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# Formation of economically valuable traits by hybrids of the sunflower (*Helianthus annuus ornamentalis (Multiflorus)*) under organic growing technology

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**Abstract** The culture of decorative sunflower in the concept of its use as a source of medicinal phytoraw materials is completely new and unconventional. Factors of crop productivity formation, namely: modern hybrid composition and seed sowing rate are proposed. The experimental results showed the superiority of the hybrid multi-flowered sunflower Teddy. In the hybrid sunflower Santa Fe, an increase in the sowing density led to a decrease in the diameter of the heads in all the studied variants. In the hybrid Teddy, this indicator was the highest, and the decrease was minimal. The decrease in the indicator was 11.7 cm to 6.3 cm; Double Sunking - from 8.4 cm to 5.5 cm and Santa Fe - from 9.3 cm to 6.0 cm. The mass of male petals in the air-dry state when growing the sunflower hybrid was maximum in Teddy - 4.0 g of phyto-raw materials from one plant, in Double Sunking - 1.5 g, and in Santa Fe - 1.8 g. The best indicators of plant productivity, as well as growth processes, were when growing multi-flowered sunflower with a standing density of 50 thousand seeds/ha. This rate ensured the collection of 5.1 g of air-dried petals from one plant or 25.5 kg/ha of phyto-raw materials in an air-dried state. At the rate of 60 thousand seeds/ha, the figures were 2.2 g and 11.0 kg/ha, and at 70 thousand seeds/ha - 2.6 g and 13.0 kg/ha, respectively.

**Keywords:** Hybrids, Organic cultivation technology, Stocking density, Sunflower

## Introduction

The analysis of the current state of the domestic market of plant products makes it possible to conclude that the "flagship" of the field of technical crops (and in some agricultural zones - and in general the leading field crop) in the last 15-18 years was and remains the sunflower (Andriychenko, 2016; Fesenko *et al.*, 2022; Lavrenko and Lavrenko, 2022). The scientifically justified limit of saturation of field crop rotations, which is 10-12.5%, was crossed a long time ago and, in our opinion, irreversibly. Therefore, the problems caused

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by the oversaturation of agrocenoses, it must be admitted, high-marginal and technological culture, come to the fore today, namely: the increasingly progressive deterioration of the agromelioration and phytosanitary condition of agro-landscapes, the lack of good predecessors for winter ear crops, etc. (Anishin, 2012; Lykhovyd *et al.*, 2022; Bazaluk *et al.*, 2022; Zaika, 2013).

We do not indulge ourselves in illusions that the situation will change fundamentally in the near future, but we see one of the very real ways to reduce the severity of the problem is to review the "profession" of the sunflower, namely, to consider its varieties through the prism of obtaining phytoraw materials for medicinal purposes, which translates the culture cultivation process into a qualitatively new one level (Zhovtobryukh and Miller, 2004; Zhuikov *et al.*, 2022 a; Zhigailo and Zhigailo, 2017). In this aspect, the ever-increasing global popularity of the multi-flowered sunflower precisely as a medicinal plant is assessed by us as a very real chance for domestic farmers (Anishin, 2004; Melnik, 2005; Miller, 2015; Wolfgan, 2013).

The culture of multi-flowered decorative sunflower as a medicinal crop is completely new for Ukraine, and those isolated (and often unsuccessful) attempts by individual economic entities to obtain phytoraw material crops are in the absolute majority of cases based on the application of rather empirical technologies built on fragmentarily involved elements of zonal technologies of oil sunflower (Anishin, 2004; Bazaliy *et al.*, 2019; Buryak, 2014; Lykhovyd *et al.*, 2020). At the same time, the specified problem is an absolute "white spot" in the scientific aspect, systematic studies of domestic scientists in this direction are not conducted at all, and isolated efforts of researchers to study individual elements of cultural technology are, rather, of a fragmentary nature and are not distinguished by systematicity (Anishin, 2012; Anishin, 2004; Zhuikov *et al.*, 2022 b; Melnik, 2021). This fact, as well as the fact that the demand for phyto-raw material (dried petals of male flowers of the culture) has increased more than 10 times in the world market over the past 5 years, determined and shaped the subject and problems of scientific research (Bazaliy *et al.*, 2019; Zhuykov *et al.*, 2020).

