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Impact of Soil Conditioners on Soil Productivity

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ABSTRACT

Soil conditioners are materials that contain limited amounts of nutrients, but are managed primarily for their beneficial impact on the biological, physical or chemical nature of the soil. They can also be used as a plant growth medium. A good soil stabilizer for such functions will strengthen aggregates against breakdown from the impact of raindrops, and will preserve a high water infiltration capacity. Soil conditioners include organic materials, gypsum, lime, natural deposits, various water-soluble polymers and cross-linked polymers that hold water in soil, living plants, microbes, many industrial waste products and others. Nowadays, there is an overabundance of fertilizers and more focus on the chemical inputs but often, the soil conditioners and soil amendments are ignored. One vital need is to control soil degradation. When considering the role and function of soil conditioners in crop production, it is important to realize that many soil properties may be affected, either favorably or adversely, by the addition of such materials to the soil. Based on the necessity to meet the ever increasing requirement of food grain and other farm products from the inadequate available land area, there is need to deploy wide usage of soil conditioners in addition to conservation methods in farming. This study evaluated the impact of soil conditioners on soil productivity. The paper concluded that soil conditioners are useful as they make soil more functional as an ecosystem and more efficient as support for crops. Nevertheless, it is imperative to be conversant with the land requirement before deploying soil conditioners.

Keywords: Farm, Soil conditioner, Fertilizer, Soil Productivity, Soil degradation

INTRODUCTION

Any process which increases the ability of a soil to enhance crop yields, or which improves the performance of a soil for any function, can be described as soil conditioning, and any product used in soil conditioning is a soil conditioner. The substantial reduction in the production capacity of soils could be attributed to its physical constraints like surface crusting and hardening, subsurface hard pan and compactness, high or slow permeability and extremes of consistence, soil water-related constraints, wind and water erosion, etc. This envisages that for increasing crop production, soil must be maintained in such a physical condition so as to allow adequate crop growth. No doubt, if soils are managed properly for good physical health, the yield potential of different crops can be increased significantly. As a means to increased production, the use of organic and inorganic soil conditioners and additives can be considered to improve agricultural land and increase productivity.

Conceptual clarification

Soil conditioners are defined as any material(s) that contain limited amounts of nutrients, but are managed primarily for their beneficial impact on the biological, physical or chemical nature of the soil. They can also be used as a plant growth medium. Soil conditioning includes the formation and the stabilization of soil aggregates propitious for the germination of seeds and for the emergence of seedlings. A good soil stabilizer for such functions will strengthen aggregates against breakdown from the impact of raindrops, and will preserve a high water infiltration capacity [4]. Soil conditioners include many kinds of organic materials, gypsum, lime, natural deposits, various water-soluble polymers and cross-linked polymers that hold water in soil, living plants,

microbes, many industrial waste products and others. Nowadays, we can see an overabundance of fertilizers and more focus on the chemical inputs but we often ignore the soil conditioners and soil amendments.
Soil needs conditioning for a number of reasons. One vital need is to control soil degradation; another is to improve soil air -water relations, soil drainage and soil aggregation; to reduce soil crusting and compaction, to overcome water repellency and etc. When considering the role and function of soil conditioners in crop production, it is important to realize that many soil properties may be affected, either favorably or adversely, by the addition of such materials to the soil [9]. Some of the soil properties that can be influenced by the addition of materials to the soil include:

i. Water holding capacity
ii. Aeration
iii. Temperature
iv. Nutrient holding capacity and availability
v. Cation exchange capacity (CEC)
vi. Structure and aggregate stability,
vii. Micro-organism population and behavior, (8) organic matter chemistry, and
viii. Animals, including insect and pest.

Significance and Roles of Soil Conditioner

- Soil conditioners improve the physical, chemical and biological properties of the soil.
- In problematic soils such as acidic or alkaline soils it helps in maintaining the soil pH.
- In dry and sandy soils, soil conditioners improve the water retention capacity, infiltration, percolation and permeability of water.
- Soil conditioners create a healthy environment in soil which helps to attracts useful microorganisms and earthworms in soil.
- Soil conditioners improve the physical properties resulting in better soil aeration, water retention, root development and soil ecosystems.
- Soil conditioners can be used to improve poor soils, or to rebuild soils which have been damaged by improper soil management.
- They also add nutrients, enriching the soil and allowing plants to grow healthier, stronger and yield more.
- Soil becomes compressed over time and it has less air space. The use of soil conditioner helps in reducing the soil compaction and hard pan problem.
- It increases the soil fertility and helps to maintain soils in good condition.

