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ВІННИЦЬКИЙ НАЦІОНАЛЬНИЙ АГРАРНИЙ УНІВЕРСИТЕТ

Сільське господарство та лісівництво

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THE APPLICATION OF DIFFERENT FERTILIZER SYSTEM FOR THE FORMATION OF CORN (*ZÉA MÁYS)* HYBRIDS GRAIN PRODUCTIVITY

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The main goal of our investigation was to determine the influence of different mineral fertilizer rates on the formation of corn hybrids productivity and their dependence on hydrothermal conditions. Medium-early hybrid SY Fenomen (FAO 220) and medium-ripe SY Torino (FAO 310) were selected and analysed for research. The corn fertilization system consists of three methods:Main, row and top dressing. Under conditions of optimal fertilization inthe growing season corn can provide high yields on almost all soils.almost all soils. Scientists distinguish two important stages of plant developmentcorn, the so-called critical phases, regarding the provision of their macro- andmicroelements, these are the phases of 3-5 and 7-8 leaves. From the provision of elementsnutrition, especially pay attention to the presence of phosphorus, depends onthe formed number of cobs on the plant and grains on them. Corn reacts strongly to nitrogen fertilization. To ensurehigh efficiency of its application and optimization of the dose, in addition to samplingsamples and expected yields, it is necessary to determine the amount of nitrogen contained in the soil.Contained in the soil. The amount of soil nitrogen can be very different andrange from 20-100 kg N depending on the predecessor and itsnutrition, soil class and agricultural practices used. Nitrogen is the most important of all nutrients that affect the level ofcorn yield. Corn consumes nitrogen up to the phase of 8 leaves, until thismoment only 2-3% of nitrogen is absorbed, from the phase of 8 leaves to the phase of dryingflower columns (hair) on the cobs - 85% of the total amount of nitrogen.The rest of the nitrogen corn continues to consume almost until the beginning of cobs. The influence of mineral fertilizers on the formation of individual productivity and the use of mineral fertilizers at a dose of $N_{128}P_{128}K_{128}$ + N_{70} provided the highest height of maize plants 212.6 cm for SY Fenomen and 227.4 cm for SY Torino. The height of cob attachment under these conditions was 82.7-88.4 cm. Additional use of 70 kg of nitrogen on the background of $N_{128}P_{128}K_{128}$ allowed to form the highest biometric values of the cob. Thus, in the hybrid SY Fenomen the length was 24.4 cm and the diameter was 5.1 cm, while in the SY Torino hybrid it was 25.6 and 5.3 cm, respectively. The use of a complete fertilizer system ($N_{128}P_{128}K_{128}$ + N_{70}) in the cultivation of corn hybrids has increased grain yield from cobs to 82.8-83.6% against 79.5-80.8% in control, and accordingly the weight of 1000 seeds up to 336-345 g against 318-329. The use of mineral fertilizers had a positive effect on the formation of grain productivity indicators of corn hybrids. And the more nitrogen fertilizers were applied, the higher was the yield. Compared to the variant without fertilizer, the yield of corn hybrids increased by 83-90% and amounted to 12.18-12.88 t ha^{-1}.

Keywords: *hybrid, corn, productivity, mineral fertilizers, yield structure.*
Table. 5. Lit. 17.

Introduction. (Formation of the problem). Corn has long been considered as one of the oldest agricultural crops and the main crop of today's world agriculture.

Today it is one of the most productive cereals with a variety of uses. According to the WTO (World Trade Organization), about 20% of corn grain is used for food needs in the world, 15-20% for technical needs, and about 60-65% is allocated for livestock feed [14].

Corn for grain in Ukraine occupies about 1.2 million hectares, and corn for silage and green fodder occupy 4.5-5 million hectares. Large areas under corn are in the United States (29 mln. ha), Brazil (12 mln. ha), India (5.8 mln. ha), Argentina (3.5 mln. ha). It is grown in large areas in Romania, Yugoslavia, Italy, Hungary, Bulgaria [6]. According to scientists, corn grain contains about 65-70% carbohydrates, 9-12% protein, and fat at the level of 4-8%, in addition, it also contains mineral salts and various vitamins. It is estimated that 100 kg of corn grain contains 134 feed units and about 8 kg of digestible protein. Due to its high energy nutrient content, namely: 100 kg of dry grain provides 1600 MJ of metabolic energy. Over the last decade, Ukraine has doubled the area under corn, and the yield of this crop has tripled [14].

