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RESEARCH ARTICLE

Cultivation of tomatoes using mycorrhizal biological preparations

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Abstract

The aim of the study was to study the effect of mycorrhizal preparations on the growth, development and yield of tomato plants. The article highlights the results of research on the use of mycorrhizal biological preparations of the BTU-Center company and their effect on the phenological phases of growth and development, biometric parameters and yield of tomato plants in open ground conditions. According to the results of the conducted research, it was found that mycorrhization contributes to the reduction of the interphase period vegetative mass growth – the beginning of fruiting of the plant. In particular, the beginning of fruiting phase began 6 days earlier compared to the variant without the use of mycorrhizal preparations.

Keywords: Tomato, Cultivation, Mycorrhization, Drug, Dose, Phenological phases, Biometric measurements, Yield

Introduction

Tomatoes are grown in almost all countries of the world with a total productivity of 180 million tons and an average cultivated area of 5 million hectares. The largest producers in the world are China, the USA and India. The potential opportunities of Ukraine as an agricultural country are quite large, given the fertility of the country's soil, there is currently an opportunity to grow many agricultural crops. Ukraine, as a state, positions itself as one of the world leaders in the production of agricultural products, it receives stable harvests of grain, technical, vegetable and fruit and berry plants. Among vegetable plants, tomato is one of the main vegetables, which is the leader in cultivation areas (Pantsyreva H., et al., 2023., Mostovenko V., 2022., Vdovenko S. A., et al., 2018).

Analyzing the last years, it is worth noting that the production of tomatoes has decreased somewhat, which is connected with the decrease of cultivated areas. Practically all products are produced for the domestic needs of the country, but the imported income has a significant impact on the cost, and therefore the shortage of own products, especially in the off-season, is filled at the expense of the foreign manufacturer. Tomatoes in Ukraine are grown in open and closed soil conditions, and greenhouse plants are adapted to growing tomatoes in several rotations, which makes it

possible to obtain products in the autumn-winter and winter-spring periods. Today, almost all greenhouse plants have switched to hydroponic cultivation, where the processes of growth, development and fruiting of tomatoes are quite successfully regulated.

Tomatoes (*Solanum lycopersicum L.*) are one of the most widely grown and consumed vegetables in the world with high economic and nutritional value, as well as certain medicinal properties (Souri M.K. & Dehnavard S. 2017, Osvalde A., Karlsons A. and Cekstere G., 2021). Tomatoes are used in a wide range of food products not only in fresh form, but also in processed form. It is worth noting that the taste and nutritional value of tomato fruits has decreased in recent decades as a direct result of traditional breeding (Fazal Ullah et al., 2023). Recently, more and more consumers are interested in high-quality, environmentally friendly vegetable products, while their production should ensure the preservation of the environment and soil fertility (Didur I.M., et al., 2019).

Materials and Methods

The study of the effect of mycorrhizal preparations on the growth, development and yield of tomato plants took place in 2020-2022. In the experiment, use mycorrhizal biological preparations *Melanoriz* and *Mycofriend* (manufacturer: «BTU-center» company).

Harvesting of tomato fruits was carried out in the phases of technical and biological ripeness, according to the standard in force in Ukraine. The yield was calculated separately from each repetition, later the average indicator was found, which was calculated in t/ha. Tomato fruits were sorted into I and II variety groups, and the number of non-standard products was also calculated. Statistical data processing was performed using the Statistica computer program.

Results and Discussion

Research on the study of biological preparations during the cultivation of vegetable plants was carried out by researchers in different soil and climatic conditions. As a result of research, their positive influence on the biometric parameters of plants, products and plant yield was revealed. In particular, according to the results of Ji-Eun Lee et al, 2021. it was found that using mycorrhization during the cultivation of pepper seedlings with fungi significantly enhances the growth processes of the plant both in the greenhouse and in the field, which indicates that AMF has a positive effect on increasing the biometric indicators of sweet pepper, improves the physical properties of the soil by increasing the concentration of glomalin. The use of AMF can positively contribute to the sustainable development of agriculture by reducing the use of chemical fertilizers, as well as increasing yields (Ji-Eun Lee, Eun-Hwa Lee, and Ahn-Heum Eom, 2021; L. Nedorost, R. Pokluda, 2012). The positive effect of arbuscular mycorrhiza on the growth of tomatoes is confirmed by Abdulkareem M. and others. According to them, on soils where phosphates were not applied, tomato plants were characterized by the greatest colonization of the root system by mycorrhizae of the fungus, and an increase in the dry weight of the plant was also noted, which definitely affects the growth and growth of the vegetative mass of the plant (Abdulkareem M., Taoheed, Elijah M. Ateka, 2018).

