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ELEMENTS OF NUTRITION OF HYSSOP OFFICINALIS ON DRIP IRRIGATION IN THE SOUTH OF UKRAINE

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Problem statement. The range of essential oil plants grown in the southern part of the steppe of Ukraine is quite poor, although many of them can be successfully grown in this subzone. Essential oils of such crops as lavender, lemon balm, hyssop, sage are widely used, for the cultivation of which very favorable conditions are created in the Mykolaiv region. These are perennial essential oil, medicinal and spicy-aromatic plants which are used in medicine, as honeybees and spices. For some of them, there are no models of the production process, as well as databases of the impact of environmental conditions on the production process at different stages of its course. In this regard, it is of particular interest to study the features of growth and development of the above-mentioned essential oil crops, the prospects for obtaining environmentally friendly products, as well as the possibility of growing them in production conditions.

One of the modern directions of increasing the yield and quality of field crops is the introduction of energy-saving technologies in agricultural production using plant growth regulators, biologics, and microfertilizers. It is proved that due to the high biological activity of these drugs, the main life processes are activated in plants. The use of growth regulators, biologics, and microfertilizers gives results that cannot be achieved by other agricultural activities. They can not only increase yields, improve the quality of grown products, but they also increase the resistance of plants to diseases and stress factors, and reduce the use of pesticides.

In the conditions of the steppe of Ukraine, for the effective use of the biological potential of essential oil crops, taking into account the natural and climatic conditions of the steppe zone, it is important to develop and introduce into production an adaptive technology for growing these crops using the latest intensification factors. In particular, the issue of optimizing the levels of moisture, norms of mineral, microfertilizers and growth-regulating substances in the plantings of essential oil crops remains relevant.

Analysis of recent research and publications. Today, the production of raw materials for essential oil crops does not fully meet the needs of consumers of essential oil products in Ukraine due to the temporary loss of the territory of Crimea. Essential oils of such crops as lavender, lemon balm, hyssop, sage are widely used, for the cultivation of which very favorable conditions are created in the Mykolaiv region. However, our region has never had historical specifics on the industrial cultivation of these crops. Global climate changes, in particular, an increase in the temperature regime and a decrease in precipitation determine the possibility of cultivating common hyssop in the steppe zone of Ukraine, but scientific data on the features of the crop, the possibility of its reproduction and cultivation in the agroclimatic conditions of this zone are extremely insufficient.

The production of essential oil raw materials has historically been developed in the Crimea and Moldova. The Autonomous Republic of Crimea was one of the main producers of essential oil and medicinal raw materials, 30 farms supplied more than 25 thousand tons of raw materials, from an area of more than 10 thousand hectares, the share of essential oils produced from those obtained in the USSR was: such as lavender as 60% (65 tons), sage as 46.5 % (30 tons), rose as 49.2% (3.4 tons), of which about 25 tons were exported, providing a considerable inflow of currency. After the withdrawal of Crimea from Ukraine, coriander and medicinal plants are grown on small areas in the country (a total of 7 thousand hectares are occupied under crops). Currently, the development of technologies for growing, storing and processing essential oil medicinal raw materials is carried out: outside of Ukraine – the All-Russian Institute of medicinal and aromatic plants Vilar (Russia), France, Moldova, Bulgaria, China; in Ukraine-the Experimental Station of Medicinal Plants of the IAP of the National Academy of Sciences of Ukraine (Berezotocha village), the Institute of Horticulture of the National Academy of Sciences (Kiev), the National Botanical Garden named after N. N. Grishko of the National Academy of Sciences (Moscow). Kiev), Experimental Station of essential oil and sparsely distributed agricultural crops of Naas (Zaporozhye), Mykolaiv National Agrarian University, LLC "Natural Essences" and LLC TD "Roskosmetika" (Mykolaiv), Dobrotrav company (Lubny), NPP "Fitkom" (Poltava region), farm "Lavandova Gora" (Perichyn village, Transcarpathian region).

