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Research Article

INFLUENCE OF MINERAL FERTILIZERS, SOIL STRUCTURE-FORMERS AND HERBICIDES ON THE GROWTH OF FOREST CROPS ON MOUNTAIN SLOPES OF THE CHATKALK RIDGE IN UZBEKISTAN

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ABSTRACT

The article presents the results of research on the study of the effect of the complex use of mineral fertilizers, structure-forming agents and herbicides on the growth of the main forest-forming species in a hot and dry climate on the mountain slopes of the Chatkal ridge.

The dynamics of the growth of forest crops over the years under the influence of mineral fertilizers, structure-forming agents "CMC" and "Polymeliorant" and the herbicide "Uragan forte", as well as their influence on the formation of soil structure and the intensity of its water permeability, are outlined.

KEYWORDS

Mineral fertilizers, structurant, carboxymethylcellulose, polyameliorant, herbicide, annual growth, granular soil structure, soil water permeability, crop growth, growth dynamics, low mountains, mountain slopes.

INTRODUCTION

In the conditions of the Republic of Uzbekistan with a low amount of precipitation and high summer temperatures, one of the main measures is the regulation of surface runoff in the mountains and foothills, which affects water erosion, causing soil erosion, the formation of ravines, the occurrence of mudflows that reduce the productivity of mountain

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slopes, bringing enormous damage to the national economy [1,4].

Forest plantations have the greatest effect in preventing water erosion of soils on mountain slopes. At the same time, the forests of Uzbekistan perform many other useful functions for the national economy. These include soil protection, water protection, climate control, recreational, sanitary and hygienic and other functions. In recent years, the recreational role of forests has come to the fore, in which local recreation centers and health improvement of the population are being created [1,2].

At the same time, natural forests in the mountainous conditions of the republic, due to the peculiarities of climate and anthropogenic influence, currently occupy less than 3% of the area of mountain territories, and the increase in forest area artificially comes to the fore [2,4].

Research Institute of Forestry has developed technologies for the artificial creation of forests by using planting material with a closed root system. Planting experimental forest crops with planting material with closed roots made it possible to achieve a survival rate of 80–90% in difficult forest conditions on the western slope [1,4].

However, due to dry, hot conditions in the summer, their growth was slowed down and there was a need to develop measures to accelerate it.

A set of studies to develop measures to improve the growth of forest crops created in the mountains in rain-fed conditions included measures to improve plant nutrition by adding mineral fertilizers to the soil, to preserve the moisture that entered the soil from precipitation falling in the winter-spring period, as well as to reduce consumption this moisture is transferred to weeds for use by forest crops during the dry summer period.

METHODS

The methodology for conducting an experiment on the use of mineral fertilizers in young rainfed forest crops created by planting material with closed roots, as well as in forest crops created in the usual way, consisted of applying fertilizers to the soil in the second year after planting in early spring, immediately after thawing snow, in the trunk circles of each plant or in a continuous strip 1 m wide, in the root distribution zone. After spreading the fertilizers, they were embedded in the soil to a shallow depth, up to 10 cm, so as not to damage the root system.

The experience of studying the effect of mineral fertilizers was laid down in accordance with the methodology for planning the use of mineral fertilizers set out in the work of V.N. Efimov V.S.Pobedov et al [4,5] and included three options - two options with the application of mineral fertilizers in doses with active ingredients: N90P90K60andN120P180K60, recommended in the works of other researchers, as well as based on the experiences of previous years for similar types of soils in the same environmental

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conditions [4], and the third option - without complete intervention (control) .

An increase in soil moisture reserves can be achieved by constructing simple hydraulic structures - terraces or sites - on the slopes before planting forest crops. Traditional methods of preserving moisture in planted forest crops by periodically loosening the soil and removing weeds on terraces and sites are too expensive, since they require the use of manual labor in modern conditions [1,2,3].

The solution to the problem of reducing the share of manual labor to combat the physical evaporation of soil moisture was carried out by improving its structural composition. This measure makes it possible to increase the filtration into the soil of precipitation moisture, which would uselessly flow down as surface runoff, and also complicates its physical evaporation [1,2].

