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FEATURES OF SUNFLOWER OF STRAWBERRY DEPENDING ON ADAPTIVE GROWING TECHNOLOGIES

ABSTRACT:

When growing strawberries, we must pay special attention and make the transition to less harmful technologies in order to obtain environmentally friendly products. This position minimizes the possibility of using mineral fertilizers or inorganic protection in favor of organic methods or substances of biological nature that do not have a harmful aftereffect. This is of particular importance when mulching the soil with various materials, as the most advanced method of increasing the productivity of strawberry stands. Therefore, the selection of the most adapted and improved technologies for growing environmentally friendly strawberries determines the purpose of our research. The highest results were achieved in the growth productivity of strawberries when it was grown using environmental technology with mulching the soil together with black agrofibre and straw. Moreover, the average results of the assimilation surface of strawberries amounted to 28.4 thousand m2 / ha for the Dukat variety, and 29.1 thousand m2 / ha for the Malvina variety. Such results practically exceeded the data of the control variant twice. A significant increase in the number of tendrils on the strawberry bushes was about 30%. At the same time, the number of peduncles in the bushes increased by 15%. On the whole, according to the experiment, the results for strawberry varieties varied within 6.7–7.3 pcs / bush. A significant difference compared with the control option was 1.4–1.8 pcs / bush. We have achieved a 35% increase in strawberry berries when mulching the soil with black agrofibre together with straw as part of environmental cultivation technology. On average, over the years of research, the strawberry yield for the Dukat variety was 21.5 t / ha, and for the Malvina variety - 15.5 t / ha. At the same time, commodity quality of berries increased to 93.4%. The use of intensive (traditional) and biological technologies for growing strawberries, in terms of productivity, was significantly inferior to environmental technology, like other mulching materials inferior to black agrofibre.

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INTRODUCTION.

Throughout the history of economic thought and practice, man's production activity has been significantly different and still differs from the laws of nature. In an effort to satisfy their unlimited needs in the conditions of limited natural resources and the natural living environment, man, having created for himself as a result of technological progress the illusion of independence from nature and at the same time remaining part of nature, forgot that nature is the primary source of existence of life. It is impossible to ignore this indisputable fact. It should not be forgotten that one of the most important aspects of a sustainable development strategy is to fill the world (including national) economy with new - environmental - content.

Strawberry cultivation is a major global berry business. Its efficiency depends on the technology of cultivation and varies insignificantly over the years [1]. Of particular importance is the shift to less harmful technologies towards the production of environmentally friendly products. This condition practically negates the possibility of applying mineral fertilizers or inorganic protection in favor of organic methods or substances of biological nature, which have no harmful effects [2]. At the same time, there are questions of effectiveness of such agro-measures on biologically active chernozem soils of the Right-bank Forest Steppe of Ukraine [3]. This is of particular importance for mulching the soil with different materials, as the most common technique for improving the productivity of strawberry plantations [4].

Analysis of recent research and publications. In recent years, most elements of intensive strawberry cultivation technologies related to fertilization, irrigation, planting, or soil retention have been investigated and studied [5]. The transition to the cultivation of environmentally friendly production of berries requires the selection of the most environmentally friendly methods and agro-measures of its cultivation and their combination in separate technologies. Therefore, the selection of the most adapted and improved technologies for the cultivation of eco-friendly strawberries is a key task today in this direction, which determines the relevance and purpose of our research.

Research methodology. Research on the cultivation of strawberries related to the cultivation of environmentally friendly products was conducted on the research field of the training production department of Uman Horticulture University in 2018-2019. The study of the planned questions was carried out on two pomologic varieties of strawberries - the middle-ripe Ducat and the late-ripe Malvin. Plants are planted according to the scheme 90 + 40x30 cm in the first decade of April 2018 seedlings of refrigerated storage - "frigo", class A +. The experimental site has a small slope (up to 3º) of southern exposure with a randomized location of the sites in triple repetition. The implementation of the research work is related to the state budget theme of Uman NUS "Development

and implementation of adaptive technologies for growing strawberries and comparing their economic efficiency" (GDR 0118U003749).

Soil - black soil heavy loam on the forest with a humus content of 3.3%, depth of humus horizon up to 90 cm and deep occurrence of carbonates and groundwater - at a depth of 12 m. Reaction of soil solution of weak acid - pH = 6.2–6 , hydrolytic acidity is 2.0 mg-eq / 100 g of soil, and the sum of absorbed bases is 27.5 mg-eq / 100 g of soil. Nitrogen soil content (by nitrification at 14 days composting) - 23.1 mg / kg P205 - 302 and K20 - 264 mg / kg (by Egner - Rome - Domingo method).

