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INFLUENCE OF MINERAL FERTILIZERS ON THE CONTENT OF BASIC MACRO ELEMENTS IN SOIL AND TWO YEARS PLANTS OF APPLE SIVERS FOREST CROPS CREATED BY SEEDLINGS WITH A CLOSED ROOT SYSTEM

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Abstract. In this article, data is given on the results of an experiment on the use of mineral fertilizers - nitrogen, phosphorus and potassium for two-year forest crops of the Sivers apple tree in a hot and dry climate in the summer in the low-mountain zone of the spur of the Chatkal Range of the Western Tien Shan. The content of nitrate and ammonia nitrogen and mobile assimilable forms of phosphorus and potassium in the soil layer to a depth of 1 m and the content of these elements in apple plants for two years after fertilization were studied in dynamics.
Keywords: mineral fertilizers, macronutrients, soil moisture, mobile forms of nitrogen, phosphorus and potassium, closed root system, seedlings, microflora, control, soil horizon, western and southern slope, survival rate.

Introduction. Mountains in Uzbekistan occupy almost 15% of the territory in the eastern and southeastern parts of the republic. The height of the mountain ranges here reaches 3000–4000 m (Kocherga F.K, 1965). Many medium and small rivers and springs are born here, due to which all irrigated agriculture is developed. The climate of the republic is sharply continental with large fluctuations in air temperature.

Precipitation is cyclonic in nature and falls mainly in the late autumn-winter-early spring period. The summer period is dry and hot, negatively affecting the development of forest vegetation, which plays a leading role in the origin and nutrition of rivers and springs. The forest cover of the mountains is currently very low, not more than 3%, for the indicated reasons and active anthropogenic influence. In this regard, increasing the area of mountain forests is a priority, but due to the dry summer period, the survival rate of forest plantations created on mountain slopes using traditional technologies is very low (Khanazarov A.A, 2002).

In connection with the need for afforestation of the mountain slopes, the Research Institute of Forestry of the Republic has developed an effective technology for creating forest plantations of promising forest-forming species under these conditions - Crimean pine, English oak, Korolkov's hawthorn and Sivers' apple tree with planting material with a closed root system, while achieving a high survival rate of these species up to 85 – 100% (Butkov E.A and B.Kh. Mamutov, 2017).

However, due to the peculiarities of the soil and climatic conditions of the region, the growth of crops in the first years after planting turned out to be slow. There was a need to accelerate the growth of crops, since their protective, reclamation and water-saving influence begins to manifest itself after the closing of tree crowns and the creation of a forest environment (Matyushkin V.A, 2005).

One of the effective ways to accelerate the growth of woody vegetation is the use of mineral fertilizers, which has long been widely used for growing commercial timber in the forest boreal belt of the Earth with good moisture in summer (Matyushkin V.A, 2005; Bobrinev V.P and Pak L.N, 2015).

