of drugs had less effect on grain size (171.34 g), but it should be recalled that this period of application of growth regulators contributed to the formation of more grain.

Factor B revealed the effectiveness of Albit TPS, Atonic Plus, Megafol, Vermistim and Stimulate. On these variants the largest grain with a weight of 1000 pieces was formed. (178.33–180.26 g). Without the use of drugs (control) was obtained grain weighing 1000 pcs. - 174.51

Conclusions. The content of chlorophyll was 42.95 Spad - units when introducing growth regulators in BBCH $_{61}$. The highest rates were obtained in the options for plant treatment Atonic Plus (43.9) and Bioforge (44.9), which is higher compared to the control of 2.3 and 3.3 Spad - units in accordance. The introduction of the X-site (0.4) had a minimal effect. With the introduction of PPP in the 69th microstage, the highest rate was found in the variants Megafol (44.1) and Atonic Plus (43.8). The minimum values (42.0) were obtained from the analysis of soybean leaves treated with Albit TPS and Vermistym D. It was found that the introduction of plant growth regulators in BBCH $_{69}$ on average formed a smaller number of tubers compared to the treatment in the phase BBCH $_{61}$ (297.06 pcs.) and a slight increase in their total weight to 19.72 g. An increase in the symbiotic activity of soybean plants with the use of Atonic Plus (394 pcs. tubers weighing 29.6 g.), Stimulant (346 pcs. tubers) weighing 20.5 g) and Vermistim D (332.5 pieces of bubbles) weighing 17.8 g). There is an inhibitory effect on symbiotic activity from the introduction of Albite TPS (242.5 pcs. bubbles weighing 16.3 g), that lower by 14% compared to control em. It should be noted the increase in the weight of one tuber with the use of regulators at a later 69th microstage . Calculated mass one nodules on average by factor A was 0.066 g and varied from 0.054 to 0.077 g. The maximum number of fruits (15.74 pcs.) Was found with double use of growth regulators in BBCH 61 $_{and}$ BBCH $_{69}$. The greatest effectiveness was found with the introduction of Megafol and Stimulant (15.14-15.15 pcs.). On average, the weight of grain from one plant was maximum for the application of drugs in BBCH $_{61}$ and double application of BBCH $_{61}$ + BBCH $_{69}$. The highest efficiency on the amount of grain from one plant (28.33 pieces) was found with the use of growth regulators in BBCH $_{61}$.

REFERENCES

1. Babych A. A. (2004) Photosynthetic activity and yield of soybean seeds depending on sowing dates and system of protection against diseases in the Forest-Steppe of Ukraine / Feed and feed production . Vinnytsia, 2004. №. 5, P. 83–88.

2. Drobitko AV (2001) Influence of mineral fertilizers and inoculation on soybean productivity in the conditions of the south-western steppe of Ukraine. Bulletin of Agrarian Science of the Black Sea Coast , Issue. 1. P. 84–88.

3. Franche C. (2008) Nitrogen-fixing bacteria associated with leguminous and nonleguminous plants / C. Franche , K. Linolstrom and C. Elmerich . Springer Science Business Media B. V. № 321 (35). 59 p. P. 18.

4. Kalenska S. M. (2009) Mineral nutrition soybeans / S. M. Kalenska , N. V. Novitska , A. E. Strykhar . Seed production . № 8. C. 23–25.

5. Kolisnyk S. I. (2009) Features formation photosynthetic and seed productivity early ripening varieties soybeans in the right-bank Forest- Steppe Of Ukraine / S. I. Kolisnyk , O. M. Venediktov , D. O. Fabianski . Feed and feed production . № 64. C. 55–61.

6. Melnyk A. V., Akuaku J., Makarchuk A. V. (2018) Effect of foliar fertilizers in reducing stress in sunflower plants under conditions of climate change in the Forest-Steppe of Ukraine / A. V. Melnyk , J. Akuaku , A. V. Makarchuk // 11th International Conference " Plant Functioning Under Environmental Stress " . Krakow . P. 134.

7. Melnyk A.V, Romanko Yu. O. (2015) Influence of complex application nitrogen fertilizers and bacterial drugs for yield soybeans in conditions Left Bank Forest-steppe Of Ukraine . Herald Sumy NAU. Sumy, Issue . 30. pp. 170–172.

8. Mikheev V. G. (2019) Productivity of soybean depending on application of regulators of growth, desiccation and senication of crops in the conditions of the left-bank forest-steppe of Ukraine: the dissertation on competition of a scientific degree of the candidate of agricultural sciences, the Kharkiv national university of them. VV Dokuchaev. Kharkiv, S. 9–17.

9. Posypanov G. C. (1982) Features of calculation of doses of fertilizers for legumes for the planned harvest. Agrochemistry . № 9, S. 77–81.

DYNAMICS OF UNGULATES ANIMALS UNDER MODERN ANTOPOGENIC LOAD IN FORESTRY FACILITIES OF SUMY REGION

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Introduction. Hunting has long been considered the main form of human activity and the main source of its existence. With the development of civilization, the biological significance of hunting for man has been lost. Today , hunting is a traditional type of activity of the population and economic entities, hunting is a type of active recreation and sport, which in general forms an important component of forest use.

Analysis of official statistics on the dynamics of the number of major species of hunting fauna over the past decades shows the spontaneous and inefficient management of hunting in almost all regions of Ukraine. Despite the minimal volumes of extraction of the main hunting animals, the number of their populations remains almost at the same level, and some species even decrease (Muraviov, 2019).

Wild animals in their habitat are constantly under the influence of various factors - abiotic, biotic and anthropogenic, which determine the state of species populations. Such effects directly or indirectly change the number, fertility and mortality, seasonal movements, migration and immigration, morbidity, physical and physiological condition of hunting animals (Sobol, 2021 Panek, 2004).

Anthropogenic pressure on the environment can be traced in the transformation of the main abiotic factors, especially climatic (temperature, light, humidity, radiation regime, pressure), which are the most variable. Increasing the temperature regime and reducing the amount of precipitation contribute to an increase in the frequency of dry winds, heat and sudden changes in temperature during the day (Adamenko, 2006). Temperature in general affects the distribution of some species through the forage base.

Anthropogenic impact is manifested through the intensification of agricultural production (the use of highly toxic chemicals to control unwanted organisms), high plowing of land, reclamation measures, which ultimately led to a decrease in the forage base of ungulates and habitats of other hunting animals. Currently, plowed land in Ukraine is the largest in the world, reaching 56% of the total area, and 80% of agricultural land (Apostol, 2020; FAO).