Thanks to the continuous work of breeders armed with modern methods of biotechnology and genetics, more than 150 new varieties and hybrids of decorative sunflowers have been created. New products appear on the market every year, each of which is a new word in species selection.

Combining the decorative and medicinal properties of sunflower, it can be recommended for landscaping homesteads, both in group plantings and in single plantings, as a "living" fence. During the summer, the plant will please with its decorative flowers, and in the fall you can collect the inflorescences and use them as medicinal raw materials.

Sunflower petals have a diuretic, choleretic, anti-inflammatory, antispasmodic, and diuretic effect. The healing properties of the petals help strengthen the immune system. They have wound-healing and disinfecting properties, so they are often used externally as medicines for treating the skin (Lavrys and Zhuykov, 2021).

According to scientists, the use of complex multifunctional drugs based on physiologically active compounds (fulvic and humic acids, gibberellins, auxins, cytokinins, fungicidal substances of microbiological origin, meso- and microelements in chelated form) is quite an effective lever for activating growth processes, as well as successful overcoming of stress phenomena during the growing season of sunflower plants, especially under unfavorable abiotic and biotic factors of agrocenosis (Okanenko, 1959).

Scientists who studied biopreparations as an element of an integrated system of mineral nutrition of field crops came to the conclusion of their high efficiency precisely when combined with foliar feeding with fertilizers, and growth stimulators, which have different vector purposes. This ensures, together with the improvement of the supply of macro, meso, and microelements to the culture, to fully reveal the immunomodulating properties of the drugs, stimulate the mechanisms of sunflower tolerance formation against a complex of adverse factors, and ensure an increase in seed yield up to 12% (Anishin, 2012; Bazaliy *et al.*, 2019; Volkogon and Dymova, 2010).

A relevant and priority vector in the development of the popularization of biological technologies at the current stage of the development of global and domestic agriculture is the rather successful attempts of scientists and practitioners to reduce the impact of adverse weather factors on culture (Kaminsky, 2017; Markova, 2014). In their research, a group of scientists concluded that physiologically active compounds in the sunflower protection system against phytopathogens and adverse agroclimatic manifestations must be used according to the following scenario, namely: mandatory seed treatment before sowing and at least two further treatments between the "first a pair of true leaves" and to the "formation of a basket" (Anishin, 2012; Bazaliy *et al.*, 2019; Domaratskyi *et al.*, 2017; Lihokhvor, 2004).

The objective was to establish the influence of sowing rates on different hybrids of the sunflower (*Helianthus annuus ornamentalis* (*Multiflorus*)) on the timing of the onset of the main phases of plant growth and development and the structural parameters of the harvest (number of inflorescences per plant, weight of the basket, diameter of the basket, weight of petals from 1 inflorescence, weight of petals from 1 plant) using organic cultivation technology.

## Materials and methods

The culture of decorative sunflower used as a source of medicinal phytoraw a material which is considered completely new and unconventional for the agricultural sector of the domestic economy. The program of scientific research was formed from the following scientific tasks: to investigate the characteristic features of the ontogenesis of the culture, which were determined by the factors of the experiment, first of all, the intensity and duration of the formation of generative organs (inflorescence); to analyze trends and regularities of formation of above-ground biomass, formation of assimilation apparatus and efficiency of its functioning under the influence of various technological factors; analyze the elements of the structure of the crop crop.

To implement the above scientific tasks, we set up a field two-factor experiment, where factor A was represented by modern hybrids of decorative sunflowers (Teddy, Double Sunking, Santa Fe), and factor B was represented by exponentially increasing seed sowing rates per unit area (50,000; 60,000 and 70,000 seeds/ha). The repetition in the experiment is fourfold. Plots in the experiment were placed using the method of split blocks with partial randomization.

The total area of the experimental field was 1.1 hectares, of which the protective strips were 0.1 ha; the number of experimental plots in the experiment is 36, the total area of the first-order plot is 280 $m^2$ (length – 50.0 m, width - 5.6 m), accounting - 250 $m^2$ (length - 44.6 m, width - 5.6 m).

The soil of the experimental field where the research was conducted was dark chestnut medium loamy moderately saline soil. The humus content was 2.34-2.60%, mobile forms of mineral nutrition elements: nitrogen - 1.7-2.0 mg-eq per 100 g of soil; phosphorus - 4.9-6.5 mg-eq per 100 g of soil; potassium - 28-36 mg-eq per 100 g of soil, pH - 6.9-7.2.

