The 55th International October Conference on Mining and Metallurgy
15 - 17 October 2024, Kladovo, Serbia
https://ioc.irmbor.co.rs

DOI: .5937/IOC24311J Original Scientific Paper-Material Science

SOIL CONDITIONERS AND AMENDMENTS ARE KEY FOR SOIL RESTORATION - TYPES AND METHODS OF PRODUCTION

Vladimir Jovanović[1a], Sonja Milićević[1b], Dejan Todorović[1c], Branislav Ivošević[1d], Dragan Radulović[1e]

[1]Institute for Technology of Nuclear and Other Mineral Raw Materials, Franše D Eperea 86, 11000 Belgrade, Serbia

[1a] v.jovanovic@itnms.ac.rs, https://orcid.org/0000-0001-6069-1630;
[1b] s.milicevic@itnms.ac.rs, https://orcid.org/0000-0001-8929-1673;
[1c] d.todorovic@itnms.ac.rs, https://orcid.org/0000-0002-2776-3388;
[1d] b.ivosevic@itnms.ac.rs, https://orcid.org/ 0000-0001-9445-8159;
[1e] d.radulovic@itnms.ac.rs, https://orcid.org/ 0000-0001-8210-8100

Abstract

Soil amendments and conditioners are indeed crucial for maintaining soil health and fertility, especially in the face of a growing global population. These tools help to create an environment where fertilizers can effectively provide essential nutrients to crops. As soils become increasingly depleted worldwide, it is essential to focus on improving soil health through the use of these amendments and conditioners. This will support the production of nutrient-rich crops and also contribute to sustainable agriculture practices that can feed a growing population. This paper, provide an overview of their purpose, how they function, and how soil conditioners are generally obtained.

Keywords: *soil amendments, fertilizers, soil health, agglomeration*

1. INTRODUCTION

While most discussions about soil health focus on the use and misuse of fertilizers, soil amendments and conditioners are equally important tools in efforts to restore soil fertility and our ability to feed the expected 9 billion people who will inhabit the Earth by 2050. While fertilizers provide the nutrients that plants need to grow crops, soil improvers provide an environment in which fertilizers can be effective. "Soil health" has become an increasingly important topic in recent years as scientists call for action to restore deteriorating soils around the world [1] (soils worldwide have become depleted) and subsequent nutrient-deficient crops that a rapidly growing population demands produce. With increasing awareness of this critical problem, the use of soil conditioners has increased in recent years and continues to grow.

2. DISCUSSION

2.1 How Soil Conditioners Improve Soil

The foundation of healthy soil and its ability to produce crops and withstand weather events and erosion is its physical, chemical, and biological composition [2]. This is where soil conditioners and soil amendments are crucial. The terms soil

conditioner and soil amendment are often used interchangeably, covering a wide range of additive types – all are either organic (derived from something living) or inorganic. Within each category, there are different products available, but generally, they all work to improve the soil in some way. A soil conditioner differs from fertilizers in that the focus is not necessarily on providing nutrients to the soil but on improving the environment within the soil to maximize growth opportunities, although in some cases nutrients may be provided as well. Ultimately, soil conditioners can help restore depleted soils to a revitalized state that will support growth and help conserve this critical resource. The most common objectives for using soil conditioners are outlined below along with common sources for each.

2.2 Increase or decrease in soil pH value

The pH value of the soil is a crucial factor in promoting proper growth. Soil that is too acidic or too alkaline cannot support fruitful production, as the pH value of the soil affects various components within it. When the soil is not within the ideal pH range, plants may experience a lack of nutrients (regardless of how much fertilizer is applied), aluminum toxicity, or other problems that inhibit growth [3].

Soil pH can be adjusted by applying lime or sulfur; lime increases the soil's pH, while sulfur decreases it [4]. Generally, most plants prefer a neutral pH range for their soil, although some plants may prefer more acidic or alkaline soils than others [5].

2.3 Adding organic matter to the soil

Organic matter provides a range of benefits to the soil, promoting a healthier and more productive environment. The advantages that organic matter can offer include: Reduced potential for erosion; Improved soil structure; Enhanced water retention; Increased retention and uptake of nutrients; Increased microbial activity.