The scheme of experience includes the most common technologies for growing strawberries, including the ecological direction. They provide the necessary system of agro-measures for mulching the soil with different materials. Among the technologies of cultivation of strawberries used intensive (provided for the system of traditional agro-measures, including the use of mineral fertilizers, pesticides, etc.), biological (including optimization of soil nutrition, plant growth and development, protection against diseases and pests using drugs exclusively biological, natural, ecological, natural (the essence was to maximize the adaptation of intensive, traditional technology to biological, which was to maximize the introduction into traditional technology of cultivation of strawberries elements of biological technology). Intensive technology has been adopted for control, as the most widespread and traditional in most industrial plantations. Soil retention options included mulching the soil in rows of strawberries with crushed cereal straw, 40 μm thick black plastic film and 60 g / m2 black agro-fabric. Non-mulched soil was taken for control. In the aisles before flowering in all experimental areas, except the control spread cereal straw. The diameter of the openings for planting plants in the film and agro-fabric was 8 cm. Soil moisture was maintained by drip irrigation at 80% of the lowest moisture capacity (HB) in the fruiting phase and 70% HB after it. In appropriate phases of strawberry growth, the area of leaf area, number of horns and peduncles, yield and its marketable quality were determined [6, 7, 8].

THE NEED FOR GREENING AGRICULTURAL PRODUCTION.

The development of mankind in the last century was focused on the rapid growth of the economy, which led to an unprecedented scale of adverse impact on the biosphere. There were contradictions between the growing needs of the global community and the limited capacity of the biosphere to meet them. That is why the problem of greening began to be considered globally, and became an important part of the leading concept of social development - the concept of sustainable development.

We agree with V.Ya.Shevchuk's statement that the idea of "green revival" and "green growth", which envisages the development of alternative energy

based on renewable energy sources, has matured in the world; application of environmentally friendly production technologies; rational use of nature; conservation of the environment [9]. In his view, it will help to harmonize the relationship between nature and man, improve the environmental situation and move to a new level of development of society.

It must be acknowledged that the ecological crisis has accompanied humanity in recent decades. Without it, the sustainable development of society is impossible. Moreover, there is a risk of deepening existing crisis trends, which could lead to environmental disasters and the loss of the planet for future generations. Quite often, economic systems focus on short-term problems, ignoring long-term and environmental side effects. And in general, human nature, for genetic reasons, does not lead him to worry about the future, but only about current survival. Kirilenko IG in his studies states that "over the past 25 years, 300 million hectares of forest have been cut down; over a quarter of the fauna species has disappeared forever; ocean area, unsuitable for most species, increased by 70%; fresh water per capita has decreased by 26%" [10]. Only in the last 20 years of the twentieth century energy was used 1.2 times more than it was obtained in the world before 1980 [11].

The importance of environmental issues can be confirmed by impressive numbers. Thus, during the twentieth century. the consumption of fossil fuels per person increased 12 times and the consumption of material resources - 34 times. According to the latest figures released by the International Energy Agency, fossil resources account for 80% of the energy market, of which 60% are coal and oil. These resources provide almost the entire set of basic needs of the Earth's population: electricity, transport, heating. The remaining 20% is from renewable resources (wind, water, land, biomass) and nuclear energy. It should also be noted that 11.5% of the planet's land is actively used for human needs. Over time, this figure will increase, as farmers will need to develop more land to meet the needs of a growing population. This will have serious environmental consequences.

An important problem of our time is also the emission of CO2 into the atmosphere, which leads to the emergence of the so-called "greenhouse effect". According to the European Commission, based on an analysis of the Emission Database for Global Atmospheric Research (EDGAR) [12] and the EU's Trends in global CO2 emissions: 2016 Report. European Commission" [13] in 2015, global GHG emissions from 2010 to 2015 increased by 7% and exceeded 36 billion tonnes of CO2. Indisputable leadership in emissions belongs to China. With a population of 1.4 billion people, in 2015, CO2 emissions in the country amounted to 10.641 billion tons. China is followed by a significant gap by volume, the United States with 320 million inhabitants with a volume of 5.172 billion tons. third place belongs to the EU - 590 million people and 3.469 billion tons of CO2 emissions. According to Global Carbon Project experts, the dynamics of emissions in the coming years will depend on

the long-term national strategies for low-carbon development of energy and climate change identified in line with the Paris Agreement's temperature targets.