During the research, generally accepted methods of setting up and conducting field experiments and laboratory studies were guided (Kostenko *et al.*, 2016; Dimitrov, 2015; Zhovtobryukh and Miller, 2004). The conducted experiments were accompanied by the necessary observations, measurements, and analyses of soil and plant samples.

Precipitation during the growing season of sunflowers was determined using a rain gauge installed on the experimental field. Air temperature, air humidity, and the sum of active and effective temperatures were given according weather station to the place of the experiments.

Soil samples for moisture determination were taken using a soil auger. The repetition of selection in experimental areas is threefold. Samples were taken at regular intervals along the diagonal of the plot. Samples were taken in

layers every 10 cm. The selected sample was dried in a drying cabinet (at a temperature of 105ºC for 6-10 hours to a constant weight). Moisture reserves in the soil, total water consumption, and the coefficient of water consumption of the culture were calculated.

The content of individual groups of microorganisms in the soil and their general microbiological activity was determined by seeding on a nutrient medium with subsequent differentiation by groups and counting of germinated colonies.

Phenological observations were carried out at permanently fixed recording sites in two non-adjacent repetitions. The beginning of the phase was taken as the time of its onset in 10% and as the full phase - in 75% of the plants. Be sure to note the dates of the main phases of sunflower development: seedlings, I-VI pairs of true leaves, basket formation, flowering, milky-waxy seed maturity, and full seed maturity.

The calculation of the survival rate of plants during the growing season was carried out by counting the density of plant stands on pre-fixed sites in three locations of the site. Determination of the resistance of plants to lodging was carried out visually according to the appropriate scale. Before and after the implementation of plant care methods, as well as during the harvest period, the weed infestation of sunflower crops was determined using a quantitative-weight method (on the diagonal of the plots in ten repetitions) with differentiation by groups and types of weeds. For this, a frame with an area of 1 $m^2$ was used.

The determination of the structure of the multi-flowered sunflower yield and chemical analysis of the phyto-raw materials were selected for each variant of the experiment, which included plants typical for the variant that was dried to an air-dry state. The accounting of the phyto-raw materials yield of multi-flowered sunflowers was carried out by manual collection of flower baskets with subsequent manual removal of petals. The obtained experimental data were reduced to standard humidity (10%) and absolute purity (100%).

The experimental data of sunflower were processed by the standard procedure of ANOVA within MS Excel software. The significance of the differences was proved for the reliability level of 95% ($LSD_{05}$).

The agricultural technology of sunflower cultivation in the field experiment was generally accepted. The predecessor in the field experiment was winter barley for grain, after harvesting of which the soil was disked to a depth of 10-12 cm. After 14 days, plowing was carried out to a depth of 22-24 cm. To level the soil, cultivation was carried out to a depth of 8-10 cm. Pre-sowing cultivation was carried out to a depth of sowing sunflower seeds of 5-7 cm.

According to the previous agreement with the companies-originators of

hybrids of decorative sunflowers, seed units of the culture without pre-sowing seed incrustation with a fungicidal-insecticidal composition were purchased for the establishment of the experiment.

**Table 1.** Biological preparations: characteristics, standards and methods of application

| Preparation | Content | Methods and rates of application |
|---|---|---|
| Organic fertilizer**"Eco-Growth"** | *Bacillus thermophiles*, *Bacillus subtilis*, phosphorus-mobilizing, nitrifying bacteria; 51 g/l N, 12.0 g/l $K_2O$, 58 g/l MgO, 50 g/l $SO_3$, 6.5 g/l B, 12.5 g/l Cu, 12.4 g/l Fe, 12.0 g/l Mn, 0.2 g/l Mo, 6.4 g/l Zn, 0.1 g/l Co, 66.4 g/l amino acids; 67.8 g/l organic acids (succinic, malic, tartaric and citric); 3.3 g/l humic acids, 0.58 g/l fulvic acids, 0.0055 g/l phytohormones, 0.049 g/l of polysaccharides, vitamins, cytokinins, gibberellins compounds). | pre-sowing seed treatment – 2 l/t; vegetative foliar feeding – 2 l/ha |
| Bio-fungicide **Gaubsin-FORTE** | *Pseudomonas aureofaciens* (two strains), cell titer of at least $4\times10^9$ KUO/ml | plant vegetative spraying – 2 l/ha |
| Biofungicide **Viridin** (Trichodermin) | *Trichoderma* spp. cell titer of at least $1\times10^8$KUO/ml; and metabolic products - biologically active substances. | pre-sowing seed treatment – 5 l/t; plant vegetative spraying – 2 l/ha |
| Biofungicide **Entocid** (Metaryzyn) | Spores of entomopathogenic fungi - not less than $2\times10^8$ KUO/ml | soil spraying for pre-sowing treatment – 5 l/ha |
| Biofungicide **Actarofit** | *Streptomyces avermitilis* (*abamectin* - 50%, *emamectin* - 50%), not less than 1.8%. | plant spraying – 0.2 l/ha |

