New innovative technologies for obtaining compost using forestry and agriculture waste

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Abstract. The use of organic fertilizers creates optimal conditions for obtaining standard planting material. The technology of obtaining organomineral compost via storing bunker method using sawdust, poultry excreta and waste of mushroom production is presented. It was established that at a 60 -65% humidity of organomineral compost, the degree of its readiness is 3-5 months. The use of agricultural and forestry wastes contributes to their more efficient use in forest nursery production. The rational use of non-traditional organic fertilizers in the form of mushroom waste and sawdust will help reduce the burden on the environmental condition. To grow standard forest species seedlings and increase soil fertility, it is necessary to use both pure organic fertilizers and compost as they contain nutrients in plant-accessible form.

1 Introduction

Intensification of forest nursery farming is ensured by maintaining soil fertility at a sufficiently high level. Currently, some nurseries in Belarus have insufficient levels of humus and fertilizer elements [1,2]. Organic fertilizers are used to increase the content of nutrients in the soil. Optimal conditions are created for obtaining standard planting material with a well-developed root system and above-ground plants' part when applying organic fertilizers [3-5].

In Belarus, timber industry waste in the form of wood sawdust in 2020 amounted to 400 thousand m^3, which is by 2.3 times higher compared to 2015. Annual waste of mushroom production is 18 thousand tons. Existing waste from forest and agricultural production should be used to produce organomineral compost that will contribute to forest nurseries' soil fertility increase and higher output of standard planting material [6]. Optimal ratios development of all ingredients for compost production will provide all nurseries in Belarus with organic fertilizers. This will facilitate the cultivation of its own standard planting material to create forest cultures.

The aim of our work was to develop the optimal ratio of all organomineral compost ingredients for planting material cultivation intensification. To achieve this goal, the following objectives were set:

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- to study the readiness degree of organomineral compost at different ratios of all ingredients;
- to identify the forestry efficiency of using compost in planting material cultivation.

2 Materials and methods of research

The study of organomineral compost readiness was carried out on the basis of two permanent forest nurseries: Korenevskaya experimental forestry base of the Institute of Forest of the National Academy of Sciences of Belarus and Osipovichsky experimental forestry station. Experimental objects for obtaining organomineral compost via storing bunker method were created in these nurseries. Experimental facility in Korenevskaya EFB IF NAS of Belarus was laid with the use of sawdust, poultry excreta and mushroom waste in a ratio of 1:1:1:0,5 and 1:1:0 ,25, in Osipovichsky experimental forestry station — using sawdust, cow manure and peat in a ratio of 1:1:1:0,5 and 1:1:1:0 ,25.

The finished compost is a homogeneous dark brown crumby mass with 55 -60% moisture and a ratio of C:N as 25 to 1 [7]. By the experimental options at the end of the growing season the height of the above-ground seedlings' part and the diameter of the root neck were determined. The output of standard seedlings was determined in accordance with the available regulatory documents [8,9]. The obtained research results were processed mathematically using statistical methods [10].

3 Research results

Wood sawdust in a mixture with poultry excreta and mushroom production waste was used to obtain organomineral compost. During the entire study period, organomineral compost moisture amounted to 60 -70%. Table 1 presents data on the preparedness degree of organomineral compost via storing bunker method.

Table 1. Carbon to nitrogen ratio in obtaining different composts

Compost components		Ratio C:N, month			
		1	3	5	7
1	Sawdust + poultry excreta + mushroom waste (1:1:1:0 ,5)	32.6	24.8	22.6	21.1
2	Sawdust + poultry excreta + mushroom waste (1:1:1:0 ,25)	34.8	25.7	24.4	22.3
3	Sawdust + cow manure + mushroom waste (1:1:1:0 ,5)	35.5	25.0	24.1	22.0
4	Sawdust + cow manure + mushroom waste (1:1:1:0 ,25)	35.1	25.2	22.3	20.6

As can be seen in table 1, the C:N ratio is gradually falling over seven months. At the fifth month, all experimental options reached optimal readiness values of organomineral compost (22.3-24.4).

Reduction of the composts' readiness period to 3 months was achieved on two experimental options (No.1 and No.3). The use of sawdust, cow manure, poultry excreta and mushroom waste as components to produce organomineral compost contributes to more intensive microbiological decomposition of all constituent components.

The most important organomineral compost indicators are their physicochemical properties, as presented in table 2.

