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AGRICULTURAL TECHNOLOGY OF GROWING DECIDUOUS SEEDLINGS FOR REFORESTATION PURPOSES

A large variety of soil conditions in the forest fund of the Republic of Belarus requires reforestation by various tree species, of which a significant role is played by deciduous species. Growing seedlings of deciduous species requires strict observance of all agricultural activities (preparation of soil, eradication of weeds, pests control, crown care, application of mineral and organic fertilizers, etc.). The paper dwells upon the study of technology and the growth of deciduous seedlings grown in close-planting forest nurseries of forest enterprises of the Republic of Belarus.

Introduction. Today forest regeneration has several important tasks such as biological diversity conservation, forest gene resources conservation, increasing area of broadleaved forests (ash, linden and maple forests) and creation of forests stands of mixed species composition. In the recent years mixed forest plantations with deciduous species have made up about 60% from their total planted area. Using large planting materials, i.e. seedlings is a very promising technique of forest planting. The most common deciduous seedlings used for forest planting are seedlings of common ash, small-leaved linden and Norway maple. The most advisable seedlings are those of biological age of 3–4 years grown according to pattern 1 + 2, 1 + 3, 2 + 2, i.e. 1–2-year seedlings are transplanted to a nursery where they are grown for 2–3 years. To obtain such planting materials there are close plantings of the first order in the forest nurseries. The seedlings are transplanted to a nursery not only by pattern 1.0×0.5 m but also by patterns 0.8×0.4 m, 0.8×0.8 m, 1.0×1.0 m. The pattern depends on the growth rate, light demand and growing time of seedling in the nursery. The planting patterns are also selected with regard to mechanized outplanting of trees.

Main part. Study of agricultural technology of growing planting material of deciduous species was done in production nurseries of Logoisk, Smolevichi, Ostrovets forestry enterprises and basic nursery of Negoreloye forestry experimental station. The study analyzed applied systems of soil cultivation, systems of fertilizer introduction and weed control with identification of biometric characteristics of seedlings.

Soil cultivation is of vital importance to the complex of agricultural practices that enable high output of standard planting material and have considerable effect on growth and development of woody plants. Cultivation improves physicco-chemical properties of soil, creates conditions for accumulating and preservation of moisture, air and warmth which in their turn activate microbiological processes in soil, assist decomposition of organic substances and storing-up of available forms of nitrogen, phosphorus, potassium and other elements, promote growth of root systems of seedlings [1].

The most acceptable system of soil cultivation in forest nurseries is treatment by green-manured fallow. Such system is to be more widely applied in nurseries. Green-manured fallow is of special importance in poor sandy soils of nurseries that lack sufficient organic fertilization.

Pre-planting soil cultivation is governed by the time of organic fertilizers introduction and their placement. As a rule organic fertilizers are applied at fall-plowing. In soils of light granulometric composition early-spring cultivation is done by dragging, in cohesive sandy clays and light loams soil is cultivated by spring-tine cultivators at a depth of 5–7 cm. The optimum soil density for planting deciduous seedlings is 1.2–1.3 g/cm^3. In soils of harder granulometric composition chisel cultivation at a depth of 16–18 cm is applied instead of spring cultivation. Such cultivation makes it possible to loosen not only the upper but also the lower ploughed horizon. Due to chisel cultivation the plough pan is destroyed thus preventing water erosion. At the same time necessary moisture is stored up and favourable conditions for root system development are created.

The best time for planting deciduous seedlings in nurseries is springtime; however autumn planting also gives good results. It is prohibited to plant seedlings in leaf during spring as it can lead to leaves drying. It can be explained by the fact that the aboveground part calls for heavy water evaporation whereas the root system has not established yet. The root regeneration takes some time, so water balance in a seedling is disturbed during this period, evaporation exceed water income thus causing the seedling to die. This process can be stopped by decreasing transpiration surface (removing leaves at autumn planting or cutting off vegetative aboveground part at spring planting). Planting depth is of considerable importance to transplanting. Our investigations have showed that one-year seedlings sur-

vive to 95–98% when their root collars are planted 5–6 cm deeper than the soil level.