**Source:** Own description based on materials provided by firm manufacturers.

Pre-sowing treatment was carried out independently with a chelated composition of microelements and a fungicidal preparation approved for use in organic farming (Table 1). Sunflower sowing was at a soil temperature of 6-7ºC at a depth of 5-7 cm with a row spacing of 0.7 m. After sowing, the field was rolled with rollers.

Weed protection was implemented with the help of methods of

mechanical weed destruction (pre- and post-frost harrowing and rotary harrow, inter-row cultivation); diseases, and pests - treatments with biological preparations approved for use in organic agriculture.

During the vegetation period of the sunflower crop, the crop was sprayed twice at the phase of "3 pairs of true leaves" and "head formation". The working solution was prepared 30 minutes before the start of spraying. The consumption rate of the sprayer working fluid was 250 l/ha. The harvest was carried out by hand picking the sunflower flower heads, followed by separating the petals and air drying them.

## Results

One of the most important biological and economically valuable features of sunflower is its precociousness, which makes it possible to use insignificant reserves of soil moisture in the initial stages of development as efficiently as possible, and the accelerated passage of the initial stages of ontogenesis allows the culture to be minimally affected by weeds and soil-inhabiting pests. At the same time, excessive acceleration of the growth and development stages of a culture negatively affects the realization of its genetic potential of seed productivity, because it is known that the longer the vegetation period of a variety or hybrid (within certain limits, of course), the more productive they are.

The thickening of plants per unit of sown area, if we do not take into account the varietal characteristics of a certain crop, is almost the most influential factor in adjusting the duration of its vegetative season, and in combination with the peculiarities of growing technology, they form a very effective and, most importantly, sufficiently controlled and predictable nature of the impact on the course of phenological processes in the agrocenosis of decorative sunflower.

According to research, the duration of the period "sowing - seedling" depended purely on the genetic characteristics of a specific multi-flowered sunflower hybrid, and was completely independent of such a factor as the rate of seed sowing. In terms of this indicator, the Teddy hybrid showed itself to be the best in the experiment, where the period from the sowing date to the phase of full emergence was the shortest (6 days) in comparison with other studied hybrids, which was 4 and 5 days less, respectively, in comparison with the Double Sunking and Santa Fe hybrids (Table 2).

**Table 2.** Phenological indicators of multi-flowered sunflower hybrids depending on the seed sowing rate (average for 2020-2023)

| Hybrid (Factor A) | Sowing rates, seeds/ha (Factor B) | Duration, days | | |
|---|---|---|---|---|
| | | interphase period "sowing-seedling" | flowering phase | general vegetation period |
| Teddy $F_1$ | 50,000 | 6 | 22 | 122 |
| | 60,000 | 6 | 19 | 118 |
| | 70,000 | 6 | 15 | 115 |
| Double Sunking $F_1$ | 50,000 | 10 | 12 | 107 |
| | 60,000 | 10 | 9 | 102 |
| | 70,000 | 10 | 8 | 100 |
| Santa Fe $F_1$ | 50,000 | 11 | 10 | 114 |
| | 60,000 | 11 | 10 | 110 |
| | 70,000 | 11 | 7 | 105 |
| $LSD_{05}$ | for mean (main) effects | | Factor A | 1.46 |
| | | | Factor B | 1.08 |
| | for partial differences | | Factor A | 1.33 |
| | | | Factor B | 0.99 |

Therefore, the duration of the specified interphase period, which can be used to judge the compliance of a particular hybrid with the agro-ecological growing conditions (temperature and humidity of the seed layer of the soil), depended exclusively on the genetic characteristics of a specific multi-flowered sunflower hybrid. According to this indicator, the Teddy sunflower hybrid significantly stood out in the experiment, the duration of the formation of the phase of full shoots from the moment of sowing was the shortest among the other sunflower hybrids studied in the experiments, it was 6 days, which was 4 and 5 days shorter, respectively, than in Double Sunking and Santa Fe.

