UDC 633.854.78: 631.82

# *INFLUENCE OF MACRO- AND MICRO-FERTILIZERS ON BIOMETRY, PERFORMANCE AND QUALITATY OF SUNFLOWER HYBRIDS*

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The results of a two-year study of fertilizer effects on the performance of hybrids sunflower Ahronomichnyi, Ahent and Serpanok in the Left-Bank Forest-Steppe of Ukraine are presented. Relationships of biometric (plant height, leaf area, calathidium size), performance (1000-seed weight, yield) and quality (oil content in seeds) indicators with mineral fertilizers, microfertilizers and their compatibility are described.

***Key words:*** *sunflower, hybrid, mineral fertilizer, microfertilizers, productivity, oil content.*

**Literature review and problem articulation**. The potential performance of sunflower is very high, but not more than 50% of the biological potential of sunflower varieties and hybrids is used, which is the lowest among oil crops. In modern agriculture, lack of nutrients in the soil is one of the main factors limiting sunflower yields. Sunflower is a crop requiring intensive mineral nutrition, therefore, its cultivation demands reserves of nutrients in the soil, which can be replenished by applying mineral fertilizers. Mineral fertilizers at a dose of $N_{40}P_{60}$ increased the yield by 0.14–0.29 t/ha compared to the control (no fertilizers) [1]. Mineral fertilizers at a dose of $N_{60}P_{60}K_{60}$ increased the yield by 0.35–0.64 t/ha in comparison with the ‘no fertilizer’ control [2]. However, for the normal development of the plant, mineral fertilizers alone are not sufficient. Trace elements play significant roles in the plant nutrition and seed yield. Despite the fact that the plant needs small amounts of micronutrients, supplementary introduction of micronutrients significantly increases yields [3]. Frequent sunflower growing in the same field, every 3–4 years, leads to symptoms of micronutrient deficits and reduced performance. The crucial phases of their consumption are 6–8 pairs of leaves. In case of micronutrient deficits, it is impossible for plants to fully assimilate macronutrients [4]. Foliar fertilization is a way to replenish micronutrients for the plant. Foliar fertilization of plants helps to increase the crop performance. Due to the use of multifunctional agent Architect 2 L/ha in the phase of 6–8 true leaves, the yield increased by 11% compared to the control [5]. Treatment of sunflower fields with compound fertilizers ensured an increase in the yield of 10.7–20.9% and improved the seed quality [6]. The use of growth-regulating agents Vympel, Vimpel – K and foliar fertilization with Vympel, Oracle Multicomplex and Oracle Colamine Boron in the phases of 2–3 and 5–6 pairs of leaves in the sunflower cultivation technology increased the yield by 0.7 t/ha (22.4%) [7]. When bioagent Biocomplex-BTU-r 1 L/ha was combined with compound microfertilizer Quantum 5 L/ha in the phase of 5–6 leaves, and plants were treated with Biocomplex-BTU-r 1 L/ha + Quantum 6 l/ha in the phase of 9–10 leaves, the yield increased by 0.73 t/ha (28%) relative to the control (no fertilizers) [8]. Against the background of the organic-mineral fertilization of soil in crop rotation, application of bioagent Groundfix 5 L/ha + Liposam and foliar fertilization with bioagents Organic-balance + Liposam + BTU-r Biocomplex for industrial crops + Liposam ensured the biological yield from sunflower of 4.79 t/ha, which is by 0.60 t/ha, or by 14.3% higher compared to the control (4.19 t/ha) [9]. When introducing modern agents into production, one should know not only the performance of new varieties and hybrids, but also the oil content and oil collection of per unit area. With mineral fertilizers, there was a decrease in the oil content in seeds; at the same time, growth-promoting agents increased of this indicator [2]. In the case of foliar fertilization with microfertilizer Reacom, the oil content in seeds of hybrids increased from 0.8% to 2.4% compared to the ‘no fertilizer’ experiment [10].

Therefore, it is important to study the effects of microfertilizers or their compatibility with mineral macrofertilizers on the sunflower performance. In addition, the introduction into production of new sunflower hybrids requires specifying parameters of their cultivation technologies for certain soil and climatic conditions.

