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Research Article

Comprehensive Analysis of Biometric Indicators of Corn Plants (*Zea mays* l.) Under the Influence of Microfertilizers

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Abstract

The purpose of the research was to establish the effect of micronutrient fertilizers on the biometric parameters of common corn plants (*Zea mays* L.) in the conditions of the western forest-steppe of Ukraine (2019-2021). The object of research was microfertilizers - oracle nasiny, brexil Combi, valagro EDTA mix 5. The research was carried out by the field method. The area of the experimental plot was 55 m^2, the placement of the options was sequential with a threefold repetition. The obtained research results allow us to conclude that pre-sowing treatment of seeds of corn hybrids with chelated forms of microfertilizers had a positive effect on increasing the growth force of the germinal root (by 1.55-2.33 mm) and the kidney (1.50-2.60 mm). With the variants of their application, compared with the control (without microfertilizers), the plants formed a longer head of cabbage by 3.2-4.1 cm, more rows by 0.8-1.6 pcs and more grains by 72-104 pcs. Between the length of the head and the number of rows and grains in it, the correlation was direct strong, respectively 0.715-0.866 and 0.808-0.995. The most effective was the use of brexil Combi microfertilizer at a rate of 0.5 kg t^{-1}, at which the average yield of grain hybrids was 8.41 t ha^{-1}. There was no significant difference with the microfertilizer oracle seed at a rate of 1.0 lt^{-1} and a significant (0.22 t ha^{-1}) difference with the valagro EDTA mix 5 variant (0.2 kg t^{-1}).

Keywords: Corn; Hybrid; FAO; Biological Characteristics of the Crop; Microfertilizers; Grain; Productivity; Quality

Introduction

The genotype-environment interaction reflects the plant's response to periodic changes in the environment, the most important requirement of which is adaptability [26].

The potential of corn hybrids can be realized with a high genetic potential to ensure a sufficient degree of reliability and protection of the genotype from the adverse effects of biotic and abiotic environmental factors [25,28].

The use of methods for assessing stability and plasticity allows you to establish the reliability of differences and obtain additional information about the selection of valuable starting material [6].

Recently, breeders use breeding material created in the ecological conditions of other countries to adapt it to the realities of the Ukrainian climate, and the created hybrids are grown in different agro-climatic zones of Ukraine [5].

Adaptation of the constituent factors of the environment and the biological requirements of culture require deep fundamental knowledge of the essence of physiological processes and the formation of elements of plant productivity [22,23]. They are the effective levers for crop productivity control and prevent the adoption of technologically unbalanced decisions [11].

In unlocking the productive potential of a crop, an important role is assigned to microelements that have a positive effect on ensuring the maximum biological yield [29]. Their influence on the growth, development, quantitative and qualitative productivity of crops is determined by the presence in soils, which in turn is determined by soil formation factors and determine the processes of solubility and sedimentation of substances, migration, accumulation and redistribution in the soil profile. Six are of the greatest importance - B, Mn, Cu, Zn, Co, Mo, making up 0.01-0.001% of the dry matter. However, plants absorb an insignificant amount of them from the soil and only those that are in a mobile, easily accessible form, and inaccessible gross reserves can only be available after complex microbiological processes involving humic acids and root secretions. Therefore, the total content of soil microelements does not reflect the real picture of plant availability, and in the form of inorganic salts they are available in very small quantities and mainly on acidic soils, only molybdenum is absorbed by plants on weakly alkaline soils. An analysis of the main studies on the effectiveness of the use of microfertilizers and publications in which the solution of this problem has begun confirms the additional receipt of about 20-30% of agricultural products [9,15,16].

The natural fertility of the soils of the Western Forest-Steppe was estimated at 38 points, the average for Ukraine - 55. According to the content of microelements, gray forest surface gleyed soils belong to the level of medium supply B (0.67 mg kg of soil), low - Mg (21.99), Co (0.56), Cu (1.68) and high - Zn (0.59 mg kg of soil) with hard-to-reach forms.

Corn is a very demanding crop in terms of nutrition. For the formation of 1 ton of grain with the corresponding amount of leafy mass, hybrids of different early maturity consume from soil and fertilizers - 20-25 kg of nitrogen, 10-14 kg of phosphorus, 25-35 kg of potassium, 6-10 kg of magnesium and calcium, 3-4 kg - sulfur; 11 g - boron, 14 - copper, 110 - manganese, 0.9 - molybdenum, 85 - zinc and 200 g - iron. Today, a number of microfertilizers are offered to production, which stimulate seed germination, regulate growth processes, increase resistance to diseases, reduce crop losses, but their effectiveness is different and requires scientific justification and practical recommendations [8,18].

