Plant growth stimulants and the effect of foliar feeding on the yield of some vegetable crops

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ABSTRACT

When the light chestnut soil of the Tashkent region was studied, a positive effect of the application of growth-stimulating preparations in the cultivation of vegetable crops was established against the background of $N_{120}P_{60}K_{60}$ for table beet and $N_{180}P_{60}K_{60}$ for onion. On average, over two years of study (2019 - 2020), the increase in the yield of onion ranged from 8,5 to 48,7 t/ha compared to the control variant, while in table beet from 8,1 to 29,9 t/ha. The highest effect on yield for all varieties and hybrids of onion was achieved when $N_{180}P_{60}K_{60}$ + gibberellin was used, as for table beet $N_{120}P_{60}K_{60}$ + GA-3 gibberellin was used. The complex use of plant growth stimulants at the phase of various levels of mineral nutrition led to the reduction in the concentration of nitrates in onions and root crops of grown products. Foliar treatments by vegetation phases led to a significant accumulation of the mass fraction of sugar and vitamin C.

Keywords: cultivation of vegetable crops, growth stimulating preparations, foliar feeding, gibberellin GA-3, table beet and onion varieties, carbohydrates, nitrates.

Introduction

In the industrial branch of vegetable growing, the table beet sown areas in Uzbekistan in 2019 amounted to 6,0 thousand hectares. The onion fields were around 28 thousand hectares. The share of the Tashkent region in the cultivation of onion accounted for 2,5%, the growth in area was 0,8%.

In accordance with the results of 2020, table beet sown areas on the share of farms accounted for 6,8 thousand hectares, while for onion 5,8 thousand hectares, which indicate a significant increase in the area for these crops (8).

An increase in the production of vegetable products can be achieved only on the basis of an optimal combination of various doses of mineral fertilizers, growth-stimulating preparations and high-yielding domestic varieties and hybrids (4,9,11).

One of the possible reserves for increasing the productivity of agricultural plants is the use of stimulants of physiological processes (3.12). In order to obtain high yields of table beet, a certain combination of special nutrients is required, which are applied with fertilizers to the soil or to the plant directly with foliar feeding. However, fertilizers affect not only the size of the crop, but also its quality and chemical composition (5,6).

The technology of onion cultivation in the farms of the Volgograd region is based on the integrated use of high-yielding hybrids from domestic and foreign breeding, the use of modern plant growth regulators, the latest technology which ensures that all agricultural

technical work is carried out on time (13,14,15).

In their studies, N.Yu. Petrov and et al (2015) revealed the positive effect of the organosilicon preparation "Energiya-M", which stimulated the growth and development of the plant, increased the productivity of onion varieties "Volgodonets" and hybrids "Octant" and "Valero".

On the irrigated lands of the Volgograd region, research was carried out by D.A. Akhmedov during 2015-2017. As a result of three-year studies on light chestnut soils of the Volga-Don interfluve with the drip method of irrigation, the results showed that the applied irrigation regimes (up to 70, 80 and 90%) and the application rates of mineral fertilizers ($N_{130}P_{80}K_{20}$; $N_{180}P_{130}K_{60}$; and $N_{230}P_{180}K_{100}$) made it possible to obtain the planned table beet yield at the level of 60-80 t/ha (1).

Onion and table beet are of particular value for food purposes. These crops respond well to the application of mineral fertilizers and foliar treatments with growth stimulants (2,10).

The purpose of this study was to study various plant growth-stimulating preparations against the background of mineral fertilizers on the cultivation of onion and table beet in the conditions of the Tashkent region.

Materials and the methods of the study

The research was carried out on the experimental plot of the Tashkent state agrarian university. The studied objects were onion and table beet crops. The experiment was carried out in three replications according to the method of Dospekhov B.A (7). In two-factor experiments, factor A was a hybrid variety of vegetable crops (onion: "Gordion", "Kristina" and "Bayram" hybrid), while factor B – variant of foliar (leaf) treatments with preparations: Gibberellin GA_3, Aminovit and Novosil.