**Purpose.** Our purpose was to study the effects of fertilizers on the growth, development and yield of sunflower hybrids of different ripeness groups (bred at the Institute of Oil Crops) in the Left-Bank Forest-Steppe of Ukraine.

**Material and methods.** The study was conducted at Poltava State Agricultural Research Station named after N.I. Vavilov in 2019–2020

The study object was processes of the growth and development of sunflower plants and formation of sunflower seeds depending on farming techniques.

The study subject was sunflower hybrids Ahronomichnyi, Ahent and Serpanok. The following fertilizers were applied: 1) no fertilizers (control); 2) $N_{32}P_{32}K_{32}$; 3) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with urea (10 kg/ha) in the phase of 5–6 pairs of leaves; 4) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 2-3 pairs of leaves; 5) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 5–6 pairs of leaves.

The sunflower cultivation technology in the experiments was traditional for the soil-climatic zone. The experiments were laid out and carried out in accordance with conventional methods of field experiments in agriculture and crop production [1].

The soil in the plots was typical low-humus chernozem. The mechanical composition of the soil is heavy loam with the following agrochemical parameters: the humus content in the 0–20 cm layer was 4.85%; in the 20–40 cm layer, it was 3.91%; and in the 150–170 cm layer, it was 0.71%. The agrochemical survey showed that the soil of the experimental field was well supplied with major nutrients. The arable layer contained 11–13 mg of hydrolysable nitrogen (by Cornfield’s methos), 10–15 mg of mobile phosphorus (by Chyrykov’s method), and 16–20 mg of exchangeable potassium per 100 g of soil (by Chyrykov’s method).

The climate of this zone is temperate-continental with unstable precipitation, cold winters and hot, often dry, summers. The average multi-year air temperature is + 7.7°C, the amount of precipitation is 508 mm. The average air temperature is 18.3°C, and the amount of precipitation is 225 mm during the growing period (third 10 days of April - September). In the study years, the weather indicators differed from the multi-year averages. In 2019, the amount of precipitation during the vegetation period was 119 mm, and the average air temperature was 20.8°C. In 2020, they were 294 mm and 19.7°C, respectively. The hydrothermal coefficient was 0.43 and 1.12 respectively, with the multi-year average of 0.93.

**Results and discussion.** The results show that mineral macro- and microfertilizers contributed to more intensive growth and development of plants. Thus, the tallest plants grew with mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 2–3 pairs of leaves. The plant height increased from 7.0 cm to 11.0 cm compared with the control (no fertilizers). On average for the two study years, fertilization made plants taller, from 2.0 to 9.0 cm, depending on the experimental variant. The study revealed that the leaf area depended on treatment in the sunflower hybrids. On average, the leaf area in hybrids Ahronomichnyi, Ahent and Serpanok was the largest with mineral fertilizers $N_{32}R_{32}K_{32}$ + foliar fertilization of plants with urea (10 kg/ha) in the phase of 5-6 pairs of leaves: 45.9 $dm^2$, 45.2 $dm^2$ and 45.3 $dm^2$, respectively. Taller sunflower plants with well-developed assimilating surface of leaves form larger calathidiums with more flowers, which ultimately increases yields. In our study, mineral fertilizers helped to increase the size of calathidiums. The calathidium diameter in the hybrids increased from 0.7 cm to 1.4 cm, depending on the fertilizer dose, compared with the control (no fertilizers). The maximum calathidium diameter of 16.7–17.5 cm was achieved in hybrids Ahronomichnyi, Ahent and Serpanok mainly with mineral fertilizers $N_{32}R_{32}K_{32}$ and foliar fertilization of plants with urea or microfertilizer Novalon Foliar (1 kg/ha) (Table 1).