A. V. Domnich, I. O. Smirnova, D. O. Buglo, V. V. Petrichenko (Domnich, 2010; Smirnova et al., 2011) studied the features of the transformation of natural habitats of hunting fauna. In the forest-steppe zone, similar studies were conducted by Korzh (Korzh & et al., 2006), Katysh (Katysh, 2016).

Human actions in the natural environment, conscious or unconscious, often cause stress in wild animals, which can lead to significant physiological changes in

animals. The so-called disturbance factor in hunting grounds arises mainly due to the presence of a significant number of people in them: conducting various forestry and forestry operations, picking berries and mushrooms, tourism and more.

Materials and methods of research. *The purpose of the research* is statistical analysis of the dynamics of the number of ungulates hunting animals depending on the anthropogenic load in the conditions of the north-eastern Forest-Steppe of Ukraine (Sumy region).

The object of research - the number of ungulates, in particular, European bison (*Bison bonasus* L.), European elk (*Alces alces* L.), red deer (noble) (*Cervus elaphus* L.), spotted deer (*Cervus nippon n.* Temminsk), roe deer (European deer) (*Capreolus capreolus* L.), wild boar (*Sus scrofa* L.).

Research methods - comparative analysis and mathematical statistics. The materials of statistical reporting and accounting of the State Statistics Committee, the State Agency of Forest Resources of Ukraine, the Sumy Regional Department of Forestry and Hunting, literature sources, the results of own research were used for the analysis. Statistical analysis of research results was performed using analysis of variance using computer programs Statistica-8.0.

Results. According to statistics for the analyzed period, the total area of hunting grounds in Ukraine is 38,779.9 thousand hectares (table 1).

Table 1 - Area of hunting grounds and number of ungulates by regions of Ukraine (2019)

Region	Area of hunting grounds, thousand hectares		Total number of ungulates in hunting farms, thousand individuals	Density of ungulates hunting animals / thousand ha
	provided for use	covered by hunting regulation		
Ukraine	38779.9	38060.9	221.0	5.8
Poltava	2092,0	2086,0	9.0	4.3
Sumy	2026.4	2021.4	7.7	3.8
Kharkiv	1494,0	1494,0	10.5	7.0
Chernihiv	2768.2	2731.8	13.6	5.0

In Sumy region it is 2053.6 thousand hectares (5.3%) and is divided between 40 users. State enterprises of the Sumy Regional Department of Forestry and Hunting occupy 12% (237.8 thousand hectares), the rest of the area (1571.4 thousand hectares) is divided between 17 branches of district organizations of the Ukrainian Society of Hunters and Fishermen (UHFA) and 10 other users , which transferred 228, 7 thousand hectares of hunting grounds. In total, almost 1,150 legal entities are

engaged in hunting. More than 800,000 hunters are registered in Ukraine. The analysis of the density of ungulates in the allotted hunting areas, in Sumy region, is the lowest, both in terms of density of individuals per 1 thousand hectares and the total number in hunting farms.

The dynamics of the number of ungulates in Ukraine during the analyzed period (2010-2022) is shown in Table 2.

Table 2 - Dynamics of the number of hunting animals, the number and percentage of caught in hunting farms of Ukraine

Year	Number of ungulates animals, thousands of individuals	Number of extracted (removed) ungulates, thousand individuals	Percentage of animal removal,%
2010	239.0	12.3	5.1
2011	244.4	13.3	5.4
2012	239.6	12.8	5.3
2013	238.3	12.8	5.4
2014	233.6	13.9	6.0
2015	231.3	18.6	8.0
2016	220.2	14.7	6.7
2017	221.0	13.3	6.0
2018	217.1	13.0	6.0
2019	217.4	13.1	6.0
2020	222.9	13.2	5.9
Duncan test $_{05}$	22.5	1.7	

Therefore, we can observe variations in the total number of major species of ungulates over the past ten years from 217.1 (2018) to 244, 4 thousand individuals (2011). The average number of ungulates during this period in Ukraine was 252.48 thousand individuals, and the number of captured - 15.1 thousand individuals. The withdrawal rate was 6.58% and varied over the years from the lowest 5.1% in 2010 to 8.0% in 2015. Withdrawal of animals had significant differences in species and years. Thus, the mass death and increased percentage of wild boar seizures in 2015-2018 led to a significant decrease in the total population in subsequent years compared to 2011. In 2020, began to show an increasing trend of ungulate fauna in hunting farms in Ukraine and Sumy region (Table 3).

Table 3 - Number of ungulates and their products (2020), thousand individuals, thousands of individuals in Ukraine

The name of the species of ungulates	Number ungulate hunting animals	Number of ungulates caught
European bison	0.3	0
European moose	6.2	0
European deer	13.7	0.4
Spotted deer	4.3	0.2
European fallow deer	1.3	0.1
European roe deer	167.7	10.4
European mouflon	0.9	0
Wild boar	28.5	2.1
Total	**222.9**	**13.2**

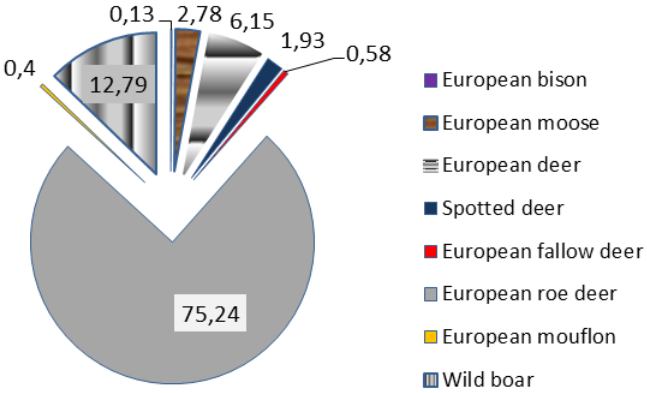
In terms of species, among ungulates of Ukraine, the dominant place is occupied by European roe deer (167.7 thousand individuals), which is - 75.2%. The second place in terms of distribution is classically occupied by wild boar (28.5 thousand individuals). The number of red deer and spotted deer is 13.7 and 4.3 thousand individuals. The number of European fallow deer (1.3 thousand individuals) and European mouflon (0.9 thousand individuals) is gradually increasing.

The particular note are the growth rates of the European moose population, which in 2020 numbered 6.2 thousand individuals, and the European bison. This unique species feels good under the protection of the Red Book and the number of livestock is currently over 300 individuals.