In such conditions, it is very important to promote the accumulation and preservation of falling moisture in the soil for use by plants in the summer. Well-structured soil on the surface has high water permeability and almost completely allows precipitation even of high intensity, stopping surface runoff [2]. At the same time, structural soil, due to the absence of capillaries, reduces the physical evaporation of moisture from the soil, thereby preserving it for plant nutrition [6].

When creating forest crops, soil preparation by building terraces results in the removal of the structural topsoil. In this case, structureless subsoil horizons are exposed; after precipitation and drying of the upper layer, a cracked crust is formed on the surface, which prevents the absorption of moisture and promotes its evaporation [1,6].

Improving the structure of the soil surface was carried out by introducing structure formers (structurants), which prevent the formation of a crust and ensure the gluing of silty soil into lumps, creating a certain structure. Polymeliorant, developed and recommended by the Institute of Chemistry of the Academy of Sciences of Uzbekistan, and linear colloid carboxymethylcellulose (CMC) were chosen as structure-forming agents.

Reducing soil drying can also be achieved by destroying weeds using a chemical method - the use of herbicides [7]. Research in this direction was aimed at testing new drugs for the forestry of the republic. To destroy weeds, the herbicide “UraganForte” was tested at a rate of 1200 ml/ha. All of the above mentioned preparations were not used on the mountain slopes of the republic when growing forest crops in non-irrigated conditions.

The experience of testing the listed methods was carried out in the most difficult forest conditions with a hot and dry summer period - on the western slope of the spur of the Chatkal ridge at an altitude of 1200 m.

Structural agents were applied in the form of solutions to the terrace canvas evenly over the soil surface with further embedding with ketmen to a shallow depth of

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5–7 cm. The time for their application to the soil was in the spring, as soon as the soil became available for loosening after the snow had melted. Since until now structure formers have not been used for this purpose, the dose of the substance introduced into the soil was determined experimentally in the previous year. The previously identified application dose was 0.4% for Polimeliorant, and 0.2% for CMC, based on the use of 10 liters of solution per 1 m2 of terrace surface, wetting the soil to a depth of 5 cm. The application depth was also previously determined by us experimentally. Solutions of structurants were applied to the soil surface by spraying from a watering can.

Determination of the structure of the upper 5 cm layer of soil treated with structurants showed that in the control untreated section of the terrace, the surface was made up of parent rock - structureless silty loess-like heavy loam. In areas treated with Polymeliorant and CMC, an analysis of the determination of the total number of aggregates using the dry sieving method showed that after treating the soil with structurants, a granular structure with aggregates 1–3 mm in size was formed. This, as shown by measurements of the water permeability of the treated soil using the tube method, increased the filtration of water into the soil treated with polyameliorant from 2.8 to 6.0 mm/min, and into the soil treated with CMC - from 2.2 to 3.6 mm/min.

The weeds on the terrace on the western slope with experimental forest crops of the Sivers apple tree and Korolkov hawthorn were treated with herbicide using a sprayer in the third year after their planting. Treatment with herbicide was carried out in May, when the height of the grass stand was more than 15 cm, on sections of terraces containing 60 plants of each of these crops, with a herbicide solution diluted with water to the concentration recommended in the instructions. The results of studying the impact of the activities planned in the study showed the following.

RESULTS AND DISCUSSION

The influence of structurants and herbicide on the growth of experimental crops of apple and hawthorn in the experiment established in 2016 should have been fully manifested in 2017, since in 2016 the experiment was established in May, when the soil was in a state of ripeness, and the grass stand had grown to height of at least 15 cm. By this time, the apple tree and hawthorn already had a good growth of shoots. The most intensive growth of crops, as experience has shown, occurs in April - May, slowing down sharply by June, so the substances used could not have a full effect on the growth of crops in the year of the experiment.

Measurements of height growth of experimental trees carried out in 2017 are presented in the table. It should be noted that the growth of crops in the experiment with the combined use of structurants, fertilizers and herbicides turned out to be significantly lower than with their separate use, due to the fact that the joint use of the drugs was carried out in the summer period of 2017, which received much worse precipitation, when 30 mm fell then as in 2016 – almost 150 mm.