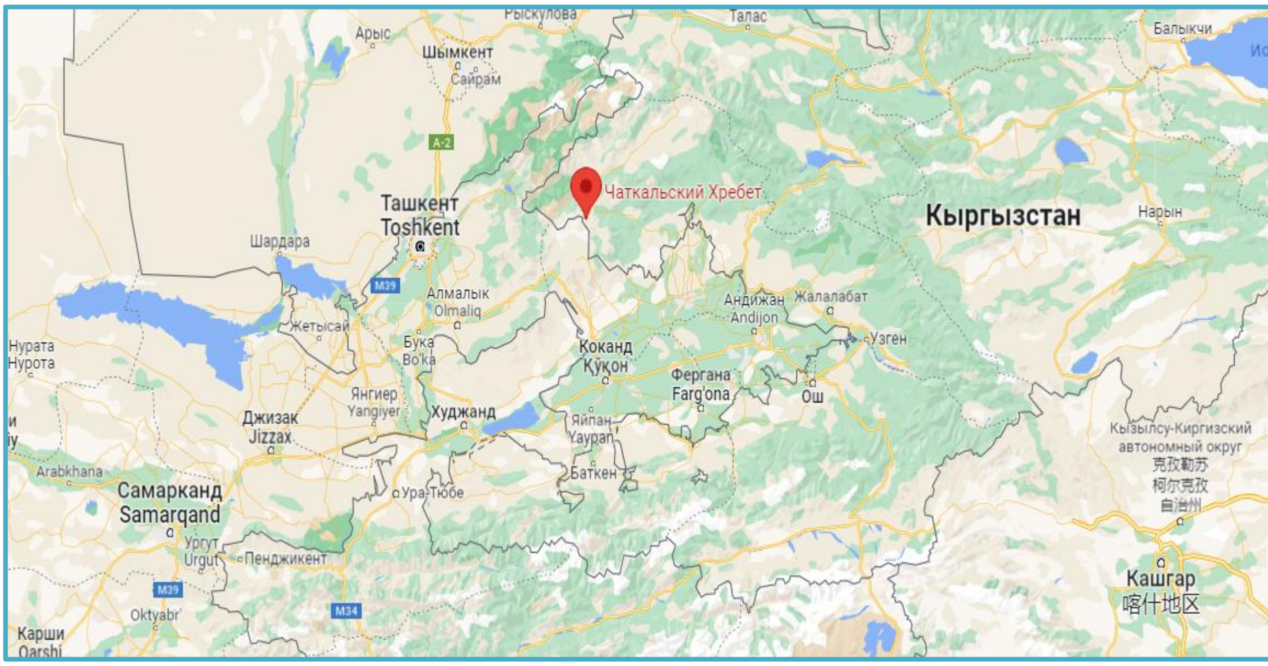

Figure-1. Physical map of the Chatkal Range in Uzbekistan

The climatic conditions of the mid-mountain belt of the Chatkal Range, where experimental work was carried out, have their own characteristics. If the temperature conditions are favorable for growing the listed tree species, the atmospheric humidification regime has negative sides (Figure-2).

Studies on the effect of mineral fertilizers on the growth and development of forest crops in the arid conditions of the middle mountains of the republic have not been previously carried out.

Despite the rather significant annual precipitation, which varied from 800 to 900 mm during the years of research, it is up to 4% or less in the summer period, which, combined with high air temperatures during this period, leads to the drying of the top meter soil layer during this period below wilting moisture. This negatively affects the survival rate and further growth of forest plantations (E.A.Butkov and B.Kh.Mamutov, 2017).

