

# Determination of the effectiveness of microbiological preparations and bioavailable nutrients while growing a vegetative apple rootstock

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**Abstract.** This article presents the results of a study of the effect of treatment of the root system of the M9 stock with the microbiological preparation Agrinos 1, which is a consortium of natural soil microorganisms - more than 80 strains from 10 families in combination with the preparation Agrinos 2, containing a complex of bioavailable nutrients (macro-, microelements, protein, amino acids, chitin, chitosan) in order to activate metabolic processes, reduce the impact of stress on the plant. The effect of biological products on the survival rate of the stock in the nursery, an increase in the yield and standardization of offshoots, and an improvement in their biometric parameters was established.

## 1 Introduction

In the Russian Federation, the production of fruit planting material is currently very relevant. Special requirements are imposed on the quality of the planting material.

Nursery is a very profitable and profitable branch of agriculture. However, the production of healthy, certified planting material is associated with significant difficulties associated with a certain professional training of an agronomist, as well as the soil and climatic conditions of the region. One of the most important structural units of a fruit nursery is the mother plant of a vegetatively propagated rootstock [1-5].

The dwarf stock M9 is the most widespread in our country and abroad for intensive apple orchards. Along with positive qualities (early maturity, high yield per unit area), the M9 stock has a number of disadvantages. The main ones are the high requirements of plantations on M9 to soil fertility, sufficient and uninterrupted supply of moisture due to the placement of most of the roots in the upper 30-40 cm offshoot. The rootstock offshoots in the nursery are poorly rooted [6-15]

The purpose of the work performed is to improve the quality indicators of the cuttings of vegetatively propagated rootstock using a biostimulator in combination with macro- and microelements.

## 2 Materials and methods

As an object of research, we used a dwarf apple stock – M9, as well as biological agents that improve the physiological state of plants.

The experiment was done at the production site of LLC "Priority Agro" in the village of Staromyshastovskaya in a nursery with a drip irrigation system. In the process of planting the vegetative rootstock M9, the pre-planting soaking of the root system of the rootstock (30-40 min) was carried out in a solution with the biological product Agrinos 1, which is a consortium of natural soil microorganisms – more than 80 strains from 10 families providing microbial symbiosis and Agrinos 2 containing the complex bioavailable nutrients (protein, amino acids, nitrogen, potassium, carbon, magnesium, copper, iron, chitin, chitosan) in order to activate metabolic processes, reduce the impact of stress on the plant.

After soaking, the roots of the stock were immersed in a mash, prepared in a solution of the same preparations. Planting was carried out according to the scheme: row spacing – 100 cm, in a row – 20-cm. To take into account the biometric parameters of plants, the variants of the experiment were randomized by 10 running meters in each replication, on which 56 plants were placed. In order to improve aeration, soil structure and moisture retention, fertigation with the Black Magic preparation was performed in the process of watering plants at a consumption rate of 2.5 kg / ha, containing nitrate and ammonium nitrogen; easily assimilated chelated forms of zinc, iron, manganese, copper; water-soluble oxides of calcium, potassium, magnesium, water-soluble boron and molybdenum; humic acids.

Additionally, foliar dressing Agrinos 2 was carried out once (May 17) at a drug consumption rate of 3.0 l/ha.

During the growing season, agrotechnical measures for the care of plants and records of observation of growth and development were carried out in accordance with the requirements set forth in the guidelines "Program and methodology for the study of varieties of fruit, berry and nut crops", Orel, 1999. The commercial quality of the cuttings was determined in accordance with GOST R 53135-2008 "National Standard of the Russian Federation. Planting material for fruit, berry, subtropical, nut, citrus and tea crops.

## 3 Results and discussion

The analysis of the data obtained indicates that the studied biometric indicators of the growth and development of the studied plants correlate with each other and indicate a positive effect of the agents used on the general physiological state of the M9 apple rootstock. In a comparative study of the results obtained, the effectiveness of the use of biological products and fertilizers that improve the structure of the soil and the bioavailability of nutrients to plants was noted, which affected the survival of the rootstocks (Table 1).

Therefore, in the control variant of 56 rootstocks, planted at 10 running meters, survival rate in average was 87.5%.

In the first variant, after the pre-planting treatment of the root system of the offshoots with Agrinos-1 product containing a complex of soil microorganisms capable of assimilating atmospheric nitrogen, converting it into various chemical forms, dissolving mineral phosphates, calcium, converting them into accessible forms for plants and other microorganisms, which, in general, contributes to an increase in the availability of soil nutrients, which, in combination with the additional application of Agrinos 2 fertilizer with a complex of bioavailable nutrients, contributed to an increase in the efficiency of plant root nutrition, as evidenced by data on an increase in rootstocks survival, which was 95.2%, which is 7.7% higher compared to control.

