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Perspective agriculture cultivation of the bulb onion with drip irrigation

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Abstract

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The difficult conditions of the modern period of development of agricultural production determine the need for the development of new technologies adapted to modern conditions of land use. In this regard, we have developed the concept of "The system of technological measures for growing vegetable crops, ensuring the rational, efficient use of material and energy resources and obtaining economically viable harvests". The article presents the results of studies of the impact of agrotechnological methods on getting a high-quality crop of bulb onion under drip irrigation. Experimental studies have been conducted since 2011 on the experimental plots of the Caspian Agrarian Federal Scientific Center of the Russian Academy of Sciences (Astrakhan region). The object of the study was a variety of onion Volgodonets (as a standard) and hybrids were taken for competitive testing – Octant F1 and Valero F1, with a growing season of 105…110 days. The area of the accounting plot was 50.4 m^2. The seeding rate is 1 million viable seeds per hectare. The repetition of the experiment is threefold. It is proved that the silicone preparation "Energy-M", water-soluble fertilizer "Rastvorin" and mineral fertilizers applied for the planned yield, as well as their complex use stimulated the growth and development of plants, increased the productivity of onions. Thus, studies have shown that the best conditions for the growth and growth of the vegetative mass of the bulb onion were added to the variants where the treatment was performed with the "Rastvorin" water-soluble fertilizer and the "Energy-M" growth regulator in combination with the use of full mineral fertilizer for the planned yield 150 tons/ha on the Octant F1 hybrid while maintaining soil moisture at 70...80...75% of field moisture capacity.

Keywords: bulbonion; crop yields; drip irrigation; hybrid; mineral fertilizers; regulator of plants growth; "Energy-M"; water soluble fertilizer; "Rastvorin"

Introduction

The Lower Volga region is one of the promising regions for growing onions, because the climatic resources, combined with controlled irrigation provide the formation of high yields (Zhilkin et al., 2005; Pleskachev & Chunikhin, 2013b; Kalmykova & Kalmykova, 2017).

The bulb onion is one of the highly vitamins of vegetable crops, therefore, the most valuable (Borovoy & Matveeva, 2010; Pleskachev & Chunikhin, 2013a; Jurgiel-Malecka et al., 2015; Kalmykova et al., 2017). The yield of onions at the present level in the main countries sowing onions reaches 46.4...51.7 tons/ha. In turn, the average yield of onions in Russia is 22.6 t/ha.

Placement of vegetable crops on fertile soils, following the right crop rotations, introducing new varieties and hybrids, widespread and scientifically based use of a new generation of mineral fertilizers, expanding vegetable production on irrigated land, especially with insufficient moisture, all this will contribute to a significant increase in the yield of this crop (Petrov et al., 2010; Pleskachev & Chunikhin, 2013b; Hanci & Cebeci, 2015).

The study of issues of biology and economic characteristics of the culture of the bulb onion is scientific and practical interest. The use of drip irrigation allows to strictly focusing on the biological needs of onions. Therefore, it is urgent to increase the productivity of the bulb onion on irrigated plantations of at least 100 t/ha and the observance of the principles of resource conservation and environmental safety of production (Aytbaev & Saparova, 2006; Kalbarczyk & Kalbarczyk, 2014; Pejic et al., 2014; Kalmykova & Kalmykova, 2017; Kalmykova et al., 2018a; Kalmykova et al., 2018b).

The knowledge of these features in different varieties in a variety of soil and climatic conditions allows the expert to approach the use of the variety and hybrid in specific growing conditions.

Based on a scientific and analytical review of literary sources and regulatory and procedural documents, a concept is proposed: A system of technological measures for growing vegetables, ensuring rational, efficient use of material and energy resources and obtaining economically viable harvests», the essence of which is to improve the elements of irrigation technology, to identify highly productive varieties and hybrids of domestic and foreign breeding, filling the deficit of mineral and organic matter in the soil, by making them into the soil.

