

Soils of the Natural Zones of Western Georgia and their Agricultural-Production Use for the Purpose of Forest Culture Development

Vano Papunidze^{*,**}, Shota Lominadze^{**}, Mariam Metreveli^{**},
Darejan Jashi^{**}, Narguli Asanidze^{**}, Nunu Nakashidze^{**},
Lamzira Gorgiladze^{**}, Inga Gaprindashvili^{**}

^{*} Academy Member, Georgian National Academy of Sciences; Ajara Regional Scientific Center, Georgia

^{**} Batumi Shota Rustaveli State University, Georgia

Abstract. The development and long-term prospects of forest cultures requires a detailed analysis of the local soils to select plant species appropriate for the location. This study focuses on the physico-mechanical properties and chemical composition of soils in agricultural production zones of western Georgia, particularly Ajara-Guria and Samegrelo-Abkhazia regions. The state of groundwater levels and other relevant issues has been examined. This work also presents a selection of fast-growing, highly productive woody species (mainly introduced exotic varieties) suitable for these conditions to create industrial plantations and restore-renew mountain forest areas with low density that have not been naturally regenerated. © 2025 Bull. Georg. Natl. Acad. Sci.

Keywords: silty-marshy soils, meadow-marshy soils, carbonate soils, alluvial-deluvial soils, yellow soils, clay soils, podzolized soils, humus

Introduction

Mountain forests, as complex natural ecosystems, unlike lowland forests are more sensitive to various forms of anthropogenic impact, including pastoral, recreational pressures and other stresses as well as extreme weather conditions. When in a stable state, they perform vital multifunctional roles (Protopopov, 1980). The trend of deterioration of mountain forests persists everywhere and the situation is particularly severe in the Caucasus region. As a result, a significant portion of these forests has lost their protective functions (soil protection, water

conservation, hydrological regulation, etc.), and in many areas thinned by logging, the process of natural forest regeneration has been interrupted. The condition of these forests causes particular concern, as their irrational use and any stressful natural situation (landslides, avalanches, etc.) can lead to the degradation of mountain forest ecosystems and the loss of their stabilizing effect on natural complexes. At the current stage of the Republic's forestry development, the possibilities for harvesting and exporting the necessary volume of timber are very limited (Khidasheli, Papunidze, 1976; Papunidze, 2012).

The results of our experimental trials of the entire technological cycle of forest culture production and the rather solid materials of the latest scientific and technical achievements accumulated in this direction make it possible to outline effective measures to significantly improve the quality of forest culture production, with the assumption that they most fully correspond to the specific environmental conditions of forest growth. The main directions of forest culture production studied in western Georgia include: (1) growing high-valuable timber of fast-growing woody species using the plantation method; (2) restoration of stands damaged by intensive cutting, insect pests, and phyto-diseases; (3) reconstruction of degraded forest and shrub stands.

Based on indicators of soil-climatic and forest growth conditions, we have studied regions of western Georgia, classifying them into corresponding areas, sub-areas, and forest culture districts. 1 – Region of "Mixed Subtropical Forests" – within 0 - 500-600 m a.s.l., which is subdivided into two sub-regions: "More humid" with administrative districts: Batumi, Kobuleti, Chokhatauri, Ozurgeti and Lanchkhuti, which are further divided into: a) primary introduction districts, within 0 - 300 m a.s.l., and b) district of subtropical forest-forming species. 2 – "Humid sub-region" from 0-300 to 500-600 m a.s.l. with administrative districts of Sukhumi, Gudauta, Gulripshi, and Gagra, which is also divided into:

a) primary introduction district from 0 to 300 m a.s.l.; b) district of subtropical forest-forming species, within 300-500-600 m a.s.l.

I – Region of "Mixed Subtropical Forests" from 0 to 500-600 m a.s.l.