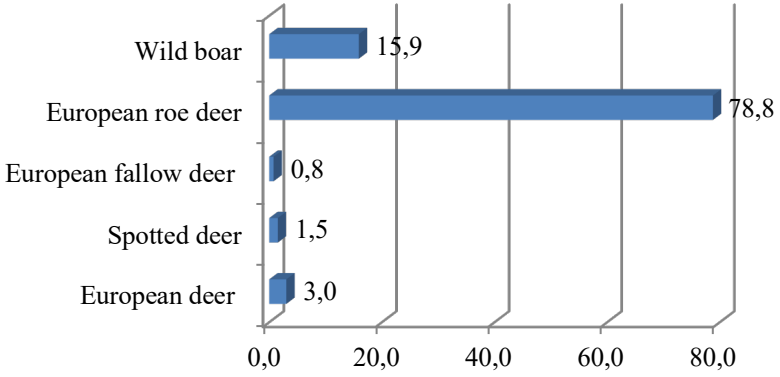
The above trends in the number of animals in Ukraine are reflected in the statistics of animal production in 2020. European roe deer (10.4 thousand individuals) were harvested the most, at the level of 78.8% (Fig. 1) and wild boar (2.1 thousand individuals) at the level of 15.9%. The percentage of harvested spotted deer and red deer is 1.5 and 3.0 of the total number of ungulates removed. No European bison, European moose or European mouflon were fished in Ukraine in the period 2020–2021.

According to the results of the analysis of the dynamics of population density of ungulates in the lands of Sumy region, a positive trend towards increasing the number over the past two years (2020-2021). It should be noted that the total number of ungulate theriofauna in 2021 was 8839 individuals, which corresponds to the level of "depopulation" in 2010 and 2011. In general, the most numerous was in 2013 - 2986 individuals of Sus scrofa L. Within the species, the dynamics of population size for the period 2010-2021 fluctuated significantly.

As can be seen from the table. 4, in 2021, 228 individuals of the European moose were found on the hunting grounds of Sumy forestry management. The largest number (35 individuals) was observed in the lands of Konotop L H. This farm is also a leader in the number of red deer (94 individuals).



A



B

*Fig. 1. Percentage of species (A) and harvested (B) ungulates,%
(for Ukraine, 2020)*

Spotted deer are most common in the hunting grounds of Krasnopilske LH (49 individuals), Konotop LH (5 individuals) and Lebedynske LH. In total, 204 individuals of this species were found in the region, taking into account other users of hunting grounds.

In terms of the number of European roe deer populations, the first place is occupied by the Sumy hunting farm (540 individuals), the second by the Konotop forestry (335 individuals) and the third by the Krolevets forestry (273 individuals). A total of 2,267 European roe deer have been registered in the hunting grounds of the Sumy forestry management.

Positive changes in the recovery of wild boar populations are observed. According to the results of the tax assessment in 2021, the number of species has increased to 1233 individuals in the region, which is 298 individuals higher than in 2020. At the same time, before the mass "depopulation" in 2013, the wild boar population in the hunting grounds of the region was 2986 individuals.

The European bison is a unique representative of the forest natural fauna of Sumy region. This “Red Book” animal is found in the hunting grounds of Konotop forestry. Its population in 2021 was 64 individuals and over the past 10 years has grown by 24 individuals. The average growth was +2.4 individuals with a peak in 2019.

In forestry farms of other forms of subordination and ownership, there is also a steady increase in the population of ungulates. The largest number of ungulates is characterized by the hunting fauna of SMG "Swan" (1158 individuals), LLC CBA "Forests of Sumy" (350 individuals) and LLC "Trostyanets SMG" (313 individuals). Appropriate biotechnical measures, regulated hunting and game breeding are the key to such positive dynamics.

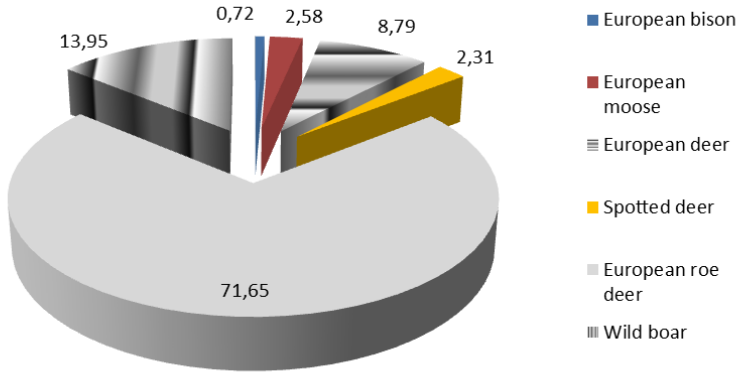


Fig. 2.- Representation of ungulate species in the hunting fauna of Sumy forestry management (2021)

Species structure of the number of ungulates hunting animals of Sumy region is presented in Figure 2. The leader in this group is the European roe deer (71.6%), wild boar

is 13.9%, red deer - 8.8%; spotted deer - 2.3%. European moose and European bison, which are banned from hunting, account for 2.6% and 0.7%, respectively.

Discussion. Climate change on the planet, especially rising temperatures, has already affected a number of meteorological characteristics in almost all regions of the globe (Adamenko, 2006). These changes also affected the conditions of the north-eastern part of the Forest-Steppe of Ukraine (Sumy region).

Thus, in comparison with the long-term averages, for the period 1994–2020 there was an increase in the sum of temperatures during the growing season by 198 ° C, a decrease in the amount of precipitation by 26.8 mm. As a result, the SCC changed from 1.18 to 0.95, which indicates the formation of conditions typical of the central and southern regions of the country (southern Kharkiv, Dnipropetrovsk, Zaporizhia and Mykolaiv regions) (Melnyk & et al., 2020).

A number of modern scientists emphasize the need for introduction and adaptation of hunting fauna in these realities of climatic conditions and growing anthropogenic pressure (Volokh, 2015; Katysh, 2016; Kratiuk, 2018). In particular, the problem can be solved by increasing the number of hunting animals.

Conclusions. Given the analysis, current threats to the biodiversity of ungulates have become significant. One of the key factors of influence is anthropogenic impact, which is manifested through significant climate change. According to the results of research it is established that in the conditions of the north-eastern Forest-Steppe of Ukraine (Sumy region) there is a tendency to increase the anthropogenic load on natural lands and as a consequence on the number of ungulates. At the same time, it should be noted the positive dynamics of reproduction of populations of individual members of the hunting fauna, including roe deer and wild boar. The rational organization of Sumy forestry management in hunting and the growing role of enterprises of other forms of ownership play an important role in this. At the same time, the existing indicators remain lower than the European ones, which should be taken into account in the priority tasks of forestry management in the region.

