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Effectiveness of Growth-regulator Energy-M By Seedlings of Tomatoes in Strict Arid Conditions of the Low Volga Region

Alexander Ivanovich Belyaev[1], Anna Mikhaylovna Pugacheva[1], Nikolay Yur'evich Petrov[1,2], Yelena Vladimirovna Kalmykova[4], Ol'ga Vladimirovna Kalmykova[2], Sergey Denisovich Fomin[2,4], and Vyacheslav Petrovich Zvolinsky[2,3]

[1]Federal Scientific Center of Agroecology, Complex Meliorations and Protective Afforestation of RAS, Volgo-grad, Russia
[2]Volgograd State Agrarian University, Volgograd, Russia
[3]Caspian Sea Agrarian Federal Scientific Center of RAS, Solenoye settl., Chernoyarsky area, Astrakhan re-gion
[4]All-Russian research institute of irrigated agriculture, Timiryazev Street, 9, Volgograd, Russia

Corresponding Author:
Nikolay Yur'evich Petrov
fsd_58@maail.ru

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Abstract

The complicated conditions of the modern period of intensification of agricultural production cause the necessity in the development of new technologies adapted to current conditions of land use. Thereby we have developed the concept of ``The system of technological measures for growing of vegetable cultures providing the rational effective use of material and energy resources and getting of economically profitable yields''. The paper presents the results of research on the effectiveness of growth-regulator for getting of high-quality yield of tomatoes. It was approved that the organosilicone product Energy-M stimulated plants` growth and development, and increased the productivity of tomatoes in strict arid conditions of the Low Volga region. The object of research was the tomato grade Hercules. The highest yields of tomatoes with the formation of big quantity of large fruits with pretty good eating characteristics were harvested when planting of the grade Hercules on the site with pre-sowing treatment of seeds and foliar nutrition of plants during the initial period of growth and the phase of budding-blossom. The application of the growth-regulator Energy-M on tomato sowings is an effective measure. The producers of high-quality vegetable production are recommended to use the said product widely when sufficient mineral nutrition by moistening of the seeds prior to sowing and by the treatment of the plants during the whole vegetation period.

Keywords: tomatoes, plants growth-regulator Energy-M, productivity, surroundings impact, quality.

1. Introduction

The main direction of reaching the progress in agriculture and meeting the requirements of the country in products of agriculture is the overall mechanization and consistent

intensification: obtaining high culture of land use for all enterprises on the basis of scientific and advanced experience, sharp increase in productivity of all species and higher yielding per 1 hectare by minimum expenses of labor and resources [1, 5, 7, 13].

Tomatoes are one of the valuable vegetable species. Their fruits are rich in sugars, organic acids, vitamins, mineral salts, therefore provide benefit to human`s health [2, 9, 12].

It is generally known that the chemical growth-regulators contribute to getting of high yields of tomatoes with sufficient eating characteristics of fruits and earlier terms of ripening [3, 6, 10].

The chemical growth-regulators replace neither nutritive substances nor any other criteria that provide living conditions for plants. They just modify the character of substances transformation and accelerate the progress of physiological processes. The maximum economic effect should be achieved with appropriate plants management. Thus, it is important to follow the main agro-technical principles by use of the given method for increase in productivity [2, 4, 5, 14, 15]. They contribute to getting of high yields of fleshy fruits rich in nutritive substances and thus are of a great importance for development of food industry. The possibility to fasten the fruits ripening with the help of the said products is very promising for vegetable production both in the northern and in the southern regions of the country where tomatoes are damaged by first early autumn frosts.

Thus, the application of high detergent chemical combinations is an effective method for reaching high yields of agricultural crops and their effectiveness increases year by year. The biological substances of new generation introduced to the agricultural engineering are a good alternative to mineral fertilizers, are applied in small doses, and provide increase in productivity of agricultural crops [8, 11].

Energy-M is a silicoprotatrane regulator of plants` growth and development and is a composition of silatrane and a synthetic analog of phytohormone (auxin) protatrane. The product does not contain hormonal additives, does not possess mutagenic, teratogenic, and cumulative properties [2, 8, 11].

Despite the regular complicated meteorological conditions in different soil-climatic zones of Russia the use of the product Energy-M provides guaranteed yields of products of vegetable cultivation with increase of between 15 and 45 %.

Treatment with chlormethylsilatranum (active substance of the product Energy-M) favors increase in the content of hydration water in plants in more than 2.5 times, and increases the percentage of dry matter content.

The hydrated water does not crystallize by freezing, thus it conserves vegetation tissues from damage, it does not evaporate from cells and contributes to higher resistance to moisture deficiency by droughts providing plant`s drought- and frost-resistance.

Temperature regime, as well as soil and atmospheric moisture play significant part in the development of plants treated by the growth-regulator. Tomatoes are known to be temperature- and-air and soil moisture-demanding species. When abnormal increase or decrease in temperature regimes, as well as occurred air aridness, the process of insemination get broken which results in fall of flowers and development of ``seated'' ovary. The insufficient water content in soil suppresses plants` growth, causes worse fruit inception and filling. The abnormal water regime of plants and temperature conditions cause fruit diseases [1, 3, 10].