The region of mixed subtropics of Georgia occupies a relatively narrow strip along the Black Sea coast. Reaching its greatest width in the middle part of the Colchis lowland, it gradually narrows to the south and northwest. This entire zone, which has a heterogeneous character of its surface structure, can be divided into two unequal parts –

1) lowland and 2) foothill. The lowland part, known as the Colchis lowland, occupies a vast territory along the lower course of the Rioni, Khobi, Inguri, and other rivers and has very small elevations – 5-10 m a.s.l. The Colchis lowland owes its formation to the accumulative activity of the mentioned rivers and their tributaries; in the past, as is known, it was a sea bay. Bordered by the Black Sea coast to the west, to the east and northeast, the Colchis lowland transitions into a more elevated part, which is a system of leveled terraces of the main rivers of Western Georgia. 2) The hilly belt of the subtropical zone in the northern and middle parts represents a series of coastal marine terraces, of which the upper one is most eroded and divided into a series of watershed hilly ridges, which is especially prominently highlighted in the Sukhumi area.

1) Marshy soils. The abundance of precipitation, flat or often depressed relief, heavy composition of sediments, river floods, and other factors create conditions of constant excessive soil-ground moisture, which is the main factor in soil formation in the western part of the lowland. This causes the presence of various in composition and properties masses of marshy soils occupying the watersheds of the Supsa, Rioni, and Khobi rivers in the coastal part of the lowland. To a significant extent, they represent areas of lowland grass marsh with peat in their central part.

The thickness of peat often does not exceed 1 m, only in places it reaches 6-7 meters. Such are the peat bogs of Paliastomi, in the coastal strip of the watershed and Khobi, and a number of other places. The ash content of the upper layer of sphagnum peat corresponds to 15-20%, while the ash content of lowland bog peat reaches about 50%.

When studying forest cultures, peat soils were encountered in Ispani (Kobuleti forestry), where eucalyptus was cultivated on drained soils, characterized by good survival and growth.

2) Silty-marshy soils. These soils are often characterized by the presence of a peat layer of insignificant thickness, heavy clay composition,

and strong gleying directly from the surface, with a thickness of 12-15 cm with inclusions of semi-decomposed residues; below, this layer transitions into a continuous gley horizon, usually of heavy clay composition and with numerous ochre-rusty spots. The reaction of these soils is more often close to neutral or slightly alkaline and only rarely is slightly acidic (Mindeli et al., 2011).

Below are analytical data for silty-marshy soils. Table 1.

The data confirm a high humus content, and correspondingly with the humus, there is a high percentage of nitrogen. The soluble phosphorus content reaches up to 12%, and the soil reaction is neutral.

Below are the data for characterizing the mechanical composition of these soils.

As can be seen from Table 2, the quantity of particles (<0.001 mm) reaches 38.89%, and the entire sum of the clay fraction (<0.01 mm) is 80-94%, which allows these soils to be classified as clay soils.

Such soils in Western Georgia are found in the Supsa forestry of the Ozurgeti forest enterprise, particularly in the area where groundwater begins at a depth of 50 centimeters.

3) **Podzolic-gley soils.** In the transition zone to the elevated part of the lowland, bog soils occupy less space and, as indicated by (Urushadze,

Bajelidze, Lominadze 2018) and others, soils of a transitional type from bog to podzolic and podzolic-gley predominate. Most areas of these soils correspond to the lowland part, within Lanchkhuti, Supsa, and other regions. Podzolic-gley soils show the heavy composition. The fine earth composition should be classified as heavy loam, with humus content in the upper layers reaching 5.05% and decreasing rather sharply with depth correspondingly to humus. The content of total nitrogen reaches a significant value, with pH variations ranging from 6.1 to 7.7.

4) **Meadow-bog soils.** Meadow-bog soils are located in the Tikeri forestry. These soils are mainly confined to areas of lowered plains or depressions of an enclosed nature and have formed under meadow bog vegetation, sedges, rushes, etc. These soils have a groundwater level closer than 1 m. Their morphological characteristic features are well-expressed sod layers and the presence of ferrous oxide spots throughout the profile; in excessively moist soils, there is usually a dirty-gley horizon in the upper half of the soil profile.