Table 1

**Biometric and performance parameters of the sunflower hybrids depending on fertilizes (2019–2020 average)**

| Treatment | Plant height during anthesis, cm | | | Leaf area during anthesis, dm²/plant | | | Calathidium diameter during physiological ripeness, cm | | | 1000-seed weight | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ahronomichnyi (factor A) | Ahent | Serpanok | Ahronomichnyi | Ahent | Serpanok | Ahronomichnyi | Ahent | Serpanok | Ahronomichnyi | Ahent | Serpanok |
| No fertilizers (control) (factor B) | 147 | 134 | 156 | 36.8 | 36.6 | 35.1 | 15.8 | 16.3 | 16.1 | 45.9 | 65.9 | 69.7 |
| $N_{32}P_{32}K_{32}$ | 149 | 138 | 160 | 42.9 | 40.8 | 40.3 | 16.6 | 17.0 | 17.1 | 48.2 | 70.3 | 71.4 |
| $N_{32}P_{32}K_{32}$ + carbamide 10 kg/ha in the phase of 5–6 pairs of leaves | 153 | 139 | 160 | 45.9 | 45.2 | 45.3 | 16.7 | 17.2 | 17.5 | 49.0 | 72.6 | 72.7 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 2–3 pairs of leaves | 155 | 140 | 161 | 42.6 | 41.8 | 43.5 | 16.9 | 17.5 | 17.5 | 49.2 | 73.1 | 73.3 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 5–6 pairs of leaves | 156 | 141 | 160 | 42.7 | 42.3 | 44.4 | 16.9 | 17.2 | 17.4 | 49.3 | 73.8 | 73.2 |
| $LSD_{095}$ A | | 1.5 | | | 0.7 | | | 0.2 | | | 0.8 | |
| B | | 1.9 | | | 0.9 | | | 0.3 | | | 1.1 | |
| AB | | 3.4 | | | 1.6 | | | 0.4 | | | 1.9 | |

Fertilization increased the 1000-seed weight from 1.7 g to 7.9 g compared to the control (no fertilizers). The highest 1000-seed weight in hybrids Ahronomichnyi, Ahent and Serpanok was recorded with mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha), amounting to 49.3 g, 73.8 g and 73.3 g, respectively.

Differences in the sunflower yields between the experimental variants indicate that the hybrids respond to factors under investigation. Hybrids (factor A) significantly affected the sunflower seed yield. Thus, the yield from Ahent was higher than that from Serpanok (by 0.17–0.26 t/ha) or from Ahronomichnyi (by 0.03–0.08 t/ha). Basic mineral fertilization $N_{32}P_{32}K_{32}$ plus foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) or urea (factor B) helped to increase yields compared to the control (no fertilizers) from 0.18 t/ha to 0.33 t/ha depending on the fertilizers. The statistically significant difference between fertilization and control averaged 0.15

t/ha, confirming the fertilizer reliability. The combination of factors AB (hybrid Ahent and mineral fertilizers $N_{32}P_{32}K_{32}$ plus foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 5–6 pairs of leaves) maximized the yield compared to non-fertilized hybrid Serpanok (by 0.48 t/ha). On average for the two years, the maximum yields from hybrids Ahronomichnyi, Ahent and Serpanok were obtained with basic mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha): 3.35 t/ha, 3.41 t/ha and 3.15 t/ha, respectively. The surplus to the control (no fertilizers) was 0.33 t/ha, 0.32 t/ha and 0.22 t/ha, respectively. Analyzing the yields of the hybrids by years, we observed an upward trend with microfertilizer Novalon Foliar in the phase of 5-6 pairs of leaves in 2019 and with this microfertilizer in the phase of 2–3 pairs of leaves in 2020. However, this difference was within the limits of experimental error. Fertilization of plants with urea (10 kg/ha) in the phase of 5–6 pairs of leaves in addition to basic mineral fertilizers $N_{32}P_{32}K_{32}$ allowed for an increase in the hybrids' yields of 0.20–0.30 t/ha compared to the 'no fertilizer' experiment. The average yield in this variant was 3.32 t/ha, 3.37 t/ha and 3.13 t/ha from hybrids Ahronomichnyi, Ahent and Serpanok, respectively. Basic fertilizers $N_{32}P_{32}K_{32}$ alone ensured the gain in the yields of 0.18–0.24 t/ha in comparison with the 'no fertilizer', and the yields amounted 3.26 t/ha, 3.31 t/ha and 3.11 t/ha from hybrids Ahronomichnyi, Ahent and Serpanok, respectively (Table 2).