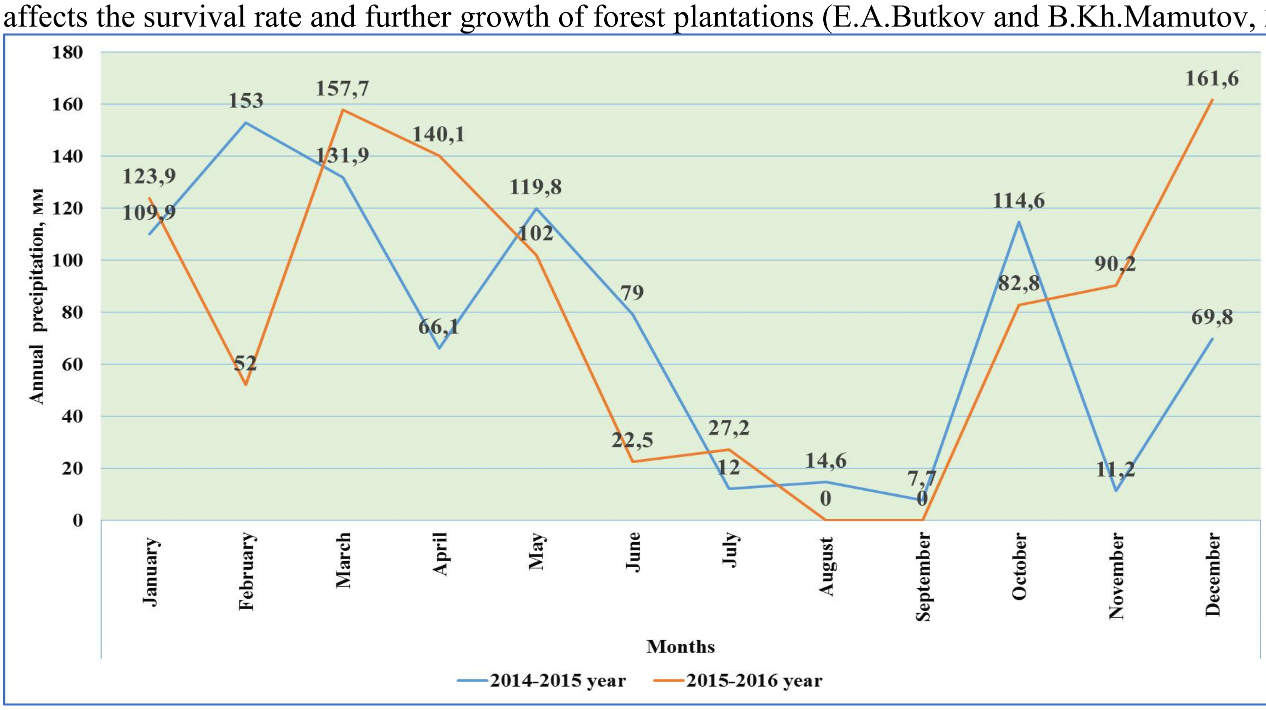

Figure-2. Average long-term monthly precipitation of the Western Tien Shan, mm, 2015-2017

The soils under the conditions of the experiment are referred to as dark sierozem soils, which are formed on the destruction products of limestones, porphyries, and loess deposits of various textures. The soil profile of dark sierozem soils with a total thickness of up to 90 см, is comparatively - weakly differentiated. The carbonate-illuvial horizon is rich in lime segregations . The amount of humus in the 0- layer 10 смis 2-3% and decreases

quite rapidly with depth. Dark sierozems have an indistinctly expressed cloddy, low water-resistant structure. They boil over the entire profile (Mazirov M.A. Vasenev I.I., Ilakhun A, 2013).
According to the mechanical composition, there is a clear confinement of heavy loams and clays to the northern slopes, and rubbly, thin loams to the southern ones. The soils of the western and southern slopes, on which the experiment was carried out, have a developed humus profile, but on the southern slopes they have a lighter color, since they are less leached and contain more lime (Babeva I.P, Zenova G.M, 1989).
The maximum soil moisture is observed in March and is 23-25%, which corresponds to their field capacity. By autumn, these soils often dry up to a depth of 1 m. In the upper horizons, - soil drought in years with average moisture begins in late May (early June) and continues until October. During this period, the moisture content in the 0- layer 20 cm often drops below the wilting moisture content. The southern slopes are drier than the western ones (E.A.Butkov, B.Kh.Mamutov 2017; Mazirov M.A. Vasenev I.I., Ilakhun A, 2013).

Materials and Methods. The work was carried out on the Chatkal mountain reclamation experimental station (GMOS) of the Institute of Forestry in the southwestern spurs of the Chatkal ridge - on the southern and western slopes at an altitude of 1200 m above sea level on cultures of the Sivers apple tree - a typical representative of the forest-forming species of the mountainous part of the Republic in single-row experimental forest plantations planted 2 years ago on terraces of a triangular profile 1 m wide (Figure-1).
The study of the effect of mineral fertilizers on the content of the main soil macroelements - nitrogen, phosphorus and potassium in experimental apple crops was carried out in 2015 - in the year of fertilizer application, and in 2016 - in the second year after their application. To do this, within 2 years, soil samples were taken for agrochemical analysis from 5 horizons: 0 - 10; 20 - 25; 30 - 35; 50 -75 and 75 - 100 cm. Soil samples were taken with the Izmailsky drill in three repetitions from each horizon. For sampling, 3 wells were drilled at each repetition, followed by averaging the indicators for each option (Aleksandrova L.N., Naydenova O.A, 1967), (Figure-3).
It should be noted that the summer period of 2016, the second year of the study, was drier, which affected the content of mobile forms of nitrogen, phosphorus and potassium in the soil.
The methodology for conducting the experiment on the use of mineral fertilizers consisted in applying fertilizers to the soil in early spring, immediately after the snow melted, in a continuous strip 1 m wide, into the root distribution zone. After spreading fertilizers, they were embedded in the soil to a shallow depth of 10 cm to prevent their loss into the atmosphere and at the same time not damage the root system (Butkov E.A. Mamutov B.Kh, 2017).

