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THE IMPACT OF FERTILIZERS ON THE YIELD OF CORN HYBRIDS IN THE CONDITIONS OF THE NORTHERN STEPPE OF UKRAINE

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Problem statement. In modern agricultural production, corn occupies a leading position due to its versatility and economic value. However, in the context of global climate change and increasing water scarcity, the issue of forming yield and productivity of corn hybrids is becoming increasingly relevant. Modern breeding seeks to address this problem by creating new hybrids that are resistant to prolonged drought and high temperatures, allowing them to adapt to stressful conditions. In conditions of insufficient moisture, it is necessary to develop cultivation technologies that take into account the specifics of particular hybrids and agro-climatic conditions. This will enhance resource use efficiency and ensure stable yields, which is critically important for food security.

Analysis of recent research and publications. Corn is a high-yielding crop capable of producing a harvest across a significant range of natural conditions, enduring the impact of adverse weather factors. At the same time, the potential of this crop has not yet been fully realized. The hybrids developed are not always well adapted to changing environmental conditions [8, 9]. Thus, the main task in the development of corn production for grain is to focus efforts on increasing the crop yield, as the expansion of sown areas has certain limits. This should be facilitated by the application of scientifically grounded cultivation technologies and the use of modern innovative hybrid potential of corn [2, 7].

In recent years, there has been a significant increase in the number of corn hybrids in the State Register of Plant Varieties of Ukraine, which differ in the duration of the growing season, plant height, resistance to crowding, diseases, drought, and reaction to fluctuations in nutrient levels and water regime, among others [15].

Researchers have established that it is almost impossible to combine high yield and stability of this trait under different growing conditions, as hybrids with FAO up to 390 generally have more stable yields, while hybrids with FAO over 400 sharply reduce productivity when optimal growing conditions are disrupted [6, 16].

In production, it is advisable to use hybrids with different types of reactions to environmental variability, including intensive types. The adaptability of corn hybrids to constantly changing external conditions plays an important role in ensuring high grain yields. The diversity of corn growing conditions requires certain ecological characteristics of the hybrids. Creating forms that combine high potential productivity with genetically determined resistance or adaptability to various soil and climatic conditions is one of the key tasks [1, 12].

Increasing corn grain production volumes is possible through the improvement of its cultivation technologies, which includes the introduction of new high-yielding hybrids, the use of modern plant protection measures, and the optimization of mineral nutrition. The most important factor for increasing yield and improving grain quality, given sufficient moisture or irrigation, is the creation of an optimal agro-environment. Providing plants with necessary macro- and microelements allows for effective regulation of their growth and development processes, which in turn enhances productivity [10, 11, 14].

Nitrogen is a key element in the initial stages of organogenesis; its deficiency significantly slows down plant growth. Plants absorb the most nitrogen two to three weeks before the tasseling phase, while its absorption ceases at the stage of milk-wax maturity of the grain. The provision of corn crops with nitrogen is particularly crucial at the initial stages of organogenesis, as its deficiency greatly delays plant growth and development. The most intense nitrogen consumption by plants occurs during the two to three weeks leading up to tasseling, and it completely ceases at the beginning of milk-wax maturity of the grain [3, 5, 6].

Foliar feeding with micronutrients also plays an important role in increasing corn productivity. Optimizing the level of mineral nutrition is an important reserve for enhancing grain productivity in corn and requires more detailed study, especially in the context of new and promising hybrids of the crop [5, 13, 17, 18].

Objective. Establishing the dependence of corn hybrid yield levels on the use of mineral fertilizers and micronutrients in the conditions of the Northern Steppe of Ukraine.

Materials and methods of research. The research was conducted from 2023 to 2025 at the farm “Kozak”, located in the territory of the Katerynivka rural community in the Kropyvnytskyi district of the Kirovohrad region.

The weather conditions during the years of the study were not sufficiently favorable for achieving high corn yield indicators.