High yields of corn grain are obtained by farms that grow it using intensive technology. Thus, according to the Harvest Online website, in the conditions of 2021, as on the October 28, Poltava, Chernihiv and Vinnytsia regions are three top leaders in corn grain harvest, respectively. The corn grain harvest amounted to 11.16 million tons from an area of 1.76 million hectares (32%) with a yield of 6.34 tons / ha [3]. Fertilizers are one of the priority factors in intensifying crop production, as it has a high impact on the productivity of crops, including corn [1].

The issue of corn fertilization has been studied in detail by both foreign and domestic scientists [7, 11]. The corn fertilization system consists of three methods: basic, line and foliar fertilization. Under conditions of optimal fertilization during the growing season, corn can provide high yields on almost all soils. Scientists identify two important stages in the development of corn plants, the so-called critical phases, in terms of providing them with macro- and micronutrients, these are the phases of 3−5 and 7−8 leaves. From the supply of nutrients, especially attention should be paid to the presence of phosphorus, depends on the number of cobs on the plant and grains on them.

Corn reacts strongly to nitrogen fertilizers. To ensure high efficiency of its application and optimization of the dose, in addition to sampling and expected yield, it is necessary to determine the amount of nitrogen contained in the soil. The amount of soil nitrogen can be very different and be in the range of 20-100 kg N depending on the predecessor and its fertilizing system, soil class and agricultural techniques used [17].

Nitrogen has the greatest effect on the level of corn yields. Corn consumes nitrogen up to the phase of 8 leaves, so far only 2-3% of nitrogen is absorbed, from the phase of 8 leaves to the phase of drying of flower columns (hair) on the cobs - 85% of the total amount of nitrogen. Corn continues to consume the rest of the nitrogen almost until the cobs reach maturity [1].

According to the authors S. P. Tanchyk and L. V. Centilo, it is ecologically

expedient to include corn in the technology of mineral fertilizers in norms not exceeding $N_{90}P_{90}K_{90}$ for growing corn for grain on typical blacksoils. Exceeding this norm is undesirable for reasons of both environmental feasibility (inhibition of nitrogen fixation throughout the growing season and significant losses of nitrogen gas) and economic (yield returns are relatively low). The use of manure and biocompost is environmentally sound and affects the yield of corn, however, compost does not cause significant emissions of N_2O in contrast to manure, which makes the loss of nitrous oxide losses are among the highest in the experiment. The advantages of compost over manure are obvious both from the point of view of environmental protection and from economic considerations, as its required amount is twice less than the norm of manure [9, 10, 15, 17].

Corn has a positive effect on the after-effects of organic fertilizers, which can last for several years after the application of manure under the predecessor. The full norm of phosphorus and potassium fertilizers and the main part of nitrogen fertilizers are most often applied under fallow tillage so that they get into the soil layer with guaranteed moisture, where the main part of the root system of plants is located. The rest of the nitrogen is added to the fertilizer during inter-row tillage and foliar.

According to research, it was found that the duration of the growing season directly depends on the density of corn plants, varietal characteristics of hybrids and the rate of mineral fertilizers. The Kakhovsky hybrid had a shorter (114 days) vegetation period with a density of 60 thousand / ha, regardless of the norms of mineral fertilizers. The longest growing season was recorded in Skadovsky hybrids at a density of 80 and 90 thousand / ha and application of $N_{120}P_{120}$ (respectively 124 and 126 days) and Arabat in variants 90 thousand / ha and $N_{90}P_{90}$ − 125 days [8].

Corn needs a certain amount of phosphorus in a certain amount than nitrogen or potassium. Phosphorus plays a particularly significant role for the plant in two phases. In the initial phase of growth and development, phosphorus provides intensive initial plant growth and optimal development of the root system of corn. It is a component of nucleic acids, participates in energy metabolism, plays a huge role in the accumulation of carbohydrates, and regulates respiration, photosynthesis and more. The second critical phase, when phosphorus is most needed, occurs during the formation of generative organs [4].

Material and methods. The medium-early hybrid SY Fenomen (FAO 220) and medium-ripe SY Torino (FAO 310) were studied, the originator of which is Syngenta Ltd. Corn hybrids were sown in a wide row (70 cm), with a standing density for the harvest period of 75 thousand plants / ha.

Corn hybrid SY FENOMEN (FAO 220). Originator – Ltd. Syngenta. Registration year – 2016. Maturity group – middle-early. The hybrid has a high yield potential. It has a high level of drought resistance, rapid moisture loss of grain during ripening. It has an erectoid arrangement of leaves. Stay Green plants provide high quality for animal feed. Coud be used for grain or silage. Grain type: dentiform. Type of adaptability: highly adaptive. The starch content in the grain is 72-74%. It has a

number of valuable features: cold resistance − 9 out of 9 points; drought resistance − 8 out of 9 points; moisture yield 9 out of 9 points; initial growth rate − 8 out of 9 points. In addition, the hybrid has a high resistance to root and stem rot and vesicular smut − 8 out of 9 points.