Overall, the European Union's public opinion poll on the environment, conducted by Special Eurobarometer in 2014, showed that a healthy and safe environment is important for 53% of citizens and important for their quality of life for 42%. That is, only 5% of the EU population do not consider environmental problems to be of personal concern to them [14]. The above forces humanity to immediately address environmental problems in order to preserve humanity.

ADAPTIVE TECHNOLOGIES OF CULTIVATION OF STRAWBERRIES AS A DIRECTION OF GREENING OF AGRICULTURE.

On the basis of the conducted researches it is necessary to notice about change of productivity of strawberries depending on technologies of its cultivation and mulching of soil (table 1).

A comparative evaluation of the soil mulching techniques used indicates the highest growth performance of strawberries when used for this black agro-fabric in combination with straw. The average annual area of leaf area for the Ducat variety fluctuated within 22.1–28.4 thousand m2 / ha, and for the Malvin variety - 23.7–29.1 thousand m2 / ha. According to the statistical data processing, the difference with the areas of non-mulched soil was significant and amounted to 8.4–10.6 thousand m2 / ha and 6.8–9.9 thousand m2 / ha, respectively. For soil mulching with a black film in combination with straw, the growth of the assimilation surface was slightly smaller than the previous variant, but significantly exceeded the values of the control variant by an average of 45-50% for both experimental varieties of strawberries.

Table 1

Growing productivity of strawberry varieties depending on the technology of growing and mulching soil in the planting (average for 2018-2019)

Growing technology	Soil mulching	Ducat		Malvinas	
		Area of leaf surface, thousand m2 / ha	Number of horns, pieces / bush	Leaf area, thousand m2 / ha	Number of horns, pieces / bush
Intensive (control)	Without mulching (control)	15,8	9,2	17,4	8,3
	Straw	20,6	11,3	22,8	9,5
	Black film + straw	23,4	12,7	26,1	11,7
	Black agro-fabric + straw	25,2	13,8	27,1	12,4
Ecological	Without mulching (control)	17,8	10,7	19,2	9,1
	Straw	24,2	12,6	25,6	10,8
	Black film + straw	26,9	14,4	27,7	12,5
	Black agro-fabric + straw	28,4	15,2	29,1	13,7

Table 1 (continued)

Biological	Without mulching (control)	13,7	8,2	14,9	7,4
	Straw	16,9	9,4	18,3	8,6
	Black film + straw	20,5	11,5	22,2	10,3
	Black agro-fabric + straw	22,1	12,2	23,7	11,1
HIP_{05}		*1,9*	*1,3*	*1,8*	*1,2*

** - author's development*

The smallest increase in leaf area among mulching variants was obtained by using straw for this purpose. Exceedance of the indices on the areas with non-mulched soil was 3.2–6.4 thousand m2/ha for both varieties of strawberries and was reliable. The data obtained indicate a significant increase in the assimilation surface of strawberry stands for mulching soil with any material used for this purpose.

Among the technologies used for cultivation of strawberries, the highest average indicator of the area of the leaf surface was the variant with environmental technology. During the years of research, the indicator for the Ducat variety was 24.3 thousand m2/ha, and the Malvin variety - 25.4 thousand m2 / ha. When comparing the indicators of intensive and ecological technologies of cultivation of strawberries, the last advantage with a difference in the area of the assimilation surface of 2-3 m3 / ha was a significant advantage. This indicates a positive effect of the replacement or saturation of traditional technology with the techniques of biologization. In contrast, the cultivation of wild strawberries by biological technology alone has reduced the growth activity of plants, and in particular the area of leaf area. With this technology, the area of assimilation surface of strawberries for Ducat and Malvin varieties was 18.3 and 19.8 thousand m2 / ha, respectively, and was significantly smaller than the indicator with intensive technology by 17%. This indicates that the conditions of strawberry growth are insufficiently provided by methods of biological nature only.

A similar pattern of formation of growth productivity of strawberries was obtained by forming a perennial part of bushes - horns. As a rule, strawberry bushes increase the number of horns with age, but in our studies this was facilitated by mulching the soil in the planting. Significantly higher indices of horns for Ducat and Malvin varieties were obtained by mulching the soil with black agro-cloth combined with straw. On average, over the years it varied from 11.1 to 15.2 pcs / bush for both varieties and significantly exceeded the indicator from non-mulched soil - 7.4-10.7 pcs / bush. This indicates the most intensive increase in the stem mass of strawberries due to more favorable growth conditions.

Similar figures were obtained for mulching the soil with a black film in combination with straw - 10.3–14.4 pcs / bush on average for both varieties. A further reduction in the number of horns in the strawberry bushes was obtained by mulching the soil with straw only. In general, all soil mulching variants significantly exceeded non-mulched soil by the number of horns.