Improving the return of irrigated hectares is the main problem, which is considered in this concept, according to which, it becomes possible to obtain additional products from a unit of irrigated hectares and, thus, more fully utilize land resources and solar energy, to direct it to receive additional products, and on the preservation and improvement of soil fertility.

Materials and Methods

Experimental studies have been conducted since 2011 in accordance with the goals set on the experimental plots of the Caspian Agrarian Federal Scientific Center of the Russian Academy of Sciences (Astrakhan region, Chernoyarsky District, Solenoe Zimishche Village) in the zone of a sharply continental climate. The experimental plot is located in the right-bank steppe of the Chernoyarsky district of the Astrakhan region at a distance of 3 km south of the Solenoe Zimishche Village in the subzone of light-chestnut soils of the North-West Caspian. The soil cover of the site is represented by a subtype of light chestnut alkaline soils without the presence of spots of alkaline. The granulometric composition of the arable layer of the experimental plot is medium loamy. The relief of the experimental plot is leveled, with a small southeast slope. The average level of groundwater occurrence is at a depth of 15...20 m. Strong aridity, abundance of solar insulation, adverse temperature conditions, which greatly complicate agricultural production. During the warm period of the year, evaporation reaches 800...1000 mm with an average SCC – 0.2...0.3, which clearly reflects arid climatic conditions.

The object of the research was the variety of the bulb onion Volgodonets (as a standard) and hybrids – Octant F1 and Valero F1 were used for competitive testing, with a growing season of 105...110 days. The area of the accounting plot was 50.4 m^2. The seeding rate is 1 million viable seeds per hectare. The repetition of the experiment is threefold. The location of the plots is systematic. A 4-line seeding scheme was used. Sowing was carried out by the Agricol-1.4 planter with microprocessor control and quality control. Watering of the studied culture was carried out with a drip irrigation system while maintaining soil moisture in a layer of 0.0...0.3 m 75...75...75% of field moisture capacity (FMC) and 70...80...75% of FMC in accordance with the recommendations of research accepted in the region.

The watering was carried out for 4 months, and in May-June the irrigation rate on average by year of research was 2400 m^3/ha, and in July-August – 4100 m^3/ha (Table 1).

The irrigation rate during the growing season was 6500 m^3/ha. The total water consumption at the same time was at the level of 7927 m^3/ha with moderate irrigation regime, 8120 m^3/ha with differential irrigation regime, respectively.

Table 1. The water balance of the bulb onion in the experiment, (average for 2011–2016 years)

The performance	75…75…75% of FMC	70…80…75% of FMC
Precipitation during thelanding and harvesting period, mm	95.0	95.0
Irrigation water, mm	650.0	650.0
Productive moisture reserve at the beginning of the growing season, mm	115.6	114.8
Productive moisture reserve at the end of the growing season, mm	38.7	33.2
Total water consumption, m^3/ha	7927	8120

Results and Discussion

Drip irrigation, as a method of irrigation to the greatest extent corresponds to the biology of the bulb onion, provides the possibility of using energy-efficient, intensive technologies with obtaining guaranteed yields.

The bulb onion was sown from March 27 to April 5. As our observations showed, during 6 years, single shoots of onions appeared depending on the temperature and soil moisture in 12...16 days and full shoots – on 21...25 days after sowing.

After 6...12 days, after the emergence of shoots, the first true leaf of the onion developed, after 5...7 days subsequent leaves were formed. After 50...55 days after sowing, the onion plants already had 3…5 small true leaves.

With the formation of leaves began the forming of the onion. Nutrients formed in the leaves, moved to their bases and here were deposited in the form of a stock.

In the studied variants, with a moderate irrigation regime (75...75...75% of FMC), phase advance "The beginning of the formation of the bulb,, occurred on average for 2011...2016 years, 1...2 days earlier than on the variant with a differentiated irrigation regime (70...80...75% of FMC) and, as a result, the growing season was shortened.