Table 2. Indicators of physiochemical properties of organomineral compost

Indicator	Organomineral compost			
Sawdust + poultry excreta + mushroom waste (1:1:0,5)				
Macronutrient composition	organic matter	nitrogen	phosphorus	potassium
Content, %	61.0-63.0	1.5-1.9	1.6-2.3	1.4-1.6
Composition of microelements	manganese	sulphur	zinc	copper
Content, mg/kg	310-340	42.6-44.3	21.2-23.4	3.1-3.3
Sawdust + poultry excreta + mushroom waste (1:1:0,25)				
Macronutrient composition	organic matter	nitrogen	phosphorus	potassium
Content, %	58.4-61.2	1.3-1.5	1.2-1.4	1.1-1.3
Composition of microelements	manganese	sulphur	zinc	copper
Content, mg/kg	280-310	40.4-42.1	19.3-20.7	2.7-3.0
Sawdust + cow manure + mushroom waste (1:1:0,5)				
Macronutrient composition	organic matter	nitrogen	phosphorus	potassium
Content, %	52.1-54.0	1.3-1.6	1.2-2.0	1.2-1.4
Composition of microelements	manganese	sulphur	zinc	copper
Content, mg/kg	285-300	36.4-38.4	18.0-20.0	2.6-2.8
Sawdust + cow manure + mushroom waste (1:1:0,25)				
Macronutrient composition	organic matter	nitrogen	phosphorus	potassium
Content, %	49.3-51.6	1.1-1.3	1.0-1.5	1.0-1.2
Composition of microelements	manganese	sulphur	zinc	copper
Content, mg/kg	260-285	32.1-35.6	16.4-18.5	2.2-2.5

The studies have shown that organomineral compost using sawdust, poultry excreta, waste of mushroom production in ratio 1:1:1:0 ,5 possesses optimum physicochemical properties, since this experimental option showed the greatest content of not only macroelements, but also microelements.

Studies have been carried out on the organomineral composts' influence on biometric indicators and output of standard forest species seedlings (table 3). The height of the above-ground part of Baltic pine seedlings using organomineral compost exceeded the experimental control option by 21%, English oak seedlings - by 29%. Forest seedlings' root neck diameter exceeded the control option by 40% and 20%, respectively.

The main criterion of organomineral composts' influence is the standard seedlings' output from 1 ha. When growing Baltic pine seedlings, the developed organomineral compost contributed to an increased output of standard planting material by 40%, when growing seedlings of English oak- by 50% compared to control.

The obtained studies' results indicate the effective use of developed organomineral fertilizers in the forest species' standard seedlings cultivation

Table 3. Biometric indicators and output of Baltic pine and English oak standard seedlings after the organomineral compost introduction

Options with the compost introduction	Height of the above-ground part, cm	Diameter of root neck, mm	Seedlings output in M/pcs.
Baltic pine seedlings			
Control (without compost introduction)	7.10±0.60	1.50±0.50	2.00±0.70
Sawdust + poultry excreta + mushroom waste (1:1:1:0 ,5)	8.60±0.63	2.10±1.50	2.80±196
English oak seedlings			
Control (without compost introduction)	12.30±0.49	3.00±0.40	0.80±0.30
Sawdust + poultry excreta + mushroom waste (1:1:1:0 ,5)	15.90±1.53	3.60±0.60	1.20±0.40

Mathematical processing of the obtained data showed a reliable difference in height of the above-ground part Baltic pine seedlings ($t_{fact.}$=-9,202) at $t_{tabl.}$= 2.01.

When growing English oak seedlings, a reliable difference between the experimental control version and the organomineral compost introduction was also obtained.

4 Conclusion

The use of organic fertilizers creates optimal conditions for obtaining standard planting material. The technology of obtaining organomineral compost via storing bunker method using sawdust, poultry excreta and waste of mushroom production is presented. It was established that at a 60 -65% humidity of organomineral compost, the degree of its readiness is 3-5 months. The use of agricultural and forestry wastes contributes to their more efficient use in forest nursery production. The rational use of non-traditional organic fertilizers in the form of mushroom waste and sawdust will help reduce the burden on the environmental condition.

To grow standard forest species seedlings and increase soil fertility, it is necessary to use both pure organic fertilizers and compost as they contain nutrients in plant-accessible form.

References

1. V.V. Kopytkov, New composite polymer compositions for forest cultivation in natural climatic conditions of Belarus and Kazakhstan, 509 (2014)
2. V.V. Kopytkov, Composite polymer materials in forestry, 304 (2008)
3. D. Hilszczańska, CXL1V, **4**, 93-97 (2000)
4. Recommendations on cultivation of forest planting material in closed soil conditions, 14 (2014)

5. Z.N. Markina, Fruit growing, seed production, introduction of wood plants, *Proceedings of the X International Scientific Conference*, 52-54 (2007)
6. A.R. Rodin, Forestry, **1**, 28-30 (1997)
7. Peat-perlite substrates. Technical conditions: TC BY 100061961.002-2015, Included in the register of state registration 24.04.2015.
8. TCP TCP/PR-1-2015 Guidance on planting material cultivation of wood and shrub species in forest nurseries of the Republic of Belarus, 55 (2015)
9. NSS, Growing planting material in closed soil conditions, 9 (2017)
10. G.N. Zaitsev, Mathematical statistics in experimental botany, Moscow, 424 (1984)