The formation of horns was more intensive than the ecological technology of growing strawberries. During the years of research, the average values for varieties of Dukat and Malvin strawberries were 11.5–13.2 pcs / bush, which significantly exceeded the indicator from traditional technology by 1.0–1.6 pcs / bush. Similar to the formation of the leaf surface of strawberries, significantly smaller growth rates of the bush were obtained by biological technology. According to this technology, the number of horns on the bushes of strawberries of the experimental varieties was 9.4-10.3 pcs / bush, which indicates a delay in their growth compared to other technologies.

As a whole, the largest area of assimilation surface of strawberries and number of horns on bushes was obtained by ecological technology of its cultivation with mulching of soil by black agro-cloth and straw. For the Ducat variety, the figures were 28.4 thousand m2 / ha and 15.2 units / bush, respectively, and for the Malvin variety - 29.1 thousand m2 / ha and 13.7 units / bush. Such averaged data over the years indicate high productivity of strawberry plants.

The use of different technologies for growing strawberries in combination with mulching the soil with different materials caused a change in the generative productivity of plants. It includes the number of flowering bushes formed by the bushes and the yield of plantations (Table 2). By the number of flower stalks among the mulching materials, the advantage was in favor of the combined use of black agro-cloth and straw. Throughout the experiment, the indices for strawberry varieties ranged from 6.6 to 7.3 pcs / bush (Ducat) and 5.8 to 6.7 pcs / bush (Malvinas).

The difference from the non-mulched plots averaged 1.4–1.8 pcs / bush for both varieties and was significant for NIR05 = 0.5. Among other soil mulching variants, the number of peduncles was smaller but also significantly higher than the control variant. For mulching the soil with black film in combination with straw, the number of peduncles was on average 15–20% higher than that of non-mulched soil, and for mulching only straw - 6–11%.

A comparative evaluation of the strawberry cultivation technologies used indicates the highest number of flower stalks generated by environmental technology. The average number of these organs for the Ducat variety was 6.7 pcs / bush, and for the Malvin variety - 6.0 pcs / bush, which significantly

exceeded the intensive technology index by 0.6 and 0.7 pcs / bush, respectively (NIR05 = 0.5). In biological technology, these indicators were 0.3–0.4 pcs / bush smaller, although this difference was not always significant. The obtained pattern was traced on both experimental varieties of wild strawberries.

Table 2

Generative productivity of strawberry varieties depending on the technology of cultivation and mulching of soil in planting (average for 2018-2019)

Growing technology	Soil mulching	Ducat		Malvinas	
		Number of peduncles pcs / bush	Crop capacity, t / ha	Number of peduncles pcs / bush	Crop capacity, t / ha
Intensive (control)	Without mulching (control)	5,2	12,7	4,4	10,2
	Straw	5,8	15,9	4,9	11,7
	Black film + straw	6,4	18,4	5,6	12,8
	Black agro-fabric + straw	6,9	19,7	6,2	14,7
Ecological	Without mulching (control)	6,1	13,9	5,2	10,9
	Straw	6,5	16,7	5,8	12,2
	Black film + straw	7,0	20,2	6,4	13,8
	Black agro-fabric + straw	7,3	21,5	6,7	15,5
Biological	Without mulching (control)	4,9	9,8	4,2	9,7
	Straw	5,4	12,7	4,6	10,9
	Black film + straw	6,1	14,4	5,1	12,1
	Black agro-fabric + straw	6,6	15,9	5,8	13,3
HIP_{05}		*0,5*	*1,8*	*0,4*	*1,2*

** - author's development*

The main indicators of productivity of strawberries include crop yields. The change in its indicator was influenced by all the measures applied in the studies. The highest yields were observed for strawberry varieties for mulching the soil in black agroplating combined with straw. however, the two-year average reached 21.5 t / ha for the Ducat variety and 15.5 for the Malvin variety. Significant excess of indicators from non-mulched soil was 7.6 t / ha and 4.6 t / ha of berries, respectively. Quite high was the indicator for mulching with a compatible combination of black film and straw. In this case, a significant excess of the control variant reached an average of 30% for both varieties. According to the statistical calculations, the difference between the black agro-fabric and the film variants was not significant.

Mulching the soil with straw also helped to increase the yield of strawberries by 1.2–3 t / ha for both varieties, but this difference was on the verge of reliability and less than the variants with black film and agro-fabric. Similar tendency of change of productivity indicators is received both on all variants of experience, and on varieties.