Another weighty argument in favor of the Mykolaiv region, in addition to favorable soil and climatic conditions, is the already accumulated positive result of scientific studies of some essential oil crops when grown in drip irrigation conditions on the lands of the Mykolaiv DSDS within the framework of HDPE 45 "irrigated agriculture" and HDPE 19 "fruit and ornamental gardening" (2017-2020 yrs). The result of these studies is the developed technological methods for growing common hyssop on irrigated lands, ensuring the production of green mass of the crop at the level of 30-35 t/ha, dry mass at the level of 7-10 t/ha [1-7].

The growing need for essential oil plants can be met, first of all, through further research and improvement of technologies for growing essential oil crops in the territory of the Mykolaiv region, for the sake of obtaining maximum volumes and high-quality essential oil raw materials and future integration of agricultural enterprises for their cultivation.

In this regard, it is quite effective to use mineral fertilizers, modern growth-regulating substances, microfertilizers and bacterial preparations, which at the lowest cost of their purchase and application provide the highest yield and quality of essential oil raw materials, reduce labor costs and funds for the production of a unit of production, and, therefore, high economic efficiency of cultivation. However, the inclusion of microfertilizers with biologically active substances in the technology of growing essential oil crops should be accompanied by verification related to their impact on plant growth, development and productivity. All of the above became the basis for choosing the direction of our research.

Biomass growth and stress reduction in *Artemisia dracunculus* and *Hyssopus officinalis* are observed due to the use of microfertilizers and biologics [8]. At the same time, their effect on the productivity of *Common hyssop* in the steppe of Ukraine has not been practically studied.

Today, there is a wide range of organic, environmentally friendly and highly effective microfertilizers that help to increase the adaptation of the plant body to stressful factors. They are also actively used in vegetative reproduction [9, 10, 11].

Double treatment of vegetative plants of Moldavian snakehead, *Dracocephalum moldavicum L.* growth regulators Zircon, Novosil, microfertilizers Siliplant, Ferovit contributed to earlier (by 3-5 days) flowering and maturation of seeds, their yield increased by 23-44% compared to the control, germination energy increased by 10% [12].

The use of drip irrigation for irrigation of agricultural plants is advisable not only from the point of view of increasing yields, but also from the point of view of saving water resources. Drip irrigation makes it possible to precisely adjust the depth of moisture, quantity, quality and frequency of irrigation; coming from the soil, water does not form a crust on the surface. Almost all ethyronoses belong to the group of xerophytes. There is an opinion that regular irrigation reduces the accumulation of essential oil in plants and worsens its quality. But long-term studies of the authors [13] showed that the cultivation of spicy-aromatic crops with local moisture, in particular, maintaining a constant regime of soil moisture in the root layer of these plants, contributed to a significant increase in plant productivity: such as yield, mass fraction and collection of essential oil. Greek scientists also report a significant decrease in the yield of essential oil crops compared to irrigated plantations [14].

The above literature review indicates that it is possible to ensure active growth and development of essential oil crops and their stable bio-productivity and adaptation to unstable weather conditions by exogenous treatments of plants with growth regulators, biologics and microfertilizers, as well as their combination mixtures. In this regard, it is of particular interest to study the features of growth and development of essential oil crops depending on their application, the prospects for obtaining environmentally friendly products, as well as the possibility of growing them in production conditions.

Purpose of the study. The aim of the study is to determine the influence of ecological and agrotechnical growing conditions on the productivity of common hyssop, *Hyssop officinalis* L. on drip irrigation on chernozem of the southern steppe of Ukraine, as well as the development, scientific justification and implementation of agrotechnical methods of their cultivation for the southern region.

Research methodology. The research was carried out in the conditions of drip irrigation in the experimental field of the Mykolaiv State Agricultural Experimental Station of the Institute of Irrigated Agriculture of the National Agrarian Academy of Sciences of Ukraine (Mykolaiv DSDS) located in the village of Polygon of the Mykolaiv District of the Mykolaiv region during 2020-2021.

According to the agroclimatic zoning of the territory of the region, the Mykolaiv DSDS is located in the third (Southern) agroclimatic district, which is characterized by a moderately hot and very arid climate. The average annual precipitation in the area of the experimental farm is 386 mm, and the average annual air temperature is 9.7 °C. The warmest month is July (22.9°C), The coldest one is January (-3.6 °C).