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Table

Dynamics of height growth of seedlings in experimental forest plantations on the western slope under the influence of complex application of mineral fertilizers, soil structure-forming agents "KMC" and "Polymelioranit" and herbicide "Uragan-Forte" during 2015-2017

Species	Treatments	MONTHS												Annual growth, cm	Growth relative
		April		May		June		July		August		September			
		M±m	P%	M±m	P%	M±m	P%	M±m	P%	M±m	P%	M±m	P%		
HAWTHORNE+FERTILIZER (2015-2016)															
Hawthorn	Control (no fertilizer)	58,4±2,04	3,5	62,4±2,12	3,4	62,4±2,12	3,4	62,8±2,13	3,4	63,0±2,14	3,4	63,0±2.14	3,4	4,6	100
	$N_{90}P_{90}K_{60}$	41,0±1,31	3,2	57,3±1,77	3,1	58,5±1,81	3,1	58,8±1,82	3,1	58,9±1,82	3,1	58,9±1,82	3,1	17,9	389
	$N_{120}P_{180}K_{60}$	39,1±1,17	3,0	47,5±1,42	3,0	51,0±1,47	2,9	51,7±1,50	2,9	53,0±1,48	2,8	53,0±1,48	2,8	13,9	302
APPLE TREE + FERTILIZER (2015-2016)															
Apple tree	Control (no fertilizer)	42,3±1,26	3,0	61,1±1,71	2,8	61,7±1,72	2,8	64,7±1,81	2,8	64,7±1,81	2,8	64,7±1,81	2,8	22,4	100
	$N_{90}P_{90}K_{60}$	45,3±1,72	3,8	58,4±2,16	3,7	64,5±2,25	3,5	68,7±2,26	3,3	68,8±2,27	3,3	68,8±2,27	3,3	23,5	104
	$N_{120}P_{180}K_{60}$	59,4±1,96	3,3	69,4±2,22	3,2	75,6±2,34	3,1	82,4±2,47	3,0	87,4±2,62	3,0	93,4±2,62	3,0	34,0	151
HAWTHORN – aftereffect of fertilizer (2017)															
Ha	Control (no	62,3±2,18	3,5	65,3±2,22	3,4	65,7±2,23	3,4	66,6±2,26	3,4	66,6±2,26	3,4	66,6±2,26	3,4	4,3	100

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wthorn	fertilizer)														
	$N_{90}P_{90}K_{60}$	55,7±1,94	3,5	59,9±2,03	3,4	60,1±1,98	3,3	61,0±2,01	3,3	66,5±2,12	3,2	66,5±2,12	3,2	10,8	251
	$N_{120}P_{180}K_{60}$	50,5±1,46	2,9	63,8±1,77	2,8	70,5±1,97	2,8	76,1±2,05	2,7	85,9±2,23	2,6	85,9±2,23	2,6	35,4	823
APPLE TREE – aftereffect of fertilizer (2017)															
Hawthorn	Control (no fertilizer)	60,8±1,88	3,1	69,0±2,13	3,1	74,5±2,23	3,0	80,7±2,34	2,9	80,7±2,34	2,9	80,7±2,34	2,9	19,9	100
	$N_{90}P_{90}K_{60}$	65,0±1,95	3,0	75,5±2,11	2,8	80,3±2,24	2,8	85,7±2,31	2,7	85,8±2,31	2,7	85,8±2,31	2,7	20,8	104
	$N_{120}P_{180}K_{60}$	77,1±2,15	2,8	89,2±2,40	2,7	99,3±2,68	2,7	103,5±2,79	2,7	103,5±2,79	2,7	103,5±2,79	2,7	26,4	132
BOYARKA + "KMC" + "Meliorant" (2015-2016)															
Hawthorn	Control (no fertilizer)	67,3±2,5	3,7	77,2±2,62	3,4	114,2±3,76	3,3	114.2±3,76	3,3	114,2±3,76	3,3	114,2±3,76	3.3	46,9	100
	KMC-0,2%	89,4±3,12	3,5	90,5±3,07	3,4	95,7±3,15	3,3	129,7±4,15	3,2	129,7±4,15	3,2	129,7±4,15	3,2	40,3	85
	Meliorant-0,4%	67,2±2,41	3,6	90,7±3,08	3,4	95,4±3,05	3,2	98,9±3,16	3,2	116,6±3,73	3,2	116,6±3,73	3,2	49,4	105
APPLE TREE + "KMC" + "Meliorant" (2015-2016)															
Apple tree	Control (no fertilizer)	57,6±1,95	3,4	77,2±2,62	3,4	77,4±2,70	3,5	77,6±2,56	3,3	77,6±2,56	3,3	77,6±2,56	3,3	20,0	100
	KMC-0,2%	85,4±2,30	2,7	105±2,83	2,7	107,5±2,79	2,6	107,5±2,79	2,6	108,6±2,82	2,6	108,6±2,82	2,6	23,2	116