The highest level of yield of strawberry varieties was obtained by ecological cultivation technology. For the Ducat variety, the average was 18.1 t / ha, and the Malvin variety - 13.1 t / ha. The excess of intensive technology was 1.5 t / ha and 0.7 t / ha, either within the margin of error or at the confidence limit. The transition of strawberries to biological technology has led to a decrease in the average yield of strawberries by 0.9–3.5 t / ha. Although this difference was not always significant, it does not indicate that the optimal conditions for growth and development of strawberries are incomplete.

Analyzing indicators of growth and fruiting of strawberries, it should be noted about a similar pattern of change in productivity of the plantation, depending on the methods of cultivation used throughout the experience. In the context of years of research, the plants of the second year had higher productivity, which is obviously related to the age growth of the bushes. When comparing the studied varieties with each other with higher generative productivity, and in general, the yields of Dukat varieties were noted. In contrast, the Malvin variety formed a larger assimilation surface, indicating a predominance of growth over fruiting.

For successful cultivation of strawberries an important indicator is the commercial quality of the obtained berries (Fig. 1). In our studies, the highest commercial quality had plants of the variety Malvin. It averaged 91.9% over the years and 4.6% significantly exceeded the Dukat variety.

Among the technologies used, the highest quality of berries was ecological. The amount of commercial varieties of berries was 91.6% over the two-year study period. Compared to the variant where intensive technology was used, the difference was on the verge of error of the experiment and was 4.1%. Compared to intensive technology, the quality of the berries was significantly lower by 2.8% than the biological technology. ÏÍ the average was 84.7%. Such a feature of forming the quality of berries is associated with the generosity of both experimental varieties of strawberries, especially in the early years of fruiting, which is a key element in the commodity evaluation of the crop.

The mulching of the soil by all the materials used contributed to a significant increase in the commercial quality of the berries. Among them, most commercial berries were obtained by mulching the soil with black film and agro-cloth with straw. These two variants had 91.8 - 93.4% of marketable berries and were not significantly different from each other. Black agro-fabric prevailed. The peculiarity of these variants was the purity and insignificant damage of the berries to diseases. Significantly less analyzed was obtained by mulching the soil with only straw - 87.1%, which is due to the presence of more berries with rot.

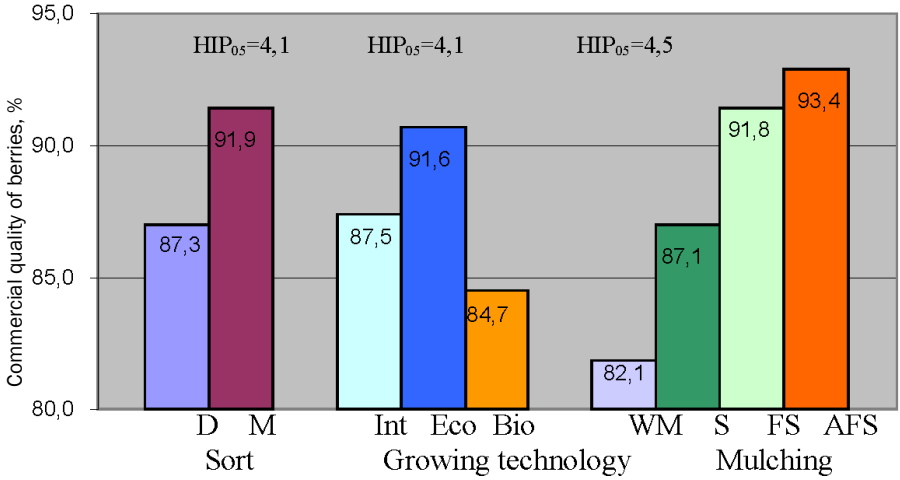

Fig. 1 **Amount of commercial varieties of strawberry berries depending on the technology of cultivation and mulching of the soil (average data for 2018 - 2019)**

Sorts: D - Ducat; M - Malvinas;
Growing technology: Eco - ecological; Int - intensive; Bio - biological;
Soil mulching: WM - no mulching; C - straw; FS - a film with straw; AFS - Agro fabric with straw.

CONCLUSION.

By mulching the soil in the strawberry planting with black film and agro-fabric, the leaf area of the strawberries is more intensively formed by 45 - 50% and the perennial stem part is 30% more intensive. The highest generative productivity of strawberries is facilitated by mulching the soil with black agro-cloth in combination with straw. In this case, the flowers are more intensively formed by 15%, and the yield increases by 35%. The highest indicators of growth and generative productivity of strawberries are obtained by the ecological technology of its cultivation. The marketable quality of berries increases to the maximum level - 93.4% when growing strawberries by environmental technology, which involves mulching the soil in conjunction with black agro-cloth and straw.

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