5) **Alluvial soils of river terraces.** Alluvial soils are very diverse in composition and properties, depending on the composition of the material brought and deposited by rivers in different parts of their flow. Compared to other types, alluvial soils are younger, and consequently,

Table 1. Humus, nitrogen, phosphorus and pH content

Soil	Depth cm	Humus %	N %	Solution P ₂ O ₅ in mg of solution	pH
Silty-marshy	2 - 12	12.10	0.55	12.09	7.2
	15 - 25	11.30	0.21	9.00	7.1
	30 - 47	-	-	-	7.2

Table 2. Results of mechanical analysis of silt-marshy soils (using the Kachinsky (1958) method)

Soil	Depth cm	Size of particles						
		1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Silty-marshy soils	2 - 12	0.00	2.28	19.96	38.96	18.04	22.76	79.76
	15 - 25	0.02	3.21	17.01	36.24	15.91	27.61	79.76
	30 - 47	0.00	0.16	5.80	38.66	18.49	38.89	94.04

they are somewhat poor in organic substances. The predominant distribution is of alluvial non-carbonate soils of medium and large thickness and more often of medium or light loamy composition. These soils are slightly acidic, close to neutral. The humus content in these soils is 6.69% and it constantly decreases with depth; correspondingly to humus, the content of total nitrogen reaches a significant value. Alluvial soils of marine terraces also belong to this group.

6) Alluvial soils of marine terraces. Alluvial soils of marine terraces are located in the plain part adjacent to the sea; their underlying rocks are modern and ancient alluvial deposits of various mechanical compositions, usually pebbly. On the sands of the sea coast, in Likhuri forestry, in Ureki, cultures of coastal Pitsunda, black, and Caucasian pines have been cultivated. Seedlings of these species were planted by adding red earth and yellow earth soils to pits, and in order to ensure survival and further normal development of these cultures, wells were arranged in this territory at a distance of 50 m.

7) Alluvial-carbonate soils. Alluvial-carbonate soils have less distribution, and are confined mainly to the same conditions of occurrence as the sandy loam varieties of alluvial non-carbonate soils. The content of calcium carbonate in these rocks reaches up to 15-18%, but with significant variation across individual layers. In connection with this, these soils are distinguished by a more often slightly alkaline reaction or slightly acidic in the upper layers and slightly alkaline in the lower ones. In terms of mechanical composition, light loamy and sandy loam varieties predominate among alluvial carbonate soils. There is a low content of humus

and nitrogen in these soils, soluble phosphorus is completely absent, and the calcium carbonate content fluctuates within the range of 12.4 - 16.3%.

The mechanical composition of these soils is presented in Table 3.

As can be seen from Table 6, the soil analysis data from Kakhaberi shows lower values of clay particles (<0.001mm) and correspondingly the sum of particles <0.01mm; according to these data, these soils should be classified as sandy loam soils.

In Kakhaberi, cultures (honey locust, cryptomeria, noble laurel, chamaecyparis, cypress) have been cultivated, which are distinguished by good survival rates and growth.

8) Alluvial-gleyed soils. These soils are characterized by gleying from a depth of 20-30 cm; in weakly gleyed varieties, it affects only the deep layers. The cause of gleying in these soils is excessive moisture throughout the massif in this part of the lowland and the poor water permeability of the deposits underlying the soil. Often, the gleying of alluvial soils is caused by flooding of coastal areas during high water periods, which occurs in a significant part of the regions. The gleying of alluvial soils at the bottom of ravines and part of the valley is also caused by washout waters from adjacent slopes. The humus content reaches 4.9% and drops rather sharply with depth; correspondingly to humus, the content of total nitrogen reaches a significant value, but attention is drawn to the significant content of soluble phosphorus, which is characteristic of most alluvial soils. The physical clay <0.01 ranges from 53.9 to 56.9%, and these soils should be classified as heavy clay soils.