Figure-3. The process of taking soil samples for laboratory research
The experience was laid down in accordance with the methodology for planning the use of mineral fertilizers, and laid down in the work of V.N.Efimov, V.S.Pobedov and others (V.N.Efimov, 2002; Pobedov V.S., Shimansky P.S. etc, 1977) and includes three options - two options for doses of fertilizers in active ingredients: $N_{90} P_{90} K_{60}$ and $N_{120}P_{180}K_{60}$, which showed the best results in the works of other researchers, based on a review of the literature, and the third variant - without fertilization (control). Each variant included 60 plants divided into two replications of 30 pcs.
In addition to measuring the amount of nitrogen, phosphorus and potassium in the soil, the amount of these elements in the leaves of the apple tree was determined. Samples were taken in accordance with the procedure

(Heywood V.H. and Dulloo In situ, 2005) during the period of active growth and complete formation of leaves of experimental trees, in June, and before the end of the growing season, in September. In each variant of the experiment, developed leaves were selected for analysis from the middle part of the crown from three medium-sized trees, and one mixed sample was made from them. In the same way, stem and root samples were made from the same plants. Analyzes of soil and leaf samples for the content of nitrogen, phosphorus and potassium in them were carried out at the Institute of Soil Science of the Academy of Sciences of the Republic of Uzbekistan.
The results of analyzes for the content of the main macroelements - nitrogen, phosphorus and potassium in the soil, which were applied as mineral fertilizers, in the root-inhabited soil horizons on the western and southern slopes are presented in tables 1 and 2., and the results of analyzes for the content of these elements in different parts of plants apple trees are presented in table 3.

Results and Discussion. The content of mobile forms of nitrogen when simple superphosphate was introduced into the soil in the first year after application showed that in May its amount increased significantly after application in the upper 25 cm soil layer in accordance with the application rate.
On the western slope with leached soils, the increase was from 11.2 mg/kg in control to 21.6 mg/kg at 90 kg and up to 57.5 mg/kg at 180 kg. Due to the poor mobility of phosphorus in deeper horizons, its content turned out to be approximately the same in all 3 variants. By the end of the growing season, its amount decreased in the upper horizons to 8 mg/kg in the control and approximately the same in the variants with fertilizer to 16.3 mg/kg due to consumption by plants. In the lower horizons, it remained unchanged at the level of 6 mg/kg of soil (Table-1).
In the second year after application with a reduced amount of precipitation, the phosphorus content in the control increased to 17–12 mg/kg in all horizons, and in the variants with fertilizer it decreased to 14 mg/kg in both variants and was the same as in the control throughout the profile. The same picture was observed at the end of the growing season with some increase in the $N_{90}P_{90}K_{60}$ variant (Table 2).
On the southern slope, with an increased content of lime in the soil and higher solar insolation in the first year at the beginning of the growing season, the phosphorus content in the control approximately corresponded to the western slope (10.8 mg/kg), and when fertilizers were applied in the upper horizons, it exceeded it in the same horizons, but did not depend on the dose of fertilizers and was the same in both cases (24.4 and 26.7 mg/kg). At the end of the growing season, the phosphorus content decreased in the control to 8 mg/kg, and with fertilizer to 10-13.5 mg/kg. In deeper horizons in these variants, it slightly exceeded the control (table-1).
In the second year, the phosphorus content leveled off for all options, including control, both at the beginning and at the end of the growing season, with a decrease in deep horizons from 15-17 mg/kg to 11 mg/kg of soil (Table-2).
The content of potassium in the soil after fertilization changed somewhat differently. In the first year after fertilization in the spring, the largest amount of potassium in the upper horizons was 275 mg/kg in the control, and with an increase in the dose of fertilizers, its amount turned out to be lower - 215 and 193 mg/kg, respectively. In the control, its amount rapidly decreased with depth - up to 18 mg/kg, while when applied in both variants, it was leveled over the entire profile and amounted to 60-80 mg/kg (Table-1).
In autumn, in the control, the amount of potassium decreased to 75-80 mg/kg and was the same throughout the soil profile, while when fertilized, its amount increased starting from the 10 cm horizon and in both variants was approximately the same within 200-240 mg/kg in upper and 100 mg/kg in the lower horizons (table 1).
On the southern slope, the amount of potassium in the control in spring was less than on the western one in the upper horizon (93 mg/kg), but it increased significantly with depth up to 100-130 mg/kg. In the fertilized variants, when K_{60} and K_{90} were added in the upper 25 cm layer, the amount of potassium was approximately the same, but in the lower horizons, when K_{90} was added, its amount turned out to be significantly higher than when K_{60} was added (table-1).
Table 1.
The content of mobile forms of nitrogen, phosphorus and potassium in the soil of experimental Sivers apple crops in the first year after the application of mineral fertilizers, mg/kg.

