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## **PROSPECTS OF SUNFLOWER GROWING AND THE INFLUENCE OF PLANT DENSITY ON PRODUCTIVITY**

Prospects for sunflower cultivation in different regions of the country are described. Based on the studied literature, it is concluded that among all crops, the sown area of sunflower in Ukraine is one of the largest and ranks second after wheat. Over the past five years, sunflower cultivation has expanded by a quarter, with record production expected. In recent years, the crop is perhaps the most profitable in the field of crop production.

In economic terms, sunflower is not inferior to crops such as wheat, corn, soybeans and is one of the most popular oilseeds not only in Ukraine. Simple cultivation technology and high profitability, growing demand for seeds and sunflower oil, oilcake, both in domestic and world markets, leads to increase of sown areas and crop yields.

It is established that stable yields of sunflower can be obtained by introducing highly efficient varieties and hybrids and intensive cultivation technology, which would maximize the realization of its potential productivity. In terms of seed yield, sunflower hybrids are 20-30%, and in terms of oil content – 15-20% more effective than best zoned varieties. It is possible to increase the production of commercial sunflower seeds in Ukraine without expanding the sown area by creating and implementing more productive hybrids with certain economically valuable features that combine high yield stability with product quality, and by adapting new hybrids and parent forms to the relevant weather conditions, which will increase yields above 4 t/ha. Currently, there is a wide selection of varieties and hybrids of sunflower for growers. Over the past few years, the Register of plant varieties suitable for distribution in Ukraine includes more than 200 hybrids of domestic and foreign selection. This contributes to the expansion of the area of sunflower cultivation in all soil and climatic zones of Ukraine, thus creating an efficient hybrid conveyor.

There has been a rapid increase in the area under sunflower in the western part of the country, where soil and climatic conditions contribute to its unimpeded cultivation.

The results of research conducted in different regions of the country on the effectiveness of the elements of cultivation technology on the productivity of sunflower hybrids are presented.

**Key words:** sunflower, standing density, varieties, hybrids, productivity.

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**Перспективи вирощування соняшнику та вплив густоти стояння рослин на їх продуктивність**

Охарактеризовано перспективи вирощування соняшнику в різних регіонах країни. На основі опрацьованої літератури зроблено висновок, що серед усіх сільськогосподарських культур посівна площа соняшнику в Україні є однією з найбільших і займає друге місце, поступаючись лише пшениці. Протягом останніх п'яти років площі вирощування соняшнику на чверть розширилися, передбачається рекордне його виробництво. Упродовж останніх років культура є чи не найрентабельнішою у галузі рослинництва.

За господарським значенням соняшник не поступається пшениці, кукурудзі, сої та є однією з найпопулярніших олійних культур не тільки в Україні. Нескладна технологія вирощування та висока рентабельність, зростання попиту на насіння та соняшникову олію, макуху як на внутрішньому, так і світових ринках зумовлює зростання посівних площ та підвищення врожайності культури.

Встановлено, що сталі врожаї соняшнику можна одержувати, впроваджуючи високоефективні сорти і гібриди та інтенсивну технологію вирощування, яка б максимально сприяла реалізації його потенційної продуктивності. За врожайністю насіння гібриди соняшнику на 20–30 %, а за олійністю – на 15–20 % переважають кращі районовані сорти. Збільшити обсяги виробництва товарного насіння олійного соняшнику в Україні без розширення посівних площ можливо за створення та впровадження продуктивніших гібридів з певними господарсько цінними ознаками, які поєднують стабільність високої врожайності з якістю продукції, та за рахунок адаптованості нових гібридів і батьківських форм до відповідних погоднокліматичних умов вирощування, що забезпечить зростання врожайності понад 4 т/га. На сьогодні існує широкий вибір сортів та гібридів соняшнику для виробників. За останні декілька років у Реєстр сортів рослин, придатних для поширення в Україні, включено понад 200 гібридів вітчизняної та іноземної селекції. Саме це сприяє поширенню ареалу вирощування соняшнику в усіх ґрунтово-кліматичних зонах України, створюючи цим самим ефективно працюючий гібридний конвєср.