The purpose of the study is to establish the effect of microfertilizers on the biometric parameters of common corn plants (*Zea mays L.*) in the conditions of the western forest-steppe of Ukraine.

Materials and Methods

The research was carried out during 2019-2021 at the Department of Seed Production and Seed Science of the Institute of Agriculture of Carpathian region of National Academy of Agrarian Sciences (NAAS) of Ukraine (49°47′07″ N, 23°52′07″E; 314 m a.m.s.l.).

The yield of corn hybrids under the influence of microfertilizers applied during pre-sowing seed treatment from the institution of the owner of Ukraine was tested.

The total area of the sowing area is 60 m^2, the accounting area is 50 m^2. The repetition was threefold, the placement of variants was systematic.

The soil of the experimental plots is gray forest, superficially gleyed, light loamy, characterized by the following indicators: humus content (according to Tyurin) - 1.7%, the amount of absorbed bases - 13.7 meq per 100 g of soil, alkaline available nitrogen (according to Kornfield) - 89.6 mg kg^{-1} of soil, phosphorus and potassium (according to Kirsanov), 69.5 and 68.0 mg kg^{-1} of soil, respectively. Beyond the gradation, such a soil has a very low supply of nitrogen, a medium supply of phosphorus, and a low supply of potassium. The reaction of the soil solution (pH salt - 5.4) is slightly acidic.

The agrotechnology of cultivation is generally accepted for crops in this zone. The predecessor is winter rapeseed, the sowing time is optimal (the first decade of May). The sowing method is wide-row with a row spacing of 70 cm at a seeding rate: early-ripening (FAO 150-199) - 80 thousand pieces ha^{-1}, medium-early (FAO 200-299) - 75 thousand pieces ha^{-1}. Fungicidal dressing agent - avicenna (0.5 lt^{-1}, active substance - tebyconazol, 50 gl^{-1} + prochloraz, 250 gl^{-1} + krezoxim-methyl, 50 gl^{-1}). Herbicide - adengo (0.5 l ha^{-1}, active substance - isoczaflutol, 225 gl^{-1} + thiencarbazon-methyl, 90 gl^{-1} + cyprosulfamid, 150 gl^{-1}). Insecticide: zalp (1.2 l ha^{-1}, active substance - chlorpiryfos, 500 gl^{-1} + cypermethryn, 50 gl^{-1}). Mineral nutrition background $N_{120}P_{90}K_{90}$.

The studies were carried out according to the generally accepted methods indicated below.

According to the data of the Lviv hydrogeological reclamation station, the sum of the temperature regime (°C) and the amount of precipitation (mm) during the period of growth and development of the plant was determined.

For each hybrid, the seeding rate (R) was determined by the formula:

$$R = \frac{N x W x 100}{Es} \quad \text{-------- (1)}$$

N - number of thousands of germinated seeds per 1 ha,
W - weight of 1000 seeds,
Es - economic suitability of the seed.

Economic suitability of the seed (Es) determined according to the following formula:

$$Es = \frac{\text{seed germination x seed purit}}{100} \quad \text{------------- (2)}$$

The germination of seeds was determined using the method of accounting plots based on the following calculations: the beginning of seedlings development (at least 15% of seedlings appeared), mass seedlings (50%), full seedlings (75% or more), the end of the phase - the emergence of the last seedlings and calculated (in percent) as the ratio of the number of seedlings to the total number of similar seeds sown [4].

Calculation of the density of plant standing per unit area will allow you to establish the completeness of seedlings - the percentage of seedlings to the number of sown grains and the survival rate (%) of grains and plants.

According to the method of Eschchenko., *et al*. (2014) [3], phenological observations were made with the following phenophases of vegetation noted: the appearance of a full staircase, the initial and complete ejection of panicles; initial and full flowering of heads of cabbage; milk, milk-wax, wax and full ripeness of grain. The beginning of the flowering of heads of cabbage occurs when the stigmas appear; the phase of milky ripeness of the grain falls on the period when the grain has already formed, but is easily crushed and a white liquid flows out of it in the form of milk; with milky-wax ripeness, a pasty mass is released from the grain with the inclusion of hard grains; in waxy ripeness, the grain is not crushed with fingers, but is still cut with a fingernail; a sign of complete ripeness of the grain is its blackening at the place of attachment to the stem of the head and yellowing of the wrappers. To determine the phase of ripeness, open the wrappers on 10 cobs in protective stripes. The phase has come if eight cobs out of 10 have characteristic features for it.