Table 3. Data of mechanical analyses of alluvial-carbonate soils (using the Kachinsky (1958) method)

Soils	Depth cm	Size of particles						
		1-0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Alluvial-carbonate	0-10	12.05	50.4	25.0	4.3	4.4	3.0	11.7
Kakhaberi	10-70	1.8	59.0	30.1	4.1	3.3	1.7	9.1

9) Alluvial-deluvial soils. Alluvial-deluvial soils are located at the foot of slopes with a steepness of 3-10, leading to river channels. They were formed due to the removal of fine earth from mountain slopes and its deposition on alluvium. Since usually the smallest, lightest particles by weight are washed away from the slopes, alluvial-deluvial soils often have a heavier mechanical composition and include skeletal material carried down from the mountains.

In the eastern part, the foothill strip narrows significantly and is composed of the foothills of the Meskheti ridge, divided into a system of watershed hills and having rather sharp contour outlines. In the geological structure of these hills, clay shales, marls, and clay strata occupy a predominant place. In the Adjara-Imereti foothills, the following soil types are distinguished: red soils, yellow soils, and brown soils. Let's characterize each of these soils.

10) Red soils. They have the greatest distribution in Ajara and Guria, in conditions of hilly relief, these soils are mainly formed on igneous rocks and ancient pebble-boulder strata. Ancient pebble-boulder deposits, the petrographic composition of which is determined by andesites and basalts with an admixture of sandstones, cover almost the entire territory of red soils distribution, with the exception of a small area in Ajara (Chakvi, Tsikhisdziri), which is composed of igneous rocks consisting, according to a number of researchers, mainly of andesites (Gedevanishvili, Talakhadze, 1961; Daraselia, 1949).

The humus content for red soils is 6-7%, with a relatively gradual decrease downward. In podzolized varieties of red soils, the percentage of humus is somewhat less and decreases more sharply with depth. Corresponding to humus levels, the content of total nitrogen reaches a significant value, showing in the upper layer usually 0.3-0.4%.

The average value of humus for red soils is 5-6% with a relatively gradual decrease downward. Correspondingly to humus, the content of total nitrogen reaches a significant value, showing 0.3 -

0.2% in the upper layer; phosphorus in the upper layers of red soils fluctuates within the range of 111-2%, and traces are found in the lower layers; the reaction in these soils is acidic. In the third profile, the clay fraction is very high (<0.01 mm) and reaches 75 percent, the silt fraction (0.001 mm) fluctuates within the range of 37-46%; in the fourth profile, the physical clay fraction <0.01 reaches 49 percent, and the silt fraction fluctuates within the range of 18-21 %.

Plane trees with poor survival rates have been planted on the red soils of Tikeri.

Areas with red soils and small patches of **yellow soils** have been identified in the foothill zone (up to 400 m a.s.l.) in the Chaisuban, Merisi, Karasharval, and Gorgoi forestry districts. The mechanical composition is mainly heavy loamy and clayey. In terms of thickness, shallow varieties predominate. The main characteristics distinguishing yellow soils from red soils are their paler field color or slightly orange hue, due to lower iron oxide content, heavier mechanical composition, and lesser thickness, rarely exceeding 80-100 cm. The humus content in the first layers, ranges from 1.8 to 2.1 percent. The variation in humus generally depends on the degree of surface layer erosion, which is less in these soils than in red soils and on average may be 4-5%; the nitrogen content value for these soils is 0.11-0.10%, with a relatively gradual decrease downward, and the reaction is acidic. The physical clay <0.01 in both sections ranges between 40.3-58.0 percent, and these soils should be classified as heavy clay soils. All cultivated tree species planted on these soils in the Ozurgeti forestry district are characterized by good survival rates, and pine plantations in the Chokatauri forestry enterprise also demonstrate good survival and growth.