Відзначено стрімке збільшення посівних площ соняшнику на території західної частини країни, де ґрунтово-кліматичні умови сприяють його безперешкодному вирощуванню.

Наведено результати досліджень, проведених у різних регіонах країни, щодо ефективності впливу елементів технології вирощування на продуктивність гібридів соняшнику.

**Ключові слова:** соняшник, густина стояння, сорти, гібриди, продуктивність.

Sunflower is one of the most important oilseeds in the world, as well as the main oilseed crop in Ukraine. The rapid increase in sunflower sown areas is characteristic not only for the Southern regions of Ukraine, but also more and more often we see an increase in their volumes in the Western part of the country, where weather conditions contribute to unimpeded cultivation. In recent years, the crop is perhaps the most profitable in the field of crop production.

Sunflower oil accounts for 98% of total oil production in Ukraine. Compared to other oilseeds, sunflower provides one of the highest oil yield per unit area (average 750 kg/ha in the country) [8, 18, 30]. Ukraine is a recognized world leader in both oil production and exporter. In 2020, exports reached a record high of 6.9 million tons. In the same year, 6.4 million hectares were sown with sunflower.

At present, the special attention of world consumers is focused on the production of oil with a high content of oleic acid, which will be able to compete with olive oil in terms of quality. The latter in turn is characterized by high resistance to oxidation, longer consumption time, versatility of industrial use.

Over the past three years in Ukraine there has been a tendency to increase the share of high oleic hybrids in the total sown area under sunflower. During this period, it increased by 1.4%, and in physical terms the growth amounted to about 110 thousand hectares and occupies 260 thousand hectares [28].

Demand today is formed mainly by EU countries, and in the near future is expected to increase due to the introduction of mandatory labeling of products indicating the source of oil. For sunflower producers in Ukraine, this is a unique opportunity to get additional income from each hectare without additional investments, as well as to insure against fluctuations in product prices [6].

Sunflower oil due to the presence of the most valuable components that are part of it, is widely used for human nutrition. Based on studies of its biochemical composition, it has been proven that it contains such polyunsaturated fatty acids as omega-6 and omega-9. These components have a powerful health effect, protect the human body from atherosclerosis, improve the activity of many vital organs – liver, kidneys, gallbladder. The composition of vitamin F in sunflower oil is characterized by an anticholesterol effect, promotes the dissolution of atherosclerotic plaques, improves metabolism and accelerates metabolic processes [22]. As a food product, sunflower oil is widely used in cooking, baking, for the

manufacture of various confectionery and canned food. It is a major component in the production of margarine. The nutritional value that has a positive effect on human health is due to the high content of polyunsaturated fatty linoleic acid (55-60%), which has significant biological activity and accelerates the metabolism of cholesterol esters in the body. The composition of sunflower oil includes such very valuable components for the human body as phosphatides, sterols, vitamins (A, D, E, K). This oil is widely used in the paint industry, as well as in the manufacture of linoleum, electrical fittings, oilcloth, waterproof fabrics, etc. [22, 25].

The analysis of the researched issues covered in the scientific literature states that among all agricultural crops the sunflower sowing area in Ukraine is one of the largest and takes the second place, second only to wheat.

Among all oilseeds, sunflower ranks first in both area and oil production. It is well known that the southern part of Ukraine is the largest producer of sunflower seeds. Such popularity as the main oil crop here is justified by the fact that it is a typical plant of the steppe zone, but the success of its cultivation is largely determined by environmental conditions, ie weather and climate. Therefore, the prospects of growing sunflowers in climate change have become a topical issue recently [11].

According to biological features, the genus of sunflower *Helianthus* L. includes more than 110 species, of which 100 are perennial and 10 are annual. One of the annual species in the culture is *H. annuus* L. According to the modern classification developed at the Russian Research Institute of Plant Breeding by F. S. Ventslavovich it is divided into two independent species: cultivated sunflower (*H. cultus* Wenz.) and wild (*H. ruderalis* Wenz.) [13, 17].