The weight of 1000 seeds (M) was determined by 2 weighings of 500 pieces, and the average weight was calculated with an accuracy of 0.1 g. If the weight of 2 samples differed from the average by more than 0.5%, the third sample was weighed and calculated according to the following formula:

$$M = \frac{M1x(100-h)}{100-Sh} \quad \text{------------ (3)}$$

M_1 - mass of 1000 grains, g,
h - grain moisture, %,
Sh - standard grain moisture, 14%.

Phytopathological evaluation was performed according to the method of Omelyuta., *et al*. (1986) [14] using the formula:

$$I = \frac{\Sigma(a \cdot в) \cdot 100}{K \cdot B} \quad \text{----------(4)}$$

I - disease development (in %),
Σ (a x в) - the sum of the product obtained by multiplying the number of leaves by the corresponding score,
K - total number of counted leaves (healthy and damaged)
B - the highest score on the accounting scale.

The assimilation coefficient (AC) was determined by the method of Peterson., *et al*. (1993) [19] using the following formula:

$$AC = \frac{m_2 - m_1\,(In\,S_2 - In\,S_1)}{(S_2 - S_1)} \cdot \quad \text{------------- (5)}$$

m_1 i m_2 - dry mass of the harvest sample at the beginning and end of the accounting period, g,

ln S_1 i ln S_2 - natural logarithms of leaf areas for the accounting period,

t - duration of the experiment, days.

Biomass gain (G) per day (g m^2) was determined by the following formula:

$$G = \frac{AC\ x\ A}{a} \cdot \quad \text{--------- (6)}$$

a - number of plants per 1 m^2 of sowing, pcs.,
A - number of experimental plants, pcs.

We monitor the growth of plants and the dynamics of the growth of the green mass of corn hybrids by the phases of vegetation. We note the attachment of the lower developed (with grain) head of cabbage (the distance from the soil surface to the place of its attachment to the stem), cm; bushiness - the number of all stems on the plant, resistance to plant lodging, on a nine-point scale: 9 - not fallen; 7 - slightly fallen, deviated from the vertical position up to 30°; 5 - medium fallen, deviated by 31-45°; 3 - fallen, deviated by 46-60°; 1 - heavily fallen, inclined from the vertical position by more than 60° [1].

Harvesting and accounting of grain yield of corn hybrids was carried out manually. Heads of cabbage from each plot were unwrapped and weighed. According to the average sample of heads (5 pieces from each repetition), the percentage of grain yield was determined, recalculated for 14% moisture content, and listed according to the formula:

$$X = \frac{U\ P\ x(100 - V}{8600} \cdot \quad \text{----------- (7)}$$

X - grain yield at 14% moisture content, V - head yield in full and waxy ripeness, P - grain yield from head yield (%), V - actual grain moisture content, 8600 - head yield conversion factor to grain yield at 14%.

Grain moisture is determined by the thermostatic-weight method using the formula:

$$B = \frac{b\ x\ 100}{C} \cdot \quad \text{--------- (8)}$$

B - grain moisture content, %, b - mass of evaporated water from the bottle with grain, g; C is the weight of the sample of grain in the bottle before drying, g.

Correlation coefficients, the reliability of the established indications were determined by the method of Litun., *et al*. (2009) [10].

Processing and summarizing the results of the experiment was carried out on a computer using Microsoft Excel. According to the method Ushkarenko., *et al*. (2013) [27], analysis of variance was carried out according to the two-factor type.

Results and Discussion

Weather conditions during the years of research had their own characteristics. The dates for sowing corn were shifted to the first ten days of May, since the temperature conditions in May, with the exception of 2020, were within the long-term average (13.2°C) (Figure 1).

In 2019 and 2020 the amount of precipitation was excessive, respectively 149.6 mm and 125.3 mm, with an indicator of 85 mm, and less than 55.4 mm in 2021 (Figure 2).

