POSSIBILITIES FOR ORGANIC MATERIAL COMPOSTING FOR THE NEEDS OF MINING SITE RECLAMATON

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ABSTRACT. The pursuit of better reclamation and closure of mines brings about considering technological aspects to improve the restoration of disturbed areas. With the improvement of reclamation technology, there is a need for a larger volume of fertile soil. To accomplish this goal, composting of trees and shrubs that are removed to clear the terrains for mining facilities, is considered a viable alternative. This article treats how composting is done by mixing the vegetative material with organic or artificial fertilisers. The primary purpose of the proposed manner of composting is to prevent the infestation with non-local diseases, parasites, and weeds by using only an organic material from local origin.

Key words: composting, fertiliser, organic material, reclamation, mining sites

ВЪЗМОЖНОСТИ ЗА КОМПОСТИРАНЕ НА ОРГАНИЧЕН МАТЕРИАЛ ЗА НУЖДИТЕ НА РЕКУЛТИВАЦИЯТА НА МИННИ ОБЕКТИ

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РЕЗЮМЕ. Стремежът за по-рационално извършване на мероприятията по рекултивация и закриване на минните обекти води до по-добро осмисляне на подобряването на технологията на възстановяване на нарушените площи. Това създава необходимостта за използването на по-голям обем от хумусен материал за рекултивация. На тази база е разгледана алтернативата за компостиране на дървесни и храстови видове, които се премахват на територията на минния обект с цел разчистване на терените за изграждане на минните съоръжения. Посочен е и начин за компостирането на растителния материал с използването на изкуствен или естествен тор. Основната цел е използваният материал за компостирането да бъде локален с цел превенция на внасянето на болести, паразити и нелокални растителни видове.

Ключови думи: компостиране, тор, органичен материал, рекултивация, минни обекти

Introduction

Before starting any excavating or building activities, the trees and the fertile soil need to be removed at the location. The practice so far is that most mines keep the dirt and sell or pay the government institutions to remove the trees. Often when it's time for reclamation, there is a lack of fertile soil, and the mines end up buying it for a place somewhere else or buying compost from different places (Kayryakov et al., 2020). By importing soil or compost from other sites, we risk introducing new parasites, weeds, and diseases that do not exist at the reclamation location. Another drawback with importing soil is that the dirt needs to be excavated from somewhere else and delivered to the site, indirectly destroying other places that will need reclamation soon.

The soil deficiency problem during reclamation can be solved from the beginning by saving the trees and other growths and place them for decomposition. This practice will ensure the availability of the much-needed compost, which will be local and safer.

With only tree decomposition, there will be a lot of carbon and little nitrogen. The best way to find the much-needed N for getting better quality compost is to work with the local farmers. A lot of N-rich materials are obtained from farming. Some of them are mentioned in Table 1, where the ratio C:N can also be seen.

Table 1. *Carbon to nitrogen ratios in various materials.*

Organic material	C:N
Manure from pig farms	5 to 7:1
Poultry manure (with litter)	13 to 18:1
Wastes from vegetables	12 to 20:1
Manure from cow farms	20:1
Corn stalks	60:1
Straw	40 to 100:1
Wood chips, sawdust	200 to 500:1
Wood	700:1

Decomposition and decay of trees

What is decomposition?

Decomposition is the first stage that organisms use to grow and build their structure.

Decomposing is a process in which the tree breaks into a more straightforward organic form. The kind that carries out the decomposition is called detrivores. The detrivores are also known as a detrivore community, which function in tandem, and different species are responsible for specific decomposing parts of the process (Packham et al., 1992).

Compost forming

Composting is natural decomposition under monitored and controlled conditions. Organic materials are transformed to compost by a chain of organisms (Figure 1):

