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# THE INFLUENCE OF FOLIAR FERTILIZATION ON BIOMETRIC PARAMETERS OF MAIZE HYBRIDS IN THE OF THE FOREST-STEPPE OF THE MYKOLAIV REGION

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**Summary.** *The article is devoted to the study of the peculiarities of the formation of biometric parameters of maize hybrids of different maturity groups (DCS 2971 (FAO 200) early maturing; DKS 3472 (FAO 270) mid-early and DKS 4964 (FAO 380) mid-season) when grown in the forest-steppe zone of Mykolaiv region for foliar fertilization with a complex of microfertilizers Quantum (Quantum Silver, Quantum AminoMax 200, Quantum Chelate Zn (117) EDTA, Quantum BOR ACTIVE, Quantum Phytophos) and weather and climatic conditions of the year. The maximum effectiveness in the experiment for all hybrids was ensured by the use of foliar feeding of crops with a complex of microfertilizers Quantum 3.8 l/ha (Quantum Silver (1 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum CHELATE Zn (117) EDTA (1 l/ha) + Quantum BORON ACTIVE (0, 3 l/ha) + Quantum Phytophos (1 l/ha)) in the phase of 4-6 leaves of corn and the introduction of a complex of microfertilizers Quantum 3.0 l/ha (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BORON ACTIVE (0.5 l/ha)) in the phase of 8-10 leaves of corn against the background of N34P34K34. The highest indicators were observed in the mid-season hybrid DCS 4964 in this variant of microfertilizers application, the height of plants was 256.8 cm, and the cobs were located at a height of 110.3 cm.*

**Keywords:** *corn, fertilizing, microfertilizers, plant height, cob attachment height.*

In the context of the intensification of the crop production sector, it is important to increase the area under intensive crops, in particular, grain corn. In recent years, the area under grain corn cultivation in Ukraine has increased several times compared to previous years, and as of 2020, it was sown on an area of 5.39 million hectares.

Among cereals, corn is the most productive crop on Earth [1, 2]. Corn has always been one of the most sought-after crops on the market, as it can easily replace a number of other coarse grains whose production has suffered for some reason. This almost unique ability is primarily due to the fact that corn is less susceptible to weather fluctuations than other crops. The price factor also plays an important role here, as high global corn prices help expand the area under the crop and increase its production. At the same time, analysts' forecasts of the gross harvest of this product often adjust pricing both on the global market and in a particular country [2].

Corn has increased requirements for moisture, heat, light, nutrients and other environmental factors. Its hybrids differ significantly in terms of the growing season, hence the different requirements for the above factors. When agrotechnical methods are applied, taking into account the soil and climatic characteristics of the zone and environmental requirements, corn ensures maximum yield [3-8].

Currently, a number of new technologies for growing new hybrids of corn for grain are being introduced into production, which require clarification of certain elements [4-8].

The effectiveness of fertilizers, and thus the quality of products, is significantly influenced by the level of agricultural technology and the nature of weather conditions during the growing season. The impact of both individual nutrients and different combinations of nitrogen, phosphorus and potassium on these indicators is worthy of attention.

An important issue in maize cultivation is the possibility of using bacterial and microfertilizers fertilizers, which will reduce the rates of mineral (synthetic) fertilizers and significantly improve the ecological condition of the fields [9, 10, 11].

Therefore, the purpose of our research was to study the peculiarities of modern technologies for growing corn hybrids, the peculiarities of using different fertilizer systems when applying microfertilizers in the Forest-Steppe zone of Ukraine. To do this, we set up production field experiments in which we sowed 3 maize hybrids of different maturity groups [9, 10, 11].

The experiments were conducted during 2020-2021 on the experimental field of the farm located in the Forest-Steppe zone of the Pervomaiskyi district of Mykolaiv region. The soil formation factors in the process of their interaction caused the development of the sod process of soil formation on the territory of the farm, as a result of which chernozem soils were formed.

The soil of the experimental plot where the research was conducted, according to the modern classification (F. Y. Gavryliuk, 1984) is represented by ordinary carbonate black soil, powerful, warm, medium loamy, which freezes for a short time. The relief is flat. They are characterized by high carbonation and the presence of a thick humus layer that reaches 45-50 cm. The reaction of the soil solution in the salt extract is close to neutral 6.94-7.05. The soil is clayey and loamy, has a fine-grained structure, is easy to cultivate, has good air permeability and moisture capacity, and is capable of accumulating significant moisture reserves.