REFERENCES

1. Adamenko, T. (2006). Changes of agro-climatic conditions and their impact on grain farming. Agronom , 3, 12–15 (in Ukrainian).

2. Apollonio M., Belkin V., Borkowski J. et al. (2017) Challenges and science-based implications for modern management and conservation of European ungulate populations. Mammal Research . Vol. 62, 209–217. (in English).

3. Apostol M. Plowed land in Ukraine is the largest in the world and reached 56% of the state] [Electronic resource]. - Access mode: Agravery.comhttps: //agravery.com/uk/posts/show/rozoranist-zemel-v-ukraini-e-najbilsou-v-sviti-ta-dosagla-56-teritorii-derzavi-apostol. (in Ukrainian).

4. Domnich VI (2010) [Population change and anthropogenic pressure on deer and dog animals in Ukraine // zb. scientific-technical. prats: Naukovyi visnyk NLTU Ukrainy. Lviv. Issue 20.5, 8–19. (in Ukrainian).

5. Dziedzic R., Dzięciołowski R. (2010) Dziedzic Roman. Status of game species in Poland and neighboring countries. The status of game species in Poland and neighboring countries] // Międzynarodowa konferencja. The population of wild animals in the border areas (2-3 September 2010, Chelm). - Chelm, 7–23. (in Polish).

6. Katysh SV (2016) // Breeding on the territory of the Forest-Steppe and Steppe zones of Ukraine (on the example of Poltava and Zaporizhia regions) // Biological systems. T. 8. Issue. 1. 2016. S. 219–227.ovoi i Stepovoi zon ukrainy (na prykladi Poltavskoi i Zaporizkoi oblastei) // Biolohichni systemy , T. 8. Vyp. 1, 219–227. (in Ukrainian).

7. Melnyk AV, Romanko Yu.O., Brunov MI, Sorokolit Je.M. Kubrak TM (2020) Growth and development of chickpeas in the northern forest-steppe of Ukraine // Visnyk Sums'kogo NAU . № 2 (40), 38–46. (in Ukrainian).

8. Muraviov, Yu. V. (2019). Game animals resources as a prerequisite for the establishment of ecological and economic development of hunting economy. Scientific Bulletin of UNFU, 29 (4), 86–88. DOI https://doi.org/10.15421/40290418 (in English).

9. Wyniki monitoringingu zwierzyny drobnej v latach 2002/2003 [Small game monitoring results in the years] // Łowiec Polski. № 4, 11–12. (in Polish).

10. Radisak, J. (2016). A test of traditional diversity measure and taxonomic distinctness indices on benthic diatoms of soda pans in the Carpathian basin. Ecological Indicators. 64, 1–8 [Electronic resource]. - Access mode:: http://dx.doi.org/10.1016/ j.ekolind.2015.12.018. (in English).

11. Smahol VN, Havrys H. H. (2013) Zubr, Bison bonasus (Mammalia Artiodactyla), v Ukrayne: dynamyka chyslennosty, rasprostranenye, statsyy y lymytyruiushchye faktory: monohrafyia [Bison bonasus (Mammalia Artiodactyla), stat distribution and limitation), in distribution factors: monograph] Kiev: "Veles", 128 p. (in Ukrainian).

12. Smirnova IO, Buhlo DO, Domnich AV, Petrychenko VV (2011) Population dynamics and analysis of factors influencing the number of predators and ungulates in eastern Ukraine // Visnyk Zaporizhzhya National University . № 1, 61–68. (in Ukrainian).

13. Sobol O. M. (2021) Dynamics of species composition of hunting fauna of Kherson region // Tavrijs'kij vísnik. Issue 118, 368–376. (in Ukrainian). DOI https://doi.org/10.32851/2226-0099.2021.118.47.

14. Volokh, AM (2015) Mammals Hunted in Steppe Ukraine. Part 2. Green DC, Kherson, 1–401. (In Russian).

15. Jessica Bateman. Jak u Євropu povertajut'sja veliki ssavci [How big scoops return to Europe] BBC Future. [Electronic resource]. - Access mode: https://www.bbc.com/ukrainian/vert-fut-55847029 .

CURRENT CHALLENGES OF AGRICULTURAL TRANSFORMATIONS IN UKRAINE: BIODIESEL PRODUCTION

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In modern market conditions, innovative development becomes one of the main activities of the enterprise, including agricultural enterprises and should be aimed at creating an innovative structure, updating fixed assets and technologies (updating technologies, improving the quality and quantity of products, new products and services) , improvement of management and economy of the enterprise, introduction of effective innovation and investment projects. But this is possible due to state support for the development of innovation in the agricultural sector. State support in the field of agricultural entrepreneurship in Ukraine is carried out in two directions, traditional and innovative Figure 1.

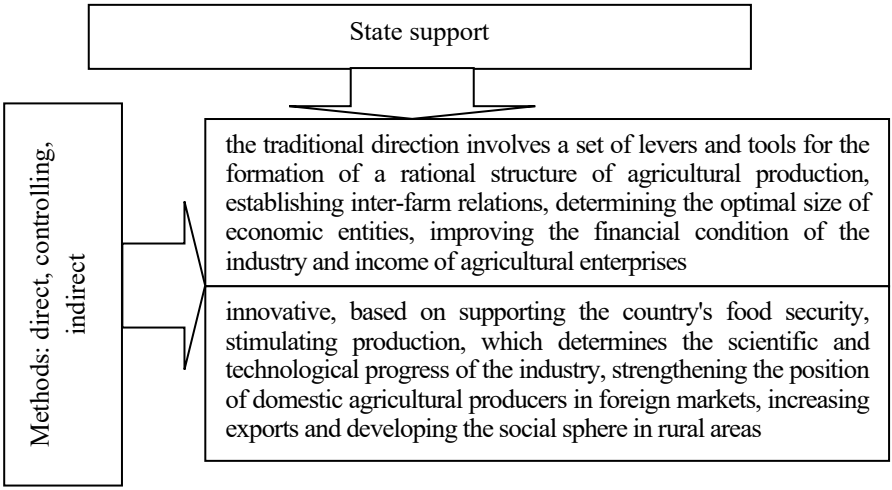

Fig. 1- State support of agricultural entrepreneurship in Ukraine

Direct state assistance is provided through: financing of innovative project programs; financial support for exports; providing property for innovation activities; training, retraining and advanced training for innovation; provision of free consulting and expert services; government order.