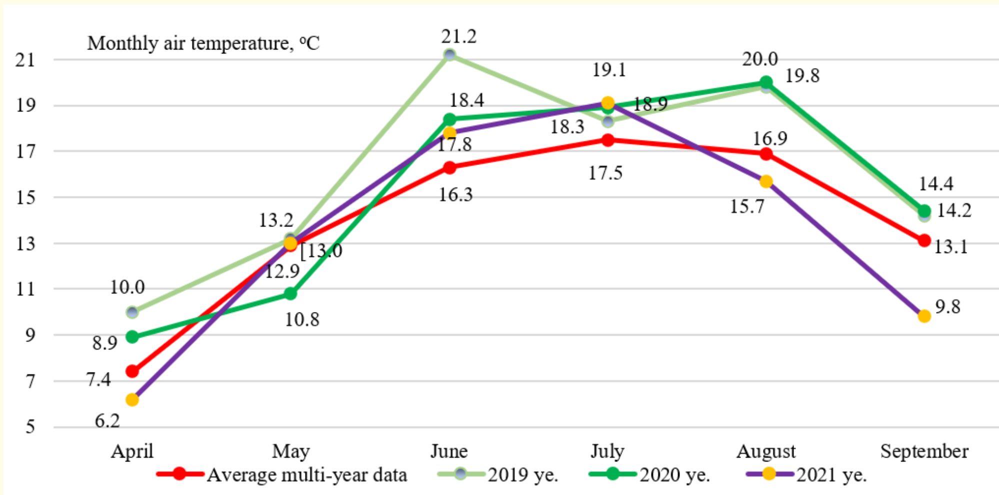


Figure 1: Average monthly air temperature (2019-2021), °C.

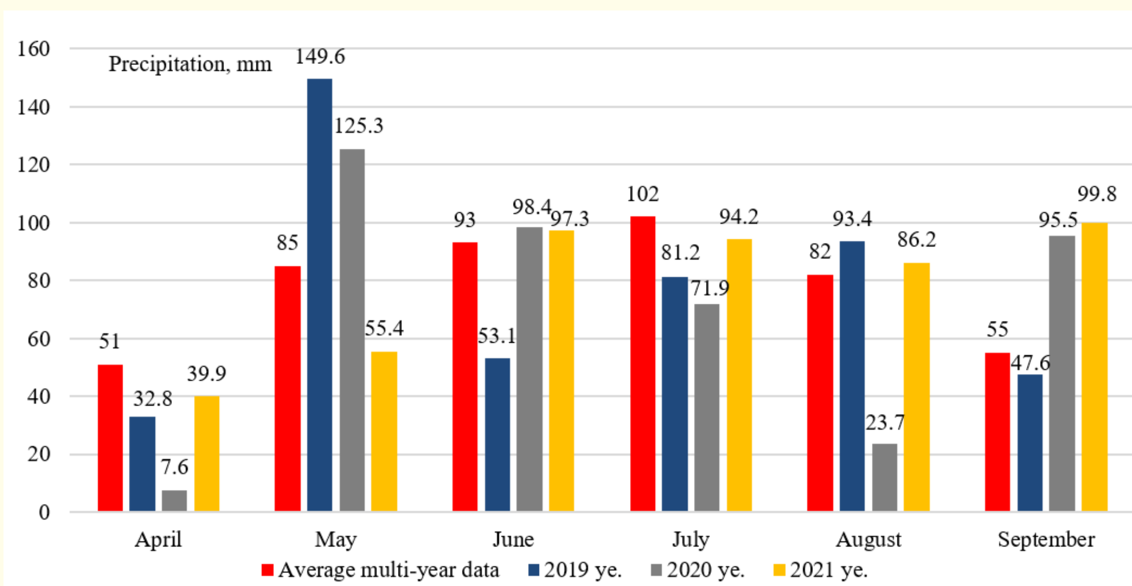


Figure 2: Monthly precipitation (2019-2021), mm.

Important indicators of seed quality, indicating the ability to form normal seedlings, are able to produce full-fledged seedlings and developed plants include the vigor of growth. This indicator is determined by two indicators - the number and weight of shoots that appear during a certain period of germination (for corn after 10 days). The weight of shoots and roots is listed per biological unit (100 pieces), the latter correlate well with the yield properties of seeds, which makes it possible to predict its potential productivity. Growth strength has a high level of correlation with field germination and seed yield, which makes it possible to establish its sowing suitability even before sowing. Some authors understand the strength of growth as the term "intensity of initial growth" [7,20].