Experience	sampling	P_2O_5	K_2O	$N\text{-}NO_3$

options	depth, cm	May 20	02.07	May 20	02.07	May 20	02.07
WESTERN SLOPE							
Without fertilizer (control)	0-10	11.2	8.00	275	80	11.5	6.0
	10-25	9.5	6.7	95	80	9.5	6.0
	25-50	10.0	6.7	40	80	9.5	6.0
	50-75	6.0	5.3	20	68	4.8	4.8
	75-100	5.3	6.0	18	75	6.0	6.5
$N_{90}P_{90}K_{60}$	0-10	21.6	16.3	215	215	14.2	10.0
	10-25	6.7	14.9	70	200	11.3	20.0
	25-50	6.7	6.0	68	75	7.3	8.8
	50-75	6.7	6.7	68	108	6.5	10.5
	75-100	8.0	6.7	80	93	6.5	6.5
$N_{120}P_{180}K_{90}$	0-10	57.5	16.3	193	128	66.0	25.0
	10-25	18.9	19.9	95	240	42.8	20.0
	25-50	7.3	9.5	60	110	18.0	15.5
	50-75	5.3	6.7	80	110	8.8	7.3
	75-100	4.7	6.0	63	100	8.8	7.5
SOUTHERN SLOPE							
Without fertilizer (control)	0-10	10.8	8.0	93	118	4.8	9.5
	10-25	10.1	7.3	68	275	5.0	7.3
	25-50	9.5	4.7	131	115	11.3	7.3
	50-75	6.7	4.7	100	100	8.8	6.0
	75-100	5.3	6.7	47	47	6.5	7.3
$N_{90}P_{90}K_{60}$	0-10	24.4	10.0	240	118	8.75	5.1
	10-25	15.6	9.5	110	80	6.5	4.8
	25-50	5.3	6.0	40	40	5.0	3.3
	50-75	5.3	5.3	30	20	4.75	4.8
	75-100	5.3	6.7	50	55	5.0	3.3
$N_{120}P_{180}K_{90}$	0-10	26.7	13.5	148	115	12.5	13.0
	10-25	11.5	8.0	200	40	25.0	13.0
	25-50	8.0	7.3	118	70	24.5	6.0
	50-75	5.3	6.7	80	50	7.3	3.3
	75-100	6.0	9.5	70	55	6.1	7.5

In autumn, in the control, the content of potassium was significantly higher up to a depth of 75 cm (275-100 mg/kg) than in the variants with fertilizer, where it varied within 55-80 mg/kg (Table-1).
In the second year, probably due to changed weather conditions and improved activity of soil microflora, the content of mobile potassium in the soil increased sharply in all variants of the experiment on both slopes, including control, up to 320-360 mg/kg, with a slight drop along the depth of the profile, somewhat larger content in control.In autumn, the content of potassium in all variants on both slopes was the same throughout the profile, except for the K_{60} variant on the western slope, where in autumn its content increased from 320 to 460 mg/kg in the upper soil horizons (Table 2)
The assimilation of nitrogen in an accessible form by plants largely depends on the activity of microorganisms. Of the nitrogen mineral fertilizers introduced into the soil, plants assimilate about 50% of nitrogen, in the ammonium and nitrate form. Unlike the content of phosphorus and potassium, nitrogen in the soil is easily mobile and can quickly spread over all root-inhabited soil horizons. The depth of its distribution depends on the water supply , which varies from year to year, as well as on the use of growing tree crowns in the experiment.
In the first year of application of nitrogen fertilizers (urea) on the western slope, there was an increase in