Categories of Soil Conditioners

According to [12], the soil conditioners can be classified on the basis of two criteria: (1) origin of the materials, and (2) composition of the materials. With regards to origin, materials may be synthetic or natural occurring. In terms of composition, soil conditioners materials are either organic or inorganic.

Organic Soil Conditioners: Organic conditioners consist of material derived from living things (e.g. plants and animals). They are applied to increase infiltration and soil water retention, promote aggregation, provide substrate for soil biological activity, improve aeration, reduce soil strength, and resist compaction, crusting, and surface sealing. There are a number of organic products that can be used as soil conditioners, but perhaps the most popular one is composts. Organic conditioners also include crop residues, manures, peat, biochar, bone meal, blood meal, coffee grounds, compost tea, coir, sewage sludges, FYM, sawdust lignite, humate and vermiculite [5].

Composts: Compost is produced due to decomposition of organic wastes by microorganisms in the presence of oxygen. Multiple benefits are derived from the use of compost as soil conditioner, for example an increase in organic C content and microbial activity, a source of plant nutrients like N, P K and Mg, and a root reinforcement [2]. An important feature of compost is the capability to influence soil micro flora by suppressing many soil borne pathogens such as Pythium, Phytophthora and Fusarium spp. Thus in general, the use of compost maintains and enhances stability and fertility of the agricultural soil [13].

Farmyard manure (FYM): FYM refers to the bulky organic manure resulting from the naturally decomposed mixture of dung and urine of farm animals along with the litter (bedding material). It is rich sources of nutrients and improves the soil physical, chemical and biological properties through the addition of organic matter [6]. It can be used in all types of problematic soils and crops.

Green Manures: Green manures are the crops that are mainly grown to add nutrients and organic matter to the soil; they are used in rotation with other crops, ploughed and incorporated in soil in order to serve the same purposes as manures. Green manures help to provide the stable soil structure for plant growth and development. It promotes aeration, drainage and aggregation in soil and thereby increases the microbial activity and soil fertility [11].

Sewage Sludge: Sewage sludge or biosolids are organic solids subjected to several treatments to stabilize organic matter in order to reduce unpleasant smell and to not attract pests and spreading disease [7]. As containing nutrients and organic matter, biosolids can be applied to agricultural soils but under regulatory controls that set limits for heavy metals, weeds, human and plant pathogens.

Crop residues: Crop residues are the plant materials left in an agricultural field or orchard after the harvests of crops. These residues include stalks and stubble (stems), leaves and seed pods. Crop residues are an important source of organic matter that can be returned to soil for nutrient recycling and to improve soil physical, chemical and biological properties. Thus crop residues incorporation in soil enhances nutrient cycling, soil and water conservation, and subsequent crop yield [8, 10].

Peat Moss: It is an accumulation of partially decayed vegetation or organic matter. It is found in areas of peat lands, bogs, moors. Peat is formed when plant material does not fully decay in acidic and anaerobic conditions. It helps to improves soil structure by increasing the water holding capacity.

Humates: It is a mined ancient organic soil or products derived from oxidized lignite, an earthy, coal-like substance associated with lignite outcrops. Unlike peat, humates are thoroughly decayed or mineralized, so nutrients are available to plants. It Contains up to 35% humic acids that dissolve other nutrients for plant utilization.

Biochar: Biochar is generally a solid, fine, granular and black charcoal material produced by slow pyrolysis of biomass often sourced from agricultural or forestry industries. Greater surface area, negative surface charge and high charge density of biochar enables greater ability to adsorb cations and to retain and exchange nutrients with soil environment, including microorganisms and plant roots. Biochar stabilizes biomass and native SOM, which enhances soil aeration, improves microbial activity and immobilize N which together reduces the emission of major greenhouse gases viz., CH_4, CO_2 and N_2O.

Inorganic soil conditioners: Inorganic soil conditioners are either mined or byproducts of manufacturing or some are both or man-made. They may be natural occurring or synthetically produced. The inorganic conditioners include the mineral conditioners such as Gypsum, Lime, pyrites, crushed rocks, flyash, sulfur, zeolites, phosphogypsum, etc. While synthetic conditioners include water soluble polymers used to stabilize clay, hydrogel polymers and synthetic binding agents which include anionic and catalytic polymers, non-viable polymers and so on.