Indicators of sowing qualities of corn seeds that correspond to the standard cannot always provide high field germination, since they are affected by negative factors when they get into the soil. The direct influence on the process of seed germination is exerted by: productive soil moisture and air temperature [17,20].

An important argument for increasing this indicator is the use of microfertilizers and growth stimulants, under the influence of which there is an intensive absorption of moisture and activation of enzymes in the treated seeds, which helps to increase the germination of roots, the length of the shoots, increases the weight of the plant, and ultimately provides a high percentage of germination energy and field similarities. The successes achieved in the methods of pre-sowing treatment of seeds of agricultural crops with various growth stimulants, microelements have not yet received sufficient practical application and wide distribution in the cultivation of corn, so our research was focused on these problematic issues.

In our experiments, the presowing treatment of seeds of corn hybrids with microfertilizers was accompanied by an increase in the growth force (on the third day) of the germinal root. If in the control the average root length in hybrids was 5.65 mm, then in the variants with the introduction of microelements it increased by 1.55-2.33 mm. The same pattern was observed for the height of the embryonic bud. The greatest effect of seed treatment was recorded from the use of brexil Combi micronutrient fertilizers (0.5 kg t^{-1}).

Presowing treatment of seeds with microfertilizers	Hybrid				Average	
	Pochaevskiy 190 MV	DN Meotyda	DN Khortytsa	Orzhytsa 237 MV	mm	± to control
Without seed treatment (control)	5.8/4.4	5.5/4.1	5.7/4.6	5.6/4.5	5.65/4.4	-
Oracle nasiny (1.0 l t^{-1})	6.9/5.5	7.1/5.9	7.5/6.3	7.3/6.0	7.20/5.9	1.55/1.5
Brexil Combi (0.5 kg t^{-1})	7.6/6.5	8.0/7.0	8.2/7.3	8.1/7.3	7.98/7.0	2.33/2.6
Valagro EDTA mix 5 (0.2 kg t^{-1})	7.0/6.1	7.4/6.3	7.7/6.4	7.9/6.8	7.50/6.4	1.85/2.0
Factor:	Impact intensity	$SSD_{0.05}$	Impact intensity		$SSD_{0.05}$	
A (microfertilizer)	89	2.46	90		2.11	
B (hybrid)	4	2.46	5		2.11	
Interaction of factors AB	3	4.12	2		4.28	
Other factors	4		3			

Table 1: The growth force of the germinal root/bud of corn hybrids depending on the presowing treatment of seeds with microfertilizers (2019-2021), mm.

Note: in the numerator - the length of the root, in the denominator - the kidneys for 3 days.

The impact of presowing treatment of seeds with microfertilizers on plant height was traced from the initial phases of development. In the phase of full ripeness, the height of corn plants increased in comparison with the control (without seed treatment with microfertilizers) for all the studied variants (Figure 3).

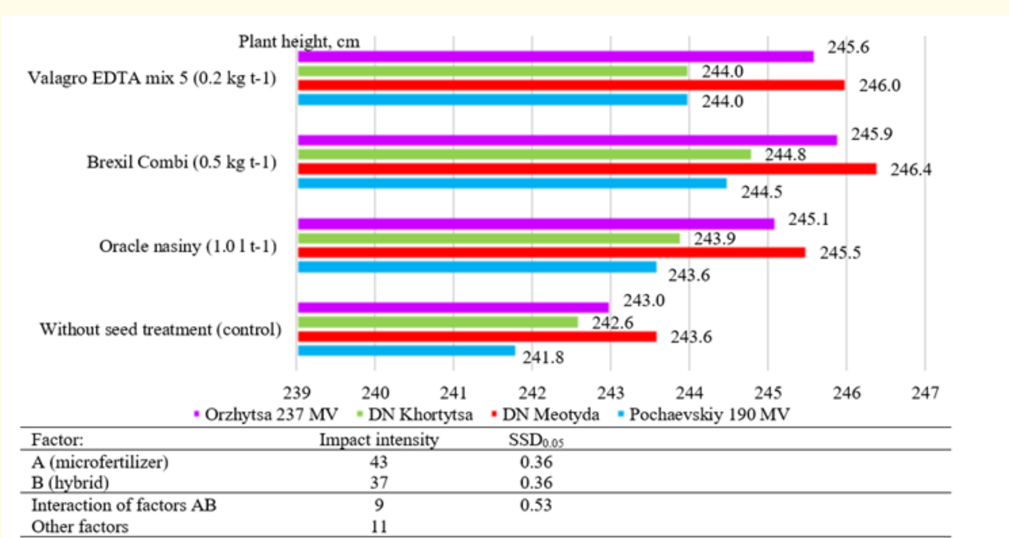


Figure 3: Plant height of corn hybrids depending on presowing seed treatment with microfertilizers (2019-2021), cm.