It is suitable for sowing in the early stages (at a temperature of +6 ...8 ° C at the depth of seed wrapping). It is suitable for re-cultivation in the same field (for monoculture). It is recommended for harvesting at an optimal early date. The hybrid is recommended to growing in soils-climatic zones: Steppe (Northern), Forest-Steppe, Polissya. Recommended plant density for the harvest period: in conditions of sufficient moisture − 70-80 thousand / ha, unstable moisture − 60-70 thousand / ha and insufficient moisture − 45-55 thousand / ha.

Corn hybrid SY TORINO (FAO 310). Originator – Ltd. Syngenta. Registration year – 2019. Maturity group – medium-ripe. The hybrid is able to provide high and stable yields. Has an average growth rate at the beginning of the growing season. Has a high yield potential, able to provide high cost recovery for intensive cultivation technology. The erectile type of leaf placement reduces the competition of plants in light crops and increases the efficiency of photosynthesis. The grain quickly releases moisture during ripening, which saves the cost of post-harvest drying of grain.

Coud be used for grain. Grain type: dentiform. Type of adaptability: medium flexible. The hybrid has a fairly high cold resistance − 8 out of 9 points; drought resistance − 7 out of 9 points; moisture transfer − 9 out of 9 points; initial growth rate − 7 out of 9 points. The corn hybrid has a high resistance of 7 out of 9 points to root and stem rot and 8 out of 9 points to vesicular smut.

It is recommended to sow at the optimally early time (at a temperature of +9 ... 12 ° C at the depth of seed wrapping). It is suitable for re-cultivation in the same field (for monoculture). The hybrid is recommended to growing in soils-climatic zones: Steppe, Forest-Steppe, and Polissya. Recommended plant density for the harvest period: in conditions of sufficient moisture − 70-80 thousand / ha, unstable moisture - 60-70 thousand / ha, insufficient moisture − 45-55 thousand / ha.

The predecessor for corn was winter wheat. Soil preparation in the pre-sowing period depended on the predecessor and was aimed at maximally preserving and accumulating moisture in the soil and destroying weeds. Tillage included: after harvesting the predecessor, disking was carried out with heavy harrows BDT-7, and later plowing was carried out with a plow PLN−5-35 to a depth of 25 cm. In the spring, harrowing and pre-sowing cultivation were carried out, under which mineral fertilizers were applied in the dose of $N_{128}P_{128}K_{128}$ in the form of nitroammophoska. Also, the scheme of the experiment for some options provided for the additional application fertilizers at a dose of 70 kg of radical nitrogen in the form of ammonium nitrate in the phase of 6-7 leaves of corn.

The growing technology of corn hybrids was generally accepted for the Forest-Steppe Zone of Ukraine and, in addition to the issues raised, met regional and zonal recommendations.

Climatic conditions of the right-bank Forest-Steppe territory of Ukraine, in

particular where crops are located, were characterized by certain features. The climate is temperate continental, with moderately mild winters and warm and humid summers. The typical temperature in January is -4… -6 °C, while in July + 18.6… + 20.5 °C. The period with a temperature above +10 °C is about 200 days. The sum of active temperatures is 2600 °C. Precipitation in the region is unevenly distributed. 550-600 mm falls in the south-western and western parts, and 500-550 mm in the south-eastern part. The main part (65-75%) of them falls on the warm period of the year. The height of the snow cover reaches 7-15 cm.

Hydrothermal conditions in the year of research were characterized by certain features. It should be noted that in general, the average monthly air temperature and rainfall during the growing season were favorable for growing corn for grain, but the uneven distribution of precipitation did not allow forming the maximum productivity. April turned out to be quite warm, the average daily air temperature was close to the average long-term data and amounted to 9.3 °C, while the amount of precipitation was 29 mm. The following month saw an increase in the average daily air temperature, which was typical for the region. The average monthly air temperature in May 2021 was 13.7 °C, while the amount of precipitation per month was 109 mm, which is almost twice as high as the long-term average of 62 mm.