The interphase period of the formation of bulbs – technical ripeness is one of the most important in the organogenesis of the bulb onion plants, due to the fact that at this time the most intensive growth of bulbs occurs. Observations have shown that the integrated application of mineral fertilizers and growth regulators on the planned yield increased this period from 53...54 to 54...55 days on the studied hybrids, respectively, on irrigation regimes.

It was noted that a single lodging of the tops, on onion crops with a differentiated irrigation regime of 70...80...75% of FMC, was observed 99...106 days after germination, mass lodging, respectively, after 97...117 days. A moderate irrigation regime of 75...75...75% of FMC allowed to reduce the phase of bulb formation and thereby accelerate the lodging period of the tops of the onion on all variants of the experiment.

The onion was ready for harvesting after 127...141 days after sowing, with a moderate irrigation regime, after 129...142 days – with a differentiated irrigation regime.

Analysis of the data showed a significant influence of weather conditions on the dynamics of the duration of the passage of the main phases of the development of the bulb onion plants. During the years of research, they evolved differently. So, 2011 and 2015 years were characterized as very dry, 2012 and 2014 – dry, 2013 – arid, 2016 – weakly arid.

The application of the studied factors made it possible to regulate the optimal regime of drip irrigation and the necessary doses of mineral nutrition, thereby creating favorable conditions for the growth and development of all plant organs, that is, to manage their productivity.

Comparison of promising hybrids Octant F1 and Valero F1, with the zoned standard, showed that in the studied hybrids, the vegetation period lengthened on all variants by an average of 2...4 days.

The comparative analysis of the effects of moderate and differential irrigation regime showed that with differential irigation regime (70...80...75% of FMC) the growth and development phases were 1...3 days longer than with moderate irrigation mode (75...75...75% of FMC). This is explained by the physiological pattern of plant growth and development – the longer the vegetative period, the more plants formed a vegetative mass and the higher the yield. The increase in the growing season, in general, indicates more favorable conditions for the growth and development of the bulb onions. The increase in the duration of the phenological phase of growth and development –the beginning of the formation of the bulb – lodging and yellowing of the leaves, that for several days allowed to extend the period of synthesis of substances and their accumulation in plants. This affected the productivity of the bulb onion.

On the bulb onion plants, new leaves grew during the growing season; therefore, before the beginning of the ripening, leaves of different ages were noted on the plants: young bulbs growing from the central part, adults – the most active and dying – are extreme leaves. In the early phases, a new growth and growth of leaves was observed, and later – the dying off and transportation of plastic substances from them to productive organs – the bulbs.

Analyzing the studied variety and hybrids of the bulb onion in terms of the absolute growth rate of the bulbs, one can note the differences between them in different irrigation regimes (Table 2). The smallest absolute growth of the bulbs (0.022...0.024 mm) was observed on the standard variety Volgodonets for the irrigation regimes under study, that is, with the shortest growing season. The most promising hybrids Valero F1 and Octant F1 had the highest absolute gain (0.049...0.050) on the variant of combined use of mineral fertilizers and a growth regulator for a planned yield of 150 t/ha.

A similar pattern was manifested in terms of the absolute increase in the number of leaves on a plant, that is, the shorter the growing season, the lower the absolute growth of leaves, and vice versa.

Analyzing the technological methods used in research (Table 3 and Table 4), the effectiveness of the developed concept was proved. This is confirmed by the fact that the productivity of the bulb onion increased with an improve-

Table 2. The nature of the development of the bulb onion plants during the growing season, on average for 2011...2016 years