Thus, the plants treated with the solutions of regulators turn to be more resistant to decreased and increased temperatures, to insufficient soil moisture, to high air dryness as the said products increase the water-holding capacity of plant cells and reduce transpiration [11].

On the basis of scientific analytic study of literature sources and regulatory methodical documents, there is developed a concept of «The system of technological measures for growing of vegetable species providing rational effective use of material, energy resources and harvesting of profitable yields».

The purpose of our research is to determine the optimal concentrations and terms of treatment of tomatoes with the solutions of the regulator Energy-M in conditions of the Volgograd region, to determine the influence of the environmental factors on the effect of the regulator, to identify the dependence between the said regulator and the productivity of tomatoes.

2. Methods and Equipment

The experimental works were developed in conditions of the husbandry of a private enterpriser Zaytsev V. A. (Gorodishchensky district of the Volgograd region). During 2014-2016 a number of experiments have been set to determine the dependence between the effect of the growth-regulator Energy-M on the development of tomatoes and the conditions of mineral nutrition by open ground. The research was conducted with the plants of tomatoes of the grade Hercules. The studied plants were treated by the spraying with the solution of the growth regulator by preceding fertilization with $N_{250}P_{100}K_{125.}$ The control plants were sprayed with water. Prior to sowing the seeds of tomatoes were moistened in the solution of the growth-regulator Energy-M for 30-40

min (consumption of work solution 2 l/kg). After that the seeds were dried till friability and sowed by the sowing machine Agroicola-1.4. The foliar treatments were conducted on the area of 1 ha with the dose of 15 g of the product per 300 g of water during the vegetation period (early period of growth and the phase of budding-blossom). The research was developed according to «The methods of field research» (Dospekhov B.A., 1985).

3. Results

Our tests were conducted with the purpose to study the effect of the growth-regulator Energy-M on the development of tomatoes showed the resistance of treated plants to unfavorable environmental conditions high temperatures (Table 1).

The rapid increase of temperature conduces to rapid evaporation of moisture from the upper soil horizons. The droughts starting in May cover almost the total area of the Low Volga region and last for the whole spring-summer period with short breaks. In conditions of the Low Volga region the summer starts not in June as common but several weeks earlier the average temperature in the 8--10th of May reaches +17 ˚C. The hot sunny weather sets in June and lasts for three months. During this period the mean daily air temperature is between +22 and +C26 ˚C. By the end of August the values of temperature gradually decrease till +C20 ˚C and lower.

Table 1: Mean monthly air temperatures, ˚C.

Years	Months												Mean yearly
	January	February	March	April	May	June	July	August	Septemb-er	October	Novemb-er	Decemb-er	
Mean many-year	8.5	8.0	2.0	8.0	16.5	21.0	24.0	22.5	15.5	7.5	0.5	5.5	7.5
2014	1.3	1.0	0.8	8.6	19.9	21.0	24.4	25.2	15.7	5.4	2.5	3.6	9.8
2015	1.2	4.1	1.3	9.3	16.9	23.9	24.1	23.0	20.1	5.9	3.2	0.2	10.4
2016	7.5	0.4	3.4	11.2	16.3	21.6	24.5	26.1	14.7	6.5	0.4	7.0	9.2

The relative air humidity in July-August is less than 50 % and during strict droughty years is only 20--30 % decreasing till 10--14 % in single days.

The insignificant amount of snow and precipitations in spring and summer, total thermal pressure, and high evaporation in summer result in strict deficiency of soil moisture.

On the whole, the agroclimatic conditions of the dry steppe zone of the Low Volga region should not be considered as favorable for vegetable production, as the vegetable plants need high moisture supply during initial phases of growth and further periods of vegetation, and require increased temperatures only when ripening of fruits.

The high temperatures influenced the formation of flowers and seed buds of the plants of tomatoes treated with the growth regulators. The untreated plants had the highest percentage of fallen flowers and seed buds that was caused by unfavorable temperature conditions. The data presented in the Table 2 show the lowest percentage of fallen seed buds (18.7 %) by the first bunch of the plants of tomatoes, the seeds of which were moistened in the solution of the growth regulator, and the plants of which were treated with the said regulator during the whole period of vegetation. The said research variant displayed considerably lower fall of flowers and seed buds by 16.1 % in comparison to the control variant (34.8%) that resulted in increase in yield of fruits of tomatoes.

The flowering of the second bunches happened to the hottest and driest period that affected negatively the fruit setting by plants on the control variant 34.8 and 59.3 % for the first and the second bunches correspondingly that caused the highest percentage of drying of flowers and fall of seed buds.

Table 2: Dependence between the effect of the growth regulator Energy-M on the formation of flowers and seed buds of tomatoes and high temperatures.