The indicators of June differed slightly from the long-term average in the direction of increase. Thus, the average daily air temperature in June was 18.9 °C against 16.7 °C, and the amount of precipitation was 99 mm against 72 mm. The month of July 2021 turned out to be quite dry, which to some extent had a negative impact on the growth processes of corn. At the same time, the average daily air temperature for the month was 19.5 °C, and the amount of precipitation was 55 mm, while the average long-term indicators were 18.8 °C and 77 mm, respectively. August was also quite arid, as the amount of precipitation of 35 mm was twice less than the norm (72 mm), while the average monthly air temperature was 21.0 °C. Indicators of temperature and moisture in September were almost equal to the average long-term indicators and were 14.8 °C and 46 mm, respectively. The average daily temperature in October was 8.4 °C and the amount of precipitation was 71 mm, which generally did not prevent the timely start of harvesting corn.

Outline of the main research material. It is proved that the use of mineral fertilizer system, which is based on pre-sowing application of mineral fertilizers and foliar fertilization with nitrogen fertilizers, in corn crops for grain was more efficient, compared to organic by 4.3% [12].

According to scientists, in irrigated conditions in the south of Ukraine, the maximum yield of corn grain (12.9 t ha^{-1}.) was obtained by plowing to a depth of 20-22 cm in a system of differentiated tillage with one slit for crop rotation. Increasing the rate of nitrogen fertilizers from N_{120} to N_{150} did not significantly affect the yield (0.35 t ha^{-1} at LSD_{05} t ha^{-1} − 0.39), and increasing them to N_{180} increased this value by 0.73 t ha^{-1} on average of factor B. Thus, the best tillage scheme is plowing to a depth of 20-22 cm in a system of differentiated tillage with one split for rotation of crop

rotation and fertilizer application at the level of N_{180}.

Some scientists recommend to improve and to increase the biometric performance and productivity of corn for grain, to use biofertilizers, and preparations of mycorrhizal biopreparations [13,14].

The literature often cites the results of studies that indicate that obtaining consistently high yields of corn, primarily formed under conditions of sufficient moisture and high soil fertility, and establishing the optimal dose of fertilizer for each hybrid is the most difficult and priority in growing technology. At the same time, scientists note that in dry years, increasing doses of fertilizers led to a significant decrease in yield. Therefore, increasing nitrogen doses on soils with low fertility further contributed to the increase in corn grain yields in dry years.

The use of NRK_{316} for corn on the options for plowing by-products did not contribute to the accumulation of excess heavy metals in the product. But at the same time, the introduction of high doses of mineral fertilizers for corn crops, namely - $N_{90}R_{90}K_{135}$ against the background of the aftereffect of 30 t ha^{-1} of organic matter stimulated the intensity of the use of plant trace elements. However, the authors noted that the mobility of zinc into the soil decreased, which may have necessitated additional feeding of this trace element [2].

It is well known that foliar fertilizing corn with nitrogen fertilizers enhances the effect of the main fertilizer, but does not replace it. Foliar fertilizing is recommended to be carried out on low-nitrogen, gray forest soils and blacksoils leached, and sod-podzolic soils. The most positive effect is given by early foliar fertilizing of corn plants in the phase of 3-5 leaves. It is primarily needed on poor low-humus soils and in case of insufficient fertilization before sowing corn. Late foliar fertilization reduces its effectiveness and, consequently, prolongs the growing season of corn.

It is necessary to ensure equal distribution of fertilizers to a sufficient depth in the moist soil layer during fertilization. Often in the literature there is a positive effect of foliar fertilization of corn in the period before the ejection of panicles with a solution of urea, it helps to obtain higher yields. About 90% of the total amount of consumed elements corn absorbs before the onset of the phase of milk ripeness, ie almost throughout the growing season. Moreover, nitrogen supply is a key factor in increasing yields, as this element affects the formation of both vegetative biomass and generative organs (cobs) of the crop.

At the beginning of the growing season, plants absorb 3-5% of it, which is to some extent due to low spring temperatures, which inhibit this process. The intensity of nitrogen absorption increases starting from the phase of six to eight leaves formation. In the range of ontogenesis from eight leaves to the phase of drying of flower columns ("hair") on the cobs, the culture absorbs about 85% of the total nitrogen (and the most intensive absorption process is observed 10-20 days before ejection of panicles) [16].

At Eridon company, experts have identified the priority of using fertilizers in the cultivation of corn. Nitrogen fertilizers have been singled out as the main type of

fertilizer used for corn. It is important to use fertilizers with a prolonged effect, such as urea, urea-ammonia mixture. When using liquid nitrogen fertilizers (UAN, ammonia water) it is advisable to use inhibitors of ammonification and nitrification.

