AGRISCIENCE AND TECHNOLOGY
Armenian National Agrarian University
ԱԳՐՈԳԻՏՈՒԹՅՈՒՆ ԵՎ ՏԵԽՆՈԼՈԳԻԱ АГРОНАУКА И ТЕХНОЛОГИЯ
International Scientific Journal
ISSN 2579-2822

Journal homepage: anau.am/hy/teghekagir

UDC 635.4:631.527.8

The Effect of Mykonet on the Quality of Pepper and Tomato Fruits, their Bio-Morphological Properties and Yield Indicators

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ARTICLE INFO

Keywords:
Mykonet,
pepper,
tomato variety,
fruit quality,
yield

ABSTRACT

The effect of Indian mycorrhizal preparation Mykonet (Mn) on the growth, development, productivity and yield quality of the pepper varieties Zmrukht, Nush-55 and tomato varieties Anahit-351 and Noy was studied. Seeds of each variety were soaked in 0.01 % Mn solution for 1 and 2 hours. It was shown that Mn increased fruit quality and yield capacity of the pepper and tomato, depending on the treatment duration and crop variety. Two-hour-treatment was the most effective method for the mentioned plants. High productivity was recorded in the pepper variety Zmrukht and tomato variety Anahit-351. They exceeded the control variant by 16.5 % and 11.1 % respectively.

Introduction

Healthy soil is a fundamental necessity for increased food production. Soil fungi and their relationships with host plants (Fernanda, Hernan and others, 2012) significantly contribute to the soil fertility.

When the researchers apply natural fertilizers, they notice that certain extracts of the living organisms can often function as the natural stimulators for plant growth and protection.

In natural conditions the plants and mycorrhizal fungus are connected by mutually beneficial symbiosis. The fungal filaments can penetrate into the smallest pores of the soil minerals up to their thinnest root hairs, then, by gradually destroying them, fungi extract elements that are unavailable for plants nutrition, including such essential elements as phosphorus or the trace elements of zinc and cobalt. By marking the minerals with radioactive isotopes, it has been proved that there is a whole underground system of the thinnest yarns, where plants communicate by transferring and sharing the organic and mineral compounds. Thus, the total length of mycorrhizal filaments in the soil around the plant roots is 20-40 m/cm^3, due to which these fungi manage to get about 30 % of the synthesized carbohydrates (Chagnon, Bradley and others, 2013).

Mycorrhizal fungus Mykonet can enhance efficiency of plant roots to absorb water and macro and microelements from the soil or container media. This helps to reduce fertility and irrigation requirements, increases drought resistance and plant resistance to pathogens (Davies, et. al, 2000). The researched mycorrhizal fungus Mykonet was provided by the Indian producer “Elegant India”.

Materials and methods

For the experiment the sweet pepper (Zmrukht and Nush-55) and tomato (Anahit and Noy) varieties were chosen which are produced in Armenia and are very popular.

Zmrukht is a determinant variety of medium-early maturity. Fruits are conical, smooth, thick-walled with 70.0 g – 80.0 g weight. In technical ripening phase the color is green, in biological ripening phase it is red. It is also resistant to fusarium. Fruits are marketable, suitable for fresh use, marinades and drying.

Nush-55 is a determinant variety with medium maturity. Fruits are elongated and conical, smooth, thick-walled with 80 g - 90 g weight. In the technical ripening phase it has light green color, while in biological ripening phase it is red. This variety is resistant to fusarium and early withering. Fruits are marketable, suitable for fresh use, marinades and drying.

Anahit-351 is again a determinant variety of medium-early maturity. Its fruit is flat-roundish, with intensive red color; it weighs 150 g-170 g and is transportable.

Noy is still a determinant variety of medium maturity. Fruits are roundish with intensive red color; the weight is 200 g-220 g.

Seeds of experimental varieties were soaked in 0.01 % Mn solution for 1 or 2 hours, while the control seeds were placed in distilled water with the same duration, after which the seeds were sown. Forty five-fifty days after germinating seedlings were planted in the open field.