Variants	Irrigation regime	Diameter of the onion, m		Absolute increase of the onions, mm	The number of leaves on the plant		The absolute increase in the number of leaves, mm	Length of leaves, mm		The absolute increase in the length of the leaves, mm
		to 20.06	to 25.07		to 20.06	to achieving maximum		to 20.06	to achieving maximum	
1	2	3	4	5	6	7	8	9	10	11
Volgodonets										
Control	75…75…75% of FMC	0.014	0.053	0.039	5.7	7.8	2.1	0.280	0.302	0.022
	70…80…75% of FMC	0.014	0.056	0.042	5.9	8.2	2.3	0.286	0.310	0.024
Energy-M	75…75…75% of FMC	0.015	0.058	0.043	5.9	8.2	2.3	0.281	0.309	0.028
	70…80…75% of FMC	0.015	0.063	0.048	6.4	9.0	2.6	0.292	0.322	0.030
$N_{330}P_{135}K_{100}$	75…75…75% of FMC	0.016	0.060	0.044	5.9	8.4	2.5	0.285	0.323	0.038
	70…80…75% of FMC	0.016	0.062	0.046	6.4	9.1	2.7	0.290	0.330	0.040
$N_{390}P_{160}K_{120}$	75…75…75% of FMC	0.016	0.063	0.047	6.0	8.6	2.6	0.292	0.336	0.044
	70…80…75% of FMC	0.016	0.065	0.049	6.7	9.5	2.8	0.296	0.343	0.047
$N_{450}P_{180}K_{135}$	75…75…75% of FMC	0.016	0.068	0.052	6.2	8.9	2.7	0.299	0.344	0.045
	70…80…75% of FMC	0.016	0.071	0.055	6.8	9.6	2.8	0.300	0.349	0.049
Rastvorin	75…75…75% of FMC	0.015	0.060	0.045	6.1	8.6	2.5	0.283	0.312	0.029
	70…80…75% of FMC	0.016	0.066	0.050	6.8	9.4	2.6	0.294	0.326	0.032
$N_{330}P_{135}K_{100}$+Rastvorin	75…75…75% of FMC	0.015	0.066	0.051	6.1	8.7	2.6	0.288	0.329	0.041
	70…80…75% of FMC	0.016	0.069	0.053	6.6	9.4	2.8	0.294	0.338	0.044
$N_{390}P_{160}K_{120}$ +Rastvorin	75…75…75% of FMC	0.016	0.068	0.052	6.2	8.9	2.7	0.295	0.339	0.044
	70…80…75% of FMC	0.016	0.070	0.054	6.8	9.7	2.9	0.299	0.346	0.047
$N_{450}P_{180}K_{135}$ +Rastvorin	75…75…75% of FMC	0.016	0.069	0.053	6.3	9.2	2.9	0.302	0.348	0.046
	70…80…75% of FMC	0.016	0.071	0.055	6.9	9.9	3.0	0.305	0.352	0.047
Rastvorin+Energy-M	75…75…75% of FMC	0.016	0.068	0.052	6.5	8.9	2.4	0.285	0.323	0.038
	70…80…75% of FMC	0.017	0.069	0.052	6.9	9.8	2.9	0.297	0.337	0.040
$N_{330}P_{135}K_{100}$+Rastvorin+Energy-M	75…75…75% of FMC	0.016	0.069	0.053	6.2	8.9	2.7	0.295	0.339	0.044
	70…80…75% of FMC	0.017	0.071	0.054	7.1	10.2	3.1	0.299	0.345	0.046
$N_{390}P_{160}K_{120}$+Rastvorin+Energy-M	75…75…75% of FMC	0.017	0.072	0.055	6.4	9.2	2.8	0.301	0.346	0.045
	70…80…75% of FMC	0.018	0.075	0.057	7.5	10.7	3.2	0.307	0.355	0.048
$N_{450}P_{180}K_{135}$+Rastvorin+Energy-M	75…75…75% of FMC	0.017	0.072	0.055	6.4	9.1	2.7	0.306	0.351	0.045
	70…80…75% of FMC	0.018	0.075	0.057	7.5	10.8	3.3	0.312	0.360	0.048