The area of the plot under one variety of onion is 90 m^2, the area of the plot under variants is 30 m^2.

The area of the registration plot is 8 m^2. The total area under the study of onion is 368 m^2.

The area of the plot under one variety of table beet is 60 m^2, the area of the plot under variants is 20 m^2.

The area of the registration plot is 5 m^2, the total area under the study of table beet is 240 m^2.

Laboratory research was carried out at the department of Ecology and Botany of the Tashkent state agrarian university. In plant samples, the dry matter content was determined in a percentage (%); mass fraction of nitrates in mg/kg, mass fraction of vitamin C in mg/kg, mass fraction of sugar in percentage (%).

The results and their discussion

In accordance with the results of the studies, on average for 2 years (2019 - 2020) of studying the cultivation of onions, the maximum biological yield was obtained for the "Kristina" variety – 132,6 t/ha and for the "Bayram" F hybrid – 137,2 t / ha in the variant of joint application of $N_{120}P_{60}K_{60}$ + Novosil. Over the years of the study, the increase in yield was on average + 46,5 ... + 48,7 t/ha relative to the control variant. Commercial yield was in the range of 110,5…117,2 t/ha (Table 1).

Table- 1
Onion yield depending on treatment variants during 2019 - 2020

№	Hybrid	Yield t/ha			± to control t/ha			Commercial yield t/ha on average		
		2019	2020	variant	2019	2020	On average 2019 – 2020			
1	Kristina	72,2	78,8	control–background $N_{180}P_{60}K_{60}$	-	-	-	61,8	63,5	65,3
		96,2	148,7	$N_{180}P_{60}K_{60}$	10,2	52,4	31,3	72,2	128,4	100,3

				+ Novosil						
		82,1	128,3	$N_{180}P_{60}K_{60}$ + HybridA_3	22,8	74,3	46,7	82,9	140,2	110,5
2	Gordion	84,0	92,1	control–background $N_{180}P_{60}K_{60}$	-	-	-	71,8	82,6	77,6
		106,4	128,2	$N_{180}P_{60}K_{60}$ + Novosil	22,7	36,3	29,5	91,8	118,7	105,3
		84,0	100,8	$N_{180}P_{60}K_{60}$ + HybridA_3	0,2	8,7	29,5	73,6	91,8	82,7
3	Bayram	92,1	69,5	control–background $N_{180}P_{60}K_{60}$	5,7	58,8	32,3	85,2	132,8	108,2
		108,2	135	$N_{180}P_{60}K_{60}$ + Novosil	23,7	61,3	46,5	105,2	129,2	117,2
		98,4	84,6	$N_{180}P_{60}K_{60}$ + HybridA_3	5,3	17,0	11,2	87,7	85,5	86,5
	HCP 0,5(A)									
	HCP 0,5(B)									
	HCP 0,5(A,B)									

Based on the results of the analysis of table beet yields, the following should be highlighted: in the course of two years of study, the integrated use of $N_{120}P_{60}K_{60}$ + Aminovit provided a significant increase in the share of both biological and commercial yields, this was especially noted in table beet variety "Diyor".

The biological yield averaged 85,5 t/ha for 2 years of study while the commercial yield was 63,2 t/ha. The application of the mineral fertilizer Aminovit for foliar treatments against the background of $N_{120}P_{60}K_{60}$ led to a significant increase in the control + 23,2 t/ha (table 2)

Table- 2
The yield of table beet depending on treatment variants

№	Hybrid	Variant	Yield t/ha			± to control t/ha			Commercial yield t/ha		
			2019	2020	On average 2019 – 2020	2019	2020	On average 2019 – 2020			On average 2019 – 2020
1	Mulatka	control – background $N_{120}P_{60}K_{60}$	59	46,2	52,6	-	-	-	25,3	34,8	30,1
		$N_{120}P_{60}K_{60}$ + Aminovet	71,5	62,8	67,2	14,5	18,6	16,6	41,2	53,4	47,3
		$N_{120}P_{60}K_{60}$ + Novosil	58,9	54,3	56,6	1,9	10,0	6,0	26,2	46,8	36,5