Indirect methods of state support include: formation of a preferential system of taxation of innovation activities; simplification of certification and licensing procedures; marketing support of knowledge-intensive products; monitoring of innovation activity and active use of antitrust measures; subsidizing the interest rate on the loan.

Controlling methods of supporting innovation processes in agricultural entrepreneurship are carried out through the active use of antitrust measures, examination of innovation activities and its monitoring [1].

Government R&D appropriations (GBARDs) are a funding-based approach to R&D reporting that identifies all budget items that may support R&D and measures or evaluates their research content. This makes it possible to link these budget lines to policy considerations by classifying them by socio-economic objectives. However, it provides only a partial indicator of investment in state agricultural research, as it is a research funding tool dedicated to agriculture. Government spending on agriculture has declined over time in several major exporting countries. This may jeopardize the ability of public research to cover areas of less interest to producers (long-term, public goods) and to participate in joint activities (for example, internationally). In countries with significant private investment in research and development, this has not necessarily replaced public investment, as private and public research is expected to be complementary.

The state is the most important institution that influences innovative transformations in the agricultural sector. Ukrainian scientists have developed the main criteria by which agricultural producers can apply for state support aimed at innovation [2]. The main ones are:

1. High-tech projects. If we are talking about the crop industry, then in the technological process it is advisable to use varieties that are resistant to diseases and pests. Seeds should have a high level (up to 98-100%) of germination, give a high level of profitability.

2. Creation of new jobs and development of domestic production. High technologies require highly qualified personnel and an appropriate incentive and motivational mechanism.

3. The problem of low readiness of investment objects, which is that various institutions and departments are involved in innovation processes. Some resources necessary for innovation in Ukraine are completely absent - they should be purchased abroad.

4. Cost-effectiveness and self-sufficiency of the project. In a market economy, every project must be self-sustaining. An innovative project should yield higher profits in the short term. Yes, an innovative project will not be invested if the projected profitability is lower than the interest rate.

5. Joint participation in the project of public and private capital.

6. Import substitution. Projects that involve national capital and that involve the production of products that can be produced in Ukraine and reduce imports must be given a clear advantage.

7. Environmental friendliness. The innovative project must meet environmental criteria. Products made on the basis of this project must be safe for life and have a positive impact on the environment.

To ensure the effectiveness of state regulation of the innovative potential of the agricultural sector in Ukraine, we have proposed a functional model that provides for the unification of such participants as: the state (adopts legislation, prioritizes science and technology, technology, develops foresight projects, science concepts,

scientific technical programs, road maps, etc.), scientific and educational sector (formation of techno-parks and small innovation enterprises; conducting basic research and experimental testing of their results in technology parks, etc.), agricultural sector (production of innovative products; attracting own resources for innovation; formation of new structures, etc.) and the public (forms various requests for goods and services and other needs of society up to individual orders of individuals and legal entities) [3].

According to paragraph 7 Environmental friendliness, State support for innovative development of agricultural enterprises and the Regional Development Strategy of Sumy region for 2021 - 2027 and the Program of development of agro-industrial complex of Sumy region for the period until 2027 which states that the innovation project must meet environmental criteria. Products made on the basis of this project must be safe for life and have a positive impact on the environment [6, 7].

Considering the process of innovation and investment development in the environmental aspect, it should be noted the significant impact of this element of economic activity of the enterprise on the environment. Thus, the process of innovation and investment development: supports and implements economic activities aimed at improving the quality of the environment; stimulates the reduction of environmentally hazardous waste and emissions, as well as the processing and rational disposal of waste generated by enterprises as a result of economic activities, and thus helps to minimize the harmful effects on the environment; promotes the production, as well as financial support of environmentally friendly products and the introduction of appropriate environmentally friendly technologies; contributes to the sustainable regional development of the country.

In the current conditions of transformational changes, its fuel and energy dependence has a significant impact on the efficiency of agricultural production, which is due to the use of fuel and lubricants, which are mainly imported. The experience of many foreign countries, such as the United States, Germany, France, Austria, shows the possibility of significantly reducing energy dependence through the cultivation and processing of oilseeds for biodiesel. Given the significant shortage of energy resources, agriculture can significantly contribute to solving the problem of self-sufficiency of agricultural enterprises in fuel.

As already mentioned, biodiesel as an alternative to diesel fuel produced from petroleum products has been widely used around the world. It is used both in pure form and in various proportions in a mixture with petroleum fuels. Our study proposes a significant (over 70%) replacement of the consumption of diesel fuel produced from petroleum products with appropriate fuel of vegetable origin based on oilseeds.

Biogas plants are very popular in Ukraine and this is not surprising, because they provide the most efficient processing of organic waste, provide additional income and most importantly biogas plants are environmentally friendly.

The costs of industrial production of biofuels consist of the cost of oilseeds, catalysts and production costs for the production, purification of oil less the cost of meal, glycerin, husk. We calculated the production cost of 1 ton of biodiesel from major oilseeds in two ways:

1) when using raw materials of own production;

2) when using purchased raw materials.

Thus, in 2019, when using raw materials of own production, the cost of production of biodiesel from sunflower was 3995.9 UAH / t, from rape - 3001.2 UAH / t, from soybeans - 4475.4 UAH / t. According to the second option, when using the purchased raw materials, the cost of biodiesel from sunflower was UAH 9,689.4 / t, from rapeseed - UAH 3,275.3 / t, from soybean - UAH 6,644.3 / t. Thus, the lower level of costs among oilseeds is characterized by the production of biodiesel from soybeans due to high purchase prices for soybean meal and soybean oil.

Comparison of the average profitability of biodiesel production in 2020 from sunflower, soybean, rapeseed conditions of the same price per 1 ton of biodiesel at UAH 9,000 / t with VAT and in terms of sales of all by-products at average market prices provided the following results. According to the 1st option of biodiesel production (own raw material) the first position among oilseeds is occupied by rapeseed (profitability 71.3%) due to the high price of soybean meal, the second position belongs to sunflower (profitability 47.7%), the third position is soybeans (profitability 35.19%).