Sunflower – a short-day plant, very demanding of intense sunlight. At shading growth of plants weakens, small baskets are formed, the stalk is extended, productivity decreases. As it spreads to the north, its growing season lengthens. The duration of vegetation of sunflower varieties and hybrids from sowing to seed ripening in Ukraine is from 80 to 130 days. The best conditions for the development of sunflower in Ukraine are observed on chernozems and chestnut soils of the steppe zone with a neutral or slightly alkaline reaction of the soil solution. In forest-steppe regions, this culture is placed on gray and dark gray soils. Heavy, unstructured soils, as well as light sandy and very acidic soils are unsuitable for it [29].

Currently, there is a wide selection of varieties and hybrids of sunflower for growers. Over the past few years, the Register of Plant

Varieties Suitable for Distribution in Ukraine includes more than 200 hybrids of domestic and foreign selection. This is what contributes to the expansion of the sunflower growing area in all soil and climatic zones of Ukraine, thus creating an efficient hybrid conveyor. The share of precocious hybrids in the Register is increased to 22%, every third hybrid represents an early-ripening group. During the growing season, 16% of hybrids are classified as medium-early, in the group of medium-ripe hybrids – 14%. This stabilizes the level of yield and minimizes the risks associated with growing this crop [4]. Modern varieties and hybrids of sunflower are created on a large selection material, often with the involvement of interspecific hybridization. The result is a pronounced difference in the requirements for growing conditions, which can not be realized by dividing into groups for specific growing areas according to the duration of the growing season. Application of standard, generally accepted for a zone, technologies of cultivation of culture allows to receive mediocre results with sharp fluctuations of productivity in different years. Therefore, obtaining a high yield depends not only on compliance with the technology of cultivation, but also on the level of conformity of the variety or hybrid to the weather conditions of the year [19, 27].

Thus, the main direction of increasing the production of sunflower seeds is the introduction into production of new high-yielding hybrids and intensive technologies for their cultivation. In terms of seed yield, sunflower hybrids by 20–30%, and in terms of oil content by 15-20% predominate the best zoned varieties. It is possible to increase the production of commercial sunflower seeds in Ukraine without expanding the sown area by creating and implementing more productive hybrids with certain economically valuable features that combine high yield stability with product quality, and by adapting new hybrids and parent forms to the appropriate weather and climatic conditions of cultivation, which will increase yields above 4 t/ha.

In order to consolidate a stable share in the production and export of oil on the world market, we also need to take care of the support of Ukrainian originators of varieties and hybrids of sunflower. Among domestic applicants the most productive in this direction is the Institute of Plant Breeding named after V. Yuriev, where a number of high-oleic and palmetin hybrids have been created thanks to cooperation with both Ukrainian and foreign originators. Domestic sunflower hybrids of the Institute of Plant Breeding are characterized by precocity, high yield and fat content of not less than 49–53%, resistance to major diseases [5, 12]. The introduction of new high-yielding varieties, the use of adaptive cultivation technology significantly affect the economic efficiency and competitiveness

of seed production. In order for the Ukrainian economy to rise and our country to gain a stable position on the international market, it is necessary that the domestic oil industry not only reaches a level that meets international standards, but is also able to exceed it [20].

For farms of different sizes and specialization in a market economy, increasing the yield of sunflower seeds is possible by creating and introducing into production new varieties and hybrids with high agroecological adaptability, precocity, genetic resistance and tolerance to powdery mildew, different races of wolfberry, phomopsis, white and gray rot. In recent years, the world market of sunflower seeds, along with varieties, more and more attention is paid to the selection of new hybrids with high productivity potential, their inclusion in the State Register of Plant Varieties suitable for distribution in Ukraine and recommended for widespread use in production [10].

In terms of economic importance, sunflower is not inferior to such crops as wheat, corn, soybeans and is one of the most popular oilseeds not only in Ukraine. Simple cultivation technology and high profitability, increasing demand for seeds and sunflower oil, oilcake, both in domestic and world markets, leads to increased sown areas and increased crop yields. However, according to scientific research and experience of producers at the production level, the genetic potential of sunflower is not realized by 50-70% [2, 21].