The soil cover of the experimental site is represented by Southern low-humus powdery-heavy loamy chernozems. The thickness of the humus horizon is 30 cm, the humus–transition horizon is 60 cm. The reaction of the soil solution is close to neutral (pH 6.5-6.8), hydrolytic acidity is in the range of 2.00-2.52 mg EQ. per 100 g of soil. The sum of the absorbed bases is 32-35 mg EQ. per 100 g of soil, the degree of saturation with bases is 95.7 %. The presence of humus in the arable soil layer is 2.92 % (by Tyurin), nitrate nitrogen is 27.3 (by Kravkov), mobile phosphorus is 149.0 (by Chirikov), exchange potassium is 273.0 mg per 1 kg of soil (by Chirikov). According to the content of moving elements, the soil of the experimental site is characterized by an increased content of nitrogen and phosphorus and a very high content of potassium. This characteristic is typical for Southern chernozems. In general, the soil of the experimental site is suitable for growing common hyssop.

Agricultural technology in the experiment was generally accepted for the Southern steppe of Ukraine. After germination of the crop, drip irrigation was installed throughout the site, for more efficient and high-quality provision of moisture to the root system of plants. The sown area of the plot was 42 m^2. The area of the accounting plot was 10 m^2. The repetition of the studied variants was threefold.

The experiment scheme included the following options: dose of mineral fertilizers (factor A):

1. Control (without fertilizer);
2. Application of $N_{45}P_{45}$;
3. Application of $N_{90}P_{90}$.

Treatment with complex specialized microfertilizers for vegetation (factor B):

1. Control (without the use of microfertilizers);
2. Single treatment of plants with Quantum-Technical (2 l/ha);
3. Single treatment of plants with Helafit Combi (2 l/ha);
4. Double treatment of plants with Quantum-Technical (2 l/ha);
5. Double treatment of plants with Helafit Combi (2 l/ha).

The object of research was a medium-ripened variety "Marquis", which has a blue-purple color of the Corolla. Sowing was carried out according to the experiment scheme to a depth of 2-3 cm with a precision seeding machine. The seeding rate was 6 kg/ha.

The research was accompanied by analysis of soil and plant samples, observations of the dynamics of plant growth and development [15, 16]. All observations were performed in two non-contiguous repetitions.

The increase in raw biomass was determined by weighing the plants. With each definition, 10 typical plants were selected in two non-contiguous repetitions. When determining the dry matter, the plants were crushed, three samples of 100 g were taken from the mass, and then dried at a temperature of 100-105^0 C.

Crop accounting was carried out in the mass flowering phase. The results of crop accounting were recorded in a field log and subjected to mathematical processing.

The mass fraction of essential oil was determined by hydrodistillation using a Ginsberg receiver.

Statistical and mathematical processing of the obtained analytical digital material was performed using the Microsoft Excel computer program "Agrostat" by the method of variance analysis.

Economic efficiency was analyzed using the calculation and regulatory method. Calculations of direct labor and money costs per hectare of sowing were determined on the basis of technological maps of growing and harvesting the studied crop.

Presentation of the main material. Our research, on average for 2020-2021 yrs, it was found that the introduction of mineral and microfertilizers partially extended the duration of the growing season of common hyssop plants. The introduction of mineral fertilizers formed the onset of the mass flowering phase of crops 1-3 days later. With a single treatment with microfertilizers of plants during the growing season, the onset of the phase was noted for 1-2 days, and with a double treatment was noted 2-4 days later (Table. 1).

Biometric observations have established the influence of nutrition backgrounds and complex specialized, universal microfertilizers on the growth and development of plants during the entire growing season as from intensive weight gain as to mowing ripeness of the crop.

The difference in plant height, the number of stems per plant, and the weight of the aboveground part of plants was revealed, depending on fertilizer and foliar treatments of hyssop plantings (Table. 2).

It should be noted that in the control version without fertilizers, these indicators were the lowest, in particular, the number of stems on one plant was 18 – 42 PCs., plant height was 34.2 – 43.4 cm, Bush diameter was 38 – 54 cm. Improvement of the soil nutrient regime and treatment of plantings with complex specialized, universal microfertilizers contributed to better development of common hyssop plants, the number of stems increased by 7-21 PCs. per plant, plant height increased by 7.8 – 28.0 cm, Bush diameter increased by 3-12 cm compared to the non-fertilized control.