Depending on the biological characteristics of the hybrid, the increments to the contra were different and averaged 1.7-2.6 cm, however, the general pattern remained unchanged - the effectiveness of microfertilizers was significantly different ($SSD_{0.05}$ = 0.36).

According to mathematical processing of data, the effect of microfertilizers on plant height was 38%, the biological characteristics of the hybrid - 32, their interactions - 19, and other factors - 11%.

Depending on the weather conditions of the growing seasons and options for the use of micronutrient fertilizers, the head productivity indicators were different (Figure 4).

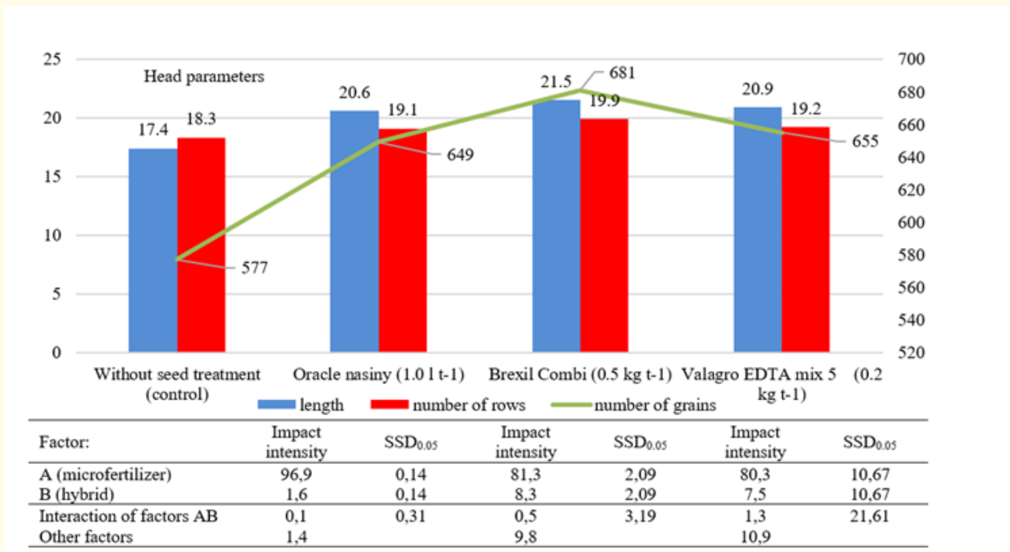


Figure 4: Average indicators of the structure of plants of the Pochaevskiy 190 MW hybrid corn, depending on the presowing treatment of seeds with microfertilizers (2019-2021).

The average head length varied from 17.4 cm in the control (without presowing treatment of seeds with microfertilizers) to 21.5 cm after the introduction of brexil Combi (0.5 kg t^{-1}). According to the same variant, the number of lines in the head was 1.6 more, and the number of grains in the line was 104 pcs. Under favorable weather conditions, flowering-seed formation in 2019 and 2020 the number of grains in one head was 21-27% more compared to 2021.