As for phosphate fertilizers, they were ranked second in importance in the results of agrochemical analysis of soil. Usually, with medium and high content of mobile phosphorus in the soil, sowing with phosphate fertilizers applying is sufficient. Sulfur fertilizers ranked third in importance. The need for sulfur can be partially met by the addition of ammonium thiosulfate. If the actual content of mobile sulfur is <5 mg / kg of soil − it is advisable to apply before sowing ammonium sulfate or magnesium sulfate.

Potash fertilizers are the fourth most important for corn in the agrochemical analysis of soil is the content of mobile potassium. Usually in the main areas of maize sowing, on chernozem soils, the content of available potassium ranges from 80 to 120 mg / kg of soil, which is quite sufficient to ensure a yield potential of 10-12 t ha^{-1} (potassium).

With lower potassium content in the soil and the desire to get a high yield, it is advisable to apply in the fall 100-150 kg / ha of potassium chloride for tillage. Other indicators of agrochemical analysis of soil: the content of meso- (magnesium, calcium) and trace elements (zinc, boron, copper, iron, manganese, molybdenum, and cobalt) are important and need to monitor their content in the soil. However, full control over the supply of nutrients to plants will give the analysis of plant samples taken during the growing season. Doctor of Agricultural Sciences Hryhoriy Hospodarenko believes that corn has special requirements for mineral nutrition. At the beginning of the growing season, both the aboveground part and the root system develop slowly. It is at this time that a sufficient supply of readily available nutrients is required. Over time, corn develops a strong root system capable of absorbing nutrients from a 1.5-meter layer of soil. This should be taken into account when forming a fertilizer system, especially the application of nitrogen fertilizers.

Fertilization will provide more productive use of moisture by corn plants. With optimal nitrogen nutrition, they actively absorb phosphorus. This accelerates the formation of the leaf apparatus and promotes deeper penetration of roots into the soil, which is especially important in conditions of insufficient moisture. Fertilizers rates for corn are determined taking into account the yield, the content of mobile compounds of nutrients in the soil, rapid diagnosis of plant nutrition. Phosphorus and potassium fertilizers are applied under fallow tillage. This ensures that they are placed in the guaranteed moisture zone during the maize growing season. Nitrogen fertilizers are applied under fallow tillage and on permafrost soil, before leveling the fallow or under pre-sowing cultivation.

It is especially effective to apply urea and UAN on permafrost soil. Urea is not fixed by soil absorbing complex and moves with water to the lower, constantly moistened soil layers, which makes it available to plants in the later stages of the growing season. Applying nitrogen fertilizers under pre-sowing cultivation in case of

insufficient moisture is less effective, because it provokes plants to form the bulk of the root system in the upper layer of the soil, which can dry out, increases weediness of crops. Late autumn application of anhydrous ammonia, ammonia water or urea is also effective (in case of lowering the soil temperature below -10 –5 ° C), and in regions with unwashed water regime − UAN [5].

To solve the main tasks in the cultivation of corn for grain, along with the improvement of agricultural techniques, it is necessary to take into account the weather and climatic conditions of the region and the location of research.

In the main phases of development of corn hybrids, the height of plants and the height of cobs attachment were measured by measuring 10 fixed, typical for this variant plants, in two non-contiguous repetitions, in the flowering phase − from the soil surface to the upper limb. Observations and accounting of the harvest were carried out according to appropriate methods.

The height of the corn plants and the height of the cob attachment are among the important economic features. It is very important that the indicators are as even as possible across the corn field. Because it depends on the quality of harvesting and possible crop losses.

We have established the influence of fertilizer systems and features of hybrids of different maturity groups on the formation of height indicators.

It was found that the maize hybrid SY Fenomen on the variant without fertilizers formed the height of plants at the level of 156.5 cm, when introduced into pre-sowing cultivation nitroammophoska at a dose of $N_{128}P_{128}K_{128}$ plant height increased to 187.3 cm. The additional use of ammonium nitrate at a dose of 70 kg a. s. in the phase of 6-7 leaves provided the height of plants at the level of 212, 6 cm (Table 1).

Table 1

Influence of fertilizer systems on the height of corn plants and the height of the cob attachment, cm (average for 2020-2021)

Fertilizer system	Corn hybrid	
	SY Fenomen (FAO 220)	SY Torino (FAO 310)
	Plant height, cm	
Without fertilizers	156.5	167.3
$N_{128}P_{128}K_{128}$	187.3	205.5
$N_{128}P_{128}K_{128}+N_{70}$	212.6	227.4
	Cob attachment heigh, cm	
Without fertilizers	53.2	64.0
$N_{128}P_{128}K_{128}$	62.5	73.3
$N_{128}P_{128}K_{128}+N_{70}$	82.7	88.4

the source is formed on the basis of own research results

Growing corn of the SY Torino hybrid on the variant without fertilizer provided a plant height of 167.3 cm. Application of 128 kg of nitrogen, phosphorus and potassium increased the height of corn plants of this hybrid to 205.5 cm, while with the additional introduction of 70 kg of nitrogen height increased to 227.4 cm.

