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PLANTING STOCK CULTIVATION IN COMBINED SCHOOLS OF FOREST NURSERIES

Various methods of initiation and cultivation agrotechnology of the planting stock were studied in the combined schools and combined school-sowing departments of forest nurseries. Differences in biometric indices of saplings and seedlings of different wood species aspects were detected. The comparative analysis of the planting stock growth indices was carried out at cultivation in an open ground and in school-sowing department of forest nursery.

Introduction. For qualitative and timely renewal of the republic wood resources it is necessary to have enough planting stock with good hereditary properties. It is impossible to receive it in the required amount without foundation of highly technological forest nurseries in the republic forestry enterprises. According to "The development program of forest nurseries in the organizations of the forestry ministry of the Republic of Belarus for 2010–2015" [1], it is appropriate to concentrate the forest planting stock cultivation in permanent forest nurseries with complete mechanization of all agrotechnical activity (cultivation of soil, crop rotations, weed and pest control of seedlings and saplings, taking care, mineral and organic fertilizers application, etc.).

Agrotechnology of the planting stock cultivation should be based on profound knowledge of formation regularities of plants vegetative organs accretion during the season, of accumulation dynamics of dry matter and consumption rhythm of mineral nutrition elements, their need for basic elements of mineral nutrition, and also of the necessary doses and terms of application of the used fertilizers.

Greater attention is paid to usage of large planting stock at forest plantations production, belt forest creation, settlements landscape gardening; it requires more thorough and technological approach to initiation of nursery school departments [2].

Especially it is topical for the combined schools intended for joint cultivation of saplings of trees and bushes. Usage of fertilizers application system, of chemical plants protectors, of complex mechanization at all stages from school creation to planting stock digging out permits to receive a bigger amount of qualitative saplings in short terms.

Main part. The planting stock cultivation technology in the combined schools includes different operations, beginning with soil cultivation in the system of crop rotation and finishing with its digging out and storage. Studies of different technological operations, methods of initiation, sowing layouts of combined schools and influence of cultivation agrotechnology on the planting stock qualitative indicators were conducted in the forest nurseries of Logoisk, Smolevichy, Ivatsevichy, Novogrudok forestry enterprises and of Negoreloe teaching-experimental forestry enterprise. Application of the combined method when saplings of wood species and shrubs are grown simultaneously in schools, permits to use the given nurseries area more effectively. Thus, 2–3 rotations of shrubs saplings take place during one rotation of trees saplings. Saplings cultivation of wood species with different growth speed, and also the planting stock of one wood species with different cultivation terms are also practiced. In row-spacings of combined schools the seedlings of wood species and shrubs are grown. To this purpose the combined schools are converted into school-sowing departments.

Combined schools have several ecologic and economic advantages. Combined layout of saplings permits to use soil fertility in the maximum extent and to increase the planting stock cultivation profitability.

The statistical analysis of the research received results was done according to conventional procedures [3] with the help of statistical package Statistica 6.0.

Several plants layouts are developed in combined schools. Most often they use mixing layouts in forestry enterprises, where placing of wood spices between rows are 2.4; 3.2; 4.0 m, and in a row are 0.5–0.8 m; for shrubs it is 0.6–0.8×0.25–0.50 m (depending on the growth speed, cultivation term, applied mechanisms). Cultivation term of trees is 6–8 years; of shrubs is 2–3 years. There are other variants of trees placing between rows – 2.2 m [4, 5] which are used less often.

Now the most often used planting layout is the one at which three rows of shrubs are between two rows of wood species. Placing for wood species are 3.2×0.5–0.8 m; for shrubs – 0.8×0.25–0.80 m [5].

An example of the combined planting in school can be planting of two-year-old maple seedlings which are planted according to the layout of 2.4×0.8 m, with the subsequent planting of a two-row line of barberry in row-spacings with a planting space of 0.6 m (Fig. 1).

Fig. 1. Combined school of common maple and Tunberg barberry in the nursery SFI "Logoisk forestry enterprise"

Cultivation term of maple in a school is 4 years, of a barberry – 2 years. In two years after planting the barberry saplings are dug out, the soil is disked and new barberry seedlings are planted according to the same layout. Maple as a species with a long period of cultivation continues its growth in rows. Two years later the scrubs and trees are dug out, and the plot left vacant remains fallow. Biometric indices of saplings are given in Table 1.

In this case in the combined school there are several maple rows which are planted in connivent rows with the planting layout of 0.8×0.8 m, they alternate with several barberry rows with placing of 0.6×0.6 m.

As it is clear from the given data, with such placing mode of wood species the biometric indices of maple and barberry are rather high.

The planting stock has good growth indicators in the forest nursery of Logoisk forestry enterprise with wood species placing in the combined school according to the layout of 2.4×1.0 m and shrub placing of 0.7×0.5 m (Tab. 2).