This increase was most significant when plants were treated in the branching and budding phases with Combi Helafite against the background of $N_{90}P_{90}$. In this variant, there were 59 stems on one plant, the height of the plants was 71.4 cm, the diameter of the Bush was 66 cm.

The use of fertilizers in the cultivation of common hyssop affected the nutrient content in the soil (Table. 3).

Thus, during the restoration of the growing season of the crop (the third decade of March), fertilizer application increased the nitrogen content in the soil by 5-31%, mobile phosphorus increased by 16-24%, and there were no certain patterns in the exchange potassium.

The highest amount of nitrate nitrogen, phosphorus and potassium during the resumption of vegetation was

Table 1

Phenological observations of growth and development plants of common hyssop (average for 2020-2021 yrs)

Treatment with microfertilizers	Phase onset date			
	Restortation of vegetation	complete regrowth	Budding	mass flowering
Control				
Control (without treatment)	30.III	1.VI	5.VI	18.VI
Quantum-Technical	30.III	1.VI	5.VI	18.VI
Helafite Combi	30.III	1.VI	4.VI	18.VI
Quantum-Technical (twice)	30.III	1.VI	4.VI	18.VI
Helafite Combi (twice)	30.III	1.VI	4.VI	18.VI
$N_{45}P_{45}$				
Control (without treatment)	30.III	1.VI	6.VI	19.VI
Quantum-Technical	30.III	1.VI	6.VI	19.VI
Helafite Combi	30.III	1.VI	5.VI	19.VI
Quantum-Technical (twice)	30.III	1.VI	5.VI	20.VI
Helafite Combi (twice)	30.III	1.VI	5.VI	20.VI
$N_{90}P_{90}$				
Control (without treatment)	30.III	1.VI	7.VI	20.VI
Quantum-Technical	30.III	1.VI	7.VI	21.VI
Helafite Combi	30.III	1.VI	7.VI	20.VI
Quantum-Technical (twice)	30.III	1.VI	6.VI	22.VI
Helafite Combi (twice)	30.III	1.VI	6.VI	22.VI

Table 2

Effect of mineral and microfertilizers on biometric parameters of common hyssop plants at the beginning of flowering (average for 2020-2021 yrs)

Treatment with microfertilizers (factor B)	Height of plants, cm	Number of stems, PCs.	Bush diameter, cm
Control (factor A)			
Control (without treatment)	34,2	18	38
Quantum-Technical	40,6	28	49
Helafite Combi	41,3	30	47
Quantum-Technical (twice)	42,8	39	52
Helafite Combi (twice)	43,4	42	54
$N_{45}P_{45}$ (factor A)			
Control (without treatment)	42,0	25	41
Quantum-Technical	50,3	36	52
Helafite Combi	52,1	39	52
Quantum-Technical (twice)	54,2	48	57
Helafite Combi (twice)	54,8	51	56
$N_{90}P_{90}$ (factor A)			
Control (without treatment)	50,5	39	47
Quantum-Technical	60,3	49	55
Helafite Combi	60,7	51	57
Quantum-Technical (twice)	69,9	58	64
Helafite Combi (twice)	71,4	59	66
Standard deviation S	*11,3*	*11,9*	*6,9*
Standard error S_x	*2,9*	*3,1*	*1,8*

Table 3

Soil nutrient content in the 0-40 cm horizon (average for 2020-2021 yrs), mg / 100 g of dry soil*

