

Formation of the corn root system depending on the norms of mineral fertilizers and biostimulants

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Abstract

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The article is devoted to the growth and development of the corn root system at various norms of mineral fertilizers and biostimulants in the gray soils of Uzbekistan. The introduction of mineral fertilizers and biostimulants “VL-77” and “Avangard Start” have a positive effect on the formation of the root system and the distribution of the root system in the arable and subsurface layers of the soil.

It was revealed that when applying fertilizers in the norms $N_{180}P_{120}K_{90}$ and $N_{250}P_{175}K_{125}$ kg/ha and the use of biostimulants, it stimulates the weight of the root system and above-ground organs.

It has been established that when applying fertilizers in the norm $N_{250}P_{175}K_{125}$ kg/ha and the biostimulator “VL-77”, the corn root system is located more in the arable soil layer. This contributes to a more efficient use of nutrients, and thus creates favorable conditions for the formation of a high yield of corn.

Keywords: corn; root system; mineral fertilizers; biostimulant; arable soil layer; dry mass weight; root location

Introduction

In the formation of the corn crop, an important role is played by the root system, which is the main and determining organ of plants. Undoubtedly, maximum yields can be obtained with an optimal combination of plant growth and development, as well as maize assimilation indicators. They change depending on soil and climatic conditions, the biological characteristics of the variety or hybrid, as well as agrotechnical conditions, in particular plant nutrition (Agafonov, 2000; Barentseva & Bukharev, 2009; Balyura, 1979; Bzikov, 2007; Volodarsky, 1986; Getmanets et al., 1985; Zhunko, 1969).

In our experiments, we studied the effect of various norms of mineral fertilizers and biostimulants (“VL-77”,

“Avangard Start”) on the weight of the above-ground part and the root system of gray soils in the Kashkadarya region of the Republic of Uzbekistan.

As a result, the degree of conjugation between the norms of mineral fertilizers and biostimulants, above-ground organs, and the root system was determined. The growth and development of the root system is largely determined by nutritional conditions, in particular, the provision of soil with macro- and microelements (Nazarov, 2016; Onishchenko, 2006; Radjabov, 1970; Shelganov & Voronin, 2008). However, there are relatively few works on the effect of mineral fertilizers and biostimulants on the development of the root system depending on the above-ground mass of corn, since in most cases researchers limit

themselves to taking into account their effect on the growth and development of plants.

Materials and Methods

To develop the scientific foundations for the rational use of mineral fertilizers and biostimulants in the cultivation of corn, the study of the formation of the root system of plants is of great scientific and practical importance. In our experiments, we studied the effect of various concentrations of mineral fertilizers and biostimulants on the weight of the aerial part, dry roots, and the location of corn roots in sierozem soils.

Field experiments were carried out in the farm “Mul hisil sifat” of the Karshi district of the Kashkadarya region of Uzbekistan with a zoned corn hybrid “Uzbekistan 300 MV”, according to the “Methodology of field experiments for studying agricultural practices for the cultivation of corn” and “Methodological recommendations for conducting field experiments with corn” (Filev, 1967; Filev et al., 1980). The area of each experimental treatment is 180 m², the accounting plot is 135 m², the replication is 4 times for each treatment, and the total area of the experimental plot is 8640 m².

The soil of the experimental plot is a typical serozem, slightly saline, with humus of 0.81%, phosphorus of 46 mg/kg, and potassium of 214 mg/kg. The climate is sharply continental; the average air temperature is 18°C; the air humidity is 46%; and the precipitation is 350 mm.

The following forms of mineral fertilizers were used in the experiments: ammophos (11% nitrogen, 36% phosphorus), carbamide (46% nitrogen), and potassium sulfate (60%

potassium). Processing of vegetative plants was carried out with biostimulants “VL-77” (drug consumption: 500 ml/ha) and “Avangard Start” (drug consumption: 1.5 l/ha). The composition of the “VL-77” biostimulator is polyethylene oxide (770 g/l) and humic acids purified from salt (30 g/l). Biostimulant “Avangard Start” contains nitrogen (100 g/l), phosphorus (70 g/l), potassium (20 g/l), calcium (10 g/l), boron (5 g/l), iron (10 g/l), ultramicroelements, amino acids, Mn, Zn, and Cu.

Results and Discussion

In the formation of corn grain yield, the root system plays an important role, which is closely related to plant nutrition.