**Table 1.** The survival rate of apple stocks M9, taking into account the use of biological preparations

№ variant	Variant of the experiment	№ row	Name of the product	Dose of the product	Repetition	Survival rate,	
						amount	%
	Control (without treatment)	1-10	-	-	10 m	46	82.1
					10 m	52	92.9
					10 m	49	87.5
					average	<b>49</b>	<b>87.5</b>
1	Root system treatment when planting	11-30	Agrinos 1	0,15L/6000 pc.	10 m	54	96.4
					10 m	56	100.0
			Agrinos 2	0,15L/6000 PC.	10 m	50	89.3
					average	<b>53.3</b>	<b>95.2</b>
2	Root processing when planting Fertigation 04/23/20	31-75	Agrinos 1	0,15L/6000 PC.	10 m	53	94.6
			Agrinos 2		10 m	55	98.2
			Black Magic		10 m	56	100.0
	Spraying 05/17/20	Agrinos 2	2,5 kg/ha 3,0 L/ha	average	54.6	97.6	

In the second variant, where, in addition to the pre-planting treatment of the root system of the M9 rootstock during the growing season, fertigation was performed with the Black Magic preparation, which, along with improving the soil structure, contributed to the retention of moisture and better dissolution of nutrients containing in this preparation (nitrate and ammonium nitrogen; easily digestible chelated forms of zinc, iron, humic acid, etc.), as well as foliar feeding in May with Agrinos-2 biofertilizer, which in combination provided an increase in rootstocks survival up to 97.6% with a significant increase in yield and improved quality indicators of cuttings (Table 2).

The quality assessment of the cuttings was carried out in accordance with GOST R 53135-2008. The strength of the growth of the offshoots, depending on the technological methods performed in the variants, was different. Thus, in the control variant, the height of the offshoots was 62.8 mm with an average diameter of offshoots trunk of 6.6 mm.

Soaking the root system of the stock with Agrinos 1 promoted better assimilation of the complex of bioavailable nutrients introduced by Agrinos 2 by the stock, especially nitrogen, amino acids, potassium, which ensured an increase in the yield of offshoots to 268 thousand pieces / ha with an increase in the number of standard offshoots to 69, 4%, which is 3.6% higher in comparison with the control due to the improvement in the growth of offshoots and their quality indicators. An improvement in the growth of offshoots was also noted in the first version, where the height of the offshoots reached an average of 69.6 mm, which is 6.8 mm more than the control variant, while the best indicators for the diameter of the offshoots were also noted, averaging 8.2 mm.

In the second variant, due to the use of fertigation with Black Magic, as well as the secondary introduction of Agrinos 2, not only an increase in the yield of the offshoots was noted, which amounted to 279.0 thousand pieces per hectare, but also a significant increase in the yield of standard offshoots - up to 75.7% due to the improvement of the biometric parameters, where their height reached 72.0 mm. Taking into account that the diameter of the cut is a defining indicator in assessing the quality of the planting material (standard cut), it was measured at a height of 25 cm from the basal part of the cut, while the height of the offshoots in average was 8.8 mm.

**Table 2.** Biometric indicators of the M9 stock taking into account the use of microbiological preparations and biofertilizers that stimulate the growth and development of offshoots

№ variant	Variant of the experiment	offshoots output, thous. pcs / ha	The number of standard offshotts		Height of offshoots, cm.	Diameter of offshoots, mm
			pcs	%		
	Control (without treatment)	252	165	65.4	67.2	6.8
		258	174	67.4	62.6	6.4
		261	169	64.7	58.5	6.6
		257	169	65.8	<b>62.8</b>	<b>6.6</b>
1	Agrinos 1 Agrinos 2	274	180	65.7	68.4	8.1
		269	189	70.2	70.6	8.3
		263	190	72.2	69.8	8.3
		268	186	69.4	<b>69.6</b>	<b>8.2</b>
2	Agrinos 1 Agrinos 2 Black Magic Agrinos 2	267	211	79.0	75.1	8.9
		279	200	71.6	68.7	8.9
		291	223	76.6	72.3	8.7
		279	211	75.7	<b>72.0</b>	<b>8.8</b>

## 4 Conclusion

Thus, the performed studies to determine the effect of treatment of the root system of the M9 rootstock with the microbiological preparation Agrinos 1 followed by foliar treatment of Agrinos 2 showed that the survival rate of the stock was 7.7% higher than in the control and amounted to 95.2%. Additional fertigation of the rootstocks during the growing season with the Black Magic product, which, along with the improvement of the soil structure, contributed to the retention of moisture and better dissolution of nutrients contained in this preparation, provided an increase in the rootstock survival rate up to 97.6% with a significant increase in the yield and improvement of the biometric parameters of the offshoots, having a height of 9.2 cm more than in the control with a offshoot diameter of 8.8 mm.

Taking into account the high efficiency of the action of microbiological preparations when growing rootstocks in the mother stock, it is planned to study the results of the influence of Agrinos 1, Agrinos 2 and Black Magic on the growth and development of vegetative rootstocks of different growth rates - M 26, MM 106 in the mother stock, as well as when growing apple seedlings in the first and a second nursery field.

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