Biological effectiveness of the drug Esfon use for tomatoes

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Abstract. Tomatoes play a leading role in providing the population of Russia with vegetable products, which is due to their high productivity, good taste properties, diverse use, ability to cultivate in open and closed ground, and, consequently, to consume them all year round. Based on the fact that the consumption of tomatoes is growing every year, the main task is to increase the yield and quality of fruits. One of the ways to solve this problem is, according to research data, four-fold treatment of tomato plants in the phase of milk ripeness with Esfon at a dose of 1.0l/ ha, which is due to obtaining a high yield of good quality fruits (6,204 kg/m^2, in the control - 5,108 kg/m^2, HCR_{05} = 0.250 kg/m^2) and a reduction in the maturation period, in comparison with the control, is 14 days.

1 Introduction

Based on the nutritional value of tomatoes (the content of vitamins, organic acids, mineral salts, trace elements, etc.), the annual consumption rate of tomatoes should be 30-35 kg. However, the production of tomatoes lags significantly behind their consumption. The noted imbalance can be eliminated by applying natural and synthetic growth regulators, new agrochemicals and their complexes with amino acids and trace elements, humic substances that activate growth and production processes, increasing the yield and quality of the products obtained, as well as plant resistance to various kinds of stresses - climatic, diseases, pests [1, 2, 3, 4, 5].

In the technology of cultivation of agricultural plants, it is possible to use various natural hormonal substances that are similar in structure and chemical composition to auxin, gibberellin and ethylene. Of undoubted interest is the natural phytohormone – ethylene, the treatment of vegetative tomato plants with which reduces the ripening time of fruits and increases the content of sugars, organic acids and vitamin C in them. Ethylene has an important property – it can change the metabolic processes of plant cells and vary the timing of their phenological phases [6, 7].

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2 Materials and methods

The tested growth regulator, Esfon, is an ethylene-producing substance that accelerates the maturation of various crops. The studied crop is a tomato of the Dar Zavolzhya variety – the most common in Krasnodar Territory.

Tomato plants in the field experiment were sprayed with a solution of the test preparation: 1^{e} – in the phase of milk ripeness of fruits on the first brush, the next three sprays – after harvesting the fruits. At the same time, the diameter and mass of each fruit were measured. In the control variant (option 1), the plants were not treated. The experimental variants differed in the rate of consumption of the drug: 0.5 l/ha – option 2; 0.75 l/ha – option 3; 1.0l/ha – option 4, the consumption of the working solution – 300 l/ha. The selection of plants to determine the growth parameters and the content of total sugar and vitamin C in fruits was carried out during the period of mass fruiting [8]. The yield was determined by the amount of fruit collections from the recording area. The obtained data were processed mathematically [9].

3 Results

Taking into account the composition of the tested preparation (the active substance is ethylene) and the mechanism of its action – acceleration of fruit ripening, the first treatment of plants with it was carried out in the phase of milk ripeness of the first brush in the doses indicated in the scheme. The following plant treatments were carried out after harvesting red tomato fruits. A week after the fourth treatment, carried out in the mass harvest of fruits, plant samples were taken for biometric and structural analysis.

Ethylene, which is part of the test preparation, is a specific gaseous hormone that inhibits growth [10]. At the same time, with a decrease in length, the stem thickens, which leads to an increase in the mass of organs (Table 1).

Table 1. The effect of the drug Esfon on the parameters of the aboveground organs of tomato plants.