		$N_{120}P_{60}K_{60}$ + Hybrid	66,6	50,4	58,5	9,6	6,2	7,9	32,4	46,6	39,5
2	Diyor	control – background $N_{120}P_{60}K_{60}$	81,2	45,4	63,3	-	-	-	61,4	42,6	52,0
		$N_{120}P_{60}K_{60}$ + Aminovet	86,4	80,7	83,5	4,8	35,0	19,9	63,8	59,6	61,5
		$N_{120}P_{60}K_{60}$ + Novosil	81,6	58,4	70,0	0,1	14,2	7,2	57,0	50,6	53,8
		$N_{120}P_{60}K_{60}$ + Hybrid	82,2	52,4	67,5	3,0	5,2	4,1	61,2	44,2	52,7
3	Bona F_1	$N_{120}P_{60}K_{60}$ control – background	63,6	47,4	55,5	-	-	-	47,9	42,4	44,9
		$N_{120}P_{60}K_{60}$ + Aminovet	72,3	59,3	65,8	8,8	12,2	10,5	55,4	49,4	52,4
		$N_{120}P_{60}K_{60}$ + Novosil	67,3	52,6	60,0	3,8	5,6	4,7	52,0	46,4	49,2
		$N_{120}P_{60}K_{60}$ + Hybrid	64,3	55,4	60,1	1,3	8,4	4,9	52,2	41,2	46,7
		HCP 0,5(A)	0,2	0,7							
		HCP 0,5(B)	0,2	0,7							
		HCP 0,5(A,B)	0,2	0,6							

Mathematical relationships were obtained between the yield of onion, table beet and treatment variants, which described the correlation dependence of these factors, while it is possible to calculate the future yield increase depending on the leaf processing variants with the background application of mineral fertilizers (Figure 1.2).