Table 2

**Yields of the sunflower hybrids depending on fertilization, t/ha (2019–2020 average)**

| Treatment | Ahronomichnyi | | | Ahent (factor A) | | | Serpanok | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | Average | 2019 | 2020 | Average | 2019 | 2020 | Average |
| No fertilizers (control) (factor B) | 3.00 | 3.04 | 3.02 | 3.09 | 3.10 | 3.10 | 2.94 | 2.92 | 2.93 |
| $N_{32}P_{32}K_{32}$ | 3.23 | 3.29 | 3.26 | 3.28 | 3.33 | 3.31 | 3.09 | 3.13 | 3.11 |
| $N_{32}P_{32}K_{32}$ + carbamide 10 kg/ha in the phase of 5–6 pairs of leaves | 3.29 | 3.35 | 3.32 | 3.34 | 3.39 | 3.37 | 3.10 | 3.15 | 3.13 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 2–3 pairs of leaves | 3.32 | 3.38 | 3.35 | 3.34 | 3.41 | 3.38 | 3.12 | 3.18 | 3.15 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 5–6 pairs of leaves | 3.33 | 3.36 | 3.35 | 3.44 | 3.38 | 3.41 | 3.14 | 3.16 | 3.15 |
| In 2019, experimental accuracy = 2.93%; $LSD_{095}$ Factor A = 0.12 t/ha, $LSD_{095}$ Factor B = 0.16 t/ha, $LSD_{095}$ Factors AB = 0.27 t/ha | | | | | | | | | |
| In 2020, experimental accuracy = 2.43%; $LSD_{095}$ Factor A = 0.10 t/ha, $LSD_{095}$ Factor B = 0.13 t/ha, $LSD_{095}$ Factors AB = 0.23 t/ha | | | | | | | | | |

In our study, fertilization also affected the oil content in seeds. Mineral fertilizers $N_{32}P_{32}K_{32}$ decreased the oil content in the hybrids 1.1–1.7% compared to the 'no fertilizers' experiment. However, when plants were fertilized with urea or Novalon Foliar microfertilizer during the growing period, the oil content in seeds increased by 0.9–1.6%. When other variants were compared, the difference was 0.1–0.5%, which was within the limits of experimental error (LSD

0.7%). The highest content of oil in seeds was accumulated by hybrids Ahronomichnyi and Ahent with mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with urea 10 kg/ha in the phase of 5-6 pairs of leaves (47.8% and 48.4%, respectively). Serpanok accumulated the greatest amount of oil (49.4%) without fertilizers. It should be noted that this hybrid ripened very too early, which may be consequence of a lower effectiveness of fertilizers for increasing the yield and oil content in seeds.

Along with the oil content in seeds, the oil collection per unit area is important. The highest collection of oil was achieved in the experiments with the best yields: 1,406 kg/ha, 1,446 kg/ha and 1,356 kg/ha, respectively. Due to application of mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizers, this parameter increased by 147 kg/ha, 139 kg/ha and 82 kg/ha compared to the control (no fertilizers) in hybrids Ahronomichnyi, Ahent and Serpanok, respectively (Table 3).

Table 3

**Oil content in seeds and oil collection in the sunflower hybrids depending on fertilization (2019–2020 average)**

| Treatment | Ahronomichnyi | | | Ahent (factor A) | | | Serpanok | | |
|---|---|---|---|---|---|---|---|---|---|
| | Oil content in seeds, % | Yield, t/ha | Oil collection, kg/ha | Oil content in seeds, % | Yield, t/ha | Oil collection, kg/ha | Oil content in seeds, % | Yield, t/ha | Oil collection, kg/ha |
| No fertilizers (control) (factor B) | 47.4 | 3.02 | 1259 | 47.9 | 3.10 | 1307 | 49.4 | 2.93 | 1274 |
| $N_{32}P_{32}K_{32}$ | 46.3 | 3.26 | 1328 | 46.8 | 3.31 | 1363 | 47.7 | 3.11 | 1305 |
| $N_{32}P_{32}K_{32}$ + carbamide 10 kg/ha in the phase of 5–6 pairs of leaves | 47.8 | 3.32 | 1397 | 48.4 | 3.37 | 1435 | 48.9 | 3.13 | 1347 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 2–3 pairs of leaves | 47.7 | 3.35 | 1406 | 48.0 | 3.38 | 1428 | 48.6 | 3.15 | 1347 |
| $N_{32}P_{32}K_{32}$+ Novalon Foliar 1 kg/ha in the phase of 5–6 pairs of leaves | 47.7 | 3.35 | 1406 | 48.2 | 3.41 | 1446 | 48.9 | 3.15 | 1356 |
| $LSD_{095}$ Oil content in seeds A – 0.5; B – 0.7; AB – 1.1, Oil collection A – 18; B – 22; AB – 35 | | | | | | | | | |