The spring of 2023 was characterized by contrasting weather, but overall it fell within the range of long-term average values. By the end of May, corn had formed 3–5 leaves, while earlier sown varieties had 7 leaves. The average air temperature during the calendar summer was 21.2–22.4 °C, which is one degree above the norm. Precipitation during the summer amounted to 110 mm, which is less than the climatic norm by 61–79 %. During the third decade of September, due to prolonged dry weather, grain moisture loss accelerated, and harvesting began

The spring of 2024 was also characterized by contrasting weather, but overall it remained within the range of long-term average values. Corn sowing that year began in early April due to early spring development processes. June turned out to be warm and dry, July was hot and also dry, and in August, dry hot weather predominated. This hot summer of 2024 was the first such occurrence since observations began in 1945-2024. In the second decade of August, corn reached full ripeness, and harvesting continued.

The spring of 2025 was characterized by very contrasting weather. In June, leaf formation continued in corn under satisfactory agro-meteorological conditions. By the end of the first decade of July, tasseling began, and in some areas, flowering of both tassels and ears was noted, which occurred within and 1–1.5 weeks earlier than long-term average dates. In the last days of June, due to hot weather, wilting of plants was observed during daytime hours. Rainy weather at the end of September did not promote rapid grain moisture loss and extended the harvesting period.

In the experiment, we sowed: hybrid MAS 23.M (FAO 260), a simple dent-type grain hybrid with short plants, characterized by early flowering and rapid grain moisture loss, and a simple hybrid LG 31272 (FAO 270), a flint-dent type grown for grain and high-starch silage, which is characterized by early flowering and stable yields under various soil-climatic conditions.

In the experiment, Factor B was the application of mineral fertilizers: urea was used during spring cultivation at a rate of 100 kg/ha, and a urea-ammonium mixture (CAS 30) was applied before sowing at a rate of 150 kg/ha (aqueous solution 1:0.4). In the 5-8 leaf stage, foliar fertilization (Factor C) was conducted using a liquid chelated water-soluble micronutrient Smart Grow Zinc at a rate of 1 l/ha.

Research results. The results of the three-year research conducted by us in the conditions of the Northern Steppe of Ukraine confirmed that the choice of hybrid for cultivation in a specific farm is an important element of agricultural technology.

It was established that the hybrid LG 31272 significantly lagged behind the yield indicators of another hybrid, MAS 23.M, which we studied. On average, the difference was 0.25 t/ha or 5.6 % at LSD 0.05 = 0.23 t/ha. The maximum yield difference was achieved by using urea – 0.31 t/ha or 6.6 %, while additional foliar fertilization with the micronutrient Smart Grow Zinc somewhat mitigated this difference, indicating an increased response of the LG 31272 hybrid to the action of micronutrients. It should also be noted that the application of CAS 30 in the cultivation technology of hybrids in our experiment did not affect the difference in their yield indicators – 4.69–4.88 t/ha (Table 1).

The application of mineral fertilizers, regardless of type, provided a significant increase in the yield of the hybrids we cultivated in the experiment; moreover, the difference between the indicators was significant – 1.23–1.33 t/ha or 33.7–38.8 %. Additionally, it should be noted that the response of the MAS 23.M hybrid to urea and CAS 30 was more pronounced than that of the LG 31272 hybrid. Thus, with the application of urea at a rate of 100 kg/ha, the yield increase for the MAS 23.M hybrid was 1.33 t/ha or 36.4 %, while with CAS 30 it was 1.23 t/ha or 33.7 %. The increase in yield for the LG 31272 hybrid was within 1.29–1.31 t/ha or 38.2–38.8 %.

We have also demonstrated the effectiveness of using micronutrients when growing corn. Spraying corn plants with microfertilizer during the 5–8 leaf stage resulted in a yield increase of 0.15–0.22 t/ha, which corresponds to a significant difference at LSD05 = 0.13 t/ha. When growing the MAS 23.M hybrid, the use of microfertilizer against the background of various macronutrients had the same effect, +0.17–0.18 t/ha, or 3.4–3.7 %. The LG 31272 hybrid reacted more actively to the combination of the Smart Grow Zinc microfertilizer with urea in the cultivation technology, resulting in a yield increase of 0.22 t/ha.