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	Meliorant - 0,4%	76,7±2,37	3,1	90,7±2,90	3,2	92,5±2,86	3,1	92,5±2,86	3,1	92,5±2,86	3,1	92,5±2,86	3,1	15,8	79
HAWTHORN - HERBICIDE "Uragan Forte" (2015-2016)															
Hawthorn	Control (no fertilizer)	55,4±1,71	3,1	63,5±1,90	3,0	69,9±2,09	3,0	69,9±2,09	3,0	72,1±2,01	2,8	72,1±2,01	2,7	16,7	100
	Uragan forte - (1200 мл/га)	58,3±1,74	3,0	109,7±3,07	2,8	113,4 ± 3,06	2,7	113,4± 3,06	2,7	115,6±3,12	2,7	115,6±3,12	2,7	57,3	343
APPLE TREE - HERBICIDE "Uragan Forte" (2015-2016)															
Apple tree	Control (no fertilizer)	40,5±1,21	3,0	43,1±1,29	3,0	48,4±1,40	2,9	48,4±1,40	2,9	48,4±1,40	2,9	48,4±1,40	2,9	7,9	100
	Uragan forte - (1200 мл/га)	59,6±1,67	2,8	73,3±2,05	2,8	88,7±2,39	2,7	88,7±2,39	2,7	88,7±2,39	2,7	88,7±2,39	2,7	29,1	368
HAWTHORNE- HERBICIDE + FERTILIZER + CMC (2015-2017)															
Hawthorn	Control (no fertilizer)	43,1±1,33	3,1	45,1±1,35	3,0	45,9±1,35	3,0	46,0±1,38	3,0	46,0±1,38	3,0	46,0±1,38	3,0	2,9	100
	Uragan forte - (1200 мл/га) +N_{90} $P_{90}K_{60}$ + КМЦ (0,2 %)	75,6±2,26	3,0	78,9±2,28	2,9	88,1±2,55	2,9	89,1±2,58	2,9	89,1±2,58	2,9	89,1±2,58	2,9	13,5	465

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APPLE TREE + HERBICIDE + FERTILIZER + MELIORANT (2015-2017)															
Apple tree	Control (no fertilizer)	44,5±1,51	3,4	45,8±1,55	3,4	46,3±1,52	3,3	46,3±1,52	3,3	46,3±1,52	3,3	46,3±1,52	3,3	1,8	100
	Uragan forte - (1200 мл/га)+$N_{90}P_{90}K_{60}$+ Мелиорант (0,4%)	75,3±2,40	3,2	79,6±2,54	3,2	82,5±2,55	3,1	88,3±2,73	3,1	88,3±2,73	3,1	88,3±2,73	3,1	13,0	722

In an experiment with the use of mineral fertilizers, in which the effect of fertilizers on the growth of hawthorn and apple trees was studied, in the year of their application, fertilizers had a positive effect on the growth of shoots only in hawthorn. At the same time, the highest growth in height was observed with a lower fertilizer rate (N90P90K60), where the annual growth was 17.9 cm, which compared to the higher fertilizer rate was 1.2 times higher (28%), and the difference with the control was more than 3 .8 times (389%). In the apple tree, the highest increase in height compared to other options was provided by a higher fertilizer rate (N120P180K60), where the increase relative to the control exceeded 51%. At this moment, the increase in height in the variants with a lower dose of fertilizers (N90P90K60) and the control turned out to be the same - within 51-53%.