Table 2. Continued

1	2	3	4	5	6	7	8	9	10	11
Octant F1										
Control	75…75…75% of FMC	0.015	0.075	0.060	6.0	8.2	2.2	0.300	0.338	0.038
	70…80…75% of FMC	0.015	0.079	0.064	6.2	8.5	2.3	0.303	0.342	0.039
Energy-M	75…75…75% of FMC	0.015	0.083	0.068	6.1	8.7	2.6	0.302	0.342	0.040
	70…80…75% of FMC	0.015	0.087	0.072	6.4	9.2	2.8	0.306	0.348	0.042
$N_{330}P_{135}K_{100}$	75…75…75% of FMC	0.015	0.092	0.077	5.9	9.1	3.2	0.308	0.351	0.043
	70…80…75% of FMC	0.016	0.097	0.081	6.5	9.8	3.3	0.307	0.352	0.045
$N_{390}P_{160}K_{120}$	75…75…75% of FMC	0.016	0.096	0.080	6.3	9.6	3.3	0.310	0.356	0.046
	70…80…75% of FMC	0.016	0.102	0.086	6.6	10.0	3.4	0.312	0.359	0.047
$N_{450}P_{180}K_{135}$	75…75…75% of FMC	0.016	0.099	0.083	6.5	9.9	3.4	0.313	0.359	0.046
	70…80…75% of FMC	0.016	0.104	0.088	6.8	10.3	3.5	0.314	0.362	0.048
Rastvorin	75…75…75% of FMC	0.015	0.085	0.070	6.2	8.9	2.7	0.304	0.344	0.040
	70…80…75% of FMC	0.016	0.089	0.073	6.5	9.3	2.8	0.309	0.350	0.041
$N_{330}P_{135}K_{100}$+Rastvorin	75…75…75% of FMC	0.015	0.098	0.083	6.3	9.2	2.9	0.311	0.355	0.044
	70…80…75% of FMC	0.016	0.102	0.086	6.6	9.6	3.0	0.313	0.358	0.045
$N_{390}P_{160}K_{120}$+Rastvorin	75…75…75% of FMC	0.016	0.103	0.087	6.5	9.6	3.1	0.314	0.359	0.045
	70…80…75% of FMC	0.016	0.104	0.088	6.9	10.1	3.2	0.317	0.363	0.046
$N_{450}P_{180}K_{135}$+Rastvorin	75…75…75% of FMC	0.016	0.105	0.089	6.6	9.9	3.3	0.315	0.361	0.046
	70…80…75% of FMC	0.016	0.107	0.091	7.0	10.4	3.4	0.319	0.366	0.047
Rastvorin+Energy-M	75…75…75% of FMC	0.016	0.089	0.073	6.4	9.1	2.7	0.309	0.350	0.041
	70…80…75% of FMC	0.016	0.092	0.076	6.8	9.6	2.8	0.313	0.356	0.043
$N_{330}P_{135}K_{100}$+Rastvorin+Energy-M	75…75…75% of FMC	0.017	0.105	0.088	6.7	9.7	3.0	0.313	0.360	0.047
	70…80…75% of FMC	0.017	0.108	0.091	7.2	10.3	3.1	0.318	0.366	0.048
$N_{390}P_{160}K_{120}$+Rastvorin+Energy-M	75…75…75% of FMC	0.017	0.106	0.089	6.9	10.0	3.1	0.317	0.365	0.048
	70…80…75% of FMC	0.017	0.110	0.093	7.2	10.7	3.5	0.322	0.371	0.049
$N_{450}P_{180}K_{135}$+Rastvorin+Energy-M	75…75…75% of FMC	0.018	0.108	0.090	7.1	10.9	3.8	0.319	0.369	0.050
	70…80…75% of FMC	0.018	0.112	0.094	7.3	11.4	4.1	0.325	0.375	0.050
Valero F1										
Control	75…75…75% of FMC	0.014	0.067	0.053	5.9	8.0	2.1	0.291	0.322	0.031
	70…80…75% of FMC	0.014	0.071	0.057	6.0	8.5	2.5	0.295	0.332	0.037