From 500-600 to 2200 m above sea level, the following soil types are distinguished: 1) Mountain-forest brown soils; 2) Light and podzolized brown soils; 3) Mountain-meadow soils; 4) Mountain-meadow peat soils; 5) Alluvial

soils. Below are the characteristics of each of them separately.

1) Mountain-forest brown soils. Compared to soils of plain regions, the soils of mountain-forest districts are characterized by distinctive features and significantly greater diversity. This is primarily due to relief conditions, its dissection, varying elevations above sea level, different slope steepness, diversity of rock types, etc.

These factors determine, as is known, different climates, vegetation, varying intensity of erosion phenomena, and correspond to different expressions of soil-forming processes, degree of development, and the physical and chemical nature of mountain-forest soils.

Brown soils are developed mainly on weathering products of clay shales, sandstones, and igneous rocks. These soils are diverse in their degree of development, mechanical composition, and other characteristics. In their greatest mass, they are distinguished by shallow depth, stoniness, and heavy loamy composition. Poorly developed and in places severely eroded soils occupy a large area in this zone.

In Western Georgia, this part is represented by a transitional strip between the humid subtropical zone and a relatively colder humid region. Brown soils are also found in the hilly strip of the subtropical zone, where they lie in complexes, predominantly with yellow soils. In their composition and properties, brown soils significantly approach the data of yellow soils.

Brown soils are characterized by a well-expressed humus horizon. The amount of humus in forest brown soils reaches 8-10%. On slopes with steepness greater than 20-25°, soils are often subject to erosion; eroded soils are depleted of humus and lighter in mechanical composition. The humus content in brown soils varies and reaches 5.04-4.16%, decreasing quite sharply with depth. Corresponding to the humus, the total nitrogen content reaches significant values, showing 0.25-0.21% in the upper layer with a relatively gradual

decrease downward. Soluble phosphorus does not exceed 2% or is completely absent, with pH fluctuating within the range of 5.2 - 4.5. Based on the sum of particles <0.01, these soils belong to heavy loams. Pine forests with poor survival rates have been cultivated on these soils in the forestry enterprises of Mtirala (Batumi) and Mzhavetskali.

2) Light and podzolized brown soils – These soils are widely distributed in the upper part of the mountain forest zone, where the podzolization of brown soils is facilitated by humid and moderately cold climate, acidic properties, and solubility of humus, which characterizes the zone of coniferous and mixed forests in these climatic conditions. Podzolized brown soils also occupy a significant place in the lower forest belt and foothill strip of Western Georgia in relatively leveled areas. These soils are found in large masses on various non-carbonate rocks; on carbonate rocks, the podzolization of these soils is expressed to a very slight degree. Podzolized brown soils vary in degree of development, podzolization, mechanical composition, and other characteristics; most commonly they are characterized by shallow depth, stoniness, heavy loamy and clayey composition, and distinct signs of podzolization. In the upper layers, the percentage of humus fluctuates within 4.75-7.64% and usually drops sharply with depth. The C:N ratio in these soils is 12.0-15.3, which distinguishes them from non-podzolized brown soils. Meadow-forest soils were formed in sparse forests under conditions of enhanced meadow process development. These soils are characterized by the formation of sod in the surface layer and a crumbly structure in horizons A+B.

3) Mountain-meadow soils occupy the highest position and develop in the subalpine and alpine zones of high mountain regions under dense herbaceous vegetation.

The great diversity of mountain-meadow soils is due to the different positions of mountain systems, their height, steepness and exposure of slopes, erosion phenomena, and others. In this

respect, vegetation and parent rocks also have different influences. The main characteristics of mountain-meadow soils are their shallow depth, high skeletal content, and large accumulation of organic matter in the form of root residues and peaty mass.