Studies have established that on gray earth soils, mineral fertilizers and biostimulants are of great importance in terms of their effect on root growth. The combined use of mineral fertilizers and biostimulants stimulates the growth of roots, while the effects of the macro- and microelements contained in them are noticeable.

The distribution of the root system in the arable and sub-surface layers largely depends on the norms of mineral fertilizers with various types of biostimulants (Table 1).

From the above data, it can be seen that when mineral fertilizers are applied at the rates of N₁₈₀P₁₂₀K₉₀ and N₂₅₀P₁₇₅K₁₂₅ kg/ha, active ingredients and biostimulants “VL-77” and “Avangard Start” with 84.6–84.9% of the corn root system placed in the arable layer (0–25 cm). This placement of the corn root system contributes to the most complete use of the nutrients in the fertile humus horizon and moisture from the upper layers of the soil.

Table 1. Influence of norms for mineral fertilizers and biostimulants on the weight and location of corn roots

№	Experience variants	Weight of dry roots, kg/ha			Root location, %	
		0–25 cm	26–50 cm	0–50 cm	0–25 cm	26–50 cm
1	Without fertilizer	1015	376	1391	73.0	27.0
2	N ₁₀₀ P ₇₅ K ₅₀	1406	317	1723	81.6	18.4
3	N ₁₈₀ P ₁₂₀ K ₉₀	1720	353	2025	83.4	15.1
4	N ₂₅₀ P ₁₇₅ K ₁₂₅	1910	380	2290	84.9	16.6
5	Without fertilizers + Avangard Start	1256	397	1653	75.9	24.1
6	N ₁₀₀ P ₇₅ K ₅₀ + Avangard Start	1587	353	1940	81.8	18.2
7	N ₁₈₀ P ₁₂₀ K ₉₀ + Avangard Start	2144	384	2528	84.8	15.2
8	N ₂₅₀ P ₁₇₅ K ₁₂₅ + Avangard Start	2161	391	2552	84.7	15.3
9	Without fertilizers + VL-77	1140	358	1498	76.1	23.9
10	N ₁₀₀ P ₇₅ K ₅₀ + VL-77	1415	338	1753	80.7	19.3
11	N ₁₈₀ P ₁₂₀ K ₉₀ + VL-77	2053	373	2426	84.6	15.4
12	N ₂₅₀ P ₁₇₅ K ₁₂₅ + VL-77	2152	384	2536	84.9	15.1

It was established that in the control variant (without fertilizers), the weight of dry roots in the arable soil layer was 1015 kg/ha, and on the layer of 26–50 cm, 295 kg/ha were recorded, respectively, in a percentage ratio of 75.1 and 24.9%. This indicator for the $N_{180}P_{120}K_{90}$ + “Avangard Start” and $N_{180}P_{120}K_{90}$ + “VL-77” variants was 2144 and 384 kg/ha, 84.8 and 15.3%, respectively; 2053 and 373 kg/ha, 84.6 and 15.4%. The highest location of roots on the arable horizon was noted on the $N_{250}P_{175}K_{125}$ + “VL-77” variant (84.9%), and the $N_{250}P_{175}K_{125}$ + “Avangard Start” (84.7%). These indicators, compared with the control variant, improved by 11.9 and 11.7%, respectively. The location of the roots in the arable layer of the soil provides a more efficient use of macro- and microelements contained in the composition of mineral fertilizers and biostimulants and thus creates favorable conditions for the growth and development of corn, which provide an increase in plant productivity.

Usually, when choosing agrotechnical processes for the care of corn, the features related to the above-ground parts of the plant are taken into account first of all, and the features related to the underground parts are often neglected. This leads to a violation of the growth and development of plants and a sharp decrease in the productivity of corn.

The aerial part and the root system of corn develop in close connection with each other. Therefore, in order to obtain a high yield of corn, it is necessary to apply high agricultural technology, including mineral nutrition, in order to

simultaneously provide normal conditions for the development of both the aerial parts of plants and the root system (Table 2).

One of the total indicators of the productivity of a corn plant is the accumulation of dry matter in the aerial part and root system. These indicators are interconnected, are determined by the course of physiological and biochemical processes, and are regulated by environmental factors, in particular mineral fertilizers.