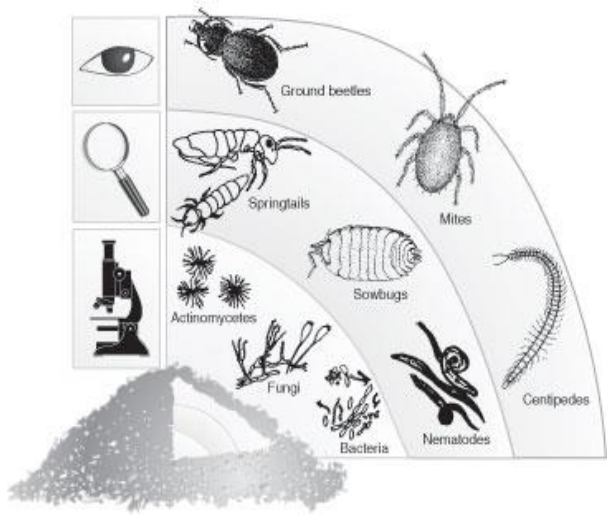

Fig. 1. A succession of organisms decomposing organic matter in compost

In the first stages, the bacteria population grows rapidly. In the further stages, actinomycetes, fungi, and protozoans take over. Then, when most of the Carbon has been used, and the pile's temperature is lower, earthworms, millipedes, sowbugs, and centipedes continue with the decomposition (Dickinson et al., 1991).

The body heat from the micro-organisms causes the temperature of the stack to rise dramatically. A heap properly made should reach a 43 to 60 degrees C temperature in the centre within four to five days. In this period, the stack begins "settling", which signifies that the stack is working correctly. At first, the pH of the pile will become acidic, approximately 4.0 to 5.5. When the process is finished, the pH should rise again to about 7.0 to 7.2.

In the areas where the most intense temperatures develop, the heating destroys a portion of the weed, seeds, and disease organisms. Part of the weed, seeds, or disease organisms may survive in colder sections toward the outer sides of the pile. Turning is essential so that all the material gets heated.

Nitrogen is needed for the organisms that break down the organic material. Adding nitrogen (in the form of a fertiliser) or other materials that supply nitrogen is essential for quality composition. The added nitrogen is released when the decomposition is finished, and the compost is used in the garden (Starbuck, 2010).

Timber decomposition. The breaking down of woody material is longer than that of the herbaceous plants (as they have no woody stem) because of the significant difference in the constituent tissues. The first role of decomposing goes to fungi. The fungi fungal hyphae, which grow inside the timber, give access to the bacteria and beetle larvae. Cellulose and lignin are what fungi feed on, consequently converting them into their softer tissues. Then, they start to decompose when the fungal fruiting body dies. Many species of slime mold grow inside dead logs and play a role in decomposition. Like fungi, they are visible only when ready to reproduce and their fruiting bodies appear. Once the fungi have penetrated the wood, it becomes vulnerable to moisture and water can access it more easily. After the log gets wet, the phase decomposition becomes easier. Woodlice and millipedes start a feed on the wood. The timber becomes wet and rotten and falls apart faster. Earthworms and springtails take over after the log has been assimilated into the soil. If the log is from a pine tree, it can take longer to decompose because of the high resin content (Starbuck, 2010).

Composting. The length of time necessary for the process of composting to occur depends on several circumstances:

- Surface area of particles
- Carbon to nitrogen ratio
- Moisture of the material
- Aeration of the pile
- Pile temperature

Carbon-to-nitrogen ratios:

The main components of organic materials are carbon and nitrogen. Carbon, which is the source of strength for the cell walls, is a significant component of cellulose and lignin. Nitrogen can be found in cells proteins and many other compounds. Inside the plant cells, nitrogen is found as part in the proteins. The carbon-to-nitrogen ratio shows the amount of these elements that the material contains. Usually, the balance is based on the percent of nitrogen and carbon in the material measured in dry weight. The balance between them can be achieved by controlling the mix of ingredients included in the compost, or by adding nitrogen-rich organic materials or fertilisers.

Table 1 above shows the carbon to nitrogen ratios for some materials. The items with the highest nitrogen content are at the top of the list, and at the bottom are with the lowest.

The ratios represent relative weights. So, in the example, five to seven pounds (or about 3.5 kg) of pig manure would have about 1 pound (or 0.5 kg) of nitrogen, and 500 pounds (or about 250 kg) of sawdust would have maybe 1 pound of nitrogen.

The most desirable ratio of C:N in compost is 30:1. In this combination, there is enough carbon for energy and nitrogen for protein synthesis.

Different densities of the tree population and types of forest

For determining the density of the trees for an area, we are going to use the following equation:

$$N_{tr} = \frac{S_a}{a * b} \quad (1)$$

where:

N_{tr} is the number of trees;

S_a – the area from which we want to remove the trees, m^2;

a – the distance between the trees in a row, m;

b – the distance between the rows of trees, m.