4) **Mountain-meadow peat soils.** Mountain-meadow peat soils develop under rhododendron thickets Gulisashvili V. Z. (1935). The thickness of the peat layer often reaches 30-40 cm or more. The nature of accumulation and amount of organic matter can be judged by V. A. Ambokadze's data for peat mountain-meadow soil, which show a very high content of organic matter, confirming the peaty character of the soils; with 60.5% organic matter, the nitrogen content does not exceed 1.97%. The soil reaction is very acidic, which is also characteristic of peaty soils. In the upper part of the alpine zone, soils have a very primitive, discontinuous character, with a small proportion of fine earth and organic matter. Under alpine carpets and dense grass cover, the soils are very shallow, but in the upper layer they form a well-sodded, and often sod-peat mass.

5) **Alluvial soils**, as mentioned above, are very diverse in composition, which depends on the material brought and deposited by rivers in different parts of their flow.

Below we present the main assortment of woody forest species studied and recommended for establishing plantations of fast-growing forest species and for restoration-renewal of mountain forests thinned by cutting, according to soil types and climatic conditions of individual agro-production zones of Western Georgia:

For **swampy-silty soils** in the zone from 0-500 meters a.s.l.: *Populus balsamifera* L., *P. canadensis*, *P. Tremula* L., *P. alba-Plant* L.; *Platanus orientalis* L., *P. Acerifolia* (*Occidentalis*) Wild.; *Liriodendron tulipifera* L.; *Liquidambar orientalis* mill.; *Sequoiadendron giganteum* Lindl.; *Salix Salix caprea* L., *S. purpurea* L.; *Paulownia fortune* (Seem.)Hems.; *Quercus serrata* Thunb., *Q. Hartwissiana* Stev., *Q.*

castaneifolia, *Q. macrocarpa* Michx. *Q. suber* L. etc.), *Pinus pinaster* A I t., *P. Strobus* L., *P. engelmannii* Carr., *P. Pityusa* Stev. *P. palustris* Miill. etc.); *Abies alba* Mill.; *Cupressus distichum* (*Taxodium distichum* (L.) Rich.); *Cryptomeria Japonica* Don, etc.; **For humus-carbonate soils:** *Populus balsamifera* L., *P. tremula* L.; *Carya illinoensis* (pekan); *Quercus castaneifolia*, *Q. Petraea subsp iberica*. *Q. Rubra*; *Liriodendron tulipifera* L.; *Liquidambar orientalis* mill.; *Paulownia fortune* (Seem.) Hems.; *Tilia caucasica* Rupr.; etc.; *Eucalyptus gigantea* Hook., *E. mannifera* A. Cunn., *E. cinerea* F. v. Mucll., *E. globulus* Labill., *E. Macarthurii* Deane et Maiden., *E. viminialis* Labill. Etc.; *Cupressus horizontalis*, *C. torulosa* D. Don, *C. lusitanica* Mill. etc.; *Taxodium distichum* L. **For alluvial, yellow soil, red soil, podzolized brown and other non-carbonate soils:** *Castanea sativa* Mill. *C. crenata* Sieb et Zucc.; *Zelkova carpinifolia* Dipp.; *Quercus suber* L., *Q. serrata* Thunb.; *Fraxinus excelsior* v. *monophyll* Desf.; *Cryptomeria Japonica* Don, etc. The restoration and renewal of forest stands depleted by unsystematic logging, and increasing their productivity, has extremely important theoretical and practical significance for all regions of the mountainous conditions of Western Georgia. From 500 to 1000 meters a.s.l. in the middle zone, this is a well-defined chestnut-oak (*Fagus-Quercus*) forest belt. Promising species for planting on thin soils are Austrian pine (*Pinus nigra* J.F. Arnold) and Scots pine (*Pinus sylvestris* L.) (above 600 meters above sea level), while in river valleys the preferred species are sessile oak subspecies *Polycarpa* (*Quercus petraea subsp. Polycarpa* (Schur) Soo), *Q. Petraea subsp iberica* and *Q. Robur subsp iberetina*). On **non-calcareous** soils, preference is given to sweet chestnut (*Castanea sativa* Mill.), and as accompanying species (up to 800 meters above sea level), we can use Japanese cedar (*Cryptomeria Japonica* Don). The use of **humus-calcareous** soils is advisable for planting Austrian pine (*Pinus nigra* J.F. Arnold), Chorokhi