Agnieszka Jamiołkowska and others investigated that the mycorrhization of tomato roots by the fungi *Claroideoglomus etunicatum* and *Rhizophagus intraradices* leads to a better absorption of Ca and K. The root length index, especially for varieties treated with *Claroideoglomus etunicatum*, was significantly greater than control plants (Agnieszka Jamiołkowska, et al., 2020). Youssef Ait Rahou and others. investigated that a combination of biologics increases plant immunity and reduces disease, as well as improves the leaf index relative to pathogen-infested control plants (Youssef Ait Rahou, et al., 2021).

Taking into account the appearance of the bud of the first tassel, it is worth noting the effect of mycorrhizal biological preparations (Tab. 1).

Table 1. The beginning of the main phases of growth and development of tomato plants, depending on the variety and applied mycorrhization, days from sowing the seeds (average for 2020-2022).

Research Options		The Period of Emergence of Seedlings	Phase of The Appearance of the I Tassel	The Phase of Appearance of The II Tassel	Beginning of Fruiting Phase	Mass Fruiting Phase
Variety (factor A)	Biological drugs (factor B)					
Lagidny	Drugs were not used (control)	9	69	92	115	121
	Melanoriz 0.5 l/1000 units.	9	71	92	112	118
	Melanoriz 0.5 l/1000 units.	9	66	88	111	117
	Mycofriend 0.5 l/1000 units.	8	67	86	110	116
	Mycofriend 1.0 l/1000 units.	8	67	87	110	116
Novichok	Drugs were not used (control)	9	64	96	107	116
	Melanoriz 0.5 l/1000 units.	9	65	92	107	113
	Melanoriz 0.5 l/1000 units.	8	63	91	105	109
	Mycofriend 0.5 l/1000 units.	8	61	79	99	105
	Mycofriend 1.0 l/1000 units.	8	62	81	101	107
Tayana	Drugs were not used (control)	11	71	92	118	124
	Melanoriz 0.5 l/1000 units.	10	70	90	110	116
	Melanoriz 0.5 l/1000 units.	10	62	84	111	117
	Mycofriend 0.5 l/1000 units.	9	68	85	109	115
	Mycofriend 1.0 l/1000 units.	9	66	84	109	115

The phase «Beginning of fruiting» in plants was observed on 99-112 days from the time of seed sowing. Such a trend was characteristic of the Novichok, Tayana and Lagidny varieties. From the application of Micofrend at a dose of 0.5 or 1.0 l/1000 units of seedlings, the «beginning of fruiting» phase for the Novichok variety began the fastest. In this variant, the beginning of fruiting was observed 99-101 days after sowing the seeds. Other variants of the experiment were characterized by the fact that the beginning of fruiting was observed a little later than the specified variant, but earlier than the plants of the control variant. A longer period of the beginning of fruiting was established in the control version, where mycorrhizal preparations were not used during the cultivation of the Tayana variety – 118 days.

The treatment of seedlings with mycorrhizal preparations had a positive effect on the establishment of plants in the open ground, the formation of fruits and the beginning of their technical ripeness due to the positive effect of the fungi *Glomus VS*, *Trichoderma harzianum*; microorganisms *Streptomyces* sp., *Pseudomonas fluorescen* and *bacteria Bacillius megaterium var. phosphaticum*, *Bacillus subtilis*, *Bacillus muciloginosus*, *Enterobacter sp*. Tomato fruits were characterized by typical varietal color, shape, weight, and fruit diameter (Tab. 2).

Table 2. Biometric parameters of the tomato plant in 2020-2022.

Research Options		Average Fruit Weight, g	Number of Fruits Per Plant (pcs.)	Plant Height, (cm)
Variety (Factor A)	biological Drugs (Factor B)			
Lagidny	Drugs were not used (control)	87	17	40

	Melanoriz 0.5 l/1000 units.	90	16	44
	Melanoriz 0.5 l/1000 units.	91	13	45
	Mycofriend 0.5 l/1000 units.	97	20	47
	Mycofriend 1.0 l/1000 units.	95	19	45
	Drugs were not used (control)	71	13	63
	Melanoriz 0.5 l/1000 units.	84	17	68
	Melanoriz 0.5 l/1000 units.	76	16	70
	Mycofriend 0.5 l/1000 units.	91	13	79
Novichok	**Mycofriend 1.0 l/1000 units.**	87	13	71
	Drugs were not used (control)	85	10	52
	Melanoriz 0.5 l/1000 units.	102	11	53
	Melanoriz 0.5 l/1000 units.	56	12	50
	Mycofriend 0.5 l/1000 units.	93	14	62
Tayana	**Mycofriend 1.0 l/1000 units.**	66	16	68