nitrogen in the form of ammonium nitrate during the period of the most active tree growth. When N_{90} was applied, there was an insignificant increase in nitrogen in the soil layer up to 25 cm (14.2 mg/kg) compared to the control (11.5 mg/kg), while when N_{120} was applied, the amount of nitrogen in this layer increased by almost 6 times - up to 66 mg / kg. At the same time, the amount of nitrogen increased throughout the profile to a depth of 1 m, in contrast to the first two options. By autumn, in all variants, the amount of nitrogen decreased: in the control in the layer up to 50 cm to 6.0 mg/ kg, with the introduction of N_{90} to 10.0 mg/kg, and even increased in the layer up to 50 cm the amount decreased in the upper layers to 25-20 mg/kg, remaining the highest in the experience (table-1).

On the southern slope with highly calcareous soils, the amount of absorbed nitrogen in the spring was less than on the western one, while the effect of applying N_{90} was not high, it increased only in a layer of 10 cm by about 2 times, and in the rest it turned out to be approximately equal to the control (Table1).

In making N_{120} was the most effective. The nitrogen content in the layer up to 50 cm in this variant was from 12.5 to 25 mg/kg. In the autumn period, the content of nitrogen in the control in the upper layers even increased by 1.5-2.0 times - up to 9.5-7.2 mg/kg, apparently due to its low consumption due to poor growth.

Table 2

The content of mobile forms of nitrogen, phosphorus and potassium in the soil of experimental crops of the Sivers apple tree in the second year after the application of mineral fertilizers, mg / 100 g

Options experience	Sampling depth, cm	P_2O_5		K_2O		$N\text{-}NO_3$	
		May 25	06.09	May 25	06.09	May 25	06.09
WESTERN SLOPE							
Control (without fertilizer)	0-10	17.0	13.0	370	320	4.72	1.67
	10-25	16.0	12.0	360	320	4.45	1.40
	25-35	14.0	11.0	350	310	2.80	1.26
	35-50	13.0	10.0	340	310	1.98	0.99
	50-75	12.0	8.0	320	310	1.70	0.85
$N_{90}P_{90}K_{60}$	0-10	14.0	26.4	320	460	4.18	2.09
	10-25	13.0	24.0	320	440	3.08	1.81
	25-35	12.0	21.0	320	360	2.80	1.40
	35-50	11.0	15.0	320	340	1.98	1.12
	50-75	10.0	12.0	320	330	1.70	0.99
$N_{120}P_{180}K_{90}$	0-10	14.0	13.0	330	330	3.35	1.81
	10-25	13.0	12.0	320	310	2.52	1.54
	25-35	12.0	11.0	320	310	2.25	1.12
	35-50	11.0	10.0	320	310	1.98	0.99
	50-75	10.0	8.0	310	310	1.70	0.58
SOUTHERN SLOPE							
Control (without fertilizer)	0-10	15.0	13.0	350	320	6.22	1.12
	10-25	14.0	12.0	340	310	4.18	0.99
	25-35	13.0	11.0	330	310	2.52	0.85
	35-50	12.0	10.0	330	310	2.25	0.71
	50-75	11.0	8.0	320	310	1.98	0.58
$N_{90}P_{90}K_{60}$	0-10	17.0	13.0	360	330	4.45	1.12
	10-25	14.0	12.0	340	320	4.18	0.99
	25-35	13.0	11.0	340	310	3.35	0.85
	35-50	12.0	10.0	330	310	3.08	0.58
	50-75	11.0	8.0	320	310	1.42	0.44
$N_{120}P_{180}K_{90}$	0-10	16.0	12.0	330	320	3.08	0.68
	10-25	15.0	11.0	330	310	2.80	1.26
	25-35	14.0	10.0	320	310	2.25	1.12