Table 2. Continued

1	2	3	4	5	6	7	8	9	10	11
Energy-M	75…75…75% of FMC	0.015	0.072	0.057	6.0	8.8	2.8	0.302	0.337	0.035
	70…80…75% of FMC	0.015	0.074	0.059	6.2	9.1	2.9	0.308	0.349	0.041
$N_{330}P_{135}K_{100}$	75…75…75% of FMC	0.015	0.076	0.061	6.3	9.2	2.9	0.306	0.343	0.037
	70…80…75% of FMC	0.015	0.079	0.064	6.4	9.5	3.1	0.309	0.352	0.043
$N_{390}P_{160}K_{120}$	75…75…75% of FMC	0.016	0.085	0.069	6.5	9.4	2.9	0.308	0.349	0.041
	70…80…75% of FMC	0.016	0.087	0.071	6.6	9.7	3.1	0.311	0.358	0.047
$N_{450}P_{180}K_{135}$	75…75…75% of FMC	0.016	0.094	0.078	6.6	9.6	3.0	0.310	0.354	0.044
	70…80…75% of FMC	0.016	0.096	0.080	6.7	9.9	3.2	0.315	0.366	0.051
Rastvorin	75…75…75% of FMC	0.015	0.087	0.072	6.1	8.9	2.8	0.306	0.341	0.035
	70…80…75% of FMC	0.016	0.092	0.076	6.2	9.2	3.0	0.311	0.352	0.041
$N_{330}P_{135}K_{100}$+Rastvorin	75…75…75% of FMC	0.015	0.092	0.077	6.4	9.3	2.9	0.310	0.352	0.042
	70…80…75% of FMC	0.016	0.095	0.079	6.5	9.7	3.2	0.312	0.359	0.047
$N_{390}P_{160}K_{120}$ +Rastvorin	75…75…75% of FMC	0.016	0.094	0.078	6.6	9.6	3.0	0.312	0.356	0.044
	70…80…75% of FMC	0.016	0.096	0.080	6.7	9.9	3.2	0.316	0.364	0.048
$N_{450}P_{180}K_{135}$ +Rastvorin	75…75…75% of FMC	0.016	0.095	0.079	6.8	9.9	3.1	0.314	0.360	0.046
	70…80…75% of FMC	0.016	0.097	0.081	6.9	10.1	3.2	0.318	0.368	0.050
Rastvorin+Energy-M	75…75…75% of FMC	0.016	0.089	0.073	6.3	9.0	2.7	0.311	0.349	0.038
	70…80…75% of FMC	0.016	0.094	0.078	6.4	9.4	3.0	0.316	0.359	0.043
$N_{330}P_{135}K_{100}$+Rastvorin+Energy-M	75…75…75% of FMC	0.016	0.095	0.079	6.7	9.7	3.0	0.312	0.357	0.045
	70…80…75% of FMC	0.017	0.097	0.080	6.8	10.0	3.2	0.318	0.366	0.048
$N_{390}P_{160}K_{120}$+Rastvotin+Energy-M	75…75…75% of FMC	0.016	0.097	0.081	6.8	9.9	3.1	0.314	0.362	0.048
	70…80…75% of FMC	0.017	0.099	0.082	6.9	10.1	3.2	0.319	0.369	0.050
$N_{450}P_{180}K_{135}$+Rastvorin+Energy-M	75…75…75% of FMC	0.017	0.098	0.081	6.9	10.0	3.1	0.315	0.364	0.049
	70…80…75% of FMC	0.017	0.100	0.083	7.1	10.3	3.2	0.321	0.371	0.050

Table 3. Efficiency of agricultural methods under study in the bulb onion crops under moderate irrigation regime, on average for 2011...2016 years