The applied mycorrhizal preparations influenced the formation of the total number of fruits. Tomato varieties Novichok and Lagidny were characterized by the largest number of fruits per plant. In these varieties, the total number of fruits ranged from 13 to 20 fruits per plant. As a result of treatment of seedlings before planting with a solution of Melanoriza at a dose of 0.5 l/1000 units according to the Novichok variety, 17 fruits were formed, and in the variant using the preparation Micofrend at a dose of 0.5 units or 1.0 l/1000 units according to the Tayana variety, 14-16 fruits were formed , which was 4-6 more fruits than in the control version. In other variants, the total number of fruits did not significantly exceed the number of control fruits.

The value of the tomato yield varied widely: from 24.7 t/ha to 41.8 t/ha (Tab. 3).

Table 3. The total yield of tomatoes in the experiment, t/ha.

Research Options								
Variety (Factor A)		**Biological Drugs (Factor B)**	**Productivity (t/ha)**			**Average**	**Deviation to Control**	
			2020	**2021**	**2022**		**(± t/ha)**	**%**
Lagidny		**Drugs were not used (control)**	28,5	27,8	28,8	28,4	-	-
		Melanoriz 0.5 l/1000 units	37,7	36,5	38,2	37,5	9,1	31,9
		Melanoriz 0.5 l/1000 units	34,3	33,7	34,6	34,2	5,8	20,4
		Mycofriend 0.5 l/1000 units	38,1	37,9	38,5	38,2	9,8	34,4
		Mycofriend 1.0 l/1000 units	39,3	38,6	39,8	39,2	10,8	38,1
Novichok		**Drugs were not used (control)**	41,3	40,5	41,7	41,2	-	-
		Melanoriz 0.5 l/1000 units	41,9	41,1	42,3	41,8	-16,5	-40,1
		Melanoriz 0.5 l/1000 units	25,3	24,7	25,8	25,3	-5,2	-12,6

		Mycofriend 0.5 l/1000 units	36,8	35,7	37,3	36,6	-3,4	-8,3
		Mycofriend 1.0 l/1000 units	38,5	37,4	39,2	38,4	-17,1	-41,6
		Drugs were not used (control)	24,6	24,2	25,2	24,7	-	-
		Melanoriz 0.5 l/1000 units	38,4	37,7	38,7	38,3	13,6	54,9
		Melanoriz 0.5 l/1000 units	33,3	32,8	33,8	33,3	8,6	34,8
	Tayana	**Mycofriend 0.5 l/1000 units**	30,3	29,8	30,6	30,2	5,5	22,4
		Mycofriend 1.0 l/1000 units	30,6	29,1	31,2	30,3	5,6	22,7
$LSD_{0,95}$ (A)			1,6	1,5	1,6			
(B)			1,6	1,5	1,6	-		
(AB)			3,2	3,0	3,1			

On average, over the years of conducting the experiment, the highest total productivity of the Lagidny variety was established in the variants where the seedlings were treated with *Melanorhiz* at a dose of 0.5 l/1000 units, Mycofrend at a dose of 0.5 units or 1.0 l/1000 units, and seedlings of the Tayana variety using *Melanorhiz* in amount of 0.5 units or 1.0 l/1000 units. During mycorrhization of the root system, more nutrients and moisture were absorbed from the soil in a timely manner, plants were better supplied with phytohormones and amino acids, which contributed to the formation of a larger vegetative mass of the plant and yield, which significantly exceeded the yield of plants of the control variant.

Analyzing the total yield of tomatoes, experiments established a different content of marketable fruits. The total yield consisted of fruits belonging to the I and II varietal groups and non-standard fruits. Fruits of the I and II varietal groups met the requirements of the generally accepted standard, had the appropriate varietal color and size, and had technical and biological ripeness. The non-standard group included fruits that were damaged by pests and diseases, with inappropriate shape and size.

Conclusions

Thus, the highest overall productivity of the Lagidny variety can be obtained by using Melanoriz at a dose of 0.5 l/1000 units, Mycofriend at a dose of 0.5 units or 1.0 l/1000 units, and by growing the Tayana variety with treatment of seedlings with Melanoriz at a dose of 0.5 units or 1.0 l/1000 units. The Lagidnyi and Tayana varieties were characterized by the largest number of standard fruits from the application of Melanoriza at a dose of 0.5 units or 1.0 l/1000 units. Mycorrhization contributed to the shortening of interphase periods, in particular, the «start of fruiting» phase began 6 days earlier compared to options without the use of mycorrhizal preparations.

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