When comparing the height of the cob attachment to the corn plant, it was found

that in the hybrid SY Fenomen it was slightly lower compared to SY Torino. The differences can be explained by physiological features, but the effect of fertilizer systems is well traced. Thus, in the non-fertilizer version, the cob attachment height of the SY Fenomen hybrid was 53.2 cm, with $N_{128}P_{128}K_{128}$ it increased to 62.5 cm, while with additional N_{70} application it increased to 82.7 cm.

At the minimum value, the height of attachment of the cob in the hybrid SY Torino was traditionally on the option without fertilizer and was 64.0 cm. It increased to 73.3 cm when used in pre-sowing cultivation 128 kg of nitrogen, phosphorus and calcium. And the maximum value − 88.4 cm, it reached with the additional use of 70 kg of nitrogen at the root in the phase of 6-7 leaves.

Thus, the formation of corn plant height and cob attachment height depends significantly on the fertilizer system, as it is extremely sensitive to the level of mineral nutrition. Also, the biological characteristics of hybrids have an impact on altitude. In our case, the height of the SY Torino hybrid was higher than in the SY Phenomen.

Science and practice have proven the positive role of mineral fertilizers in the formation of yield indicators, and this effect is directly reflected in such indicators as height and diameter of the cob, weight of 1000 grains. The proportion of grain in the cob largely depends on the biological characteristics of the hybrid.

In our studies, we also noted the positive role of the use of complete mineral fertilizers compared to the option without the use of fertilizers. This was primarily reflected in the length of the cob and its diameter (Table 2).

Table 2

Biometric indicators of corn cobs depending on the hybrid and fertilizer system, g (average for 2020-2021)

Fertilizer system	Corn hybrid			
	SY Fenomen (FAO 220)		SY Torino (FAO 310)	
	length, cm	diameter, cm	length, cm	diameter, cm
Without fertilizers	19,6	4,2	20,2	4,4
$N_{128}P_{128}K_{128}$	23,5	4,5	24,7	4,7
$N_{128}P_{128}K_{128}+N_{70}$	24,4	5,1	25,6	5,3

the source is formed on the basis of own research results

It was found that the length of the cob of the SY Fenomen hybrid on the variant without fertilizer was 19.6 cm, while its diameter was 4.2 cm. When using $N_{128}P_{128}K_{128}$ in pre-sowing cultivation, the length of the cob increased to 23.5 cm, and its diameter was now 4.5 cm. Additional uses of 70 kg of nitrogen increased the length of the cob to 24.4 cm and its diameter to 5.1 cm.

The SY Torino hybrid was slightly higher in terms of cob length and diameter. Thus, in the variant without fertilizers, the length of its cob was 20.2 cm and a diameter of 4.4 cm. When 128 kg of the active substance of the main macrofertilizers was applied to the pre-sowing cultivation, the length of the cob increased to 24.7 cm, while its diameter increased to 4.7 cm.The highest biometric indicators were marked by the cobs of the SY Torino hybrid, which was grown on the background of

$N_{128}P_{128}K_{128}$ and additional application of N_{70}. The length of the cob was 25.6 cm and its diameter was 5.3 cm.

In addition to the length of the cob and its diameter, an equally important indicator that affects the yield is the yield of grain from the cobs of corn. And the higher this percentage, the higher the credit yield of corn. Observations showed that both studied factors (hybrid choice and fertilizer system) had some influence on this indicator (Table 3).

In the analysis of corn cobs of SY Fenomen hybrid it was found that the lowest grain yield from the cob 79.5% was observed in the variant without fertilizers. When applied in pre-sowing cultivation of mineral fertilizers at a dose of $N_{128}P_{128}K_{128}$ grain yield increased to 81.4%. Traditionally, the highest yield of grain from the cob, namely 82.8%, was the option with the introduction of 128 kg of nitrogen, phosphorus and potassium in pre-sowing cultivation and additional application of 70 kg of nitrogen between rows in the phase of 6-7 leaves.

After estimating the grain yield of cobs in the SY Torino hybrid, it was found that in the variant without fertilizers it was 80.8%, with $N_{128}P_{128}K_{128}$ − 82.5%, and with additional N_{70} the share of grain yield from cobs increased to 83.6%.