The dynamics of growth in height of hawthorn and apple trees during the growing season in the first year after applying fertilizers was different depending on the application rate. In hawthorn, with a lower rate, active growth continued until May, and with a higher rate - until June In the apple tree, shoot growth continued longer. With a low fertilizer rate, it lasted until June, and with a higher rate, until September. In the control, active growth continued in the hawthorn only for two months - April and May, and in the Sievers apple tree, as a species characterized by a long growth of shoots, and in the control growth continued until July.

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In the second year, the aftereffect of fertilization on height growth in hawthorn and apple trees had large differences. In hawthorn, with a lower application rate, active growth was observed during the first two months, and with a higher rate it was extended until August. In the control, the growth period was as short as in the previous year - in April-May. In the apple tree, active growth was observed in the variants with fertilizer until August, and in the control until June.

The amount of height growth in hawthorn in the year of fertilization was not affected by the application rate and the annual increases in percentage terms turned out to be equal, but significantly greater than in the control (25-26%). The growth response of the apple tree in the year of fertilization was not observed. Annual increases turned out to be the same as the control (in all variants 50-53%).

However, if we compare the percentage of excess of the annual growth of hawthorn in the variants with the application of fertilizers in relation to the control, in the best variant with the application rate of N120P180K60, it amounted to 302%. During this period, the apple tree actively responded to improved nutrition with a large dose of fertilizer ((N120P180K60). Its annual growth in comparison with the control in variants with fertilizer turned out to be 151% greater.

In the second year after applying mineral fertilizers, their positive effect on the growth of hawthorn and apple trees increased. The annual growth of hawthorn is best with a higher fertilizer rate (N120P180K60). in comparison with the control was 823%, and in the apple tree in the same variant - by 33%. The increase in the growth of experimental plants in the second year can be explained by an increase in growth at the beginning of the growing season, which occurred due to greater accumulation of nutrients in the previous year, as well as due to increased photosynthesis and the duration of the growth period by 2-3 months compared to the control.

The results of studying the growth of crops in height depending on the use of structurants "CMC" and "Polymeliorant" showed that "Polymeliorant" and "CMC" had practically no effect on the growth of experimental crops. Hawthorn increased by height in the variant with Polymeliorant was 5% higher than the control, and in the variant with CMC the increase was less than the control by 13%. The apple tree had an inverse relationship - CMC showed a slight positive effect, increasing the growth by 16%, and in the variant with ameliorant the increase was less compared to the control by 21%.

A study of the growth dynamics of experimental crops showed that apple and hawthorn differ in this indicator as well. Thus, the application of CMC to the soil surface stimulated intensive growth of hawthorn in the hottest month - July, amounting to 33 cm, and the application of polyameliorant - in August, when the growth was 17.7 cm, while in the control the main increase occurred in June - 37. 0 cm. In the apple tree there was no difference in the intensity of growth during the

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growing season in any of the variants. In this breed, almost all of its height growth occurred in May.

As observations have shown, the herbicide had a very strong effect on the growth of experimental crops. In the variant with hawthorn, its use increased the annual growth by more than 3 times (343%), and in the variant with apple tree - almost 4 times (368%).

The effect of the herbicide on the growth of the studied breeds also differed. Thus, the main growth of hawthorn under its influence occurred in May, amounting to 51.4 cm, after which in July it decreased to 4 cm, and then stopped, while in the control it occurred more evenly, amounting to 11 cm in May, 6.5 in June and August 2.3 cm. In the experiment with an apple tree, the herbicide stimulated growth in height only in April-June, amounting to 13.7 cm in May and 15.4 cm in June. In the control in this experiment, growth of the apple tree was also observed in May by 2 .6 cm and June by 5.4 cm.