The world's leading countries are switching to biofuels. Every year, the production of gasoline containing fuel ethanol increases in the United States and Western Europe. World rapeseed production exceeds 47 million tons, the annual increase in sown area is recently 17%. The total world area of rapeseed crops has a steady upward trend. Among the world's countries, the largest sown areas of rapeseed are: India, China, Canada, USA, and Australia. In European countries, the sown area of rapeseed reaches about 3.5 million hectares. The largest producers of rapeseed are the EU countries; their share in world rapeseed production is 38.5%. In the EU, exports of rapeseed to other countries are declining; imports are growing, indicating an increase in demand for industrial processing.

In Ukraine, rapeseed as an industrial crop began to be intensively introduced in the last 10-15 years. Despite the long agitation for this crop, rapeseed has not become widespread in our country. The reason is that a number of issues remain unresolved. Rapeseed is a crop with very fine grains, and therefore for its sowing, harvesting and primary processing requires special equipment or advanced traditional. Acquisition of such equipment or re-equipment of existing ones requires considerable expenditure of working time and funds, which farms usually lack. In the structure of arable land, winter rapeseed occupies about 0.2-0.3%, and the average yield is 10.7 c / ha. For comparison: in Germany, the sown area for rapeseed is 1.3 million hectares, almost 10% of arable land, and its average yield is about 30 centners per hectare. The producer receives more than 230 euros per ton of rapeseed.

For Ukraine, there are two alternative uses for rapeseed: to establish its own production of biodiesel or to grow rapeseed and export it to Western countries. If economic calculations are made, their results will show that today it is more profitable for farms to sell rapeseed on the foreign market than to produce biodiesel from it for their own needs. Currently, Ukraine is able to produce about 200 thousand tons of rapeseed for industrial needs. At the same time, there is every reason to hope that in the case of the introduction of new advanced technologies and technical

means it will be possible to increase the gross harvest of rapeseed to 1.0-1.5 million tons, process it in domestic plants, create new jobs and increase competitive ability of the Ukrainian producer in the domestic and foreign markets. A major obstacle to increasing the production and development of the rapeseed market is the backward technical base of agricultural enterprises. Due to violations of cultivation technology, including precision sowing, insufficient fertilizer application, non-compliance with sowing and harvesting deadlines, farms lose almost 60% of potential yield, which leads to increased production costs of one ton of rapeseed. In addition, most farms have a low level of agronomic measures, as a result of which they have a gross rapeseed harvest only due to the natural fertility of the soil.

The high rapeseed harvest in Ukraine contributes not only to increasing exports, but also to increasing the volume of its processing within the country. During 2019/20120, according to preliminary data, about 20 thousand tons of rapeseed were processed, which is one and a half times more than in July 2009. (12.4 thousand tons). Seasonal reduction in stocks of major oils in the European market has contributed to the development of relevant price conditions. Ukraine annually consumes about 5.5 million tons of diesel fuel, the needs of the agricultural sector are about 1.9 million tons of diesel fuel. To equivalently replace this amount of mineral diesel, it is necessary to produce 2.147 million tons of biodiesel. Depending on the quality of raw materials and technological aspects, the production of 1 ton of biodiesel requires from 2.54 to 3.05 tons of rapeseed. Therefore, from 5.5 to 6.5 million rapeseed is needed to completely convert the agro-industrial complex to biodiesel. The average yield of rapeseed (winter and spring) in Ukraine for the last three years was 1.4 t / ha. In 2019, the demand for biofuels in the EU increased by 30%. Therefore, Ukraine began to build plants for its production to establish supplies to Europe. It was previously thought that Ukrainian products could occupy up to 20% of the EU market. The volume of rapeseed production in Ukraine in 2019 decreased by 36% to 1.8 million tons. The loss of some winter rapeseed crops in early 2020 led to an increase in raw material prices by UAH 300 / t - to 2.80- 2.85 thousand UAH / t. The cost of biodiesel (10-12 UAH / l) obtained from such rapeseed is higher than that of traditional fuel sold at 7-8 UAH / l. The production of biological substitutes for traditional motor fuels requires the creation of a domestic market. Therefore, the Verkhovna Rada in 2019 passed a law according to which the country until January 1, 2014 set a zero rate of excise duty on all types of biofuels. Producers were exempted from paying income tax and import duties for ten years. Only production of more than 5,000 tons per year is licensed.

A number of European countries, which have a shortage of their own oil resources, have begun to develop rapeseed as an energy raw material that grows every year in the fields and self-renews. After all, to grow this crop on an area of 1 hectare. consumed 170 kg. fuel, and from the harvest (seeds) you can produce 1.2-1.5 tons of biofuels, in addition, get more cake - concentrated feed for animal feed. In Germany, Belgium, the Netherlands, Switzerland and other countries, the technology of biodiesel production is well improved, it is widely used for agricultural machinery, public transport, machinery that works on rivers and lakes and more. The main value of biodiesel in its environmental friendliness and the

ability to obtain from renewable raw materials. Under natural conditions, biodiesel and rapeseed oils are neutralized by microorganisms for 7-8 days by 95%, and conventional petroleum products by 16%. The main factor holding back the practical use of biodiesel is that the energy of this fuel is too expensive. With the use of biofuels, the number of technical inspections is reduced by two or three times, which in turn saves a lot of money on spare parts, materials and wages [4].

For the period 1990-2009 rapeseed area increased 12 times, gross harvest - 14.4 times. A record harvest of 2.8 million tons was recorded in 2008. In 2009, enterprises reduced production by 36% to 1.8 million tons. The main factor in reducing production was the reduction of sown area by 30%. The reduction in the area under rapeseed was a reduction in demand for it from the EU. The area under rapeseed was divided between barley and soybeans.

The current situation on the rapeseed market is reminiscent of the situation on the sunflower market in the 90s, when seed raw materials were exported and processing plants were idle. We believe that today it is necessary to take incentives to establish rapeseed processing in Ukraine, which will increase the workload of processing plants. Rapeseed prices are also high, so this crop remains economically attractive to Ukrainian farmers.

In the forest-steppe of Ukraine, along with sunflower and soybeans, rapeseed is the main oil and protein crop. As an industrial culture, it began to be intensively introduced only in recent decades. The area under it increased to 100 thousand hectares, and the yield averaged 15 centners per hectare. Some farms receive 30-35 centners per hectare. seed. In the structure of sown areas it occupies 0.3-0.5%.