Concerning the most fundamental phase of growth and development in the technology of growing multi-flowered sunflowers, which precisely determines the quantitative and qualitative indicators of the phytoraw material being grown (dried petals of male flowers) - the flowering phase, in our experiment we noted a clear dependence of the decrease in the duration of this phase with an increase in the density of sowing with all variants of factor A. Yes, its maximum duration was noted by us for the Teddy hybrid and was, 19 days (from 22 days for a density of 50 thousand pieces/ha to 15 days for 70 thousand pieces/ha). The variants of the Double Sunking and Santa Fe hybrids were significantly inferior in terms of this indicator and demonstrated an almost twice shorter duration of the specified phenological phase (10-9 days). In general, these hybrids stopped vegetation significantly earlier than the Teddy hybrid, which vegetated, on average, 118 days (122-115 days depending on the density of sowing): according to the Double Sunking hybrid variant, the duration of vegetation was 107-100 days, and for hybrid Santa Fe 114-105

days, decreasing as the rate of crop sowing increases.

Indicators of the yield structure of multi-flowered sunflower, it is reported the inverse nature of the dependence of the indicator of the number of flowering inflorescences on 1 plant on the rate of sowing of the crop for all variants of factor A. Thus, according to the variant of the Teddy hybrid, the increase of the rate of sowing from 50 to 70 thousand pieces/ha led to a decrease in the number of flowering baskets from 3.4 to 2.6; according to the Double Sunking hybrid - from 2.7 to 1.8, respectively; for the Santa Fe hybrid, this decrease was even more significant and amounted to 2.6 to 2.0 inflorescences per 1 plant. The leader in the experiment in terms of the average weight of the basket (in a naturally moist state) was the hybrid Teddy, the weight of the inflorescence of which was 47.0 g (from 60.8 to 36.1 g, depending on the density of the sowing). The value of a similar indicator for the Double Sunking hybrid variant was 31.0 g (from 42.7 to 18.1 g), for the Santa Fe hybrid 30.2 g (from 28.4 to 20.2 g) (Table 3).

**Table 3.** Structural indicators of the yield of phytoraw material of multi-flowered sunflower (average for 2020-2023)

| Hybrid (Factor A) | Sowing rates, seeds/ha (Factor B) | | Number of inflorescences per plant, pcs. | Weight of the basket, g | Diameter of the basket, cm | Weight of petals from 1 inflorescence, g (air-dry) | Weight of petals from 1 plant, g (air-dry) |
|---|---|---|---|---|---|---|---|
| Teddy $F_1$ | 50,000 | | 3.4 | 60.8 | 11.7 | 1.7 | 5.1 |
| | 60,000 | | 3.1 | 44.2 | 8.0 | 1.5 | 4.7 |
| | 70,000 | | 2.6 | 36.1 | 6.3 | 0.9 | 2.3 |
| Double Sunking $F_1$ | 50,000 | | 2.7 | 42.7 | 8.4 | 1.0 | 2.2 |
| | 60,000 | | 2.2 | 32.3 | 7.2 | 0.6 | 1.3 |
| | 70,000 | | 1.8 | 18.1 | 5.5 | 0.5 | 0.9 |
| Santa Fe $F_1$ | 50,000 | | 2.6 | 38.4 | 9.3 | 1.0 | 2.6 |
| | 60,000 | | 2.3 | 32.0 | 7.3 | 0.7 | 1.6 |
| | 70,000 | | 2.0 | 20.2 | 6.0 | 0.6 | 1.2 |
| $LSD_{05}$ | for mean (main) effects | Factor A | 0.37 | 7.09 | 1.81 | 0.36 | 1.21 |
| | | Factor B | 0.26 | 5.69 | 1.34 | 0.42 | 0.88 |
| | for partial differences | Factor A | 0.24 | 4.34 | 2.02 | 0.19 | 2.07 |
| | | Factor B | 0.22 | 5.61 | 1.93 | 0.24 | 2.27 |

An increase in the number of plants in the area led to a significant decrease in the diameter of the basket of multi-flowered sunflowers for all studied hybrids in the experimental study. Thus, in the hybrid Teddy, the diameter of the basket decreased from 11.7 cm to 6.3 cm, while the average value of the indicator over the years was 8.7 cm; Double Sunking - from 8.4 cm to 5.5 cm (average over the years of experience 7.0 cm) and Santa Fe - from 9.3

cm to 6.0 cm (average over the years of experience 7.5 cm).