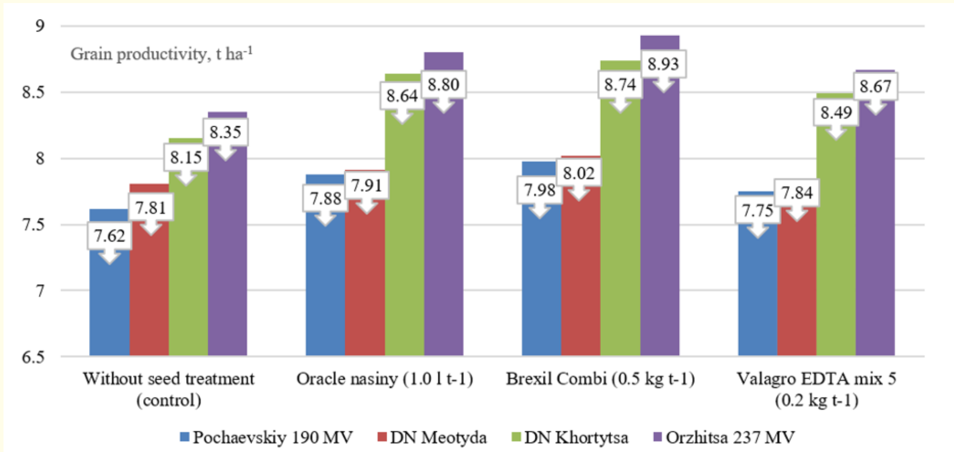
Between the length of the head and the number of rows in it, the correlation was direct average 0.423 - without seed treatment (control) and strong - 0.715-0.866 with the use of microfertilizers (Table 2). This was also the dependence on the number of grains in a head, 0.583 and 0.808-0.995, respectively.

The quantitative effect of the impact factors confirms the obtained indicator of the yield of corn grain (Figure 5).

Presowing treatment of seeds with microfertilizers	**Head length, cm**	**Quantity per head**			
		Ranks		**Grains**	
		pcs.	**r**	**pcs.**	**r**
Without seed treatment (control)	17.4	18.3	0.423	577	0.583
Oracle nasiny (1.0 l t^{-1})	20.6	19.1	0.553	649	0.808
Brexil Combi (0.5 kg t^{-1})	21.5	19.9	0.866	681	0.995
Valagro EDTA mix 5 (0.2 kg t^{-1})	20.9	19.2	0.715	655	0.961

Table 2: Correlation (r) between the length of the beginning and the number of rows and grains in it of the Pochaevskiy 190 MV corn hybrid depending on the use of microfertilizers in pre-sowing seed treatment (2019-2021).

Note. From 0 to 0.33 - weak, 0.33 to 0.66 - medium, 0.66 to 1.00 - strong, 1.00 - complete, both for direct (+) and inverse (-) correlation (r).



Factor:	Impact intensity	$SSD_{0.05}$
A (microfertilizer)	47	0.08
B (hybrid)	35	0.08
Interaction of factors AB	8	0.11
Other factors	10	

Figure 5: Grain productivity of corn hybrids depending on presowing seed treatment with microfertilizers (2019-2021), t ha^{-1}.

In the control (without the use of microfertilizers), the average grain yield of hybrids was 7.98 t ha^{-1}. Microfertilizers contributed to a significant increase in the productivity of hybrids by 0.21-0.43 t ha^{-1} ($SSD_{0.05}$ = 0.08). The most effective was the use of brexil Combi at a rate of 0.5 kg t^{-1}, at which the average grain yield of hybrids was 8.41 t ha^{-1}, however, at $SSD_{0.05}$ = 0.11 t ha^{-1}, there was a significant difference with the microfertilizer seed oracle at a rate of 1,0 lt^{-1} was not observed and there was a significant difference of 0.22 t ha^{-1} with valagro EDTA mix 5 (0.2 kg t^{-1}).

The impact of microfertilizers on the yield of corn grain was 35%, the biological characteristics of the hybrid - 47, their interaction - 8, and other factors - 10%.

A good supply of corn plants with nutrients under the influence of the use of the optimal level of macrofertilizers in the norm $N_{120}P_{90}K_{90}$ and microfertilizers, starting from the first stages of organogenesis, provided the physiological need of plants for nutrients. The difference in the yield of corn hybrids between the studied variants was due to the formed different mass of 1000 grains (Table 3). In the control, it was the lowest - 261 g, with presowing seed treatment with microfertilizer, the oracle of seeds at a rate of 1.0 lt^{-1} increased to 289 g. of this indicator was significant 34 g using valagro EDTA mix 5 (0.2 kg t^{-1}) and 41 g using brexil Combi (0.5 kg t^{-1}). On the mass index of 1000 grains, the influence of microfertilizers was 64%, the hybrid - 28, the interaction of these factors - 1, other factors - 7%.

Miroshnychenko and Shedei (2015) [12] believe that the treatment of corn seeds with microfertilizers is one of the most effective methods for providing crops with nutrients at the initial stages of plant growth and development. With this application, seed germination is accelerated due to the activation of hydrolyzing enzymes, and this contributes to faster penetration of water through the seed coat and its swelling, as a result, increases the production of friendly seedlings with a developed root system. At the same time, at the initial stages of growth and development, plants are supplied with a complex of nutrients that they are unable to obtain from the soil.

