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PERSPECTIVES OF USING SLUDGE FROM PULP AND PAPER INDUSTRY WASTEWATER AS AMELIORANT

The pulp and paper industry (CBP) uses large amounts of water at all stages of processing fiber raw materials and manufacturing paper and cardboard. During preparatory, basic and auxiliary operations, significant volumes of technological wastewater containing organic substances, cellulose particles, chemical reagents, fillers and other impurities are formed.

During wastewater purification, a wet sludge is formed, which contains both a high proportion of the organic component and inorganic components. The composition and amount of sludge formed depend on the intensity of water use in technological operations, on the degree of purification and internal recirculation of water flows.

In our work, the object of research was the sewage sludge of JSC «Dobrushskaya paper Mill «Hero of Labor». The volume of sludge formation at the enterprise ranges from 13 to 40 tons per day, depending on the workload of production. Part of the resulting waste is burned, the rest is buried. The hazard class of this type of waste is the fourth.

a) after the filter press b) dried and grinded (magnification x200)

Figure 1 – Sludge of wasterwater of JSC «Dobrushskaya paper Mill «Hero of Labor»

The determination of the physico-chemical properties of the sludge at the first stage of the work showed that the sludge has an alkaline reaction of aqueous extraction (pH 8.01), high ash content (27.7%), conforms radiation standards, which makes it potentially suitable for use as a component of ameliorant.

The sludge was dried and grinded under laboratory conditions: humidity after drying was 5.25% (initial humidity – 60%), fine fraction (<0.15 mm) prevails in the crushed sludge. Next, the sludge was mixed with a universal soil containing peat, sand and humic substances in different proportions. The control sample did not contain water waste sludge from the CBP, and ameliorants containing 5, 10, 15, and 20% of the sludge were also prepared.

At the next stage of the work, a vegetation experiment was conducted. Both technical crops (rapeseed) as well as ornamental crops (marigolds, zinnia) were selected as test crops. A 14-day experiment was conducted with daily monitoring of germination, assessment of germination energy and morphometric parameters (height, root length, weight, number of leaves).

The results of experimental studies of germination and germinating energy are shown in Tables 1 and 2. For rapeseed, these indicators were estimated on days 7 and 4, for ornamental crops on days 14 and 8.

Table 1 – Germinating energy and germination of technical test-crop (rapeseed)

Test sample	Germinating energy, %	Germination, %
Test	6	54
5%	26	62
10%	20	54
15%	24	70
20%	6	60

Table 2 – Germinating energy and germination of ornamental test-crop

Test sample	Test-crop (marigolds)		Test-crop (zinnia)	
	Germinating energy, %	Germination, %	Germinating energy, %	Germination, %
Test	13,3	60	6,6	6,6
5%	13,3	40	20,0	46,6
10%	20,0	40	13,3	26,6
15%	46,6	66	6,6	6,6

As it follows from Tables 1 and 2, the addition of CBP wastewater sludge to the substrate has a dose-dependent effect on seed germination. Thus, for rapeseed and marigolds, the optimal concentration providing maximum germination (70% and 66%, respectively) and germinating energy is 15%. For zinnia (the most sensitive crop), the minimum concentration studied is 5%.

During the experiment, the morphometric parameters of test cultures were also evaluated both in the control sample (without the addition of wastewater sludge from the CBP) and in other substrates.

Seed germination depends not only on the soil, but also on the quality of the seeds, so conclusions were drawn from a comprehensive assessment of both germination and such indicators as plant height, root length, number of leaves, green mass and mass of the root system.

The results of the research are shown in tables 3-5.

Table 3 – Morphometric parameters of rapeseed

Name of the substrate		Height of plants, cm	Number of leaves, pcs	Length of roots, cm	Green mass, gr	Mass of root system, gr
Test sample		6,21	3	3,47	2	5
The content of wastewater sludge in the substrate of CBP %	5	6,87	3-4	4,21	5	6
	10	7,65	3-4	3,80	4	4
	15	8,75	3-4	3,96	6	5
	20	7,95	3-4	3,81	5	5

Table 4 – Morphometric parameters of marigolds

Name of the substrate		Height of plants, cm	Length of roots, cm	Number of leaves, pcs
Test sample		2,05	2,33	2
The content of wastewater sludge in the substrate of CBP, %	5	2,24	2,45	2-4
	10	2,02	2,4	2-4
	15	2,72	2,90	2-4

Table 5 – Morphometric parameters of zinnia

Name of the substrate		Height of plants, cm	Length of roots, cm	Number of leaves, pcs
Test sample		2,20	1,50	2
The content of wastewater sludge in the substrate of CBP %	5	2,18	2,12	2
	10	2,83	1,46	2-4
	15	1,80	2,10	2-4

An analysis of the morphometric parameters of the test crops showed that the use of CBP wastewater sludge as a component of the ameliorant in most cases improves growth processes:

– for rapeseed (industrial crop), there is a steady positive effect in all parameters (height, root length, green mass) when the sludge content is from 5% to 15%. The maximum biomass is reached at 15%;

– for marigolds are also characterized by a clear positive growth dynamics of the stem and root system is also typical with an increase in the proportion of sludge to 15%;

– for zinnia, the reaction of morphometric parameters varies. The height of plants is maximum at 10%, while the root length is maximum at 5%, which indicates a different sensitivity of physiological processes in a given crop.

A comprehensive assessment of the parameters of the test crops (germinating energy, germination, morphometry) has shown that for each crop it is necessary to select an individual optimal concentration of substrate with a content of wastewater sludge from the CBP.

The economic effect of using wastewater sludge as an ameliorant is based on two main factors:

1. Reduction of burial costs: replacement of paid waste disposal (transportation to landfill, payment for burial) for its use.

2. Income generation from sales: sale of ready-made ameliorant for the needs of landscaping, re-cultivation of quarries, as well as for use in nurseries and agricultural enterprises in the region.

To scale results and reduce risks during industrial implementation, it is recommended:

– to conduct field tests on various types of soils (sod-podzolic, sandy, loamy) using serial technology;

- to study the long-term effect of the ameliorant on the agrochemical properties of the soil (dynamics of humus, pH, content of mobile forms of elements) for 2-3 years;

- to carry out an extended analysis for the content of heavy metals and specific organic pollutants (organochlorine compounds, phenols) in the sludge before launching large-scale production.

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