Treatment with microfertilizers (factor B)	Determination period					
	Restoration of vegetation			Beginning of flowering		
	NO_3	P_2O_5	K_2O	NO_3	P_2O_5	K_2O
Control (factor A)						
Control (without treatment)	3,5	4,9	31,2	3,2	4,3	30,8
Quantum-Technical	3,6	5,0	30,8	3,3	4,3	30,6
Helafite Combi	3,6	5,0	30,9	3,3	4,3	30,7
Quantum-Technical (twice)	3,8	5,0	31,1	3,4	4,3	30,8
Helafite Combi (twice)	3,9	5,0	31,0	3,4	4,3	30,7
$N_{45}P_{45}$ (factor A)						
Control (without treatment)	4,1	5,8	31,2	2,7	3,9	31,2
Quantum-Technical	4,1	5,9	30,8	3,0	4,0	30,8
Helafite Combi	4,1	5,8	30,9	3,0	4,0	30,9
Quantum-Technical (twice)	4,1	5,8	31,1	2,8	4,1	31,1
Helafite Combi (twice)	4,1	5,8	31,0	2,6	4,1	31,0
$N_{90}P_{90}$ (factor A)						
Control (without treatment)	4,5	6,1	31,0	2,5	3,4	31,0
Quantum-Technical	4,7	6,2	31,0	2,5	3,5	31,0
Helafite Combi	4,7	6,1	31,0	2,5	3,5	31,0
Quantum-Technical (twice)	4,8	6,2	31,0	2,7	3,5	31,0
Helafite Combi (twice)	4,8	6,2	31,0	2,7	3,5	31,0
Standard deviation S	*0,45*	*0,52*	*0,14*	*0,34*	*0,36*	*0,17*
Standard error S_x	*0,12*	*0,13*	*0,04*	*0,09*	*0,09*	*0,04*

* the content of nitrate nitrogen was determined by a Grandval Liagu, mobile phosphorus by Machigin, exchange potassium on a semi-lamp photometer)

recorded in variants with the introduction of $N_{90}P_{90}$. There were also no definite differences between the options for different treatments with biologics, because in fact they had not yet been introduced at that time.

At the beginning of the flowering phase of common hyssop (before mowing plants), the nutrient content decreased to the level of the control variant or less. Thus, in the fertilized versions, the content of nitrate nitrogen was 18-27% lower compared to the non–fertilized control, the content of mobile phosphorus decreased by 8-23%, even for the exchange potassium, there was a tendency to decrease. The results obtained indicate an intensive consumption of nutrients by plants of common hyssop in the second half of the growing season for the formation of the highest yield of aboveground mass in fertilized versions, as well as in areas where plants were sprayed with microfertilizers.

Observations of the dynamics of moisture in the meter-long soil layer during the growing season of plants have shown that depending on the level of nutrition, plants use different amounts of moisture to form the crop. This is due to the length of their growing season, the coefficient of water consumption and the size of the crop (Table. 4).

Our analysis of observations of moisture consumption in hyssop plantations showed that in 2021 yr, the main role in providing plants with water was played by atmospheric moisture as 81% of total water consumption. The share of soil moisture in the total water balance was 41 %.

When justifying the effectiveness of technological measures for growing agricultural crops, considerable attention is paid to determining of the water consumption coefficient, which shows the total amount of water spent on the formation of a crop unit. With the improvement of the water regime of plants, water consumption per unit area increases, and for the formation of 1 ton of crop it decreases. Thus, on average, according to the fertilizer background, the lowest water consumption for the formation of a unit of yield of common hyssop flower mass was recorded against the background of $N_{90}P_{90}$ (636 m^3/t), which is lower compared to the background of $N_{45}P_{45}$ by 212 m^3/t and compared to the non-fertilized control by 382 m^3/t. The total water consumption of common hyssop from the soil layer of 0-100 cm was 4625 m^3/ha.

Studies have shown (Table 5) that when growing common hyssop while observing the irrigation regime of 80-70-70% HB, the yield of raw materials in absolutely dry weight was 5.75 t/ha (the average for the experiment). In the control version, without fertilizers, this indicator was the lowest, in particular, the yield here was 3.90 – 6.24 t/ha, depending on the treatment with microfertilizers.

Improvement of the soil nutrient regime and treatment of plantings with microfertilizers contributed to better development of common hyssop plants – its yield increased by 0.52 – 1.68 t/ha compared to the non-fertilized control. This increase was most significant when plants were treated in the branching and budding phases with Combi Helafite against the background of $N_{90}P_{90}$ – in this variant, the dry weight yield of hyssop was 7.92 t/ha. So, to form the yield of common hyssop raw materials by 8.0 t/ha, it is enough to grow a crop using an irrigation regime of 80-70-70% HB

Table 4

Effect of mineral fertilizers and biologics on the water balance in common hyssop plantings (average for 2020-2021 yrs)