	35-50	13.0	8.0	310	310	1.98	0.99
	50-75	11.0	6.0	310	310	1.70	0.71

When N_{90} was applied, the nitrogen content turned out to be lower than in the control throughout the soil profile due to better absorption by plants, and in the N_{120} variant, its amount decreased, except for the top soil layer, by 2-4 times, to 6.0-13.0 mg /kg, using the largest amount for growth (table 1).

In the second year after fertilization, the content of available nitrogen in the soil decreased significantly in May in all experiments, including control, due to a drier year compared to the previous one.

The amount of nitrogen for all options, both on the western and southern slopes, turned out to be approximately the same, and more of it was observed on both slopes in the control options due to its lower consumption by less developed plants (table-2).

The smallest amount of nitrogen was found in variant N_{120}, where the plants had the best growth. By autumn, the amount of nitrogen decreased due to its consumption by trees in the summer, and in all variants it had approximately the same values in all variants on both slopes, with a decrease in the depth of the soil profile.

In the second year after the application of mineral macrofertilizers to the soil, the content of macroelements in the leaves of an apple tree in spring depends not only on their content in the soil at the time of sampling, but also on the accumulation of these elements in the trunk and roots in the previous year (Table-2).

Table 3

The content of nitrogen, phosphorus and potassium in the plants of experimental cultures of the Sivers apple tree during the growing season in the second year after the introduction of mineral macrofertilizers into the soil

Experience options	Leaves			Trunk			Root		
	N	P	K	N	P	K	N	P	K
May 25									
western slope									
Control (without fertilize	1,45	0,87	2,48	0,58	0,95	2,25	0,44	0,59	2,25
$N_{90}P_{90}K_{60}$	1,53	0,71	2,32	0,56	0,65	2,13	0,46	0,83	2,25
$N_{120}P_{180}K_{60}$	1,53	0,83	3,32	0,44	0,70	2,13	0,32	0,60	2,25
south slope									
Control (without fertilize	1,37	0,53	2,55	0,56	0,75	0,25	0,38	0,57	2,13
$N_{90}P_{90}K_{60}$	1,45	0,95	2,47	0,51	0,60	2,25	0,38	0,60	2,13
$N_{120}P_{180}K_{60}$	1,53	0,75	2,48	0,46	0,75	2,25	0,40	0,46	2,13
6 September									
western slope									
Control (without fertilize	1,32	0,91	2,40	0,63	0,79	2,13	0,48	0,91	2,25
$N_{90}P_{90}K_{60}$	1,52	0,79	2,32	0,46	0,60	2,13	0,53	0,83	2,25
$N_{120}P_{180}K_{60}$	1,77	1,07	2,48	0,73	0,64	2,25	0,44	0,91	2,25
south slope									
Control (without fertilize	1,42	1,00	2,48	0,61	0,79	2,25	0,51	0,60	2,25
$N_{90}P_{90}K_{60}$	1,27	0,95	2,48	0,58	0,75	2,25	0,44	0,75	2,25
$N_{120}P_{180}K_{60}$	1,47	0,95	2,55	0,66	0,91	2,13	0,38	0,91	2,25

The results of the analyzes showed (table -3) that in spring the nitrogen content in the leaves of the apple tree in the variants with fertilizer exceeded the control both on the western and southern slopes by 0.08 - 0.16%, mainly due to its accumulation in the stems and roots per year of fertilization.

An increased phosphorus content by 0.22–0.42% compared to the control was observed only on the southern slope with poorer soils, where the aftereffect of fertilizers affected.

On the western slope, there was less phosphorus in the leaves, apparently due to its consumption during stronger growth. For the same reason, in the leaves on both slopes in the fertilized variants, there was also less potassium than in the control by 0.08 - 0.16%.