According to Vozhegova., *et al*. (2016) [30] under irrigation conditions on dark chestnut soil in the south of Ukraine with presowing treatment of seeds with Sizam-Nano, the increase in grain yield of FAO 180-290 hybrids was 0.67-1.19 t ha^{-1}, FAO 310-430 - 0.69-2.30 t ha^{-1}.

The effectiveness of pre-sowing seed treatment on the individual productivity of maize hybrid plants: DN Meotyda, DB Khotyn, for growing on podzolized chernozems of the western Forest-Steppe, Moldovan and Sobchuk (2018) [13] note. The researchers found a positive effect of the growth stimulator Vympel-K microfertilizers - oracle seed (1.0 lt^{-1}) + oracle zinc (1.0 lt^{-1}) on plant height, leaf surface area, number of productive heads per plant and weight of 1000 grains. However, the highest rates of individual productivity in both hybrids under study were provided by complex pre-sowing seed treatment and spraying of crops in phases of 3-5 and 7-9 leaves.

When corn seeds were treated with Bifoliar microfertilizer (1 lt^{-1}), the number and length of roots increased, germination energy increased by 3-8% and field germination increased by 8-10% [2].

Presowing treatment of seeds with microfertilizers	Hybrid								Average	± to control
	Pochaevskiy 190 MV		DN Meotyda		DN Khortytsa		Orzhytsa 237 MV			
	g	± to control	g	± to control	g	± to control	g	± to control		
Without seed treatment (control)	234	-	242	-	249	-	253	-	261	-
Oracle nasiny (1.0 l t^{-1})	281	47	287	43	293	44	298	45	289	28
Brexil Combi (0.5 kg t^{-1})	292	58	298	56	302	53	312	59	302	41
Valagro EDTA mix 5 (0.2 kg t^{-1})	287	53	290	48	299	50	304	51	295	34

Factor:	Impact intensity	$SSD_{0.05}$
A (microfertilizer)	64	3.81
B (hybrid)	28	3.81
Interaction of factors AB	1	7.62
Other factors	7	

Table 3: Weight of 1000 grains of corn hybrids depending on the presowing treatment of seeds with microfertilizers (2019-2021), g.

Presowing treatment of corn seeds with solutions of nanocomposites: Saponite (H), Nb-Saponite (Cl), Nb-Saponite (Et) contributed to an increase in the assimilation surface of the leaves of the Kharkivsky 340 MV corn hybrid. The area of the leaf blade of plants under the influence of nanocomposites increases on average by 20.4%. The most intensive growth in the area of the corn leaf blade was noted under the influence of the Nb-Saponite (Et) nanocomposite at a concentration of 300 mg l^{-1}, this indicator increased by 44.5%. According to the results of spectrophotometric analysis, an increase in the amount of chlorophylls (a + b) in plants was established when seeds were treated with Nb-Saponite (Cl) and Nb-Saponite (Et) nanocomposites at a concentration of 300 mg l^{-1} by 41.2 and 40.6% in accordance with control [24].

Conclusion

Promising in the search for alternative means of influencing the formation of yields and product quality is the use of microfertilizers in growing technologies, which, at low doses, can increase the potential of biological productivity of plants within the normal range of the genotype reaction, enhance their adaptive ability to environmental stress factors. Presowing treatment of seeds of corn hybrids with chelate forms of micronutrient fertilizers had a positive effect on increasing the growth force of the germinal root (by 1.55-2.33 mm) and bud (1.50-2.60 mm). With the variants of their application, compared with the control (without micronutrient fertilizers), the plants formed a longer head of cabbage by 3.2-4.1 cm, more rows by 0.8-1.6 pcs and more grains - 72-104 pcs. Between the length of the head and the number of rows and grains in it, the correlation was direct strong, respectively 0.715-0.866 and 0.808-0.995. The most effective was the use of brexil Combi at a rate of 0.5 kg t, at which the average grain yield of hybrids was 8.41 t ha^{-1}. No significant difference was observed with the microfertilizer oracle seeds at a rate of 1.0 lt, and there was a significant difference (0.22 t ha^{-1}) with the microfertilizer valagro EDTA mix 5 (0.2 kg t).

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