**Conclusions.** Our results mainly confirm the results of other studies. Mineral fertilizers and microfertilizers promote more intensive growth and development of plants and increase the yields of sunflower seeds. However, there are some discrepancies in the oil content in seeds. Some researchers reported that mineral fertilization increased the oil content in seeds compared to the control (no fertilizers). We found that application of mineral fertilizers at a dose of $N_{32}P_{32}K_{32}$ caused a decrease in the oil content in seeds, and only supplementary foliar fertilization with urea or microfertilizers increased this indicator. The oil content in Ahronomichnyi and Ahent increased by

0.1-0.5% compared to the 'no fertilizers' experiment. Serpanok accumulated the greatest amount of oil without fertilizers. The highest yield and oil collection from hybrids Ahronomichnyi, Ahent and Serpanok were achieved by combining basic application of mineral fertilizers $N_{32}P_{32}K_{32}$ and foliar fertilization of plants with microfertilizer Novalon Foliar 1 kg/ha in the phase of 5-6 pairs of leaves: 3.35 t/ha, 3.41 t/ha, 3.15 t/ha, respectively, and 1,406 kg/ha, 1,446 kg/ha and 1,356 kg/ha, respectively. These results allow sunflower producers to choose those farming measures that will help increase not only the yield, but also the oil output per unit area.

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## *ВПЛИВ МАКРО- І МІКРОДОБРИВ НА БІОМЕТРИЧНІ, ПРОДУКТИВНІ ТА ЯКІСНІ ПОКАЗНИКИ ГІБРИДІВ СОНЯШНИКУ*

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**Метою** досліджень було вивчення впливу системи удобрення на ріст, розвиток та урожайність гібридів соняшнику різних груп стиглості (селекції Інституту олійних культур) в умовах лівобережного Лісостепу України.

**Матеріали і методи.** Дослідження проводили протягом 2019–2020 рр. на Полтавській державній сільськогосподарській дослідній станції ім. М.І. Вавилова. Вихідний матеріал – гібриди соняшнику: Агрономічний, Агент, Серпанок; варіанти удобрення: 1) без добрив (контроль); 2) $N_{32}P_{32}K_{32}$,; 3) $N_{32}P_{32}K_{32}$ + позакореневе підживлення рослин карбамідом (10 кг/га) у фазу 5–6 пар листків; 4) $N_{32}P_{32}K_{32}$ + позакореневе підживлення рослин мікродобривами Новалон Фоліар (1 кг/га) у фазу 2–3 пар листків; 5) $N_{32}P_{32}K_{32}$ + позакореневе підживлення рослин мікродобривами Новалон Фоліар (1 кг/га) у фазу 5–6 пар листків.

**Обговорення результатів**. Мінеральні макро- та мікродобрива сприяли більш інтенсивнішому росту та розвитку рослин. Так, найбільшою висота рослин була за внесення мінерального удобрення дозою $N_{32}P_{32}K_{32}$ + позакореневого підживлення рослин мікродобривами Новалон Фоліар (1 кг/га) у фазу 2–3 пар листків. Порівняно з контролем (без добрив) висота рослин на цих варіантах збільшилася від 7,0 до 11,0 см.

Внесення мінеральних добрив дозою $N_{32}P_{32}K_{32}$ зумовило зниження вмісту олії у гібридів порівняно з варіантом без добрив на 1,1–1,7 %. У разі підживлення рослин під час вегетації карбамідом або мікродобривом Новалон Фоліар установлено підвищення вмісту олії у насінні на 0,9–1,6 %. Найбільшим вміст олії у насінні був у гібридів Агрономічний, Агент за внесення мінеральних добрив $N_{32}P_{32}K_{32}$ + позакореневого підживлення рослин карбамідом 10 кг/га у фазу 5–6 пар листків – 47,8 %, 48,4 %, відповідно.