Organic matter can be added through various materials, including: Compost; Manure; Earthworm castings; Biochar; Grass clippings; Organic waste; Humus; Other biomass materials.

2.4 Improving the physical structure (soil porosity, drainage, permeability, etc.)

The structure and texture of the soil influence various factors that affect the soil's ability to promote growth. This includes permeability, drainage, porosity, and much more. These factors, in turn, affect the soil's ability to retain nutrients and water, the root's ability to spread through the soil during growth and many other functions.

Gypsum, perlite, and vermiculite are used for aerating the soil. Gypsum is often used to loosen compacted or clay soils to improve air filtration; movement of water and nutrients etc. Various sources of organic matter as well as biochar can also help improve soil structure.

2.5 Supplementing nutrients

In addition to the functions mentioned above, soil additives are also used for supplementing nutrients that are not provided within a fertilization program or as a source of organic fertilizer. This is often seen with calcium on which plants rely for structural strength, enzymatic functions, and other needs.

A wide range of products can be used to supplement nutrients in the soil based on need. This may include: Bone meal - a source of calcium and phosphorus; Blood meal - a source of nitrogen; Feather meal - a source of nitrogen; Gypsum - a source of calcium; Iron (provides iron). It is important to note that the functions of soil additives often overlap, with many serving multiple purposes. Furthermore, the relationship between nutrients, soil structure, environmental factors, and various additives is very complex; a change in one often affects a change in another.

2.6 Production of Soil Additives

Soil additives can be produced as a standalone product or added as a component in another product, such as fertilizer. Although some soil additives are available in powdered and liquid form, most are produced in granular form for easier handling and application, dust reduction, and enabling application with standard equipment.

When produced as granules (pellets), soil additives are manufactured using an agglomeration process by roll growth - a process that involves rolling small particles in the presence of binder (liquid or not) causing agglomeration and formation of granules [6]. This is commonly carried out using a pelletizing drum or disc pelletizer with the possibility of incorporating a pre-conditioning phase in the mixer, as shown in the process diagram below.

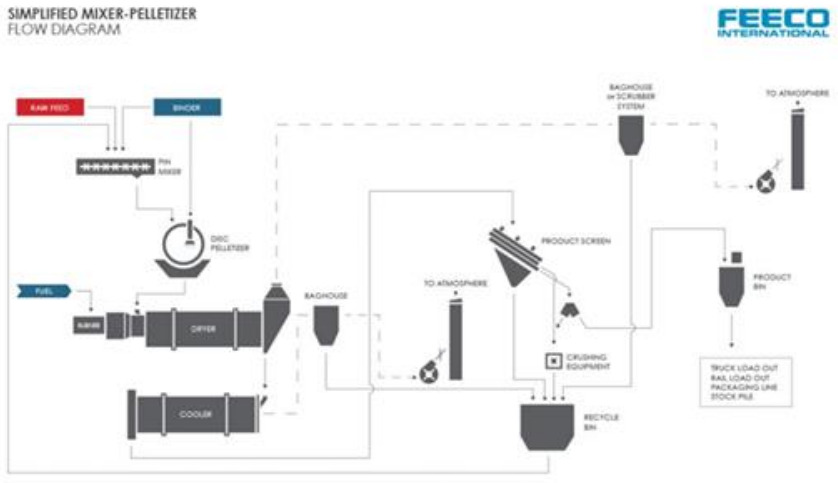

Figure 1. *Typical schematic diagram of a disc pelletizer with pre-conditioning and cooling phase [6]*

The process diagram mentioned refers to the manufacturing process of soil additives in granular form. It involves mixing the necessary ingredients, such as nutrients, binders, and other components, followed by conditioning and agglomeration to form the granules. This production method allows for better handling and application of soil additives.

In some cases, soil additives can be produced using a combination of mixers and dryers, where the binder and raw material are incorporated into a mixer with pins or mixing paddles for a specific retention time (homogenization), resulting in a homogeneous mixture and coarse agglomeration. In all scenarios, a rotary dryer (or fluidized bed dryer) is required to reduce the moisture content in the "green" pellets to their final hardened form.