Treatment with microfertilizers	Moisture reserves at the beginning of vegetation in the layer 0-100 cm, m^3/ha	Precipitations, m^3/ha	Watering, m^3/ha	Moisture reserves at the harvesting in the layer 0-100 cm, m^3/ha	Total water consumption, m^3/ha	Water consumption coefficient, m^3/t
Control						
Control	1340	3730	100	545	4625	1186
Quantum-Technical	1340	3730	100	545	4625	1046
Helafite Combi	1340	3730	100	545	4625	1032
Quantum-Technical (twice)	1340	3730	100	545	4625	952
Helafite Combi (twice)	1340	3730	100	545	4625	934
$N_{45}P_{45}$						
Control	1340	3730	100	545	4625	990
Quantum-Technical	1340	3730	100	545	4625	871
Helafite Combi	1340	3730	100	545	4625	849
Quantum-Technical (twice)	1340	3730	100	545	4625	780
Helafite Combi (twice)	1340	3730	100	545	4625	771
$N_{90}P_{90}$						
Control	1340	3730	100	545	4625	741
Quantum-Technical	1340	3730	100	545	4625	653
Helafite Combi	1340	3730	100	545	4625	605
Quantum-Technical (twice)	1340	3730	100	545	4625	588
Helafite Combi (twice)	1340	3730	100	545	4625	584

Table 5

Influence of mineral and microfertilizers on the yield and quality of common hyssop raw materials (average for 2020-2021 yrs)

Treatment with microfertilizers (factor B)	Yield, t/ha	Essential oil content, %	Conditional oil yield, kg/ha
Control (factor A)			
Control (without treatment)	3,90	0,85	33,15
Quantum-Technical	4,42	0,90	39,78
Helafite Combi	4,48	0,91	40,77
Quantum-Technical (twice)	4,86	0,94	45,68
Helafite Combi (twice)	4,95	0,98	48,51
$N_{45}P_{45}$ (factor A)			
Control (without treatment)	4,67	0,92	42,96
Quantum-Technical	5,31	1,00	53,10
Helafite Combi	5,45	0,99	53,96
Quantum-Technical (twice)	5,93	1,05	62,27
Helafite Combi (twice)	6,00	1,08	64,80
$N_{90}P_{90}$ (factor A)			
Control (without treatment)	6,24	0,99	61,78
Quantum-Technical	7,08	1,04	73,63
Helafite Combi	7,64	1,05	80,22
Quantum-Technical (twice)	7,86	1,11	87,24
Helafite Combi (twice)	7,92	1,12	95,04
HIP_{05}, factor A	0,31	0,068	5,38
factor B	0,26	0,073	5,22
Interaction of AB	0,53	0,094	8,14

Table 6

Economic efficiency of common hyssop growing (average for 2020-2021 yrs)

Treatment with microfertilizers	Conditional oil yield, kg/ha	Production costs, thousand UAH / ha	Conditional net profit, thousand UAH/ha	Cost price, thousand. UAH/kg inflorescences	Profitability, %
Control					
Control (without treatment)	33,15	21,134	15,331	5,42	72,5
Quantum-Technical	39,78	22,940	20,818	5,19	90,7
Helafite Combi	40,77	23,180	21,667	5,17	93,5
Quantum-Technical (twice)	45,68	23,800	26,448	4,90	111,1
Helafite Combi (twice)	48,51	25,230	28,131	5,10	111,5
$N_{45}P_{45}$					
Control (without treatment)	42,96	24,509	22,747	5,25	92,8
Quantum-Technical	53,10	26,500	31,910	4,99	120,4
Helafite Combi	53,96	26,790	32,566	4,92	121,6
Quantum-Technical (twice)	62,27	27,410	41,087	4,62	149,9
Helafite Combi (twice)	64,80	28,865	42,415	4,81	146,9
$N_{90}P_{90}$					
Control (without treatment)	61,78	27,884	40,074	4,47	143,7
Quantum-Technical	73,63	29,990	51,003	4,24	170,1
Helafite Combi	80,22	30,262	57,980	3,96	191,6
Quantum-Technical (twice)	87,24	30,982	64,982	3,94	209,7
Helafite Combi (twice)	95,04	32,240	72,304	4,08	224,3

against the background of $N_{90}P_{90}$ and twice treat the plants with a complex specialized, universal microfertilizer Helafit Combi.