Soil conditioning with inorganic soil conditioners implies improvement of the soil physical properties; thus permitting more effective utilization of soil and water resources. Inorganic soluble conditioners undergo physico-chemical reactions with soil constituents, especially the clay fraction. Thus, the application of different soil conditioners (VAMA, Krilium, PVA and Hygromull (a urea formaldehyde soil conditioner) result in improved aggregation, porosity and hydraulic conductivity, decreased bulk density, improved porosity, improved infiltration, permeability and increased soil profile water [3].

Mineral conditioners: This conditioner is used to retrieve problematic soil. Examples include Gypsum, Lime, sulfur, Crushed Rocks, dolomite, etc.

Gypsum: Gypsum is a moderately soluble source of the essential plant nutrients, calcium and sulfur, and can improve overall plant growth. Gypsum has ability to displace exchangeable sodium from the cation exchange sites of soils which are high in sodium. It can be used to reclaim sodic soil [1], saline areas or slick spots, soften, and crumble alkali hard pans. It supply calcium on low exchange capacity soils, and improve infiltration for some puddled soils. It also improves the physical chemical and biological properties of soils [6], thus reducing erosion losses of soils and nutrient concentrations (especially ph osphorus) in surface water runoff.

Lime: Lime is nothing but Calcium containing inorganic minerals, composed primarily of oxides, and hydroxide of calcium, which generally contains 75–95 percent $CaCO_3$. It is used to restore soil pH balance in highly acidic soils. It acts as a source of calcium and works to raise soil pH. Lime is especially applied in overly acidic soil (with pH lower than 6.0) where low soil pH interferes with soils ability to absorb nutrients, including those from fertilizers.

Fly ash: Fly ash is byproduct of thermal power plants. It is used in both soil amendment and plant nutrient sources. Fly ash is helpful in improving crop productivity and soil fertility. It not only helps in improving crop growth and yield in low fertility soils but also mobilizes macro and micronutrients in soil. It is used to produce novel soil condition known as "Biosil".

Other mineral conditioners: Limestone, Dolomite, Crushed rock, Elemental sulfur and other products high in calcium and/or magnesium helps to improve the physical condition of problematic soils, when applied at several tons per acre.

Synthetic binding agents: These are the polymers applied at much lower rates which have been promoted as soil conditioners. The compounds are very high molecular weight, long-chain, polymeric, organic compounds, which bind particles together and form stable aggregates. Organic polymers used for improving aggregate stability, maintaining fertility and reducing seal formation which are mainly polysaccharides (PSD) and polyacrylamides (PAM). The addition of small amounts of these polymers (10–20 kg ha−1), either sprayed directly on to the soil surface or added to the applied water, was noted to be effective in stabilizing and cementing aggregates together at the soil surface, and hence maintaining soil fertility in soils with ESP (>20). It consists of anionic and catalytic polymers, and non-viable polymers.

Cationic polymers: Cationic polymers such as polyvinyl choride, (PVC) polyphenol hydrochloride (PPH) are absorbed by clay through cation exchange and here the calcium act as a bridge between clay and polymers. Cationic polymers have high flocculating power.

Anionic polymers: Anionic polymers consist of hydrolyzed polyacrylontrile (HPAN) and Vinyl acetate-maleic acid (VAMA) copolymers. It is used in preventing crusting of highly sodic soils. The anionpolymers peripheral complexes form linking clay lattice together in an edges to edges arrangement by series of hydrogen bond. They do not have flocculating power but stabilizes the flocculated clays. They are adsorbed on surface of dispersed particles and bind the particles by forming bridge between the particles.

Non Ionic soil conditioners like Polyvinyl alcohol (PVA) which form interemicellar complex with expanding lattice type clay by suppressing swelling and the stability of soil aggregates i.e., caused by lining the pores with the polymers.

Polyacrylamide: polymeric soil conditioners are known since the 1950s, these polymers were developed to improve the physical properties of soil in view to reduce surface sealing, increase seedling emergence; reduce runoff and erosion, fertilizer and pesticides losses. It is a synthetic binding agent which can be used in investigating physical quality of coarse textured soil which is often poor due to high % of macrospores.

Other Soil Conditioners: This category of soil conditioners includes industrial waste, enzyme, microorganisms and activators.

CONCLUSION/RECOMMENDATION

Based on the necessity to meet the ever increasing requirement of food grain and other farm products from the inadequate available land area, there is need to deploy wide usage of soil conditioners in addition to conservation methods in farming. Soil conditioners are useful as they make soil more functional as an ecosystem and more efficient as support for crops. However, it is imperative to be conversant with the land requirement before deploying soil conditioners.