Table 3

Yield of grain from corn cobs depending on the hybrid and fertilizer system,%

(average for 2020-2021)

Fertilizer system	Corn hybrid	
	SY Fenomen (FAO 220)	SY Torino (FAO 310)
Without fertilizers	79.5	80.8
$N_{128}P_{128}K_{128}$	81.4	82.5
$N_{128}P_{128}K_{128}+N_{70}$	82.8	83.6

the source is formed on the basis of own research results

The most important indicator that directly affects the yield of any crop is the weight of 1000 seeds. It largely depends on natural factors such as air temperature and the presence of moisture during the period of grain filling. However, the impact of mineral nutrition is very high.

Our research found that the cultivation of maize hybrid SY Fenomen on the variant without fertilizers contributed to the fact that the weight of 1000 seeds was the smallest and was 318 g, while in the hybrid SY Torino it was 11 g higher and was 329 g (Table 4).

Table 4

Weight of 1000 corn grains depending on the hybrid and fertilizer system, g

(average for 2020-2021)

Fertilizer system	Corn hybrid	
	SY Fenomen (FAO 220)	SY Torino (FAO 310)
Without fertilizers	318	329
$N_{128}P_{128}K_{128}$	324	336
$N_{128}P_{128}K_{128}+N_{70}$	336	345

the source is formed on the basis of own research results

Slightly higher weights of 1000 seeds were observed with the use of $N_{128}P_{128}K_{128}$ in pre-sowing cultivation. The indicators in the hybrid SY Fenomen were 324 g, and in the hybrid SY Torino - 336 g. The highest value of the weight of 1000 seeds was the variant with the additional use of 70 kg of active substance nitrogen in the phase of 6-7 leaves. Thus in hybrid SY Fenomen weight made 336 g. And in hybrid SY Torino it was higher on 9 g and made 345 g. Thus, the positive role of fertilizer systems in terms of length and diameter of the cob, the percentages of seed yield from the cob and the weight of 1000 grains. The maximum performance was provided by the variant with the introduction of $N_{128}P_{128}K_{128}$ in pre-sowing cultivation and additional use of N_{70} in the phase of 6-7 leaves.

The formation of the productivity of any crop is directly proportional to many factors. First of all, the soil and climatic conditions of the growing zone are important, as well as varietal or hybrid composition, sowing dates and plant density, mineral nutrition system. But the most important thing is strict adherence to all methods of cultivation technology.

Our research found that to a greater extent on the indicators of yield and pre-harvest moisture of the grain had mineral fertilizers (Table 5). It was noted that the SY Fenomen corn hybrid when grown on the variant without the use of fertilizers provided a yield of 6.42 t ha^{-1} while the grain moisture at harvest was 16.1%.

Table 5

Indicators of yield and humidity of corn during the harvest period (average for 2020-2021)

Hybrid	Fertilization system	Humidity of grain at harvesting,%	Yield in 14% humidity, t ha^{-1}
SY Fenomen	Without fertilizers	16.1	6.42
	$N_{128}P_{128}K_{128}$	16.7	8.75
	$N_{128}P_{128}K_{128}+N_{70}$	17.4	12.18
SY Torino	Without fertilizers	17.0	7.05
	$N_{128}P_{128}K_{128}$	17.5	9.44
	$N_{128}P_{128}K_{128}+N_{70}$	18.3	12.88
LSD_{05} (t ha^{-1}) = A – 0,18 ; B –0,25 ; AB – 0,28.			

the source is formed on the basis of own research results

The use of mineral fertilizers in the dose of $N_{128}P_{128}K_{128}$ in pre-sowing cultivation allowed increasing productivity to 8.75 t ha^{-1}, however, the pre-harvest grain moisture was also slightly higher and amounted to 16.7%. Further additional use of 70 kg of nitrogen in the aisle in the phase of 6-7 leaves of corn increased grain yield to 12.18 t ha^{-1}, while the harvest moisture was 17.4%. The SY Torino hybrid had slightly higher productivity indicators, which can be explained by its belonging to another maturity group and, in general, a longer growing season. It was found that the lowest yields for the hybrid SY Torino were recorded in the variant without fertilizer. At the same time, they amounted to 7.05 t ha^{-1}, and the pre-harvest humidity was at the level of 17.0%.