Variant	Research variant	1st bunch			2nd bunch		
		number of buds	number of fruits	fall of buds,% fall	number of buds	number of fruits	fall of buds, %
1	Control (moistening with water)	36	28	34.8	31	14	59.3
2	Moistening of seeds in the product Energy-M	42	32	27.6	39	18	41.0
3	Treatment of plants with Energy-M during the period of blossoming	43	39	21.6	46	24	34.1
4	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the period of blossoming	66	45	31.8	50	32	31.1
5	Treatment of plants with Energy-M during the whole period of vegetation	69	50	19.3	53	39	28.5
6	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the whole period of vegetation	72	53	18.7	55	41	27.3

We managed to monitor the resistance of the treated plants to low temperatures. There was a research developed to study the effect of the growth regulator Energy-M on the development of plants of tomatoes of the grade Hercules in a greenhouse. The frosts damaged our research plantings and almost spoiled them. The heating in the greenhouse was de-energized during the most severe frosts. The temperature decreased up to +2...+3 and even up to 1 °C. Of course, this resulted in stoppage of all life processes by plants of tomatoes, the developed bunches did not even start blossoming. The low temperatures injured significantly the plants that were not treated with the growth regulator, while the treated ones in shortest time showed the ordinary form and continued blossoming and fruitage. By the time of fruits ripening the difference between the two variants was evident and striking. The treated plants had rather large ripe fruits (mean weight of between 45 and 50 g) while the plants of the control variant had single very small ripe fruits (mean weight of about 10 and 12 g). Thus, the treated plants turned out to be more resistant to low temperatures than those on the control variant on condition of short period of subjection to low temperatures.

Consequently, the effectiveness of the growth regulator was in a strong dependence from the environmental conditions. The changes in temperature conditions, such as increase or decrease of temperature did not exert negative influence on the growth and productivity of plants treated with the growth regulator. To the contrary, they showed increasing resistance to unfavorable environmental factors.

The data presented in the Table 3 confirm that the control variant had the lowest yield of fruits.

Under such unfavorable conditions, the plants treated with the product Energy-M showed high values of productivity. The plants of the variant No 6 formed increased number of buds and fruits, had the lowest percentage of fall of seed buds per plant, thus provided additional yield of 113.56 % in comparison to control variant.

We carried out the biochemical analysis of fruits and determined the content of vitamin C, dry matters, sugars, and nitrates (Table 4).

4. Discussion

The analysis displayed the excellence of the fruits of the variant with pre-sowing moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the whole period of vegetation.

The content of nitrates for all research variants was significantly lower than maximum allowable concentration (150 mg/kg). The use of the growth regulator Energy-M

Table 3: Dependence of the effect of the growth regulator Energy-M on productivity of tomatoes from high temperatures (+26...+35 °C, May-July, 2014--2016).

Varian	Research variant	Total weight of fruits of 4 plants, g	Mean weight of fruits of 1 plant, g	Percentage from control
1	Control (moistening with water)	1357	339.25	100
2	Moistening of seeds in the product Energy-M	1802	450.50	32.79
3	Treatment of plants with Energy-M during the period of blossoming	2063	515.75	52.03
4	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the period of blossoming	2104	526.00	55.05
5	Treatment of plants with Energy-M during the whole period of vegetation	2673	668.25	96.98
6	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the whole period of vegetation	2898	724.50	113.56
	HCP 05	1.54		

Table 4: Effect of growth regulator Energy-M on chemical composition of fruits of tomatoes (average for 2014--2016).

Varian	Research variant	Dry matter, %	Vitamin C, mg/%	Total of sugars, %	Acidity, %	Nitrates, mg/kg
1	Control (moistening with water)	3,7	15,2	2,5	0,53	90,2
2	Moistening of seeds in the product Energy-M	4,2	15,6	2,9	0,54	91,5
3	Treatment of plants with Energy-M during the period of blossoming	4,8	15,8	3,0	0,56	95,8
4	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the period of blossoming	5,3	16,3	3,1	0,57	96,3
5	Treatment of plants with Energy-M during the whole period of vegetation	5,7	16,4	3,2	0,59	98,6
6	Moistening of seeds in the product Energy-M + Treatment of plants with Energy-M during the whole period of vegetation	6,1	16,5	3,2	0,59	103,3

is an ecologically safe method for increase in productivity and quality of vegetable production.

The study of tested plants showed that the stimulation of tomatoes with the growth regulator resulted in a significant increase in quality of fruits of the said species. The highest yield of tomatoes with the formation of great number of big fruits with good tasting characteristics was received with the grade Hercules on the variant with pre-sowing treatment of seeds and ground spraying of plants during the initial period of growth and in the phase of budding-blossoming.

5. Conclusion

The data of the research show the possibility of increase in resistance of tomatoes to unfavourable environmental conditions when treatment with the growth regulator Energy-M.

Consequently, taking into account the results of research the bio-product Energy-M is a high effective mean for droughts control in conditions of insufficient moisture supply during the vegetation period.

The use of the growth regulator Energy-M by the species of tomato is an effective mean for getting of ecologically pure production. The producers of high quality vegetable production are recommended to use widely the said product when sufficient mineral nutrition by pre-sowing moistening of seeds and by treatment of plants during the total vegetation period.

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Conflict of Interest

The authors have no conflict of interest to declare.

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