REFERENCES

[1]. Desphande, A.N., Kamble, B.M., Shinde, R.B. and Gore, S.B. (2012). Effect of primary treated biomethanated spentwash on soil properties and yield of sunflower (Helianthus annuusL.) on sodic soil. Communications in Soil Science and Plant Analysis,43: 730–43. doi:10.1080/ 00103624.2012.644011

[2].Donn, S., Wheatley, R.E., McKenzie, B.M., Loades, K.W. and Hallett, P.D. (2014). Improved soil fertility from compost amendment increases root growth and reinforcement of surface soil on slope. Ecol. Eng., 71: 458-465.

[3].Doyle, J.J. and Hamlyn, F.G. (1960). Effect of different cropping systems and of soil conditioners (VAMA) on some soil physical properties and of growth of tomato. Can. J. Soil. Sci., 40: 89–98.

[4].Gabriels, D., Maene, L., Lenvain, J. and De Boodt, M. (1981). Possibilities of using soil conditioners for soil erosion control. In: D.J. Greenland and R. Lal (eds.), Soil Conservationand Management in the Humid Tropics. Wiley, Chichester, pp. 99-108.

[5].Gore, S.B., Shinde, R.B. and Belhekar, B.M. (2011a). Effect of post biomethanated spentwash on Azotobacter population in sodic soil. Asian journal of soil science, 6(2): 174-176.

[6].Gore, S.B., Shinde, R.B. and Belhekar, B.M. (2011b). Effect of post biomethanated spentwash on Population of Phosphate solubilizing bacteria in Soidic soil. Asian journal of soil science,6(2): 251-252.

[7].Goss, M.J., Tubeileh, A. and Goorahoo, D. (2013). A review of the use of organic amendments and the risk to human health. Adv. Agron., 120: 275-379.

[8].Grace, K.J., Sharma, K.L., Suma C.D., Srinivas, K., Mandal, U.K., Raju, B.M.K, Korwar, G.R., Venkateswarlu, B., Shalander Kumar, MaruthiSankar, G. R., Munnalal, Satish, K.T., Sammi Reddy,K. and Shinde,R.(2013). Effect of

long term use of tillage,residues and N levels in sorghum (Sorghum vulgare(L)-Castor (Ricinis comminis) cropping system under rainfed conditions-crop response and economic performance-part I.Experimental Agriculture, 42: 1-21.
[9].Nimah, M.N., Ryan, J. and Chaudhry, M.A. (1983). Effect of synthetic conditioners on soil water retention, hydraulic conductivity, porosity, and aggregation. Soil Sci. Soc. Am. J., 43: 742–745.
[10].Sharma, K.L., Maruthi Shankar, G.R., Suma, C.D., Grace, K. J., Sharma, S.K., Thakur, H.S., Jain, M.P., Sharma, R.A., Ravindra Chary, G., Srinivas, K., Gajbhiye, P., Venkatravamma, K., Munnalal, Satish Kumar, Usha Rani, Sammi Reddy,K., Shinde, R.B., Korwar G.R and Venkateswarlu, B. (2014). Effects of Conjunctive Use of Organic and Inorganic Sources of Nutrients on Soil Quality Indicators and Soil Quality Index in Sole Maize, Maize + Soybean, and Sole Soybean Cropping Systems in Hot Semi-arid Tropical Vertisol.Communications in Soil Science and Plant Analysis, 45(16): 2118-2140.
[11].Shinde, R., Sarkar, P.K., Bishnoi, S. and Naik, S.K. (2017). Vartman krishi paridrishya me mrida sanrakshan ki mahatti avashyakta evam upay. Rashtriya Krishi(Hindi), 12 (1&2): 29-31
[12].Shinde, R., Sarkar, P.K., Thombare, N. and Naik, S.K. (2019). Soil conservation: Today's need for sustainable development. Agriculture & Food: e-Newsletter, 1(5): 175-183.
[13].Zhou, H., Fang, H., Mooney, S.J. and Peng, X. (2016). Effects of long-term inorganic and organic fertilizations on the soil micro and macro structures of rice paddies. Geoderma, 266: 66–74.

Nwaofoke Charles K. D. (2023). Impact of Soil Conditioners on Soil Productivity. NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN EDUCATION (NIJRE) 3 (1):11-15.