The experiments were performed on the experimental field of the Scientific Center of Vegetable-Melon and Industrial Crops, Armenia during 2018-2019. Soils of experimental plot had heavy mechanical composition of light clay content (carbonates 0.95 %). Its organic matter content was 1.96 %, total nitrogen - 0.09 %, pH - 6.8 %. The average temperature during the development season was around 30°C.

The phenological and morphological observations of the plants were carried out throughout growing season through the method of State Variety Trial of agricultural crops (Fedin, 1985).

The fruit samples for chemical analyses were collected twice: first - at the beginning of fruiting stage, and then - just before the end of the experiment. The dry material content was identified by the refractometer "IGF-454B2M", the sugar content - by Bertran method and vitamin C- by Moory method (Peterburgski, 1968).

The data on harvest efficiency of Mn has been also identified.

The experiment was set up according to block randomization method with 4 repetitions each with 90 plants per investigated variant, the nutritional surface for each pepper plant was 0.21 m^2 (70+70x30 cm) and that of each tomato plant - 0.28 m^2, (90+70x35 cm).

Significant differences between the treatments were tested using the method of the Least Significant Difference (LSD). The saved LSD values were calculated at $P<0.05$ probability levels (Dospekhov, 1985).

Results and discussions

It was found out that all pepper and tomato seeds treated with Mn germinated 2-3 days earlier than those in the control ones. They grew simultaneously and formed extensive over ground parts with larger (13-15 %) leaf blades than those of control ones and had well-developed root systems. The duration of their development stages was shorter in case of 2-hour-treatment than that of observed in case of an hour treatment. The phenological data varied depending on the variety and duration of Mn treatment. In the first case the flowering stage of pepper plants was 3-8 days earlier and in tomato plants it was 4-8 days earlier, the fruiting stage in pepper was 5-10 days earlier, and in tomato it was 5-6 days earlier as compared to the same indicators in the control variants (Table 1).

In case of 1 h Mn treatment the vegetation period for pepper and tomato was shorter than that of control ones by 8-13 days and 3-4 days, while the period of crop formation was longer by 3-8 days and 2-5 days (Table 1). Similarly, in case of 2 h treatment, the vegetation period was shorter by 13-22 days and 7-8 days and crop formation period was longer by 2-5 days.

The most significant effect was observed for the plant growing rate in the transitional period from budding to flowering and intensive fruit formation phases, when the general growth of stem slowed down. At the end of vegetation period the stems of sweet pepper varieties were higher by 10.5 %-15.5 % and those of tomato plants by 4.0 %-7.5 % than the similar indicators of the control variant.

The biochemical analysis also revealed differences in the fruit quality. In biological ripening phase fruit dry matter content of the control and Mn treated plants varied between 7.5 % - 8.1 % in pepper and 6.0 %-6.8 % in tomato fruits. DM in pepper and tomato fruits significantly exceeded that of the control variant only when the treatment duration was 2h.

Based on the sugar content data (Table 2), it could be concluded that the tomato varieties were more sensitive to Mn than those of the pepper ones. In pepper fruits the influence of Mn was not significant on the sugar content, while in tomato fruits sugar content grew up even when the duration of the treatment was 1 hour.

Table 1. The effect of Mn on the phenophase duration of pepper and tomato (days)*

Crop	Variety	Variants	From germination to flowering	From germination to fruiting	From fruiting to technical ripening	From technical to biological ripening	Vegetation period	Harvesting period
Sweet pepper	Nush -55	Control	78±1.2	85±1.1	40±1.4	26±1.0	151±2.1	65±1.1
		Mn 1h	72±1.1	78±1.4	36±1.2	24±1.2	138±1.2	73±1.2
		Mn 2h	70±1.5	75±1.3	32±1.0	22±0.8	129±1.5	87±0.8
	Zmrukht	Control	74±1.2	82±1.2	39±1.3	26±0.3	147±1.5	68±0.9
		Mn 1h	73±1.4	78±1.3	37±1.0	24±0.3	139±0.3	71±1.2
		Mn 2h	71±1.0	77±1.5	35±1.4	22±0.3	134±1.2	72±1.3
Tomato	Anahit-351	Control	61±0.5	72±0.5	-	30±1.0	102±1.0	43±1.1
		Mn 1h	55±1.3	68±1.1	-	30±1.3	98 ±0.3	45±0.8
		Mn 2h	53±1.0	66±1.5	-	28±1.0	94±0.2	47±0.5
	Noy	Control	65±1.1	75±0.6	-	36±1.4	111±1.1	48±1.2
		Mn 1h	62±1.1	74±1.2	-	35±1.0	109±0.9	53±1.1
		Mn 2h	61±0.8	70±1.4	-	34±0.3	104±0.2	57±0.5