Type	Plant height, cm	Number of branches, pcs.	Biomass, g/plant		Dry weight, g/plant		% dry substance
			stems	leaves	stems	leaves	
1	69,4	2,3	50,88	103,57	16,31	29,10	29,40
2	64,2	2,5	55,72	119,14	18,33	34,07	29,96
3	60,5	2,6	58,62	121,36	19,57	35,32	30,50
4	56,4	2,8	61,44	123,11	20,83	36,32	30,96
HCP_{05}	2,8	0,1	2,47	4,63	0,80	1,34	

Analysis of the data in Table 1 shows that 4-fold treatment of plants (1st – at the beginning of the milk ripeness of the fruits of the first brush and three as the fruits transition to the milk ripeness of the upper brushes) reduced plant growth in height. In the experimental variants, less tall plants were formed (56.4-64.2, in the control - 69.4 cm), but more powerful in habitus (number of branches – 2.5-2.8, in the control – 2.3 pcs/plant; biomass of stems – 55.72-61.44 g, against 50.88 k in the control; raw mass of leaves –

119.14-123.11, in the control – 103.57 g/plant). In the experimental variants, an increase in the dry weight of stems by 2.02-4.52 g was noted, in the control – 16.31 g /plant and leaves by 4.97-7.22 g, against 29.10 g/plant of the control variant. Four-fold application of the test drug on plants led to an increase in the percentage of dry matter in plants (29.96-30.96%, in the control - 29.40%).

A significant increase in the mass (raw and dry) of tomato leaves is mainly due to an increase in the number of leaves and the area of the leaf apparatus (Table 2).

Table 2. The effect of the drug Esfon on the foliage of tomato plants.

Type	Number of leaves, pcs/plant	Leaf area, dm^2/plant
2	29,4	40,1
3	32,1	46,5
4	35,6	50,3
HCP_{05}	1,4	1,9

According to biometric analysis, a greater number of leaves were observed on the plants of the experimental variants than on the plants of the control variant (29.4–35.6, versus 26.3 pcs/plant in the control). An increase in the number of leaves on a plant leads, respectively, to an increase in their area (40.1–50.3 dm^2/plant, in the control – 35.8 dm^2/plant). The maximum values of the indicators considered in Table 2 are noted in the variant with the use of the test drug at a dose of 1.0l / ha.

The maturation period of tomato fruits largely depends on varietal characteristics and agricultural techniques of cultivation. To accelerate the rate of ripening of tomato fruits, phytohormone ethylene or ethylene-producing drugs are widely used in agricultural technology. The use of Esfon in experimental versions of the tested drug significantly affected the ripening time of tomato fruits.

Table 3. The effect of the drug Esfon on the ripening period of tomato fruits.

Type	The number of days from growing from seed
1	110
2	105
3	101
4	96

From the data in Table 3, it can be seen that in the control variant, fruit ripening occurred on day 110, starting from sowing, in the experimental variants – on day 96-105.

Consequently, the four-time use of the test drug on plants reduced the ripening time of tomato fruits by 5-14 days, especially when using it at the maximum dose (1.0l/ha).

A decrease in the ripening period of tomato fruits and a significant increase in the mass of aboveground organs positively affected the indicators of the structural elements of the tomato harvest (Table 4).

Table 4. The effect of the drug Esfon on the structural elements of the tomato crop.

Type	Сбор плодов с куста Picking fruits from a bush		Fruit diameter, cm	Fruit mass, g
	Number of fruits, pcs.	Mass of fruits, kg		
1	20,1	1,010	4,0	49,92
2	21,6	1,124	4,2	52,08
3	22,4	1,178	4,3	52,42
4	22,8	1,199	4,3	52,68
HCP_{05}	0,8	0,044	0,1	1,85

In experimental variants, the process of fruit formation under the action of the test drug was more active, as indicated by the formation of a larger number of fruits in them (21.6–22.8 pcs/bush, in the control – 20.1 pcs /bush, NSR05 = 0.8 pcs), larger in size and weight (4.2–4.3 cm; 52.08–52.68 g, in the control – 4.0 cm and 49.92 g), which predetermined an increase in fruit harvesting from the bush (1,124–1,199 kg/bush, and 1,010 kg/bush, respectively, NSR_{05} = 0.044 kg), and consequently, the yield of tomatoes (Table 5).

Table 5. The effect of the drug Esfon on the yield and quality of tomato fruits.