In general, the soil of the experimental plot was favorable for corn cultivation in terms of fertility, mechanical composition physical and chemical properties were favorable for growing corn.

Agrotechnics of crop cultivation in the experiment was generally accepted for the zone, except for the factors under study. The predecessor was winter wheat. After harvesting the predecessor, tillage consisted of stubble peeling with BDT-7 heavy harrows, disking with deepening with the same unit in combination with the MTZ-865B tractor.

The fertilization system included the application of background fertilizer (NPK at 34 kg of d.p. per 1 ha) in the rows during sowing and served as a background. A combined unit of the Europak type was used for pre-sowing soil cultivation. Sowing was carried out with seeders Massey Ferguson 555 with seeding rates of 60 thousand seeds per hectare. The seeding depth was 5-7 cm. In the phase of 4-7 true leaves, the herbicide Milagro was used to control weeds at a rate of 1.25 l/ha.

The experimental design included the following variants: Factor A (Fertilizer system): Option 1. Control (Application of N34P34K34 (Background) without application of the Quantum complex of microfertilizers during the growing season); Option 2. Background + application of Quantum microfertilizer complex 3.8 l/ha (Quantum Silver (1 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum Zn (117) EDTA (1 l/ha) + Quantum BORON ACTIVE (0.3 l/ha) + Quantum PHYTOPHOS (1 l/ha)) in the phase of 4-6 leaves of corn; Option 3. Background + application of Quantum 3.0 l/ha complex of microfertilizers (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BORON ACTIVE (0.5 l/ha)) in the phase of 8-10 leaves of corn; Option 4. Background + application of the complex of microfertilizers Quantum 3.8 l/ha (Quantum Silver (1 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum Chelate Zn (117) EDTA (1 l/ha) + Quantum BORON ACTIVE (0, 3 l/ha) + Quantum Phytosphos (1 l/ha)) in the phase of 4-6 leaves of corn and application of FON + application of Quantum 3.0 l/ha microfertilizer complex (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BOR Aktiv (0.5 l/ha)) in the phase of 8-10 leaves of corn; Factor B (Corn hybrid): DKS 2971 (FAO 200) early maturing; DKS 3472 (FAO 270) medium early maturing; DKS 4964 (FAO 380) medium maturing.

The plots were allocated using the method of randomized plots. The registered area of the plots for hybrids was 56 m<sup>2</sup>. Replication in the experiments for hybrids was 4 times.

During the growing season, the following phenological phases were determined: germination, ejection and flowering of panicles, flowering of cobs (appearance of stamen filaments) and full ripeness of grain, determination of linear measurements of plants: total height, cob attachment, as well as structural analysis of the crop (10 cobs in each replication), were carried out in accordance with generally accepted methods for corn [12-14].

The application of the Quantum microfertilizer complex was carried out based on the recommendations of fertilizer manufacturers in the early period from 8 to 10 hours of the phase, or in the evening from 19 to 21 hours of 4-6 and 8-10 leaves of corn with the recommended application rate.

The corn harvest from the accounting area was recorded according to the methodology of state variety testing of agricultural crops (cereals, cereals and legumes) [12, 14].

Statistical processing of yield data was performed by the method of analysis of

variance according to B.A. Dospikhov [15, 16, 17].

Among the morphological traits of the stem, plant height and the height of the economically valuable cob attachment are important for growing grain maize. Suitability for mechanized harvesting, along with resistance to lodging, is determined by such traits as the height of the ear attachment (in multi-cob hybrids, the lower economically valuable ear) and the length of the ear stalk. A significant number of zoned hybrids are characterized by low cob attachment (30-50 cm), so there are significant grain losses during mechanized harvesting. High cob attachment must be combined with a shortened stalk so that after sagging its top is at a height of at least 50-60 cm from the soil surface, thus significantly increasing the number of cobs suitable for mechanized harvesting [2-8].

Plant height and head sagging affect the quality of harvesting, its speed and energy consumption. The taller the plant, the higher the harvesting costs. Therefore, for grain-type hybrids, it is important to have a small plant height (150-180 cm) and optimal (at least 50 cm) attachment of an economically valuable cob. Due to the low and uneven attachment and sagging of cobs in the Steppe and Forest-Steppe of Ukraine, grain losses of 15-20% or more are observed during combine harvesting [1-8].