In spring, the apple tree stems showed a higher content of all elements, except for potassium on the southern

slope, also presumably due to their greater consumption for tree growth, in the variants with the use of fertilizers. Only on the southern slope in the control of potassium was significantly less for an unknown reason. In the roots of nitrogen in this period, the least of all was found in the variant with a large dose of fertilizers due to stronger growth, at which its consumption turned out to be stronger.
Most of the phosphorus in the roots of the apple tree turned out to be in the variant with a lower dose of fertilizers on both slopes. According to the content of potassium in the spring, no differences were observed between the variants on both slopes, although on the western slope its total content exceeded the southern slope.
In September, the period of the end of the growing season, the supply of nitrogen to the leaves on the western slope in the fertilized variants exceeded the control by 0.20–0.45%, and on the southern slope with poorer soils it was approximately the same, i.e. the aftereffect affected only the western slope.
The content of phosphorus exceeded the control only in the variant with a large dose of fertilizers (by 0.16%) only on the western slope, on the southern slope it was approximately the same in all variants.
The content of potassium in the leaves in autumn on the southern and western slopes was observed the least in the control (2.48 and 2.40%), and most of all in the variant with a large dose of fertilizers.

Conclusions. 1. The introduction of phosphorus fertilizer - ammophos into the soil in apple forest crops in the first year after application sharply increased its content both on the western and southern slopes, only to a depth of 25 cm, especially in the P_{180} variant - 6 times compared to the control. In autumn, its content decreased in the control over the entire soil profile, and in the P_{90} and P_{180} variants in the layer up to 25 cm. In deeper layers in these variants, it somewhat increased due to migration from the upper layers of both the western and southern slopes.
2. The content of mobile potassium, when it was introduced into the soil in the first year, did not lead to its increase in the spring period on the western slope. In the upper layers of the soil, its amount was even less than in the control variant, while in the deeper layers it somewhat increased, probably due to its migration from above.
- on the southern, drier slope, after the introduction of potash fertilizer, its content increased compared to the control both in the upper layers of the soil and in the lower ones, most of all in the K_{90} variant. In autumn, its content in the control increased to a depth of 75 cm, and in the K_{60} and K_{90} variants it decreased by 1.5-2.0 times due to consumption for food.
- in the second year after the introduction of potassium, its content in the soil in the whole experiment increased significantly, including the control, but it was approximately the same throughout the profile in the variants with fertilizer and slightly higher in the control on the western slope. In autumn, its content slightly decreased, but was approximately the same on all variants, only slightly higher on the western slope in the K_{60} variant.
3. The introduction of nitrogen fertilizer - urea into the soil led to its strong increase in the soil (6 times) in the upper horizon on the western slope with a gradual decrease in the lower ones. On the southern slope, a positive effect was also obtained in the N_{120} variant up to a depth of 50 cm.
- By autumn, on the western slope, the amount of nitrogen decreased in the control to a depth of 50 cm, with the introduction of N_{120} throughout the soil profile, and with the introduction of N_{90}, the content increased to a depth of 50 cm.
- On the southern slope, by autumn, in the control, the nitrogen content significantly decreased in all variants of the experiment, both on the western and southern slopes, including control both in the spring and autumn. At the same time, the nitrogen content was approximately the same in all variants, slightly less in the N_{120} variant. The positive effect of the application of nitrogen fertilizers was not preserved in the second year.
4. The content of nitrogen, phosphorus and potassium in leaves, stems and roots in the second year after fertilization had a different pattern.
The content of nitrogen in the leaves turned out to be increased compared to the control in both variants with fertilizer both in spring and autumn. The best effect was found with the application of N_{120}. In the stems and roots, a clear dependence in the nitrogen content on the application of fertilizers was not observed. The highest nitrogen content was observed in all variants in the leaves, and the lowest in the roots.
The content of phosphorus in all variants of the experiment had no differences, with the exception of the spring

indicator on the southern slope, where it turned out to be increased compared to the control and differed very slightly in all parts of the plants from each other.
The content of potassium in the leaves was slightly increased in the leaves in the spring in all variants compared with the stems and roots, and in the stems and roots in all cases did not differ.
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