Insignificant volumes of production of commercial rapeseed are due to the lack of state procurement system, material and technical base, fertilizers, highly effective pesticides, equipment for growing, harvesting and cleaning crops, lack of processing industry. Calculations show that the area under rapeseed in the coming years can be increased 6-8 times and increased to 500,000 hectares. and more, and increase the yield of commercial seeds to 24-26 centners per hectare. This will allow to produce 380-400 thousand tons of oil, 500-600 thousand tons of concentrated feed protein, which is 8-10 times more protein than compound feed. One hectare of rapeseed yields 20 tons of green fodder, 20 tons of green manure, 100 kg of honey, 3.0-3.5 tons of seeds, and 13 quintals. oil, 16 quintals cake, 500 kg. paper. 00-grade meal (meal), containing 37% protein, can be used in any animal feed mixture, can replace soybean and sunflower meal. In 1 kg. Rapeseed meal contains 14-16 g of essential amino acids, including lysine (in grains of barley, oats, corn and wheat – 5 g). The use of non-food rapeseed oil is now widely studied in various industries, especially when there is a risk of oil entering the water and entering groundwater.

Oils of high ore grades are used for the production of lubricants with high resistance: hydraulic oils, lubricants, cooling lubricants, anti-corrosion, for lubrication of dust chains and dust, rust removal oils, biodiesel, motor and transmission oils, oils for soft oils. In the near future, most mineral oils may be replaced by vegetable ones. In addition, rapeseed oil is used to make glycerin, methyl ester, and fatty acids, which are used to make acids, soaps, alcohols, sulfates, esters, and amines. Rapeseed oil can compete with other vegetable oils and animal

fats used for technical purposes. Replacement of mineral oils with vegetable oils is caused by environmental problems. Rapeseed oil decomposes quickly and does not pose a threat to water bodies: in the soil it decomposes in 95 days by 95% (mineral oil only by 16%).

The economic feasibility of growing rapeseed is beyond doubt. According to the analysis of world and European prices, its cultivation provides high profitability. The selling price of rapeseed is 1.8-2.4 times higher than the price of cereals. You can get high added value by processing rapeseed into biofuel. In addition, during processing we get meal - a valuable feed additive to animal feed.In addition to economic benefits, rapeseed has a positive effect on the ecological state of the environment.

Comparing the average profitability of biodiesel production in 2020 from sunflower, soybean and rapeseed at the same price per 1 ton of biodiesel at UAH 9,000 / t with VAT and at the level of sales of all by-products at average market prices provided the following results. According to the 1st option of biodiesel production (own raw material), the first position among oilseeds is occupied by rapeseed (profitability 71.3%) due to the high price of soybean meal, the second position belongs to sunflower (profitability 47.7%), the third position is soybeans (profitability 35.19%). (Table 1.)

Table 1 - Comparative characteristics of economic efficiency of biodiesel production from major oilseeds in agricultural enterprises of Ukraine in 2020

Indexes	Sunflower		Rapeseed		Soy	
	1 option own raw	2nd - purchased raw	1 option own raw	2nd - purchased raw	1 option own raw	2nd - purchased raw
Costs for biodiesel production, UAH / t.	6195,6	12519,1	13581,9	20051,5	7081,3	9192,4
Sales price of 1 ton of biodiesel, UAH without VAT.	7480	7480	7480	7480	7480	7480
Total revenue from sales of biodiesel and other products, UAH without VAT.	9897,5	9897,5	23861,3	23861,3	10228,3	10176,1
Profit from sales of biodiesel and other products, UAH / t.	3325,4	-2731,3	10301,2	3985,1	2866,1	693,2
Cost of biodiesel production, UAH / t.	3995,9	9689,4	3001,2	3275,3	4475,4	6644,3
Profitability of biodiesel production,%.	47,7	-19,9	71,3	15,4	35,9	6,9

Source: own calculations based on statistical data [5].

During the production of biodiesel in the 2nd option (purchased raw materials) in the first position - rapeseed biodiesel (profitability 15.4%), the second position was occupied by soybeans - (profitability 6.9%), and sunflower was generally unprofitable.

Since the cultivation of rapeseed is one of the best options in the production of biodiesel, we conducted a study of the effectiveness of self-sufficiency in fuel from rapeseed processing (as own raw materials) for LLC "AF" Lan "in the coming years under the introduction of rapeseed crop rotation.

To determine the required amount of rapeseed oil and the corresponding gross harvest and sown area of rapeseed (Table 2.), Which should meet the existing need for biodiesel, a number of conditions were adopted:

1) the value of yield taken for calculations corresponds to the achieved value of this indicator by similar agricultural enterprises of Sumy region in 2021;

2) rapeseed oil content was taken at the level of 37% (potential oil content of varieties of the studied crop is 44 - 47%, but when squeezing the seeds in the poppy remains about 7 - 10% of oil);

3) the required amount of rape-methyl ether (PME) was determined by increasing by 5% the annual consumption of diesel fuel (due to the lower heat of combustion of biodiesel);

4) the share of PME output is taken at the level of 96%, which is explained by the chosen technology, which produces about 960 kg of biodiesel from 1 ton of oil;

5) due to the objective features of the existing agricultural technology in the farm, research will be conducted only on the cultivation and processing of spring subspecies of rape.

Studies of analytical materials of the enterprise have shown that regulatory decisions that lead to the improvement of innovation management system should be aimed at:

– reducing the impact of negative factors;
– corresponding increase in the influence of positive factors;
– increasing the value of indicators that positively characterize the innovation management system;
– management staff;
– organizational management structure;
– organizational communications.

The results of the study showed that to cover their own needs in the diesel fuel plant under study, it is necessary to have 7.6% of rapeseed in the total sown area of 246 hectares. According to the consultations with the agronomic service of LLC "AF" Lan "is quite acceptable for crop rotation allocation of such a number of hectares for rapeseed. At the same time, the size of the share of spring rapeseed sowing does not exceed scientifically sound norms in crop rotation, ie 10% - 12%. This fact is a very important argument (from an agronomic point of view) in favor of the feasibility of such calculations.

Table 2 - Calculation of the need for self-sufficiency in biodiesel from rapeseed for LLC AF "LAN"

Indexes	
Rapeseed yield is actually average in Sumy region, t / ha	3,1
Yield of rapeseed oil from 1 ha, t.	1,1
Annual consumption of diesel fuel on average for the last 3 years, t.	240,0
The required amount of PME, t.	252,0
The amount of oil to meet their own needs in diesel fuel, t.	262,5
Gross collection to meet own needs for diesel fuel, c	709,5
Area under rapeseed to meet own needs in diesel fuel, ha.	228,9
The required share of rapeseed in crops,%	7,6

Source: developed by the author on the basis of data f. № 50 s.-g. and own observations.