The size of individual inflorescences of multi-flowered sunflowers, depending on the experimental options put to study, had differentiated values, especially as regards the mass of air-dry petals collected from one basket of sunflowers. The largest collection of petals was obtained when sowing the Teddy sunflower hybrid, the total weight of the petals over the years of research was 1.4 g. An increase, in the rate of sunflower seeds from 50 thousand pieces/ha to 70,000 seeds/ha, sunflower reduced the mass of air-dry petals yield from 1.7 to 0.9 g. Similar results were obtained in our experiments with other sunflower hybrids. Thus, in the Double Sunking hybrid, the average weight of petals over the years of research was 0.7 g (with a sowing rate of 50 thousand pieces/ha - 1.0 g, and 70 thousand pieces/ha - 0.5 g). sunflower hybrid Santa Fe, the average weight of petals over the years of research was 0.8 g (with a seeding rate of 50 thousand pieces/ha, and 70 thousand pieces/ha - 0.6 g).

According to the obtained experimental data, the productivity of male petals (weight) in an air-dry state from one plant of multi-flowered sunflower for various researched hybrids was as follows: sunflower hybrid Teddy over the years of research ensured the formation of 4.0 g of phytoraw material on one plant; when growing the Santa Fe hybrid, productivity was lower and amounted to 1.8 g and the lowest weight was determined when growing the Double Sunking sunflower hybrid - 1.5 g. Research on determining the optimal rate of sunflower sowing showed that the best conditions for the growth and development of multi-flowered plants sunflowers consisted of 50 thousand seeds per hectare. At this seeding density, the highest yield of petals was obtained - 5.1 g. An increase in the rate of 10 thousand seeds/ha reduced the weight to 2.2 g, compared to the norm of 70 thousand seeds per hectare the indicator was the lowest - 2.6 g. When calculated per hectare, the yield of phytoraw material (air-dried petals) was 25.5; 11.0, and 13.0 kg/ha, respectively.

## Discussion

The culture of multi-flowered sunflower as a source of obtaining medicinal environmentally friendly phytoraw materials is gaining more and more popularity in all agroecological zones of Ukraine (Zhuchenko, 1988). The obtained result is disclosed in several recent scientific studies on the pharmacological properties of the crop, according to which they significantly improve the condition of the human body suffering from a whole range of various diseases, and given the possibility of using medicinal raw materials, such as dry petals of male sunflower flowers in the treatment protocol for COVID-19 and related complications. In connection with these results,

scientific study and development of adaptive zonal technologies for growing multi-flowered sunflowers are becoming extremely relevant (Gavrilyuk, 2008). In this sense, the agro-ecological conditions of the southern steppe zone with such important indicators as the total active temperature during the growing season, the accumulation of mineral nutrients in the soil, productive precipitation and the phytosanitary state of agrocenoses are very favorable for obtaining economically justified harvests of plant raw materials and medicinal preparations with organic status and, in our opinion, is the basis for obtaining a completely different economic level of the cultivation process (Mrynskyi and Lavrenko, 2007).

The analysis of recent research and publications shows that along with the rapid spread of multi-flowered sunflower crops, there is almost no information about the theoretical and applied aspects of their cultivation in modern scientific journals (Lavrenko and Lavrenko, 2022). Individual efforts of farmers and other commodity producers, who are trying to obtain marketable phytoraw materials of crops, are mostly based on experimental economic research. That is, farmers apply separate technological methods of crop cultivation or even entire technological blocks by the method of analogy, using simple tracking from already existing adaptive technologies of sunflower cultivation without taking into account the ecological, morphological, and biological features for the given period of the new crop (Ushkarenko *et al.,* 2008).