In the experience of joint use of mineral fertilizers, structure-forming agents and herbicide, carried out in 2017, there was a general decrease in the annual growth of both species in all variants of the experiment compared to 2016 due to the difference in the weather conditions of the three years during which the experimental work was carried out. The most abundant precipitation in the summer period was 2015, the year preceding the experiment. As a rule, the most active growth of trees in rainfed conditions occurs at the beginning of the growing season in April - May, when it is not yet leaf mass has increased, providing growth due to photosynthesis, and the growth of new shoots is carried out due to the reserves of nutrients accumulated in the previous year. For this reason, the growth of new shoots in 2016 was stronger than in 2017, in which shoots grew due to reserves , accumulated in the drier year of 2016.

Experience has shown that the use of a set of measures to improve plant growth, including the use of mineral fertilizers, soil treatment with structurants, and weeds with herbicides, already in the first year increased the annual growth of both hawthorn and apple trees compared to the separate use of these measures. Hawthorn increased its annual growth compared to the control by 11%, and the apple tree by 9.2%.

Comparison of annual growth in relation to the control in percentage shows that the growth of hawthorn in the experiment with the use of complex measures exceeds the control by 466%, and the growth of the apple tree by 611%.

This is explained by the fact that thanks to the destruction of the herbicide “Hurricane-Forte” on the terraces of weeds, preventing soil drying out through transpiration, it significantly increased soil moisture in the root systems of plants in the summer by 4-5% and thus after treatment already in the first year on In experimental plots, 100% of weeds died. In the second year, only 15% of the area in the treated area was occupied by weeds.

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The study of the dynamics of active growth of shoots in this experiment showed, as in the experiment with the use of fertilizers, the duration of growth in height of hawthorn in the variant with complex measures lasted until July, and for the apple tree until August. In the control, in both variants, growth continued only until June.

CONCLUSIONS

According to the results of experiments on the use of nitrogen, phosphorus and potassium mineral fertilizers, soil structure formers "KMC-0.2%" and "Meliorant-0.4%", as well as the herbicide "Uragan Forte" at a rate of 1200 ml/ha in two-year rainfed areas forest crops of hawthorn and apple trees in the low-mountain zone, the following conclusions can be drawn:

1. The study of the dynamics of growth of forest crops of hawthorn and apple showed that in all the experiments analyzed in this work, all the studied methods of increasing the growth of forest crops of these species led to an increase in the duration of growth by 1-2 summer months in relation to the controls.

2. Mineral fertilizers already in the first year of application had a positive effect on the height growth of both breeds. At the same time, when applying mineral fertilizers at the norm N90P90K60, the hawthorn increased its height growth by 389%, and at the norm N120P180K60 by 302%, and the apple tree, due to its biological characteristics, with a lower dose of N90P90K60 only by 4%, and with a higher dose of N120P180K60 by 51%. In the second year of the experiment, the annual growth of these species turned out to be even greater - in hawthorn with a lower dose of N90P90K60 fertilizers by 251%, and with a higher dose of 823% in relation to the control, and in apple trees with a large dose of N120P180K60 fertilizers by 33%.

3. The use of soil structure formers – "CMC-0.2%" and "Polyameliorant-0.4%" turned out to be ineffective. In this experiment, when the soil was treated with "Polymeliorant," hawthorn increased its growth by 5% compared to the control, but with "CMC" it was 13% less. In the apple tree, an inverse relationship was observed - with the polyameliorant the increase was 21% less, and with CMC it was 16% more.

4. Treatment of weeds with the herbicide "Uragan-Forte" at a rate of 1200 ml/ha due to increased soil moisture had a great positive effect. The annual growth of hawthorn crops exceeded the growth of control crops by 343%, and the apple tree under similar conditions increased its growth by 368%.

5. The complex use of mineral fertilizers in the norm N90P90K60 soil structure-forming agents "KMC-0.2%" and the herbicide "Hurricane-Forte" in the norm already in the first year of the experiment showed the highest positive effect on the annual growth of hawthorn and Sievers apple crops. At the same time, hawthorn increased growth relative to the control by 465%, and apple tree - by 722%.

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6. Taking into account the rather high cost of soil treatment with structure-forming agents and the small effect of their use, it is possible to exclude this technique from the complex of agrotechnical techniques for the accelerated cultivation of forest crops on mountain slopes, leaving only the use of mineral fertilizers at the norm N90P90K60 and herbicides "Uragan-Forte" at the norm 1200 ml/ha.

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