Conclusions. The application of $N_{128}P_{128}K_{128}$ in pre-sowing cultivation increased the yield of corn to 9.44 t ha^{-1}, although the pre-harvest humidity increased slightly to 17.5%. The combination of mineral fertilizers applied to both pre-sowing cultivation ($N_{128}P_{128}K_{128}$) and inter-row fertilization (N_{70}) contributed to the formation of the highest grain productivity of corn hybrid SY Torino which was 12.88 t ha^{-1}, while pre-harvest grain moisture was 18.3%. Thus, the use of mineral fertilizers had a positive effect on the formation of grain productivity indicators of corn hybrids. And the more nitrogen fertilizers were applied, the higher the yield. The yield of corn hybrids has increased by 83-90%, compared to the option without fertilizer.

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АНОТАЦІЯ
ЗАСТОСУВАННЯ СИСТЕМИ УДОБРЕННЯ ПРИ ФОРМУВАННІ ЗЕРНОВОЇ ПРОДУКТИВНОСТІ ГІБРИДІВ КУКУРУДЗИ

У статті висвітлено результати досліджень впливу мінеральних добрив на формування продуктивності гібридів кукурудзи та їх залежність від гідротермічних умов. У зв'язку зі стрімким ростом цін на енергоносії на сьогодні, дуже важливим є удосконалення технології вирощування сільськогосподарських культур, передусім кукурудзи. Останнім часом різко зменшилася кількість мінеральних добрив, які вносять під посіви кукурудзи, що пов'язано з високою їх вартістю. Важливим показником є і вплив гідротермічних умов, оскільки погодно-кліматичні показники також дуже сильно варіюють по роках. У зв'язку з цим актуальними питаннями, є вивчення нових гібридів кукурудзи спрямовані на підвищення урожайності за рахунок оптимального підбору мінеральних добрив та зосередженості на погодних умовах. Це залежить перш за все від групи стиглості гібрида та його сортових особливостей. Для досліджень було обрано та проаналізовано середньоранній гібрид СИ Феномен (ФАО 220) та середньостиглий СИ Торіно (ФАО 310).

Система удобрення кукурудзи складається з трьох прийомів: основного, рядкового і підживлення.За умов оптимального удобрення у період вегетації кукурудза може забезпечувати високі врожаї практично на всіх ґрунтах. Науковці виділяють два важливі етапи розвитку рослин кукурудзи, так звані критичні фази, щодо забезпеченості їх макро- та мікроелементами це фази 3–5 та 7–8 листків. Від забезпеченості елементів живлення, особливо слід звернути увагу на наявність фосфору, залежить сформована кількість качанів на рослині та зерен на них.

Кукурудза сильно реагує на удобрення азотом. Для забезпечення високої ефективності його застосування та оптимізації дози, крім вибірки зразків та очікуваної врожайності, необхідно визначити кількість азоту, що міститься в ґрунті. Кількість ґрунтового азоту може бути дуже різною і становити в межах 20-100 кг N в залежності від попередника та його системи живлення, класу ґрунту та використовуваної агротехніки.

Азот найбільше з усіх елементів живлення впливає на показники рівня урожаю кукурудзи. Кукурудза споживає азот до фази 8 листків, до цього моменту засвоюється лише 2–3 % азоту, від фази 8 листків до фази засихання квіткових стовпчиків (волосся) на качанах – 85 % загальної кількості азоту. Решту азоту кукурудза продовжує споживати майже до початку достигання качанів.

Вивчався вплив мінеральних добрив на формування індивідуальної продуктивності та Застосування мінеральних добрив у дозі $N_{128}P_{128}K_{128}+N_{70}$ забезпечило найвищу висоту рослин кукурудзи 212,6 см для СИ Феномен та 227,4 см для СИ Торіно. При цьому висота прикріплення качана, за даних умов становила 82,7-88,4 см. Додаткове застосування 70 кг д.р. азоту на фоні $N_{128}P_{128}K_{128}$ дозволило сформувати найвищі біометричні показники

качана. Так у гібриду СИ Феномен довжина становила 24,4 см, а діаметр – 5,1 см, тоді як у гібриду СИ Торіно 25,6 та 5,3 см відповідно. Застосування повної системи удобрення ($N_{128}P_{128}K_{128}+N_{70}$) при вирощуванні гібридів кукурудзи дозволило збільшити вихід зерна з качанів до 82,8-83,6 % проти 79,5-80,8 % на контролі, і відповідно масу 1000 насінин до 336-345 г проти 318-329 г. Використання мінеральних добрив позитивно впливало на формування показників зернової продуктивності гібридів кукурудзи. І чим більше азотних добрив вносили, тим більшою була урожайність. У порівнянні до варіанту без удобрення урожайність гібридів кукурудзи зросла на 83-90 % та становила 12,18-12,88 т/га.

Ключові слова: *гібрид, кукурудза, продуктивність, мінеральні добрива, структура врожаю.*

Табл. 5. Літ. 17.

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