The next stage of our study involved the selection of equipment for biodiesel production. After studying the available proposals, our choice focused on the model range of biodiesel plants of the domestic company "Biodiesel-Carpathians", which has a good business reputation and cooperates with many foreign companies. In order to justify the choice of biodiesel equipment of the required capacity, the average monthly consumption of diesel fuel for the last 5 years was determined according to the relevant statistical reports of the studied enterprise. Based on the results of such calculations for LLC "AF" Lan "- EXON-50, the production characteristics of which (productivity was 6000 and 1200 l / day, respectively) fully meet the existing needs for diesel fuel.

Given the identified need for biodiesel, we have selected the appropriate equipment for oilseed processing. To calculate the cost of investment in the project, the useful life of the equipment involved was determined. Based on the period of use of the biodiesel plant, it was decided that the project will last for eight years. Accordingly, the total number of units of other equipment was calculated and its cost for the entire project period was determined (Table 3.). In addition, capital expenditures included the cost of preparing equipment for the transition to biodiesel, which includes the purchase of a comprehensive fuel heating system in the cold season, the purchase of filters-separators and filter elements of the fuel system.

The next step in our work was to plan the current costs of the project (Table 4). In this context, it should be noted that the cost of production of PME in general is represented by three components: the cost of grown rapeseed, the cost of processing seeds into oil, the cost of processing oil into biodiesel.

Table 3 - Calculation of capital costs for the proposed project for the processing of rapeseed for biodiesel

Equipment	LLC AF "LAN"	
	Required quantity, units	Cost (including VAT), thousand UAH.
I. Processing of rapeseed into oil		
Screw oil press	2	377,0
Filter line	2	156,4
Filter elements	4	24,0
Oil tanks	2	5,0
Together	10	562,4
II. Oil processing on PME		
EXON complex	1	809,6
Total	x	1372,0
Other expenses		
Preparation of equipment	x	798,4

Source: calculated by the author based on his own observations.

Table 5 - Calculation of the total amount of future costs for the production of biodiesel from rapeseed for LLC "AF" Lan "

.№	Cost items	thousand UAH
	The cost of growing rapeseed	4539,9
	Processing of rapeseed into oil	
1	Depreciation of equipment	29,3
2	The cost of repairing fixed assets	8,1
3	Remuneration with accruals	183,6
4	Electricity	93,7
	Total costs	314,7
	Oil processing on PME	
1	Depreciation of equipment	42,2
2	The cost of repairing fixed assets	23,6
3	Remuneration with accruals	183,6
4	Electricity	257,6
5	The cost of methanol, catalyst and ion exchange resin	382,4
	Total costs	889,3
	The total cost of growing and processing rapeseed	5743,8

Source: calculated by the author based on his own observations.

Thus, the "lion's" share of all costs will be the cost of growing rapeseed (79%). About 5% will be involved in oil production, and 16% - oil processing into biodiesel.

In the context of the study, the next stage was to calculate the economic efficiency of biodiesel production. In the process of processing rapeseed into biodiesel, we have three end products - biodiesel, meal and glycerin. Meal and glycerin were estimated according to existing market prices. The determination of the price of meal was based on the cost of its sunflower counterpart, because the market for rapeseed meal in Ukraine for some reason does not exist. To estimate the biodiesel, which is planned to replace conventional diesel fuel, used the actual average purchase price of diesel fuel in 2021, ie 27.6 thousand UAH / t. to their value at selling prices. (Table 6).

Table 6. Forecast economic efficiency of rapeseed processing into biodiesel in LLC "AF" Lan "

№	Indexes	thousand UAH
1	Benefits of rapeseed processing:	
1.1	biodiesel (volume of Substituted Diesel Fuel), t	240,0
	cost	6 624,0
1.2	meal (58%), t	411,0
	cost	3 288,0
1.3	glycerin, t	57,6
	cost	691,4
2	Cost of received products, UAH	10 603,4
3	Costs for growing and processing of rapeseed, UAH	5 743,8
4	The amount of costs attributable to: biodiesel	3 588,2
	meal	1 781,1
	glycerin	374,6
5	Cost of 1 ton: biodiesel	15,0
	meal	4,3
	glycerin	6,5
9	Savings from diesel fuel substitution (profit), UAH	4 859,6
10	Profitability of self-sufficiency,%	84,6

Source: calculated by the author on the basis of data f. № 50 agriculture and advanced research.

The results of the study allowed us to state that in the process of implementation significant performance indicators were obtained (profitability at the level of 84.6%). Thus, despite the fact that the project to process rapeseed for biodiesel is profitable, a comparison of two alternative uses of seeds in terms of profit and level of profitability showed that the current price situation in the markets of rapeseed and diesel fuel in 2021 for the study enterprises it is more expedient to sell its seeds. At the same time, the situation may change next year.

REFERENCES

1. Bondar-Pidgurska O.V. Scientific and methodological principles of sustainable innovative socially oriented economic development: monograph. Higher educational institution of Ukoopspilka "Poltava University of Economics and Trade" (PUET). Poltava: PUET, 2016. 531 p.

2. Gebremariam, S. N., and Marchetti, J. M. (2018). Economics of biodiesel production: review. Energy Convers. Manage. 168, 74–84. doi: 10.1016/j.enconman.2018.05.002.

3. Li, M., Zhang, W., Zhou, S., and Zhao, Y. (2020). Preparation of poly(vinylalcohol)/palygorskite-poly(ionic liquids) hybrid catalytic membranes to facilitate esterification. Separat. Purif. Technol. 230:115746. doi: 10.1016/j.seppur.2019.115746

4. Gholami, A., Hajinezhad, A., Pourfayaz, F., and Ahmadi, M. H. (2018). The effect of hydrodynamic and ultrasonic cavitation on biodiesel production: an exergy analysis approach. Energy 160, 478–489. doi: 10.1016/j.energy.2018.07.008

5. https://ukrstat.org/uk/operativ/oper_new.html

6. Strategy of sustainable development "Ukraine - 2020". Decree of the President of Ukraine of 12.01.2015 № 5/2015. Database "Legislation of Ukraine" / Verkhovna Rada of Ukraine. URL: https://zakon5.rada.gov.ua/laws/show/5/2015 (access date: 25.02.2020).

7. Strategy of innovative development of Ukraine for 2010-2020 in the context of globalization challenges: project. URL: http://blogs.kpi.kharkov.ua/News/file.axd?file=2009/6/strategia.doc. (application date: 25.02.2020).

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