Figure 1

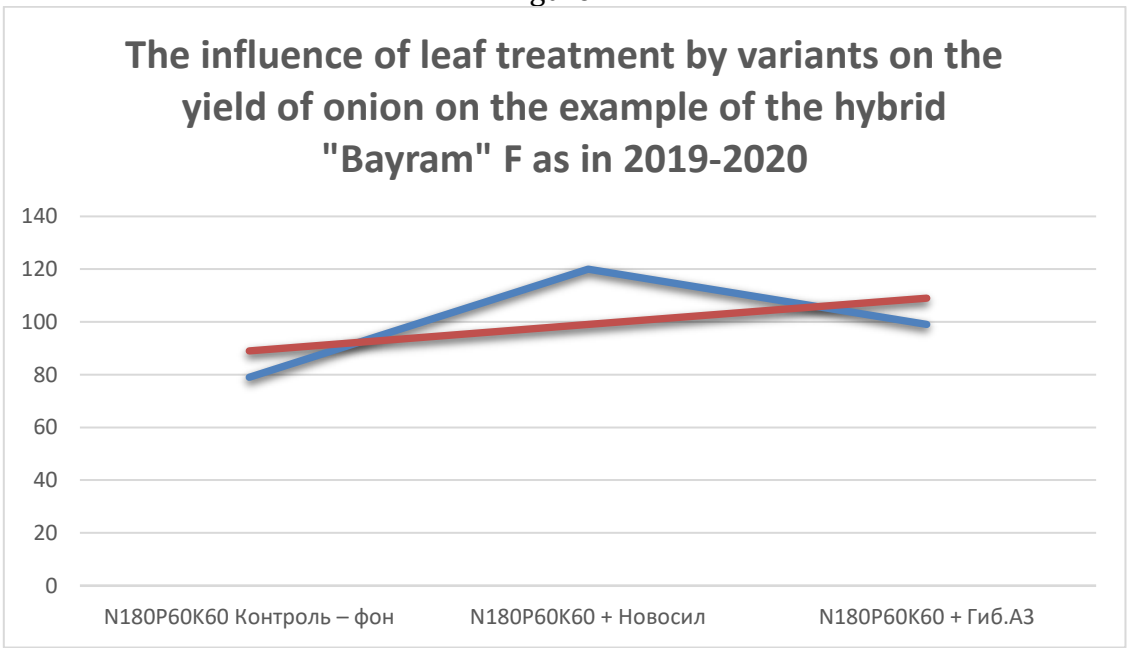
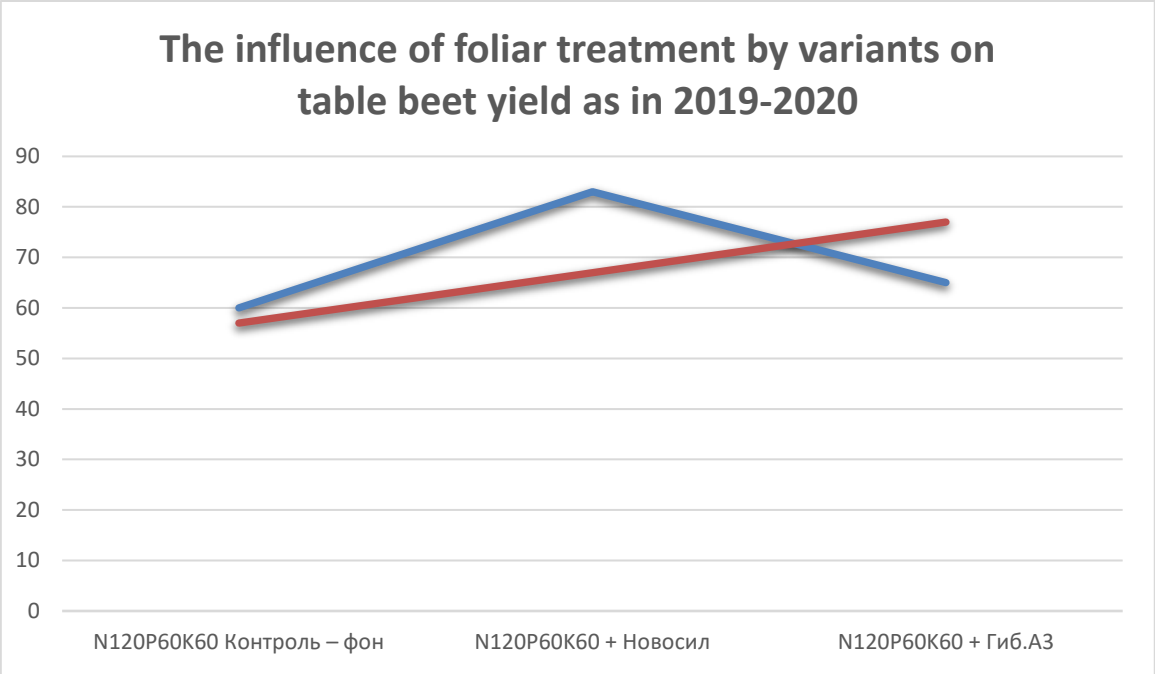


Figure 2



According to the results of biological analysis of table beet roots, on average for two years of study, we can distinguish "Diyor" variety on the variant with $N_{120}P_{60}K_{60}$ + Novosil application and the "Bona" F hybrid on the variant with leaf treatment with the Aminovit plus preparation, in terms of dry matter content they showed the best results 15,3%... ...15,8% and 16,2%. In terms of the mass fraction of sugar, the maximum value of 7,0 was achieved in "Diyor" variety on the variant of leaf processing with the Aminovit mineral fertilizer complex against the background of $N_{120}P_{60}K_{60}$. In terms of the content of vitamin C in the roots of table beet, the "Mulatka" variety was distinguished on the variant with leaf treatment with Novosil plus and showed the rate 8,3% (Table 4).