After determining the tree population in the area, it is also necessary to determine the parameters of the tree in terms of the height and diameter of the tree trunk. This information is needed to determine the trees worth selling and what will be the leftover for composting.

Most of the time, the flora of one area is composed of all kinds of trees, tall, short, thick, and bushy. That is why it is necessary to sort out them into 4 groups:

• *Dense forest* (a≈6m, b≈6m). *With a majority of tall and tick trees* that are good for wood material. As was mentioned earlier on, *a* is the tree to tree distance, [m]; *b* is the width between tree rows, [m]. Such type of forest is given in Fig. 2 below:

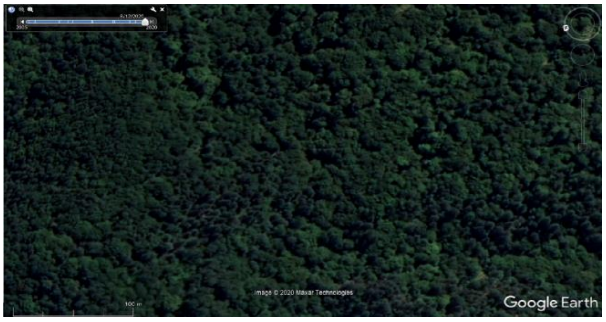

Fig. 2. Dense forest with a majority of tall and thick trees

• *Dense forest* (a≈6m, b≈6m). *With the absence of tall and thick wood* (as the one in Fig. 3 below):

Fig. 3. Dense forest with not much tall and thick forest

• *Forest with bushes and a low population of trees* (as the one in Fig. 4 below):

Fig. 4. Forest with trees and bushes

• *Forest with a rare tree population and majority of bushes* (as the one in Fig. 5 below):

Fig. 5. Land with bushes and rare tree population

The tree trunks that are thicker than 150 mm, flat, tall, and smooth, are worth considering selling for wood material.

Tree pile building and placement

Because mines deal with all kinds of trees, we need to first consider layering the tree logs on the bottom and branches and smaller parts of the trees on the top. The airflow in a pile will be improved, and with that, the decay will be faster, and the compost will have a better quality.

Bottom layer – organic materials

First, we begin with placing a layer of organic matter. Chopped or shredded materials decompose faster, so the coarse organic matter should be shredded before piling. The coarse material should be mixed with materials that tend to stick to one another. After the first layer is built, water should be applied to moisten it but not soaking it.

Next layer fertiliser or manure

After the bottom layer has been built, a nitrogen-rich material should be placed or sprayed over.

Fertiliser can be also added in doses when the pile is rotated. This is needed so that overwhelming of the micro-organisms is avoided. The amount of material needed to accommodate 1 kg nitrogen is shown in table 2 (Starbuck, 2010).

Table 2. *Amount nitrogen sources required to provide 1 kg of Nitrogen*

Nitrogen source	% N	kg for 1 kg N
Ammonium nitrate	33	3.1
Calcium nitrate	15	6.7
Urea	46	2.2
Dry blood	12	8.4

The tree pile can be placed beside the earth dump and mixed with earth, fertiliser, or manure if feasible.

One of the things for procurement of manure is negotiating with the local agricultural association to exchange manure for compost when the compost is ready, or consider buying the manure if the mining company has no surplus compost to give for exchange. In that way, both the mining industry and the agriculture will have something to work on and share the experience.

Conclusion

By saving and decomposing the removed growth, the problem with deficient fertile soil and compost will be limited or eliminated. As mentioned, creating compost from local growth limits the danger of importing dangerous parasites, diseases, and weeds.

By gathering the material rich in nitrogen from the agricultural industry, fertile soil will increase, and it might exceed the need for reclamation. If that happens, the mining company can use it to help the local community grow healthier products and in more significant amounts. Working with the local farmers will also enhance the agricultural and mining industry relationships, contributing to more environmental protective projects and more straightforward problem-solving.

Materials rich in nitrogen can also be gathered by collecting the organic waste from the local inhabitants and depositing it in the decomposing pile. This can be accomplished by building a local organic waste dump where anyone can deposit their organic wastes, from where the material will be transported to the major destination.

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