The comprehensive use of micro- and macrofertilizer ensured the formation of higher grain yields of corn hybrids in our experiment. The maximum yield was observed when cultivating the MAS 23.M hybrid – 5.15 t/ha, with an increase in yield due to these factors of 1.50 t/ha or 41.1 %. The LG 31272 hybrid had slightly lower indicators, at 4.67–4.84 t/ha, but the effect of the fertilizer complex was greater, at +1.16–1.51 t/ha.

Table 1

Yield of corn hybrids depending on fertilization, 2023-2025

Hybrid (Factor A)	Mineral fertilizers (Factor B)	Microfertilizer (Factor C)	Yield, t/ha	Difference, factor A		Difference, factor B		Difference, factor C		Difference, factor BC	
				t/ha	%	t/ha	%	t/ha	%	t/ha	%
MAC 23.M	Without fertilizers (control)		3.65			–	–	–	–	–	
	Urea	Without microfertilizer	4.98			1.33	36.4	–	–	–	–
		Smart Grow Zinc	5.15			–	–	0.17	3.4	1.50	41.1
	CAS 30	Without microfertilizer	4.88			1.23	33.7	–	–	–	–
		Smart Grow Zinc	5.06			–	–	0.18	3.7	1.41	38.6
	Average		*4.74*								
LG 31272	Without fertilizers (control)		3.38	–0.27	–8.0	–	–	–	–	–	–
	Urea	Without microfertilizer	4.67	–0.31	–6.6	1.29	38.2	–	–	–	–
		Smart Grow Zinc	4.89	–0.26	–5.3	–	–	0.22	4.7	1.51	44.7
	CAS 30	Without microfertilizer	4.69	–0.19	–4.1	1.31	38.8	–	–	–	–
		Smart Grow Zinc	4,84	–0,22	–4,5	–	–	0,15	3,2	1,46	43,2
	Average		*4,49*	*–0,25*	*–5,6*						
LSD05 (t/ha): factor A = 0.23, factor B = 0.10, factor C = 0.13, factors BC = 0.25											

Conclusions. Thus, the use of mineral fertilizers CAS 30 and urea in combination with the Smart Grow Zinc microfertilizer provided a significant increase in the yields of MAS 23.M and LG 31272 corn hybrids under conditions of insufficient moisture in the Northern Steppe of Ukraine.

Higher yield indicators were obtained when growing the MAS 23.M hybrid with the application of urea and foliar feeding with Smart Grow Zinc microfertilizer – 5.15 t/ha. The LG 31272 corn hybrid formed a slightly lower grain yield – 4.67–4.84 t/ha, but the yield increase due to the action of fertilizers was greater, at +1.16–1.51 t/ha, which confirms the high potential of this hybrid and necessitates further research.

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Sokolovska I. M., Kovalenko V. O. The impact of fertilizers on the yield of corn hybrids in the conditions of the northern steppe of Ukraine