As a result of the study, the regularities of the influence of the norms of mineral fertilizers and biostimulants on the weight of dry matter – the aerial part and the root system were revealed; a relationship was established between the weight of all roots and small roots, the aerial part of corn. The introduction of mineral fertilizers into the soil and the use of biostimulants have a positive effect on the formation of the aboveground and underground parts of corn plants.

Thus, in the $N_{180}P_{120}K_{90}$ variant, the dry matter weight of the aerial parts of one plant was 282.3 g and the dry matter weight of the roots of one plant was 38.9 g. The ratio of roots and aerial parts was 1:7.26. In the $N_{180}P_{120}K_{90}$ + “VL-77” variant, the weight of the dry matter of the aerial part, compared to the $N_{180}P_{120}K_{90}$ variant, increases by 14.7%, and the weight of the root system by 4.9%. At the same time, their ratio was 1:6.78. A similar pattern is observed on the $N_{180}P_{120}K_{90}$ + “Avangard Start” variant, but the figures are slightly lower compared to the $N_{180}P_{120}K_{90}$ + “VL-77” variant.

Table 2. The dry matter weight of the above-ground and root systems of corn, depending on the norms for mineral fertilizers and biostimulants

№	Experience variants	Dry matter weight, g (per 1 plant)			The weight of small roots from the total weight of the roots, %	The ratio of the weight of the roots to the aerial part
		above-ground part	all roots	small roots		
1	Without fertilizer	124.5	20.5	9.1	44.4	1:6.07
2	$N_{100}P_{75}K_{50}$	237.9	33.2	16.8	50.6	1:7.17
3	$N_{180}P_{120}K_{90}$	282.3	38.9	19.9	51.2	1:7.26
4	$N_{250}P_{175}K_{125}$	298.7	40.8	21.5	52.6	1:7.32
5	Without fertilizers + Avangard Start	155.1	23.0	11.0	47.8	1:6.74
6	$N_{100}P_{75}K_{50}$ + Avangard Start	247.4	38.3	21.4	55.8	1:6.46
7	$N_{180}P_{120}K_{90}$ + Avangard Start	281.7	42.1	24.4	58.2	1:6.69
8	$N_{250}P_{175}K_{125}$ + Avangard Start	305.4	43.8	25.6	58.4	1:6.97
9	Without fertilizers + VL-77	157.4	23.8	11.6	48.7	1:6.61
10	$N_{100}P_{75}K_{50}$ + VL-77	255.4	40.3	22.7	56.3	1:6.34
11	$N_{180}P_{120}K_{90}$ + VL-77	297.0	43.8	25.6	58.4	1:6.78
12	$N_{250}P_{175}K_{125}$ + VL-77	311.0	44.6	26.2	58.7	1:6.88

The two methods that stimulate the weight of the root system and above-ground organs the most intensively are the application of mineral fertilizer and the use of biostimulants “VL-77” and “Avangard Start”.

The highest rates were registered for the weight of root and aboveground organs on gray earth soils when $N_{180}P_{120}K_{90}$ and $N_{250}P_{175}K_{125}$ were introduced; it should be especially noted against the background of these norms that biostimulants “VL-77” and “Avangard Start” were used. It has been established that an increase in the weight of the roots and their optimal location with an improvement in mineral nutrition is to a certain extent accompanied by an increase in the above-ground mass, which is an important indicator in the cultivation of corn.

Thus, in the conditions of the Kashkadarya region of Uzbekistan, the weight of roots and aboveground mass in gray soils increases under the influence of biostimulants against the background of mineral fertilizers. The change in the weight of the roots with the improvement of plant nutrition is accompanied by an increase in the above-ground mass in all variants of the experiment. Consequently, favorable conditions are created for the formation of a high yield of grain and green mass of corn.

Conclusion

Regularities were revealed in the influence of the norms of mineral fertilizers and biostimulants on the weight of dry matter-the aerial part and the root system- and a relationship was established between the weight of all roots and small roots and the aerial part of corn. The soil most intensively stimulates the weight of the root system and above-ground organs with full mineral fertilizer and biostimulants. $N_{180}P_{120}K_{90}$ and $N_{250}P_{175}K_{125}$ with biostimulators “VL-77” and “Avangard Start” have a noticeable effect on the increase in the weight of the aerial part and the root system. In general, there is a direct relationship between the amount of applied mineral fertilizers and biostimulants and the weight of the root system in the gray earth soils of the Kashkadarya region of the Republic of Uzbekistan.

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