In the complex of agrotechnical measures of sunflower cultivation, on which the harvest and its quality depend, the density of standing of plants occupies an important place. A significant harvest can be obtained due to high individual productivity and the maximum allowable density of stems in a particular area of cultivation [15, 26].

Optimal standing density is one of the most important prerequisites for high and high-quality sunflower seed yields. To achieve it, the correct choice of seeding rate is of paramount importance. The higher the standing density, the smaller the size of the baskets and vice versa. With an uneven density of standing plants lie down, there is an uneven maturation of large and small baskets, which is the cause of losses and difficult harvesting, and as a result, energy costs increase significantly. At low crop density, the diameter of the baskets is larger and the seeds are larger, which to some extent can compensate the shortage of a sparse number of plants in the area. However, large baskets ripen more slowly, and large seeds are damaged during threshing and easily cleaned from the wrapper [9, 23]. This increases the proportion of volatile acids in the oil and reduces its quality. Crop density may need to provide high yields per unit area in specific soil and

climatic conditions, as too dense crops consume large amounts of water and nutrients to form the vegetative mass of plants. With a shortage of water and nutrients, this causes a sharp shortage of sunflower seeds [7, 24].

However, too low density of plants in the crop does not ensure the efficient use of moisture and nutrients to form a seed crop, and the likelihood of weed infestation increases. Therefore, the standing density may be different depending on soil and climatic conditions, and the more favorable these conditions are (especially with respect to moisture), the higher the standing density may be and vice versa [16, 23].

In the initial stages of growth and development, when the sunflower forms the root system and leaf surface, the plants do not respond to thickening. However, with the gradual development comes the moment when the growth of some plants begins to complicate the ontogenetic processes of others, which leads to increased competition in the agrocenosis, reduced viability and productivity of plants [14].

Scientific research has shown that the level of crop yields, including sunflower, largely depends on the density of plants, which can vary in specific soil and climatic conditions in a very wide range. Optimal is the density of standing, which ensures not only the normal development of each plant, but it is possible to obtain the highest level of yield per unit area. The optimal degree of thickening of sunflower crops may also vary depending on the genetic properties of varieties or hybrids and their response to certain climatic factors, weather conditions, and above all, relative to the wet supply of plants [14].

According to research by the Poltava State Agrarian Academy, the stocking density of Jason sunflower hybrids in the range from 30 to 80 thousand/ha (with fluctuations – 10 thousand/ha) had almost no effect on the development phases and duration of the growing season. There is a tendency to a slight increase in the duration of the growing season by 1-5 days with an increase in the density of standing to 70-80 thousand/ha. At higher standing densities, the leaf surface area of one plant decreased, but the total leaf area per 1 hectare, on the contrary, increased. Thickening of crops to 80 thousand/hectare caused a decrease in the mass of 1000 seeds by 9%. The lowest yield of sunflower seeds – 26.3 kg/ha was observed at a standing density of 30 thousand/ha. The increase in plant density in crops affected the increase in yield, and the maximum seed yield (33.5 kg/ha) was obtained at a plant density of 60 thousand/ha, a further increase in plant density to 80 thousand/ha was accompanied by a decrease in yield to 29.4 quintal/ha [31].

The Institute of Oilseeds of UAAS recommends for different areas of Ukraine to adjust the density of sunflower plants depending on local natural and economic conditions [32]. Many studies by domestic scientists [3, 9] have shown that the density of standing can be different depending on soil and climatic conditions, the more favorable these conditions, the higher the density of standing. Plant density is one of the main factors that determines the efficiency of soil fertility, temperature and water regimes, solar energy and other components of agrocenosis [29]. At the same time, there is no consensus on the optimal density of standing plants. This indicator depends on both climatic conditions and the genotype of the hybrid and in the steppe of Ukraine ranges from 40 to 70 thousand plants/ha [1].

**Conclusions.** Among all oilseeds, sunflower ranks first in both area and oil production. The largest producer of sunflower seeds is the southern part of Ukraine, but it is becoming more common in the western region.

The main direction of increasing the production of sunflower seeds is the introduction of new high-yielding hybrids and intensive technologies for their cultivation, which will contribute to the realization of the genetic potential of sunflower, which is realized at the production level by only 50-60%.

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