The aim of the study. Establishing the dependence of corn hybrid yield levels on the use of mineral fertilizers and micronutrients in the conditions of the Northern Steppe of Ukraine. **Methods.** The study involved growing simple hybrids MAS 23.M (dent) and LG 31272 (flint-dent) from the medium-early maturity group intended for grain production, which are recommended for the Steppe zone of Ukraine. Fertilization options included: urea applied during spring tillage at a rate of 100 kg/ha, and a urea-ammonium mixture (CAS 30) introduced before sowing at a rate of 150 kg/ha (aqueous solution 1:0.4). In the 5–8 leaf stage, foliar fertilization was conducted using the liquid chelated water-soluble Smart Grow Zinc microfertilizer at a rate of 1 l/ha. **Results.** It was established that the hybrid LG 31272 significantly lagged behind the yield indicators of hybrid MAS 23.M, with yields of 4.49 t/ha and 4.79 t/ha, respectively. The application of mineral fertilizers, regardless of type, ensured a significant increase in hybrid yields, with differences being substantial – 1.23–1.33 t/ha or 33.7–38.8 %. The use of microfertilizer provided an average yield increase of 0.15–0.22 t/ha, which corresponds to a significant difference at $LSD_{05} = 0.13$ t/ha. The maximum yield was observed with the comprehensive use of fertilization elements studied: when growing hybrid MAS 23.M – 5.15 t/ha, with a yield increase of 1.50 t/ha or 41.1 %; for hybrid LG 31272 – 4.89 t/ha and +1.51 t/ha or 44.7 %, respectively. **Conclusions:** The use of mineral fertilizers CAS 30 and urea together with the Smart Grow Zinc microfertilizer contributed to a significant increase in yields of corn hybrids MAS 23.M and LG 31272 under conditions of insufficient moisture in the Northern Steppe of Ukraine. Higher yield indicators were recorded for hybrid MAS 23.M, where the application of urea and foliar fertilization with microfertilizer resulted in a yield of 5.15 t/ha. Hybrid LG 31272 had lower yields, but higher indicators were formed against the background of CAS 30 application (4.89 t/ha) and the yield increase due to fertilizers amounted to 1.51 t/ha or 44.7 %, indicating the high potential of this hybrid and the need for further research.

Key words: corn hybrids, macronutrients, micronutrients, corn yield.

Соколовська І. М., Коваленко В. О. Вплив добрив на урожайність гібридів кукурудзи в умовах північного степу України

Мета досліджень. Встановлення залежності рівнів врожайності гібридів кукурудзи від використання мінеральних добрив та мікроелементів в умовах Північного Степу України. **Методи.** В досліді вирощували прості гібриди MAS 23.M (зубовидний) та LG 31272 (кремнисто-зубовидний) середньоранньої групи стиглості зернового напрямку використання, які рекомендовані для зони Степу України. Варіанти удобрення: карбамід використовували під час весняного обробітку з розрахунку 100 кг/га, карбамідно-аміачну суміш (CAS 30) вносили перед посівом з розрахунку 150 кг/га (водний розчин 1:0,4). У фазі 5–8 листків проводили позакореневе підживлення з використанням рідкого хелатного водорозчинного мікродобрива Smart Grow Zinc з розрахунку 1 л/га. **Результати.** Встановлено, що гібрид LG 31272 значно поступався за показниками врожайності гібриду MAS 23.M, 4,49 т/га та 4,79 т/га відповідно. Внесення мінеральних добрив, незалежно від виду, забезпечило значне збільшення врожайності гібридів, різниця між показниками була істотною – 1,23–1,33 т/га або 33,7–38,8 %. Використання мікродобрива забезпечило приріст врожаю зерна кукурудзи гібридів в середньому на 0,15–0,22 т/га, що відповідає суттєвій різниці при $HIP_{05} = 0,13$ т/га. Максимальна врожайність спостерігалася при комплексному використанні елементів удобрення, які ми досліджували: при вирощуванні гібрида MAS 23.M – 5,15 т/га, прибавка врожаю складала 1,50 т/га або 41,1 %.; гібрида ЛГ 31272–4,89 т/га та +1,51 т/га або 44,7 % відповідно. **Висновки.** Використання мінеральних добрив КАС 30 та карбаміду разом із мікродобривом Смарт Гроу Цинк сприяло значному підвищенню врожайності гібридів кукурудзи МАС 23.М та ЛГ 31272 в умовах недостатнього зволоження північного Степу України. Вищі показники урожайності були зафіксовані у гібрида МАС 23.М, де застосування карбаміду та позакореневого підживлення мікродобривом дало результат 5,15 т/га. Гібрид ЛГ 31272 мав нижчу врожайність, при цьому вищі показники формувалися на фоні внесення КАС 30 (4,89 т/га) і приріст врожаю завдяки добривам становив 1,51 т/га або 44,7 % що свідчить про високий потенціал цього гібрида та необхідність його подальших досліджень.

Ключові слова: гібриди кукурудзи, макродобрива, мікродобрива, урожайність кукурудзи.

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