According to the results of experimental studies, plants in all variants of the experiment showed an absolutely expected result in terms of oil content – the higher the productivity of plants, the higher the yield of essential oil as a percentage. In the control version, raw materials with an essential oil content of 0.92 % (average for nutrition modes) were grown without treatment with a complex specialized, universal microfertilizer. The introduction of microfertilizers contributed to an increase in this indicator by 0.06 – 0.14 %. The maximum indicator of the essential oil content was found in plants grown under the $N_{90}P_{90}$ diet against the background of applying Helafite Combi (twice), where it was 1.12 %.

The same trend continued for the release of essential oil from absolutely dry bio-raw materials. Thus, the plants in the control group had an average conditional essential oil yield of 45.96 kg/ha. This indicator in the variant with top dressing Helafite Combi (twice) was the highest on all fertilizer backgrounds. So, without fertilization, it was 48.51 kg/ha, against the background of $N_{45}P_{45}$ it was 64.80 kg/ha, against the background of $N_{90}P_{90}$ it was 95.04 kg/ha. The conditional yield of essential oil from plants treated with quantum technology was higher than the control and it reached 39.78-87.24 kg. The economic efficiency of growing common hyssop is shown in Table 6.

These data indicate that the highest profitability of 224.3% and a conditional net profit of 72,304 thousand UAH/ha were obtained when growing common hyssop against the background of $N_{90}P_{90}$ and double treatment of plants with Helafite Combi. The lowest cost of 1 kg of inflorescences of common hyssop (3.94 UAH/kg) was observed on the variant with double use of Quantum-Technical microfertilizers.

Conclusions. So, as a result of our research, the most developed plants of common hyssop were recorded against the background of applying mineral fertilizers with a dose of $N_{90}P_{90}$ and treating plants in the branching and budding phases with a complex specialized, universal Microfertilizer Helafite Combi. In this variant, the largest number of stems per plant was counted (59 PCs. the height of the plants was 71.4 cm, the diameter of the Bush was 66 cm, and the water consumption for the formation of a unit of yield of flower mass was the lowest (584 m^3/t). The yield of hyssop at the same time was 7.92 t/ha, the yield of essential oil was 95.04 kg/ha, profitability reached 224.3% and conditionally net profit was 72,304 thousand UAH/ha at the cost of 1 kg of essential oil as 339 UAH.

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Коваленко О.А. Елементи живлення гісопу лікарського за краплинного зрошення на Півдні України

Мета. Стаття присвячена висвітленню результатів наукових досліджень, проведених впродовж 2020–2021 рр., метою яких було встановити вплив екологічних і агротехнічних умов вирощування на продуктивність культури гісопу лікарського (*Hyssopus officinalis* L.) за краплинного зрошення на чорноземі південному Степу України, а також розробка, наукове обґрунтування і впровадження агротехнічних прийомів їх вирощування для південного регіону України. **Методи:** загальнонаукові (діалектичний – спостереження за динамікою росту і розвитку культури; метод гіпотез – схема досліду; метод аналізу – вивчення об'єкту досліджень; метод синтезу – формування висновків, рекомендацій виробництву; метод абстрагування – теоретичне узагальнення досліджень; розрахунковий метод – встановлення економічної і енергетичної ефективності заходів) та спеціальні (польовий метод – вивчення взаємозв'язку об'єкта з біотичними та абіотичними факторами в конкретних умовах зони проведення досліджень; лабораторні методи: морфофізіологічний – біометричні параметри рослин; хімічний – хімічний склад зерна та ґрунту; фізичний – фізичні показники ґрунту та насіння; статистичні методи: порівняльно-розрахунковий – економічна ефективність технологій вирощування. Для узагальнення і обробки експериментальних даних застосовували статистичний, розрахунковий та порівняльно-обчислювальний методи: дисперсійний, кореляційний та регресійний аналізи. **Результати досліджень.** В умовах посушливого клімату Миколаївської області і коливань температури за роками, важливим напрямком інтродукції та підвищення продуктивності ефіроолійних культур є використання зрошення та елементів живлення. Так, за краплинного способу зрошення та обробки насаджень біопрепаратами створюються оптимальні умови для росту і розвитку Hyssopus officinalis L. Найбільш розвинуті рослини гісопу лікарського були зафіксовані на фоні $N_{90}P_{90}$ та обробки рослин у фази гілкування та бутонізації Хелафітом комбі. У цьому варіанті нараховувалося найбільша кількість стебел на одній рослині (59 шт.), висота рослин становила 71,4 см, діаметр куща – 66 см, а витрати води на формування одиниці врожаю квіткової маси були найменшими (584 $м^3$/т). Урожайність гісопу за кращого варіанту становила 7,92 т/га, вихід ефірної олії – 95,04 кг/га, рентабельність сягала 224,3% і умовно чистий прибуток – 72,304 тис. грн/га при собівартості 1 кг ефірної олії – 339 грн. **Висновки.** За результатами досліджень рекомендовано виробництву за вирощування на краплинному зрошенні гісопу лікарського сорту Маркіз на чорноземах південних Степу України з метою підвищення продуктивності, якісних та економічних показників застосовувати мінеральні добрива дозою $N_{90}P_{90}$ та проводити дворазове позакореневе підживлення препаратом Хелафіт комбі у фази гілкування та бутонізації культури.