**Висновки.** Мінеральні добрива та мікродобрива сприяють більш інтенсивнішому росту та розвитку рослин, збільшенню врожайності насіння соняшнику. Внесення мінерального удобрення дозою $N_{32}P_{32}K_{32}$ зумовило зниження вмісту олії в насінні, і тільки додаткове позакореневе підживлення карбамідом або мікродобривами підвищило даний показник. Найбільша врожайність та збір олії у гібридів Агрономічний, Агент, Серпанок були одержані за поєднання основного внесення мінеральних добрив $N_{32}P_{32}K_{32}$ та позакореневого підживлення рослин мікродобривом Новалон Фоліар 1 кг/га у фазу 5–6 пар листків – 3,35 т/га, 3,41 т/га, 3,15 т/га та 1406 кг/га, 1446 кг/га, 1356 кг/га відповідно. Отримані результати досліджень дають можливість виробнику визначити ті агротехнічні заходи, які сприятимуть підвищенню не тільки врожайності соняшнику, а й виходу олії з одиниці площі.

***Ключові слова:*** *соняшник, гібрид, мінеральні добрива, мікродобрива, урожайність, вміст олії у насінні.*

# *ВЛИЯНИЕ МАКРО- И МИКРОУДОБРЕНИЙ НА БИОМЕТРИЧЕСКИЕ, ПРОДУКТИВНЫЕ И КАЧЕСТВЕННЫЕ ПОКАЗАТЕЛИ ГИБРИДОВ ПОДСОЛНЕЧНИКА*

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**Целью** исследований было изучение влияния системы удобрения на рост, развитие и урожайность гибридов подсолнечника разных групп спелости (селекции Института масличных культур) в условиях левобережной Лесостепи Украины.

**Материалы и методы.** Исследования проводили в 2019–2020 гг. на Полтавской государственной сельскохозяйственной опытной станции им. Н.И. Вавилова. Исходный материал – гибриды подсолнечника: Агрономічний, Агент, Серпанок; варианты удобрения: 1) без удобрения (контроль); 2) $N_{32}P_{32}K_{32}$,; 3) $N_{32}P_{32}K_{32}$ + внекорневая подкормка растений карбамидом (10 кг/га) в фазе 5–6 пар листьев; 4) $N_{32}P_{32}K_{32}$ + внекорневая подкормка растений микроудобрениями Новалон Фолиар (1 кг/га) в фазе 2–3 пар листьев; 5) $N_{32}P_{32}K_{32}$ + внекорневая подкормка растений микроудобрениями Новалон Фолиар (1 кг/га) в фазе 5–6 пар листьев.

**Обсуждение результатов**. Минеральные макро- и микроудобрения способствовали более интенсивному росту и развитию растений. Так, наибольшей высота растений была при внесении минерального удобрения в дозе $N_{32}P_{32}K_{32}$ + внекорневая подкормка растений микроудобрениями Новалон Фолиар (1 кг/га) в фазе 2–3 пар листьев. В сравнении с контролем (без удобрений) высота растений на этих вариантах увеличилась от 7,0 до 11,0 см.

Внесение минеральных удобрений в дозе $N_{32}P_{32}K_{32}$ обуславливает понижение содержания масла у гибридов в сравнении с вариантом без удобрений на 1,1–1,7 %. В случае подкормки растений во время вегетации карбамидом или микроудобрением Новалон Фолиар установлено повышение содержания масла в семянках на 0,9–1,6 %. Наибольшим содержание масла было у гибридов Агрономічний, Агент при внесении минеральных удобрений $N_{32}P_{32}K_{32}$ + внекорневая подкормка растений карбамидом 10 кг/га в фазе 5–6 пар листьев – 47,8 %, 48,4 %, соответственно.