Variants	Volgodonets		Octant F1		Valero F1	
	tons/ha	%	tons/ha	%	tons/ha	%
1	2	3	4	5	6	7
Control (presoaking in water)	46.8	100	69.2	100	64.6	100
Energy-M	61.3	131	85.0	123	80.6	125
$N_{330}P_{135}K_{100}$	77.7	166	102.3	148	98.0	152
$N_{390}P_{160}K_{120}$	92.1	197	117.8	170	113.2	175
$N_{450}P_{180}K_{135}$	99.6	213	126.3	182	121.7	188
Rastvorin	66.1	141	90.5	131	86.1	133
$N_{330}P_{135}K_{100}$+Rastvorin	92.9	198	119.7	173	114.8	178
$N_{390}P_{160}K_{120}$+Rastvorin	108.4	232	135.9	196	130.8	202
$N_{450}P_{180}K_{135}$+Rastvorin	117.2	250	146.0	211	141.4	219
Rastvorin+Energy-M	74.6	159	100.6	145	95.4	148
$N_{330}P_{135}K_{100}$+Rastvorin +Energy-M	101.4	217	129.2	187	123.9	192
$N_{390}P_{160}K_{120}$+Rastvorin +Energy-M	113.9	243	141.8	205	136.7	211
$N_{450}P_{180}K_{135}$+Rastvorin +Energy-M	121.2	259	150.7	218	145.4	225

Table 4. The effectiveness of the studied agricultural methods in onion crops under differentiated irrigation, on average for 2011...2016 years

Variants	Volgodonets		Octant F1		Valero F1	
	tons/ha	%	tons/ha	%	tons/ha	%
1	2	3	4	5	6	7
Control (presoaking in water)	50.3	100	73.9	100	69.9	100
Energy-M	65.5	130	89.7	121	85.0	122
$N_{330}P_{135}K_{100}$	82.6	164	107.6	146	103.0	147
$N_{390}P_{160}K_{120}$	97.6	194	123.8	168	118.9	170
$N_{450}P_{180}K_{135}$	105.9	211	133.0	180	128.3	184
Rastvorin	70.0	139	95.0	129	90.3	129
$N_{330}P_{135}K_{100}$+Rastvorin	98.9	197	125.9	170	120.3	172
$N_{390}P_{160}K_{120}$+Rastvorin	114.3	227	142.2	192	136.6	195
$N_{450}P_{180}K_{135}$+Rastvorin	123.3	245	151.9	206	146.3	209
Rastvorin +Energy-M	79.5	158	106.0	143	100.5	144
$N_{330}P_{135}K_{100}$+Rastvorin +Energy-M	107.4	214	135.9	184	129.1	185
$N_{390}P_{160}K_{120}$+Rastvorin +Energy-M	120.5	240	149.4	202	142.9	204
$N_{450}P_{180}K_{135}$+Rastvorin +Energy-M	128.2	255	157.8	214	150.6	215

ment in the nutritional regime of the soil, with an increase in the nutrient content in the soil by increasing the doses of mineral fertilizers from $N_{330}P_{135}K_{100}$ to $N_{450}P_{180}K_{135}$.

Conclusion

Presented indicators of changes in individual productivity of onions indicate that the highest yield of marketable products was formed on a variant combining a more favorable water regime of the soil, where the moisture of the active layer did not fall below 70...80...75% of FMC and the highest dose of fertilizers was applied – $N_{450}P_{180}K_{135}$ in the complex with water-soluble fertilizer "Rastvorin" and growth regulator "Energia-M" on the promising hybrid Octant F1 – 157.8 tons/ha.

Thus, studies have shown that the best conditions for the growth and growth of the vegetative mass of the bulb onion were added to the variants where the treatment was performed with the "Rastvorin" water-soluble fertilizer and the "Energy-M" growth regulator in combination with the use of full mineral fertilizer for the planned yield 150 tons/ha on the Octant F1 hybrid while maintaining soil moisture at 70...80...75% of FMC.

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