Table 2. Mn effect on the content of dry matter, sugar, and ascorbic acid in pepper and tomato fruits*

Crop	Variety	Variants	Dry matter, %	Sugars, %	Ascorbic acid, mg%
Sweet pepper	Nush -55	Control	7.5	5.4	211.2
		Mn 1h	7.5	5.5	211.3
		Mn 2h	7.9	5.5	217.8
		$LSD_{0.05}$	0.2	0.2	0.3
	Zmrukht	Control	7.5	5.5	231.3
		Mn 1h	7.6	5.5	233.1
		Mn 2h	8.1	5.6	236.2
		$LSD_{0.05}$	0.4	0.2	0.8
Tomato	Anahit-351	Control	6.1	3.0	18.4
		Mn 1h	6.2	3.2	18.5
		Mn 2h	6.8	3.2	18.8
		$LSD_{0.05}$	0.2	0.1	0.2
	Noy	Control	6.0	3.1	19.0
		Mn 1h	6.0	3.3	19.2
		Mn 2h	6.2	3.4	19.5
		$LSD_{0.05}$	0.1	0.2	0.3

**Composed by the authors*

This was due to the fact that Mn induces extra root system development, branching and flower number, all of which together increase plants' productivity.

In the experimental varieties the marketable yield of Zmrukht pepper increased by 0.5-7.5 tons as compared to that of the control variant, the yield of Nush-55 variety increased by

5.2-7.2 tons, in the tomato variety of Anahit-351 it grew up by 1.5-8.4 tons and in Noy variety -by 0.9-8.4 tons. All the experimental varieties demonstrate the best results when treated with Mn for 2 hours. In the treated varieties the fruit mass also grew up.

Table 3. The effect of Mn on the yield capacity of pepper and tomato*

Crop	Variety	Variants	Yeild t/ha		Marketable crop surplus to the control, %	Fruit mass, g
			Total	Marketable		
Sweet pepper	Nush -55	Control	45.0	43.8	-	70
		Mn 1h	50.0	49.0	11.9	78
		Mn 2h	53.1	51.0	16.4	78
		$LSD_{0.05}$		2.1		
	Zmrukht	Control	47.0	45.5	-	75
		Mn 1h	48.0	46.0	1.1	78
		Mn 2h	54.3	53.0	16.5	80
		$LSD_{0.05}$		2.4		
Tomato	Anahit-351	Control	80.0	75.5	-	150
		Mn 1h	81.0	77.0	2.0	160
		Mn 2h	85.5	83.9	11.1	160
		$LSD_{0.05}$		1.7		
	Noy	Control	110.5	108.1	-	210
		Mn 1h	111.2	109.0	0.8	215
		Mn 2h	118.0	116.5	7.8	225
		$LSD_{0.05}$		0.8		

**Composed by the authors*

Thus, Mn stimulated all development phases improving plants properties. Most probably, these changes occur due to the phytohormones from auxins group, since they intensify the processes mainly controlled by these hormones (Azaryan, et.al, 2014).

Conclusion

The results obtained give a ground to conclude that Mn improves the pepper and tomato morpho biological and biochemical indicators in various degrees, depending on the treatment duration and on the crop variety. Effectiveness is high when seeds are soaked in 0.01 % Mn solution for 2 hours.

Thus, it is recommended to apply pre-sowing seed treatment with Mycorrhizal Mykonet preparation.

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The work was supported by the RA MES State Committee of Science in the frame of research project № 18T-4B202.

Accepted on 16.12.2019
Reviewed on 26.12.2019