**Выводы.** Минеральные удобрения и микроудобрения способствуют более интенсивному росту и развитию растений, повышению урожайности семян подсолнечника. Внесение минерального удобрения в дозе $N_{32}P_{32}K_{32}$ привело к снижению содержания масла, и только дополнительная внекорневая подкормка карбамидом или микроудобрениями повысила этот показатель. Наивысшая урожайность и сбор масла у гибридов Агрономічний, Агент, Серпанок были получены при сочетании основного внесения минеральных удобрений $N_{32}P_{32}K_{32}$ и внекорневой подкормки растений микроудобрениями Новалон Фолиар 1 кг/га в фазе 5–6 пар листьев – 3,35 т/га, 3,41 т/га, 3,15 т/га и 1406 кг/га, 1446 кг/га, 1356 кг/га соответственно. Полученные результаты дают возможность производителю определять агротехнические мероприятия, способствующие повышению только урожайности подсолнечника, но и выхода масла с единицы площади.

***Ключевые слова**: подсолнечник, гибрид, минеральные удобрения, микроудобрения, урожайность, содержание масла в семенах.*

***INFLUENCE OF MACRO- AND MICRO-FERTILIZERS ON BIOMETRY, PERFORMANCE AND QUALITATY OF SUNFLOWER HYBRIDS***

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Sunflower is a crop requiring intensive mineral nutrition, therefore, its cultivation demands reserves of nutrients in the soil, which can be replenished by applying mineral fertilizers.

**Purpose.** Our purpose was to study the effects of fertilizers on the growth, development and yield of sunflower hybrids of different ripeness groups (bred at the Institute of Oil Crops) in the Left-Bank Forest-Steppe of Ukraine.

**Material and methods.** The study was conducted at Poltava State Agricultural Research Station named after N.I. Vavilov in 2019–2020

The study object was processes of the growth and development of sunflower plants and formation of sunflower seeds depending on farming techniques.

The study subject was sunflower hybrids Ahronomichnyi, Ahent and Serpanok. The following fertilizers were applied: 1) no fertilizers (control); 2) $N_{32}P_{32}K_{32}$; 3) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with urea (10 kg/ha) in the phase of 5–6 pairs of leaves; 4) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 2–3 pairs of leaves; 5) $N_{32}P_{32}K_{32}$ + foliar fertilization of plants with microfertilizer Novalon Foliar (1 kg/ha) in the phase of 5–6 pairs of leaves.

**Results and discussion**. The results show that mineral macro- and microfertilizers contributed to more intensive growth and development of plants. Thus, the tallest plants, the largest leaves and calathidiums, and the highest 1000-seed weight were recorded hybrids Ahronomichnyi, Ahent and Serpanok with basic mineral fertilizers at a dose of $N_{32}P_{32}K_{32}$ + foliar fertilization with carbamide (10 kg/ha) or with microfertilizer Novalon Foliar (1 kg/ha).

The maximum yields from hybrids Ahronomichnyi, Ahent and Serpanok were achieved with basic mineral fertilizers $N_{32}P_{32}K_{32}$ + foliar fertilization with microfertilizer Novalon Foliar (1 kg/ha) – 3.35 t/ha, 3.41 t/ha and 3.15 t/ha respectively. The gain to the control (no fertilizers) was 0.33 t/ha, 0.32 t/ha and 0.22 t/ha, respectively.

Fertilization also affected the oil content in seeds. Mineral fertilizers $N_{32}P_{32}K_{32}$ decreased the oil content in the hybrid seeds by 1.1–1.7% compared to the ‘no fertilizers’ experiment. However, fertilization of plants during the growing period with urea or microfertilizer Novalon Foliar in combination with basic mineral fertilizers $N_{32}P_{32}K_{32}$ significantly increased the oil content in seeds.

With the best yields, the highest output of oil from the hybrids was 1,406 kg/ha, 1,446 kg/ha and 1,356 kg/ha, respectively.

**Conclusions.** Our results mainly confirm the results of other studies. Mineral fertilizers and microfertilizers promote more intensive growth and development of plants and increase the yields of sunflower seeds. However, there are some discrepancies in the oil content in seeds. Some researchers reported that mineral fertilization increased the oil content in seeds compared to the control (no fertilizers). We found that application of mineral fertilizers at a dose of $N_{32}P_{32}K_{32}$ caused a decrease in the oil content in seeds, and only supplementary foliar fertilization with urea or microfertilizers increased this indicator.

***Key words:*** *sunflower, hybrid, mineral fertilizer, microfertilizers, productivity, oil content.*