Type	Yield, kg/m²	Increase in control		Content in fruits	
		kg/m²	%	sugar, %	Vitamin C, mg%
1	5,108	–	–	3,3	38,1
2	5,644	0,536	10,5	3,4	39,2
3	5,912	0,804	15,7	3,5	40,0
4	6,204	1,096	19,6	3,5	41,1
HCP_{05}	0,250				

In the experimental variants with 1 m², 5,633–6,204 kg of fruits were collected, while in the control – 5,108 kg. The maximum fruit harvest from 1 m² (yield) was noted in the variant with the treatment of plants four times with Esfon at a dose of 1 l / ha. In the tomato fruits of the experimental variants, the content of vitamin C (39.2–41.4, in the control – 38.1 mg %) and total sugar (3.4–3.5, in the control – 3.3%) increased, the maximum content of sugars and ascorbic acid in the fruits was noted in the above variant.

4 Discussion

It was found that the treatment of tomato plants with the tested preparation Esfon, the active substance of which is the hormone ethylene, starting with the milk ripeness of the fruits on the first brush and three subsequent ones after harvesting red tomato fruits, due to the

mechanism of action of the hormone, enhances and accelerates the process of fruit formation, as well as shortens the ripening period of fruits (by 5-14 days). At the same time, it should be noted that the rate of consumption of the drug had a significant impact on the process of fruit formation. The largest number of fruits on the bush (22.8, in the control – 20.1 pcs, NSR_{05} = 0.8 pcs), larger in size (diameter – 4.3, in the control – 4.0 cm, NSR_{05} = 0.1 cm) and weight (52.68, in the control – 49.92, NSR_{05} = 1.85 g) was formed in the variant using Esfon preparation at a dose of 1.0 l/ha (the consumption of the working solution is 300 l / ha), which predetermined the maximum yield increase of 19.6%, with a yield in the control of 5,108 kg / m^2 of high–quality tomato fruits.

Conclusions

The high efficiency of the use of the Esfon preparation in tomato cultivation technology when treating plants with it fourfold (the consumption of the preparation is 1.0 l/ha, the working solution is 300 l/ha) is due to obtaining the maximum fruit harvest from 1 m^2 (6,204 kg, in the control – 5,108 kg; the increase was 19.6%) of high quality (the content of total sugars – 3.5%, in the control – 3.3%; vitamin C – 41.1 mg %, in the control – 38.1 mg %).

References

1. K. Ibrahim, A. Amans, I. U. Abubakar, *Growth indicators and yield of tomato varieties (Lycopesicon esculentum) epending on the distance between crops in Samara*, Proceedings of the 18th HORTSON conference, v. **1**, pp. 40-47 (2000)
2. K.P. Debjit Bhowmik, K. Sampath, P. Shravan, S. Shweta, International journal of agricultural Sciences, v. **9(1)**, pp. 438-443 (2013).
3. K. S. Sandeep, T. Nidhika, S. Yamini, International journal of agricultural Sciences, v. **9(1)**, pp. 433-437 (2013)
4. P. Calvo, L. Nelson, J.W. Kloepper, Plant and Soil, V. **383(1)**, P. 3-41 (2014)
5. L.P. Canellas, F.L. Olivares, N.O. Aguiar, D.L. Jones, A. Nebbioso, P. Mazzei, A. Piccolo, Scientia Horticulturae, v.**196**, pp. 15-27 (2015)
6. A. Santner, L.I.A. Calderon-Villalobos, M. Estelle, Nature Chemical Biology,. № **5**, pp. 301-307 (2009)
7. E.S. Baidelyuk, International Scientific Research Journal, № **5(95)**, 017 (2020)
8. N.N. Ivanov, Methods of plant physiology and biochemistry, 493 c (1946)
9. B.A. Dospekhov, Methodology of field experience, 351 c (1985)
10. V.I. Kefeli Stories about phytohormones (1985)