Biochemical analysis of roots of table beet and mass fraction of vitamin C (2019 – 2020)

Table 4

№	Hybrid	Variant	Dry matter, in %	Raw matter, in %	Mass fraction of vitamin C
1	Mulatka	Control – background $N_{120}P_{60}K_{60}$	13,2	4,4	4,5
		$N_{120}P_{60}K_{60}$ + Novosil	14,5	5,6	8,3
		$N_{120}P_{60}K_{60}$ + Aminovit	14,3	6,3	6,9
		$N_{120}P_{60}K_{60}$ + Hybrid.A_3	14,6	5,6	5,9
2	Diyor	Control – background $N_{120}P_{60}K_{60}$	13,5	4,4	5,3
		$N_{120}P_{60}K_{60}$ + Novosil	15,3	5,8	6,8

		$N_{120}P_{60}K_{60}$ + Aminovit	15,8	4,4	7,0
		$N_{120}P_{60}K_{60}$ + Hybrid A_3	14,8	5,1	4,8
3	Bona F_1	Control – background $N_{120}P_{60}K_{60}$	14,0	4,9	4,4
		$N_{120}P_{60}K_{60}$ + Novosil	14,8	5,2	5,3
		$N_{120}P_{60}K_{60}$ + Aminovit	16,2	5,8	7,0
		$N_{120}P_{60}K_{60}$ + Hybrid.A_3	13,5	5,1	6,7

The biochemical analysis of bulbs of onion varieties and hybrids cultivated using leaf treatments with growth-stimulating preparations revealed that the maximum dry matter content of 9,5% ..... 10,2% was observed in "Gordion" variety of onion in two variants using growth stimulants – Aminovit, Novosil, as well as in "Kristina" variety 9,5% in the variant with the application of the Giberellin GA_3 plus. In terms of the amount of sugar, the onion variety "Kristina" had an advantage in the variant with $N_{180}P_{60}K_{60}$ + Novosil plus application – 6,2%, as well as the hybrid "Bayram" showed the result 6,5% in the variant with $N_{180}P_{60}K_{60}$ + Giberellin GA_3. The studies also showed that the with the background application of the estimated dose of $N_{180}P_{60}K_{60}$ in the complex of vitamin C under the variants with the use of the preparation Novosil for all varieties and the hybrids, the maximum accumulation of vitamin C was recorded, which varied from 19,5 to 27,9 mg/kg (per raw matter) (Table 3) .

Biochemical analysis of onion, on average during 2019 – 2020
Table- 3

№	Hybrid	Variants	Dry matter, in %	Raw matter, in%	Mass fraction of vitamin C
1	Kristina	control –background $N_{120}P_{60}K_{60}$	8,1	4,9	16,1
		$N_{120}P_{60}K_{60}$ + Novosil	9,5	6,1	16,8
		$N_{120}P_{60}K_{60}$ + Hybrid.A_3	9,2	5,9	20,2
2	Gordion	control –background $N_{120}P_{60}K_{60}$	7,8	4,1	16,8
		$N_{120}P_{60}K_{60}$ + Novosil	8,9	5,6	27,9
		$N_{120}P_{60}K_{60}$ + Hybrid.A_3	8,4	5,1	17,8
3	Bayram F1	control –background $N_{120}P_{60}K_{60}$	7,9	4,7	15,2
		$N_{120}P_{60}K_{60}$ + Novosil	10,2	5,9	27,6
		$N_{120}P_{60}K_{60}$ + Hybrid.A_3	9,5	5,5	16,7

Considering that vegetable crops accumulate nitrates as a result of the use of mineral fertilizers, in our studies we considered it necessary to analyze its content in the roots of both table beet and onion, depending on the research options. In the case of applying mineral fertilizers based on the calculated doses of $N_{180}P_{60}K_{60}$ for table beet and $N_{180}P_{60}K_{60}$ for onion, a sharp increase in the accumulation of nitrates was noted in the background variants (control). So, in varieties and hybrids of table beet on variants without treatments, this indicator was in the range from 876,8 to 1080,0 mg/kg.