Taking care of the plants planted in school consists in soil loosening, weeding, watering, additional fertilization and pest and diseases control of plants.

Soil loosening is done 7–12 cm deep by cultivators "Egedal".

Amount of taking care depends on the forest growth conditions of the nursery and makes 4–5 times during the first year of cultivation, 3–4 – during the second year and 2–3 – during the subsequent years.

If needed watering is done 2–3 times during the vegetation period depending on weather conditions of the year of cultivation. The norm of simultaneous watering is 300–600 m^3/hectare.

Dry root additional fertilizing is normally done simultaneously with soil cultivation and fertilizers covering on depth not less than 15 cm with obligatory subsequent watering.

Stem and head of deciduous species saplings with a long cultivation period are formed. Pruning and head shaping ensure formation of a strong tree skeleton and control growing processes. Taking into account the environmental conditions of Belarus, spring is the optimal period of trees pruning before the sap flow beginning (March).

It is possible to do pruning of shrubs, spending winter under snow and beginning vegetation early, closer to winter. Controlling pruning (removal of surculus) is done as required during the vegetation period. When shaping the tree head it is necessary to try to do it symmetric, compact and lacy.

Table 1

Saplings characteristics in the combined school of forest nursery of Logoisk forestry enterprise

Species	Layout	Age, years	Height, m			Diameter, cm		
			Average	Maximum	Minimum	Average	Maximum	Minimum
Common maple	Two-row planting with layout of 0.8×0.8 m in rows and distance of 2.4 m between maple coulisses	6	2.20	2.80	1.30	3.0	3.6	2.4
Tunberg barberry	0.6×0.6 m between maple coulisses	3	0.65	0.85	0.40	1.5	1.8	1.0

Table 2

Saplings characteristics in the combined school of forest nursery of Logoisk forestry enterprise

Species	Layout	Age, years	Height, m			Diameter, cm		
			average	maximum	minimum	average	maximum	minimum
Tillet	One-row planting with layout of 2.4×1.0 m	5	1.9	2.6	1.2	3.1	4.5	2.0
Syringa	One-row planting in row-spacing with layout of 0.7×0.5 m	3	1.1	1.7	0.7	0.6	1.0	0.4

Stem height is very important for the tree life. Stocky trees with short stems suffer less from low temperatures. Trees heads depending on the species have different amount of lateral branches and their position. The tree head shape depends greatly on presence or absence of the central main sprout which is well visible only on 5–7-year-old trees.

Doing first forming pruning of saplings it is necessary to shorten them on 20–25 cm (5–6 buds) above the stem to obtain ramifications in this area. It is necessary to select only those branches as skeletal the angles of which make not less than 40º and not more than 80º (45–65º is optimal). It is necessary to monitor the development of future skeletal branches and to equal them, to ensure submission to the main one.

In wide row-spacings of combined schools it is possible to grow not only small saplings, but also seedlings of wood species and shrubs. To this purpose combined schools are converted into school-sowing departments. Rows of saplings in combined school-sowing departments are placed every 4.5; 6.0; 7.5; 9.0 m. In wide row-spacings seeds of wood plants are sown in three-, five-line bands, 150 cm wide according to the layout: 20(25)-20(25)-20(25)-20(25)-70(50) cm.

Advantage of the combined cultivation of seedlings and saplings consists in the fact that seedlings with partial covering with shade and softened microclimate grow better. Saplings planting in rows facilitates the uniform snow distribution on the territory of school department, protects the soil from water and wind erosion.

Agrotechnical activity at seedlings cultivation, promotes formation of compact root system of perennial wood plants and that facilitates their digging out and transportation. Types of taking care and shaping of heads and stems are analogous to the previous schools.

Researches in school-sowing department of nursery of Negoreloe teaching-experimental forestry enterprise were conducted to find out the influence of joint cultivation of saplings and seedlings on their biometric and qualitative indicators. Sowings in the open ground of common pine and common spruce were taken as control. Four-line sowings of pine and spruce were done in row-spacings of English oak saplings with width of 3.4 m according to the layout: 120-33-33-33-120 cm.

Microclimate conditions in school-sowing department influenced positively on soil germination ability of pine and spruce seeds. Research results of soil germination ability are given in table 3. Research results show that at combined cultivation the median number of sprouts on 1 running meter of pine line makes 99 pieces, of spruce – 93 pieces, against 83 and 77 pieces in the open ground accordingly.

Soil germination ability of common pine seeds in school-sowing department exceeds the seeds germination ability in then open ground on 19.6 %, and of common spruce – on 20.9 %.

Higher indices of soil germination ability are explained by more favorable microclimatic conditions in school-sowing department.