Ключові слова: гісоп лікарський, краплинне зрошення, мінеральні добрива, комплексні спеціалізовані, універсальні мікродобрива, врожайність, якісні показники, економічна ефективність.

Kovalenko O.A. Elements of nutrition of *Hyssop officinalis* on drip irrigation in the South of Ukraine

Purpose. The article is devoted to highlighting the results of scientific research conducted during 2020–2021, the purpose of which was to establish the influence of ecological and agrotechnical growing conditions on the productivity of the medicinal hyssop (*Hyssopus officinalis* L.) culture under drip irrigation on the black soil of the southern Steppe of Ukraine, as well as the development, scientific justification and implementation of agrotechnical methods of their cultivation for the southern region of Ukraine. **Methods:** general scientific (dialectical – observation of the dynamics of growth and development of culture; method of hypotheses – scheme of research; method of analysis – study of the object of research; method of synthesis – formation of conclusions, recommendations for production; method of abstraction – theoretical generalization of research; calculation method – establishment of economic and energy efficiency of measures) and special (field method – study of the relationship of the object with biotic and abiotic factors in the specific conditions of the research area; laboratory methods: morphophysiological – biometric parameters of plants; chemical – chemical composition of grain and soil; physical – physical soil and seed indicators; statistical methods: comparative-calculation – economic efficiency of cultivation technologies. Statistical, calculation and comparative-calculation methods were used to generalize and process experimental data: dispersion, correlation and regression analyses. **Research results.** In the conditions of the arid climate of the Mykolaiv region and temperature fluctuations over the years, an important direction for introducing and increasing the productivity of essential oil crops is the use of irrigation and nutrition elements. Thus, the drip method of irrigation and treatment of plantings with biologics creates optimal conditions for the growth and development of *Hyssopus officinalis* L. The most developed plants of common hyssop were recorded on the background of $N_{90}P_{90}$ and treatment of plants in the phases of branching and budding with Combi Helafite. In this variant, the largest number of stems per plant was counted (59 PCs. The height of the plants was 71.4 cm, the diameter of the Bush was 66 cm, and the water consumption for the formation of a unit of yield of flower mass was the lowest (584 m^3/t). The yield of hyssop for the best option was 7.92 t/ha, the yield of essential oil was 95.04 kg/ha, profitability reached 224.3% and conditionally net profit was 72,304 thousand UAH/ha at the cost of 1 kg of essential oil as 339 UAH. **Conclusions.** According to the results of the research, it is recommended for the production of drip-irrigated hyssop of the medicinal Marquis variety on the chernozems of the southern steppes of Ukraine, in order to increase productivity, quality and economic indicators, to use mineral fertilizers with a dose of $N_{90}P_{90}$ and to carry out two foliar feedings with the drug Helafit combi in the phase of branching and budding of the culture.

Key words: common hyssop, drip irrigation, mineral fertilizers, complex specialized, universal microfertilizers, yield, quality indicators, economic efficiency.