Losses increase if low cob attachment is accompanied by sagging. Such losses are most typical for early and mid-early hybrids harvested for grain. As for medium-late and late-ripening hybrids, in the Steppe and Forest-Steppe they are practically not grown for grain, but are mainly harvested for silage in the phase of milky-wax ripeness of grain [2-8].

Corn harvesters can, according to their technical characteristics, harvest ears located at a height of at least 50 cm from the ground, so this height should be considered the minimum. All heads of cabbage located below 50 cm are injured by the harvester's working bodies or remain unharvested. Heads of cabbage located at a height of less than 50 cm and heavily sagging fall into the feeder chains of the combine's beds, are threshed and, before reaching the heading device, separate from the stem and fall to the ground. Attempts to use various devices on harvesters have not yet yielded positive results, which is why it is important to take into account the height of head attachment when breeding hybrids [2-7].

Characteristics of plant height depending on the fertilizer system are shown in Table 1.

Table 1

Plant height in maize hybrids depending on nutritional conditions  
(for 2020-2021), cm

Hybrid (factor B)	Fertilization system (factor A)	Plant height, cm				
		2020	2021	average by years	average for factor B	average for Factor A
DKS 2971 (FAO 200) early ripe	Option 1	184,1	217,2	200,7	211,2	217,1
	Option 2	196,2	233,5	214,9		231,5
	Option 3	190,6	222,1	206,4		225,7
	Option 4	204,6	241,6	223,1		240,3
DKS 3472 (FAO 270) medium early	Option 1	199,9	235,8	217,9	229,8	
	Option 2	213,1	251,8	232,5		
	Option 3	207,5	248,6	228,1		
	Option 4	220,3	261,5	240,9		
DKS 4964 (FAO 380) mid-season	Option 1	211,2	254,3	232,8	244,9	
	Option 2	222,8	271,7	247,3		
	Option 3	218,6	266,8	242,7		
	Option 4	231,4	282,2	256,8		

The height of plants and the height of head attachment depends on the biological characteristics of the plants and the conditions of their cultivation. Lack of moisture in the soil and high temperatures reduce both plant height and head height, as evidenced, for example, in 2020. Table 1 shows that 2021 was the best year for corn hybrids to show plant height in terms of climatic conditions, compared to 2020.

The plant height of the corn hybrids under study ranged from 184.1 to 231.4 cm in 2020, and from 217.2 to 282.2 cm in 2021. The tallest was the hybrid of the mid-season group DCS 4964. When applying the Quantum micronutrient complex, plant height increased, indicating a positive effect of fertilizers on growth processes. In particular, the application of the Quantum complex of microfertilizers in the phase of 4-6 leaves of corn at a rate of 3.8 l/ha provided an increase in plant height, on average for two years, in the early ripe hybrid DCS 2971 by 14.2 cm, medium early DCS 3472 by 14.6 cm, and medium ripe DCS 4964 by 14.5 cm.

Foliar fertilization in the phase of 8-10 leaves of maize with a complex of microfertilizers Quantum at a rate of 3.0 l/ha (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BOR Aktiv (0.5 l/ha)) led to a lower intensity of plant growth compared to the phase of 4-6 leaves of the crop. At the same time, plant height indicators were 206.4 cm for hybrid DKS 2971 (5.7 cm higher than the Control and 8.5 cm lower than Option 2), 228.1 cm for hybrid DKS 3472 (10.2 cm higher than the Control and 4.4 cm lower than Option 2), and 242.7 cm for hybrid DKS 4964 (9.9 cm higher than the Control and 4.6 cm lower than Option 2).

During the two-time application of the complex of microfertilizers Quantum at a rate of 3.8 l/ha in phase 4-6 (Quantum Silver (1 l/ha) + Quantum AminoMax 200 (0, 5 l/ha) + Quantum CHELATE Zn (117) EDTA (1 l/ha) + Quantum BORON ACTIVE (0.3 l/ha) + Quantum PHYTOPHOS (1 l/ha)) and 8-10 leaves of corn of the Quantum microfertilizer complex at a rate of 3, 0 l/ha (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BOR ACTIVE (0.5 l/ha)) in combination with mineral fertilizers N15P15K15 obtained the highest linear plant size indicators, which averaged over two years: DKS 2971 - 223.1 cm, DKS 3472 - 240.9 cm and DKS 4964 - 256.8 cm.

The average height of maize plants in the experiment was 211.2 cm for hybrid DKS 2971, 229.8 cm for hybrid DKS 3472 and 244.9 cm for hybrid DKS 4964.