oak (*Quercus petraea* subsp. *Polycarpa* (Schur) Soo), and Colchis oak (*Q. Hartwissiana* Stev.). As accompanying species, it is possible to use common ash (*Fraxinus excelsior* v. *monophyll* Desf.), field maple (*Acer Campestre* L.), and various species of poplars (*Populus*) and cypresses (*Cupressus*). On **brown** soils of medium depth, Chorokhi oak (*Quercus petraea* subsp. *Polycarpa* (Schur) Soo) shows good growth indicators, which can be accompanied by Colchis oak (*Q. Hartwissiana* Stev.), Austrian pine (*Pinus nigra* J.F. Arnold), Caucasian persimmon (*Diospyros lotus* L.), common ash (*Fraxinus excelsior* v. *monophyll* Desf.), and others. **Alluvial** soils are best for common walnut (*Juglans regia* L.) and various species and hybrid poplars (*Populus*). Oriental beech (*Fagus orientalis* Lipsky) forests in Western Georgia are found within the range of 1000-2100 meters, but individual stands and even entire areas dominated by beech (*Fagus orientalis* Lipsky) are found outside these boundaries, both below and above. For artificial forest regeneration on thin soils of the beech (*Fagus orientalis* Lipsky) belt, the most promising species is Caucasian pine (*Pinus sylvestris* L.), and in some cases, Austrian pine (*Pinus nigra* J.F. Arnold) should also be considered promising. Medium-depth and deep brown soils should primarily be used for the regeneration of beech (*Fagus orientalis* Lipsky). In this belt, sweet chestnut (*Castanea sativa* Mill.) should be considered one of the important accompanying species. Other accompanying species include oriental spruce (*Picea orientalis* L. Link.), Caucasian fir (*Abies nordmanniana* (Steven) Spach), Caucasian linden (*Tilia dasystyla* Supr.

caucasica (V. Engl.) Pigott), common ash (*Fraxinus excelsior* L.), Norway maple (*Acer platanoides* L.), sycamore maple (*Acer pseudoplatanus* L.), elm (*Ulmus scabra* Mill.), European white elm (*Ulmus glabra* Huds.), and others. Western Georgian spruce-fir forests are distributed within the range of 1500-1800 meters above sea level. For artificial forest regeneration on thin soils of this zone, Caucasian pine (*Pinus sylvestris* L.) should be considered the most acceptable species, and Austrian pine (*Pinus nigra* J.F. Arnold) may also be used. On forest brown soils of medium depth and deep soils, priority should be given to spruce (*Picea orientalis* L.) and fir (*Abies nordmanniana* (Steven) Spach). Among accompanying species acceptable for this zone are oriental beech (*Fagus orientalis* Lipsky), sycamore maple (*Acer pseudoplatanus* L.), Norway maple (*Acer platanoides* L.), and others. The subalpine sparse forests of Western Georgia are located at altitudes of 1800-2000-2200 meters a.s.l. In many places, this zone is represented by beech (*Fagus orientalis* Lipsky) subalpine sparse and stunted trees mixed with Medvedev's birch (*Betula Medvedvii* Regel) and goat willow (*Salix caprea* L.), among others. For artificial forest regeneration in this zone, both beech (*Fagus orientalis* Lipsky), spruce (*Picea orientalis* L.), fir (*Abies nordmanniana* (Steven) Spach), as well as Medvedev's birch, high-mountain maple (*Acer Trautvetteri* (Medv)), Litvinov's birch (*Betula Litvinovii* A. Doluch.), goat willow (*Salix caprea* L.), Caucasian rowan (*Sorbus aucuparia* subsp. *aucuparia*), and others should be widely used.