Results of growth of one-year-old seedlings of common pine and common spruce are given in table 4, and of two-year-old seedlings in Table 5.

Table 3

Soil germinating ability of seeds

Experiment variant name	Maximum amount of sprouts, pieces/r.m.	Minimum amount of sprouts, pieces/r.m.	Average amount of sprouts, pieces/r.m.	υ, %	$t_{0,95}$
Common pine					
School-sowing department	155	56	99 ± 8.6	31.3	2.01
Control (open soil)	134	45	83 ± 8.2	35.8	
Common spruce					
School-sowing department	142	52	93 ± 7.8	30.4	1.79
Control (open soil)	126	41	77 ± 7.7	36.5	

Table 4

Biometric indices of one-year-old seedlings in school-sowing department in conditions of open soil

Index name	Control in open soil		School-sowing department		*t*-criterion
	$M \pm m$	υ, %	$M \pm m$	υ, %	
Common pine					
Height of the part above ground, cm	5.75 ± 0.11	23.4	6.22 ± 0.11	23.8	2.88
Root system length, cm	10.09 ± 0.17	21.2	10.77 ± 0.22	26.8	1.77
Little trunk strength near the root collar, cm	0.69 ± 0.02	8.6	0.78 ± 0.03	9.3	3.26
Common spruce					
Height of the part above ground, cm	5.04 ± 0.13	26.5	5.80 ± 0.15	5.0	3.18
Root system length, cm	6.73 ± 0.29	31.9	7.11 ± 0.30	7.6	1.51
Little trunk strength near the root collar, cm	0.53 ± 0.01	20.7	0.61 ± 0.02	0.6	1.26

Table 5

Biometric indices of two-year-old seedlings in the school-sowing department in conditions of open soil

Cultivation conditions	Root collar diameter, cm		Seedlings height, cm		Height growth, cm	
	$D \pm m$	υ, %	$H \pm m$	υ, %	$h \pm m$	υ, %
Common pine						
In open soil	1.28 ± 0.16	8.3	15.1 ± 0.21	19.3	9.1 ± 0.14	16.3
In school-sowing department	1.40 ± 0.14	7.2	15.9 ± 0.17	17.1	10.0 ± 0.12	15.2
Common spruce						
In open soil	1.14 ± 0.19	10.1	10.8 ± 0.19	17.8	5.2 ± 0.13	14.6
In school-sowing department	1.21 ± 0.17	8.8	11.6 ± 0.21	19.4	6.0 ± 0.15	16.7

It is clear from Table 4 that with equal cultivation agrotechnology the common pine one-year-old seedlings in the school-sowing department have higher biometric indices in comparison with control.

a

b

Fig. 2. Seedlings of coniferous species in school-sowing department: *a* – of common pine; *b* – of common spruce

It is found out with confidence probability of 0,95 that their average height of the over-ground part is 8 % higher, average strength of little trunk near the root collar is 13 % bigger, average length of root system is 7 % longer than the analogous growth indices of seedlings in the open soil.

One-year-old seedlings of common spruce, grown in the school-sowing department, have biometric indices which are higher than in the open soil. It is determined on the significance level of 0.05 that their average height of the over-ground part exceeds control on 15 %. Little trunk average strength near the root collar and root system average length are also a little bigger, however, significant differences between these values are not determined statistically.

Two-year-old seedlings of common pine and common spruce are also characterized by good biometric indices at their combined cultivation with English oak saplings.

As it is clear from Table 5, in the school-sowing department the average height and height growth of two-year-old pine seedlings make accordingly 15.9 and 10.0 cm, of common spruce – 11.6 and 6.0 cm, and that exceeds the analogous seedlings parameters in the open soil. Pine and spruce seedlings in the school-sowing department are presented in Fig. 2.

Conclusion. Combined cultivation method of wood species in schools permits to use soil fertility in the maximum extent and to use effectively the nurseries area. Sowing layouts, where the distance between the wood species rows are 2.4, 3.2, 4.0 m, and in a row is 0.5–0.8 m, are used most often in forestry enterprises; shrubs are placed according to the layout: 0.6–0.8×0.25–0.50 m. Trees cultivation term is 6–8 years, that of shrubs is 2–3 years. It is also possible to grow seedlings of woody plants in row-spacings of combined schools.

To this purpose combined schools are transformed into school-sowing departments where there are favorable microclimatic conditions for seeds germination and seedlings growth.

As compared to the open soil the germinating ability of pine and spruce seeds becomes 16–17 % bigger, the average height of one-year-old seedlings is 8–15 % higher, the root collar diameter is 13–15 % bigger.

Two-year-old seedlings have the average height 5–7 % higher and the root collar diameter 6–9 % bigger than that of the seedlings growing in the open soil.

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