The use of foliar fertilization contributed to an increase in the height of plants of crop hybrids compared to the control (217.1 cm) in Variant 2 by 6.6% (231.5 cm), in Variant 3 by 4.0% (225.7 cm) and in Variant 4 by 10.7% (240.3 cm).

Thus, the obtained height parameters (200.7-256.8 cm) of the plants of the studied hybrids and a slight increase in this indicator when using the Quantum complex of microfertilizers make it possible to assert that these hybrids can be grown with full mechanization using intensive technologies.

As for the height of ear attachment in the studied maize hybrids depending on the fertilizer system (Table 2), it is necessary to note a similar trend as with plant height.

Table 2

**Height of ear attachment in maize hybrids depending on nutritional conditions (2020-2021), cm**

Гібрид (фактор А)	Система удобрення (фактор В)	Висота прикріплення качанів, см				
		2020 р.	2021 р.	середнє за роками	середнє по фактору А	середнє по Фактору В
ДКС 2971 (ФАО 200) ранньостиглий	Варіант 1	62,7	70,5	66,6	71,9	81,7
	Варіант 2	69,2	78,6	73,9		88,5
	Варіант 3	67,6	75,7	71,7		86,1
	Варіант 4	70,2	80,8	75,5		91,8
ДКС 3472 (ФАО 270) середньоранній	Варіант 1	75,1	84,8	80,0	85,0	
	Варіант 2	81,0	92,1	86,6		
	Варіант 3	79,6	88,5	84,1		
	Варіант 4	83,2	95,9	89,6		
ДКС 4964 (ФАО 380) середньостиглий	Варіант 1	93,2	104,0	98,6	104,2	
	Варіант 2	98,8	111,5	105,2		
	Варіант 3	96,3	108,9	102,6		
	Варіант 4	101,3	119,3	110,3		

In 2020, the height of attachment of an economically valuable cob on a plant when applying a general fertilizer background (N34P34K34) was 62.7 cm in hybrid DCS 2971, 75.1 cm in DCS 3472, and 93.2 cm in DCS 4964, and in 2021 these figures were 70.5, 84.8, and 104.0 cm, respectively. On average, in 2020-2021, when applying the Quantum complex of microfertilizers, the height of head attachment in the studied hybrids when applied once in the phase of 4-6 leaves (Variant 2) was in the range of 69.2-111, 5 cm depending on the years of research and averaged 73.9 cm in hybrid DKS 2971, 86.6 cm in hybrid DKS 3472 and 105.2 cm in hybrid DKS 4964, during the treatment during the growing season in the phase of 8-10 leaves of the crop (Variant 3) was in the range of 67.6 - 108.9 cm and averaged 71.7 cm in hybrid DKS 2971, 84.1 cm in hybrid DKS 3472 and 102.6 cm in hybrid DKS 4964.

Double foliar fertilization in the phase of 4-6 leaves and 8-10 leaves (Variant 4) changed the indicators from 70.2 to 119.3 cm.

The height of head attachment on average for hybrids in the experiment was: DCS 2971 - 71.9 cm, DCS 3472 - 85.0 cm and DCS 4964 - 104.2 cm. The use of preparative forms of microfertilizers Quantum against the background of mineral fertilizers N34P34K34 led to a higher attachment of heads of cabbage by 8.3% (Variant 2), 5.4% (Variant 3) and 12.4% (Variant 4).

Thus, the introduction of the Quantum microfertilizer complex stimulates plant growth and development. The maximum effectiveness in the experiment was ensured by the use of foliar feeding of crops with a complex of microfertilizers Quantum 3.8 l/ha (Quantum Silver (1 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum Chelate Zn (117) EDTA (1 l/ha) + Quantum BORON ACTIVE (0, 3 l/ha) + Quantum Phytosphos (1 l/ha)) in the phase of 4-6 leaves of corn and application of Quantum 3.0 l/ha complex of microfertilizers (Quantum Silver (2 l/ha) + Quantum AminoMax 200 (0.5 l/ha) + Quantum BORON ACTIVE (0.5 l/ha)) in the phase of 8-10 leaves of corn against the background of N34P34K34. At the same time, the height of plants increased by 23.0-24.0 cm, and the height of attachment of the lower cob by 8.9-11.7 cm. The tallest plants in this variant were plants of the mid-season hybrid DKS 4964 (256.8 cm), on which the heads of cabbage were located at a height of 110.3 cm.

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