მეტყვეობა

დასავლეთ საქართველოს ბუნებრივი ზონების ნიადაგები და მათი აგროსაწარმოო გამოყენება ტყის კულტურებით ათვისების მიზნით

ვ. პაპუნიძე^{*,**}, მ. მეტრეველი^{**}, შ. ლომინაძე^{**}, დ. ჯაში^{**}, ნ. ასანიძე^{**},
ნ. ნაკაშიძე^{**}, ლ. გორგილაძე^{**}, ი. გაფრინდაშვილი^{**}

^{*} აკადემიის წევრი, საქართველოს მეცნიერებათა ეროვნული აკადემია, აჭარის რეგიონული სამეცნიერო ცენტრი, საქართველო

^{**} ბათუმის შოთა რუსთაველის სახელმწიფო უნივერსიტეტი, საქართველო

ტყის კულტურების განვითარებისა და პერსპექტივების დამუშავებისას, პირველ რიგში, საჭიროა მოცემული ნიადაგების დეტალური შესწავლა-გაანალიზება ადგილმდებარეობის შესაბამისი მცენარეების შერჩევის მიზნით. ნაშრომში განხილულია დასავლეთ საქართველოს: აჭარა-გურიის და სამეგრელო-აფხაზეთის რეგიონების აგროსაწარმოო ზონების ნიადაგების ფიზიკურ-მექანიკური თვისებები და ქიმიური შემადგენლობა, გრუნტის წყლების დონის მდგომარეობა და სხვა აქტუალური საკითხები; წარმოდგენილია მოცემული პირობებისთვის გამოსადეგი, სწრაფმზარდი, მაღალპროდუქტიული მერქნიანი ხე-მცენარეების ნაირსახეობა (ძირითადად ინტროდუცირებული ეგზოტების) სამრეწველო დანიშნულების პლანტაციების შექმნისა და მათი განუახლებელი, დაბალი სიხშირის ტყის ფართობების აღდგენა-განახლებისათვის.

REFERENCES

- Ambokadze, V. A. (1938). *Mountain-Forest Soils of Ateni Gorge*. Tbilisi: Sabchota Sakartvelo.
- Daraselia M. K. (1949). *Red soils and podzolic soils and their use for subtropical crops*. Tbilisi: Publishing House of VNIChSK. Typography of the newspaper "Leninskoye znamya".
- Gedevanishvili, D. P., Talakhadze G. R. (1961). *Soil Science*. Tbilisi: "Kheltnatseri".
- Gulisashvili, V. Z. (1935). Physical properties of forest soils and their changes under the influence of forestry measures. 5-20. Goslestezhizdat.
- Kachinsky, N. A. (1958). Mechanical and microorganic composition of soils, methods of its study. Publishing House of the USSR Academy of Sciences.
- Khidasheli, Sh. A., Papunidze, V. R. (1976). *Forests in Adjara*. Batumi: Publishing House Sabchota Adjara
- Mindeli, K. V., Guntaishvili, L. N., *et al.* (2011). *Practical-Laboratory Manual of Soil Science*, Tbilisi.
- Papunidze, V. R. (2012). Georgia-Turkey transboundary ecological problems. Adjara Regional Scientific Center of the Georgian National Academy of Sciences. 18-31. Batumi.
- Protopopov, V.V. (1980). Methodological guidance on the biogeocenotic approach in studying the environment-forming role of the forest. Nauka, 3-14.
- Urushadze, T.T., Bajelidze, A. Sh., Lominadze, Sh. D. (2018). *Soil Science*. Batumi: BSU Publishing House.

Received June, 2025