The results of the experimental studies, which were obtained in the field experiment, proved that the duration of the interphase period "sowing-seedling" depended exclusively on the genetic characteristics of a specific multi-flowered sunflower hybrid, and did not depend at all on such a factor as the seed sowing rate. In this indicator, the Teddy hybrid stood out in the experiment, for which the period from sowing seeds to shoots was minimal in comparison with other studied hybrids and amounted to an average of 6 days over the years of research, which is 4-5 days less than the variants of the Double Sunking and Santa Fe hybrids. This coincides with other studies, which indicate that the duration of the vegetation period of plants depends entirely on the hybrid-varietal composition, growing conditions and climatic and natural conditions.

The structure formation of decorative sunflower crops has peculiarities. Most of the researchers who studied this culture were focused on the formation of seeds, not inflorescences and their mass (Dimitrov, 2015; Gavrilyuk, 2008; Lavrys and Zhuykov, 2021; Zhuikov *et al.*, 2022 a). Therefore, obtaining experimental material on the influence of technological factors on structural indicators of decorative sunflowers is new.

According to the research of scientists (Domaratskyi *et al.*, 2017; Lihokhvor, 2004; Mrynskyi and Lavrenko, 2007), it has been proven that the diameter of the basket is determined by the genetic characteristics of the hybrid,

which is influenced by agro-technological conditions. It should also be noted that the thickening of plants lowers the indoor seed yield and its quality indicators. The conducted studies confirmed these conclusions and aspects of growing decorative sunflowers. The experiment noted the inverse nature of the dependence of the indicator of the number of conditioned (blooming) inflorescences on 1 plant on the rate of crop sowing for all hybrids. The experimental variant in the experiment with sowing the Teddy hybrid with a plant density of 50 thousand per hectare formed the largest number of flower baskets 3.4, while increasing the density by 20 thousand plants reduced the indicator to 2.6; according to the variant of the Double Sunking hybrid - from 2.7 to 1.8, respectively; for the Santa Fe hybrid, this decrease was even more significant and amounted to 2.6 to 2.0 inflorescences per 1 plant. An increase in the rate of sowing seeds led to a significant decrease in the lateral generative shoots of the I and II orders, and the inflorescences that formed on them against the background of the sowing rate of 60 and 70 thousand ha were mostly underdeveloped and either did not begin to bloom at all or did not open completely. had significant appearance violations and were not involved in conditioned products. For all variants of the decorative sunflower hybrid in the experiment, a significant decrease in the weight of an individual inflorescence (basket) was noted with an increase in the rate of seed sowing. The increase in the seeding rate of the crop plants in the experiment was also due to a significant decrease in the radius of the sunflower head in all experimental hybrids: in the Teddy hybrid, the diameter of the multi-flowered sunflower head decreased from 11.7 at a density of 50 thousand pieces per hectare to 6.3 cm at a density of 70 thousand (on average over the years of research 8.7 cm); Double Sunking - from 8.4 to 5.5 cm (7.0 cm), respectively; Santa Fe - from 9.3 to 6.0 cm (7.5 cm). For all variants of decorative sunflower hybrids, increasing the rate of sowing seeds to 70,000 seeds/ha caused a decrease in the average diameter of flowering inflorescences to 6 cm or less, which significantly complicated the manual collection of baskets and, most importantly, almost made it impossible to qualitatively separate the male petals from the inflorescences - negatively affecting the final indicator - the productivity of conditioned phyto-raw materials according to the experiment options. The best seeding rate for all the studied hybrids was revealed in the course of the research to be 50 thousand seeds/ha, at which the productivity of one plant was the highest, and amounted to an average of 5.1; 2.2 and 2.6 g of air-dried petals for the studied hybrids, which, when converted to the sowing area, amounted to 25.5; 11.0 and 13.0 kg/ha of phytomaterial in an air-dried state. It was experimentally established that sowing of the Teddy F1 multi-flowered sunflower hybrid in terms of the yield of conditioned standardized phytomaterial was the best in comparison with other studied hybrids.

Increasing the seeding rate of crops to 70 thousand seeds/ha contributed to a decrease in the indicators of phenological, biometric and structural parameters (duration of the period "sowing-emergence", flowering phases and the total duration of vegetation, the number of inflorescences on the plant, their diameter and weight, yield). The nature of this dependence is established as inversely linear. In the experiment, an advantage of the Teddy $F_1$ in comparison with other variants of the A factor was noted for all the investigated indicators, and the norm of 50 thousand seeds/ha was the best seeding rate. It was established that, under these conditions, obtaining up to 25.5 kg of phytoraw material in an air-dry state is realistic from a unit of sown area.

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