In terms of maximum accumulation of nitrates in the bulbs from 73,4 mg/kg to 92,4 mg/kg, control variants were distinguished. The smallest amount of nitrates was accumulated in "Gordion" variety on the variant with foliar treatment with Novosil 32,5 mg/kg and in "Kristina" variety on the variant with Novosil 33,7 mg/kg (Figure 3).

Figure 3

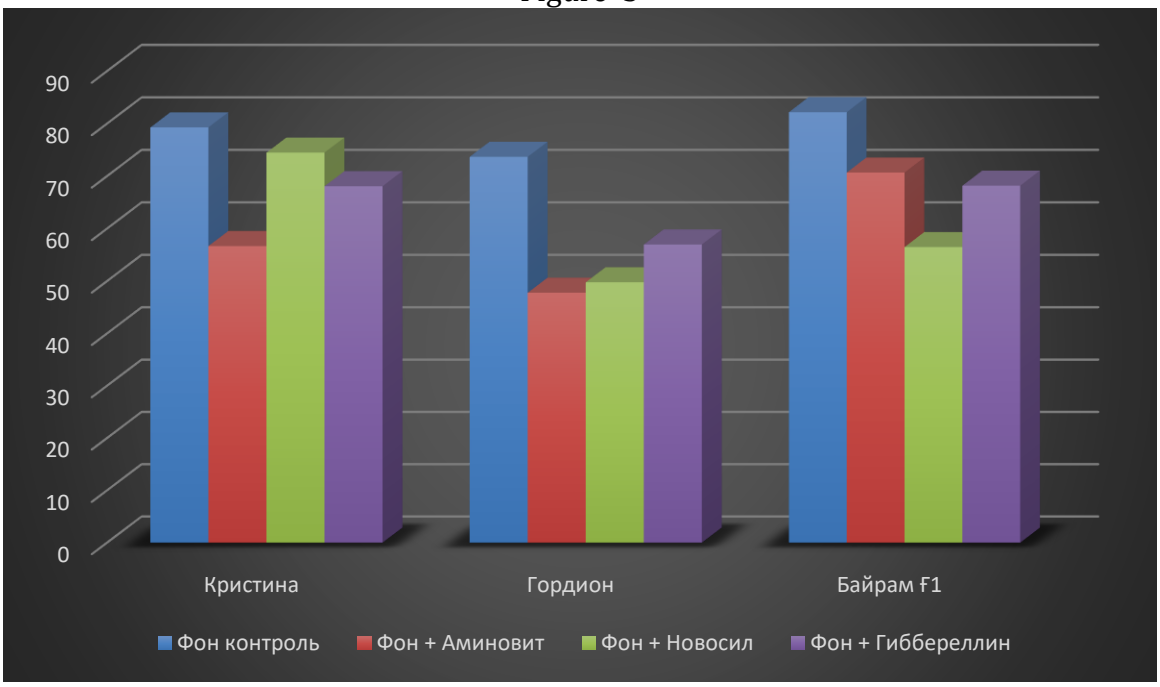
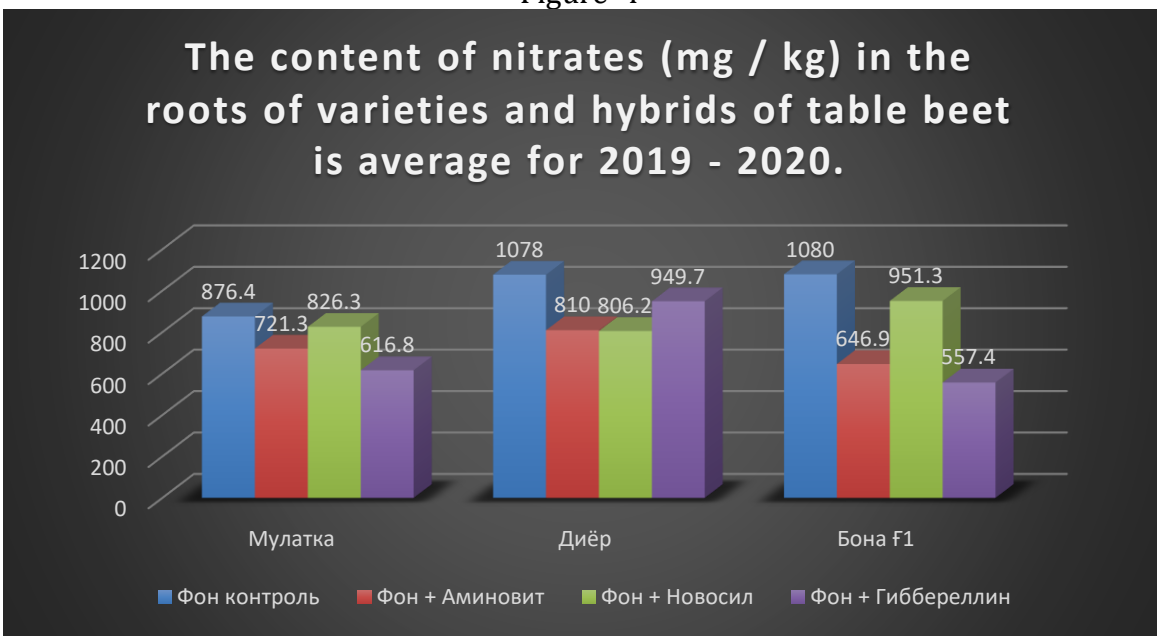