To foster the growth during the vegetation period, seedlings are fed up with mineral fertilizers. Young trees are primarily fed up with nitrogen fertilizers (1–3 fertilizations in the first half of vegetation). To promote root system development and higher resistance to low temperatures, it is advisable to feed up seedlings with phosphorus-potassium fertilizers in the second half of vegetation. In addition, it should be taken into account that phosphorus fertilizers are poorly soluble chemical compounds and require embedding into plough layer by a cultivator. This not being the case, they are left on the soil surface and do not contact with the roots of vegetating plants. The rates of mineral fertilization depend on the presence of necessary mineral elements in the plough layer, on granulometric soil composition as well as on the species and the age of seedlings [2].

The first fertilization of seedlings is done early – immediately after snow melting (usually in mid-April). The second fertilization is done after 20–30 days upon the first one. In these cases dry fertilizers are usually applied. Deciduous trees grow most intensively in June which is the best time to introduce mineral fertilizers. The third fertilization is done by phosphorous-potassium fertilizers (so-called "hardening" fertilization) in the second half of summer (late July – early August). Very common is in-root fertilization of seedlings but this is to be combined with root fertilization and to be applied as addition of nutrients during the most intensive growth of young trees. Dilute solutions of fertilizers (0.5–1%) are to be introduced to prevent leaf burn.

Herbicides treatment can be done both in autumn after leaf fall (October) and in spring before unfolding of leaves (April). An essential condition of herbicides application is mineral fertilization that improves seedlings resistance to herbicides. Glyphosate-containing herbicides such as Tornado and Roundup show the best treatment results. The rationing of herbicides depends on the age of seedlings and the species. The rates of herbicides application in forest nurseries are 2–3 l/ha, the working fluid consumption being 300 l/ha.

Agricultural technology of growing seedlings of different species has its specific features. To obtain large seedlings, Norway maple is grown in a nursery for 2–3 years. Table 1 shows characteristics of four-year maple seedlings (1 + 3) grown in the nursery of Negoreloye forestry experimental station and intended to create forest plantations.

As is seen from the data above, the four-year maple seedlings reach an average height of 112 cm. At the same time the variation coefficient is not that large and 'makes up 29.2% that proves the fact that they are approximately of the same height (Fig. 1).

Table 1

Statistical data of four–year Norway maple seedlings (1 + 3)

Parameter	Average value	Average value error	Mean–square deviation	Variation coefficient, %
Height, cm	112.0	4.7	32.8	29.2
Root crown diameter, cm	2.50	0.06	0.44	17.6

The root crown diameter of the seedlings varies from 1.1 to 3.5 cm and averages 2.5 cm.

Fig. 1. Norway maple seedlings in a close-planting nursery of Negoreloye forestry experimental station

To obtain seedlings, 1–2 year young plants of small-leaved linden are transplanted to a nursery where they are grown for 2–3 years (Fig. 2).

Fig. 2. Close-planting of small-leaved linden in a foest nursery of Smolevichi forestry enterprise

As small-leaved linden is very demanding to soil fertility, areas with a well-developed humus layer should be selected to grow seedlings. To prevent bushiness of the seedlings regular care of clear stems should be taken starting from the first year of growing. Such care should include removing of side shoots and formation of a dense crown. If central shoot is notably distorted, it should be cut at the distortion point above the bud, in this way assisting further formation of an upfront stem.

Common ash is a valuable wood species and is widely used in forestry and landscaping due to its rapid growth, well-shaped stem and laced crown. Transplanting of ash seedlings to nurseries contributes to the development of a more branchy root system. At the same time seedlings develop a larger amount of both fibrous and skeleton roots, thus reducing the path of nutrients from the roots to the crown and backwards. Seedlings with a dense root system are easier to dig up for further transplanting, besides the seedlings retain more roots and better survive afterwards.