Numerous parameters are adjusted and finely tuned during the process to achieve the desired set of particle characteristics that the manufacturer desires. This often includes: Solubility/Dispersion; Crushing strength; Attrition/Generation of dust; Moisture content; Particle size distribution; Material flow rate; Ease of handling and application[7].

2.7 Soil additives in fertilizers

Due to the increasing importance of soil additives, there is a growing trend in the fertilizer industry: incorporating additives into fertilizer formulations. Increased understanding of soil health and nutrient management, combined with advances in fertilizer production, has led to a new generation of specialized fertilizer products. Manufacturers are incorporating additives into fertilizer products to meet unique needs specific to certain regions, soil conditions or applications. Soil additives can be incorporated into fertilizers in various ways depending on the production process. In the case of granulation with a pelletizing disc or drum, they can be included as raw materials that are homogeneously mixed with other components to form granules containing all elements in one place.

Alternatively, they can be included as liquid binders. For example, molasses can be used to increase microbial activity. Molasses also frequently serves as a natural liquid binder in agglomeration/pelletization processes to promote pellet formation[8].

3. CONCLUSION

Soil amendments and enhancers work to improve the soil in various ways – from physical structure to pH control – each crucial for revitalizing degraded soils around the world in order to continue supporting a growing population. Without soil amendments, fertilizers cannot fully express their efficiency, making soil amendments crucial in the fight against soil degradation. It is important to understand the complexities involved in producing soil additives due to their multifunctional nature and their impact on various aspects of soil health. Additionally, ensuring that these additives are manufactured with

high quality standards is essential for their effectiveness in improving soil fertility and structure. Furthermore agglomeration treatments can also play a crucial factor for enhancing physical properties through creating stable aggregate structure which would enhance drainage capacity and reduce erosion. The ability to combine fertilizer products and soil amendments into customized, highly efficient soil solutions appears particularly promising, with significant research and development currently underway.

In conclusion, the production of soil additives involves careful consideration of various factors such as formulation, manufacturing processes, and quality control measures to ensure that they effectively contribute to enhancing soil health and crop productivity.

ACKNOWLEDGMENT

This paper is part of the investigation according to the research funding agreement financed by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia in 2024 under the number 451-03-66/2024-03/200023.

REFERENCES

[1] H R von Uexküll, E. Mutert: Global extent, development and economic impact of acid soils, Plant and Soil, Volume 171, Issue 1, 1-15, 1995.

[2] B. C. Nyle: "The Nature and Properties of Soils", 10th edition, p. 232-235, Macmillan Publisher, 2000.

[3] S. Milić, Plodnost zemljišta u privatnom vlasništvu različitih ratarskih proizvodnih rejona Vojvodine, 45. Savetovanje agronoma, Zlatibor, 2001.

[4] D. Vidojević, Izveštaj o stanju zemljišta u Srbiji, Ministarstvo za zaštitu životne sredine i prostorno planiranje, Beograd, 2009.
www.nsseme.com /about /inc /SAS /45SAS/2011-02-04/3%Milic.pdf

[5] Ž. Sekulić, S. Mihailović, V. Kašić, V. Ćosić, Kalcizacija kiselih zemljišta korišćenjem litotamnijskog krečnjaka, Simpozijum: «Prirodne mineralne sirovine i mogućnost njihove uopotrebe u poljoprivrednoj proizvodnji i prehrambenoj industriji, Ed: Savez inženjera i tehničara i Geoinstitut, Beograd, 113-123, 2006.

[6] Granular fertilizer systems.
https://feeco.com/wp- content/uploads/2022/07/Granular-Fertilizer-Equipment-and-Systems.pdf

[7] V. Jovanović: „Izučavanje procesa okrupnjavanja mlevenog krečnjaka radi primene u poljoprivredi“, Doktorska disertacija, (2016), Univarzitet u Beogradu, Rudarsko-geološki fakultet, Beograd

[8] V. Jovanović:”Korelacija uslova peletizacije i kvaliteta peleta flotacijskog koncentrata fluorita”; Magistarska teza, (2000), Univerzitet u Beogradu, Rudarsko-geološki fakultet, Beograd