Figure 4



In general, based on the results of the studies on the cultivation of varieties and hybrids of table beet, it can be concluded that foliar treatments against the background of $N_{120}P_{60}K_{60}$ did not lead to a significant accumulation of nitrates in the roots of table beet, all the results were below the maximum permissible concentration (MPC - 1400).

The lowest content of nitrates in root crops was noted in the hybrid "Bona" F in the variant with foliar treatment with the preparation Gibberellin GA_3 + 557,4 mg/kg, which turned out to be the best result among all the studied samples in all variants of the experiment, while in the control maximum – 1080 mg/kg.

Conclusion

In general, as a result of the studies carried out under the conditions of a typical gray soil of the Tashkent region, it was found that the integrated use of $N_{180}P_{60}K_{60}$ + Novosil has the most positive effect on the biochemical parameters and the yield of onion, as in the example of the "Bayram" F1 hybrid. The biological yield of this hybrid was 137,2 t/ha, the commercial yield was 117,2 t/ha, the increase to the control was 46,7 t/ha. The mass fraction of dry matter was 8,9%, the mass fraction of sugar was 5,9%, the mass fraction of vitamin C was 27,9 mg/kg.

A positive effect in the cultivation of table beet was achieved from the integrated application of $N_{120}P_{60}K_{60}$ + Aminovit. In the course of the studies, it was found that the maximum yields for this variant were obtained from the table beet variety "Diyor". Its biological yield was 83,5 t/ha, the increase to the control was 20,2 t/ha, the commercial yield was 61,5 t/ha. The integrated use of $N_{120}P_{60}K_{60}$ + Aminovit contributed to a significant accumulation of the mass fraction of sugar up to 7,1% , vitamin C up to 6,7 mg%

The use of foliar treatments with growth-stimulating preparations in the phases of vegetation on a mineral background for onion ($N_{180}P_{60}K_{60}$) and table beet ($N_{120}P_{60}K_{60}$) contributed to a significant decrease in the content of nitrates in grown products.

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