Usually ash seedlings are grown in a nursery until they reach the age of 4–6 years, large seedlings of 7–10 years are used for alley plantations (Fig. 3).

Fig. 3. Close-planting of common ash in a forest nursery of Logoisk forestry enterprise

The roots of young plants and seedlings are to be treated with Karponsil or clay magma with Heteroauxin immediately after digging-up. The planting of seedlings in nurseries is recommended to be done by planting machines. The seedling are to be watered after nursery planting.

Care of ash seedlings consists in regular eradication, cultivation, watering in dry seasons, fertilization, forest pests and disease control. When planting them in autumn in heavy-textured soils, bunching is usual to prevent squeezing of trees. A special measure of seedlings care is cutting away of roots in the second year of growing.

Table 2 summarizes main growth parameters of maple, linden and ash seedlings in close-planting forest nurseries of Logoisk, Smolevichi and Ostrovets forestry enterprises.

In Logoisk forestry enterprise four-year seedlings of common ash have the average height of 115 cm, root crown diameter of 2.2 cm, last year's average height increment of 51 cm. Individual ash seedlings reach the height of 164 cm. Five-year Norway maple seedlings have the average height of 160 cm, however, some seedlings have the height of 220 cm and the average annual height increment is 54 cm. Five-year seedlings of small-leaved linden demonstrate somewhat smaller growth parameters as compared to Norway maple. So, their average height is 130 cm and last year's increment is 45 cm. At the same time linden seedlings are superior to other wood species by root crown diameter which averages 2.5 cm.

Biological age of seedlings in close-planting nurseries of Smolevichi forestry enterprise is 4-5 years. The close-planting nurseries use the planting pattern 0.8–1.0×0.4–0.5 m. The results of biometric study reveal that five-year ash seedlings reach the average height of 183 cm and have the average root crown diameter of 2.3 cm. Four-year maple seedlings have the average height of 130 cm and the root crown diameter of 2.1 cm. The average height of four-year linden seedlings is 115 cm, their root crown diameter being 2.1 cm. The average height increment of all seedlings ranges from 42 to 56 cm.

Table 2

Characteristics of seedlings in forest nurseries schools closed drills

Species	Planting pattern	Age, years	Increment, cm	Height, cm			Diameter, cm		
				average	maximum	minimum	average	maximum	minimum
Logoisk forestry enterprise									
Ash	0.8×0.4	4	51	115	164	70	2.2	2.6	1.8
Maple	0.6×0.5	5	54	160	220	130	2.3	2.6	1.7
Linden	0.8×0.4	5	45	130	165	90	2.5	3.0	1.9
Smolevichi forestry enterprise									
Ash	1.0×0.5	5	56	183	220	110	2.3	3.6	1.4
Maple	0.8×0.4	4	49	130	205	54	2.1	3.9	1.0
Linden	1.0×0.4	4	42	115	175	60	2.1	3.0	1.4
Ostrovets forestry enterprise									
Linden	0.8×0.4	3	29	52	69	41	1.2	1.5	0.8
Maple	0.8×0.4	3	32	56	74	39	1.1	1.5	0.6

In Ostrovets forestry enterprise three-year seedlings of linden and maple in a close-planting nursery are grown according to the pattern 1 + 2. Two years after nursery planting, the average height of maple seedlings is 56 cm, that of linden is 52 cm, their average height increment over the last year being 32 and 29 cm respectively.

Conclusion. Generally the analysis of biometric parameters shows that provided the right agricultural technology is applied, seedlings of ash, maple and linden grown in close-planting nurseries by patterns 1 + 3 or 1 + 4 demonstrate high growth parameters which are superior to the standard ones [3]. Seedlings of the above species have well-developed assimilation apparatus and root system, straight stems thus meeting the requirements of the first commercial grade. The use of such planting material for reforestation purposes will make it possible to reduce costs of forest cultivation due to decreased labour consumption and processes of creating and growing forest plantations.

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