IMPACT OF ORGANIC MANURES ON PHYSICAL, CHEMICAL, AND BIOLOGICAL PROPERTIES OF SOIL

Utkarsh Goyal, M.K. Sharma, Moomal Bharadwaj and M.C. Jain
College of Agriculture, Ummedganj, Kota, Agriculture University Kota- 325001
Corresponding author: utkarshgoyal254@gmail.com

Abstract

The sustainable management of soil health is critical for agricultural productivity and environmental conservation. This study investigates the influence of organic manures on the physical, chemical, and biological properties of soil, aiming to enhance our understanding of their impact on soil quality. The research employs a comprehensive approach, analyzing the effects of various organic manures on soil texture, structure, and moisture retention. Additionally, the study assesses changes in soil chemical properties, including nutrient levels, pH, and cation exchange capacity, to elucidate the role of organic inputs in nutrient cycling and availability. Furthermore, the investigation delves into the dynamic interplay between organic manures and soil microorganisms, evaluating microbial abundance, diversity, and activity. The study aims to unravel the intricate relationships between organic amendments and soil biota, shedding light on their potential contributions to soil fertility and ecosystem resilience.By synthesizing data from field experiments and laboratory analyses, this research aims to provide valuable insights into the sustainable use of organic manures for soil management. The findings are expected to contribute to the development of eco-friendly agricultural practices that optimize soil health, promote crop productivity, and minimize environmental impacts. This research holds significance for farmers, policymakers, and researchers seeking to advance sustainable agriculture and soil conservation practices.

Keywords: Organic manures, Soil health, Sustainable agriculture, Cation exchange capacity, Soil fertility, Ecosystem resilience, Eco-friendly agriculture

Introduction

After 50 years of the green revolution, the continuous trend of application of fertilizers in an imbalanced way because of unawareness of the farmers, improper agricultural extension education, and some govt. policies like subsidy on urea NBS (nutrient-based subsidy) led to the emergence of water bodies' pollution by nitrate and soil health degradation. As a result, the economic efficiency of fertilizer use as well as the quality of crop products deteriorated. According to all India data, fertilizer consumption rates in 2021 were 137.150 kg/ha which is higher than the previous year's as 127.790 kg/ha.The production of food grains in the country is estimated at a record 314.51 million tonnes during 2021-22

which is higher by 1.21% than 2020-21. Now a day's a question arises about soil health which is day by day deteriorating (multi-nutrient deficiency) due to excessive and unorganized use of primary fertilizers like urea and DAP only. To overcome this problems, we have to integrate these fertilizers along with organic manures like FYM, compost, vermicompost, enriched compost and biofertilizers. So instead of conventional chemical use, the trend is moving towards organic farming.

On Farm Availability and Losses

In India, on-farm residues like straw and garden wastes are not recycled. A great amount of straw is used for feeding cattle. In the case of urine and cow dung, none of them are using scientific techniques for handling and preservation of cow dung and urine. Most of the dung is used for household fuel in the rural areas and this way decreasing the use of cow dung as farm input. Urine containing high amounts of nitrogen and potassium is significantly lost into the environment by means of leaching or volatilization losses this way a great decrease amount of nutrients in farm yard manure and composed observed.

Types of Organic Manures and their Uses

1. FYM (Farm Yard Manure):-FYM is prepared by farmers on their farm and is of very low quality and has a low amount of nutrients, as they are not following scientific techniques for preserving urine and dung. On average well decomposed farmyard manure contains 0.5 percent N 0.2 percent P_2O_5 and 0.5 percent K_2O.

Improved Method for Preparation of FYM: The Trench method of preparing FYM advocated by **C.N. Acharya** is found one of the best methods for preparing FYM. All available dry litter and refuse from the farm and the houses should be heaped up near the cattle shed and portions of litter mixed with earth if available should be spread in the shed in the evening at 2.26 kg per animal for the absorption of urine. Chemical preservatives like gypsum, and rock phosphate are added to reduce losses and enrich FYM. Bacteria and actinomycetes play an active role in decomposition. Generally, 60-70 percent moisture in the initial stage and 30-40 percent moisture in decomposed manure (ready to use) as well as 50-60°C temperature under the heap are favourable for the activities of these micro-organisms. It is possible to prepare by this process 5 to 6 t of FYM per year per head of cattle.

2. Compost: - The compost made from farm waste like sugarcane trash, paddy straw, weeds, and other plants and other waste is called farm compost. It uses all farm waste residues to form a valuable nutrient-rich compost. The N-P-K ratio of compost varies from 1.5-. 5-1 to 3.5-1-2. The compost made from town refuse like street sweepings and dustbin refuse is called **Town compost**. It contains 1.4 % N 1.0% P_2O_5 and 1.4 % K_2 O.

Composting is the natural process of 'rotting' or decomposition of organic matter such as crop residues, animal wastes, food garbage, etc. by micro-organisms under controlled conditions.

Methods of Composting

1. Bangalore Method (aerobic and anaerobic process): This process of composting was developed by Dr. C.N. Acharya in 1949. This process is called aerobic and anaerobic decomposition of compost. In this process, the basic raw material is not so well decomposed as in the other methods. But organic matter and nitrogen contents are well conserved. The number of turnings is reduced. The outturn of the compost is a relatively greater and cheapest process.

2. Indore Method (aerobic process) : This method of composting was developed by Ward and Howard. The waste materials such as plant residues, animal wastes, vegetable wastes, and weeds can be composted with the Indore Method. Under the aerobic process of decomposition,
losses of organic matter and nitrogen are heavy (40-50 percent at the initial stage). This process, however, involves considerable labour in the preparation of the heap and periodical turnings and so becomes expensive and impracticable when large quantities of materials are to be processed.

3.NADEP Compost (aerobic process): This method of composting was developed by farmer Narayan devraopandripande (also popularly known as NADEP kaka). Build a rectangular tank of 3 m length,2 m width and 1 m depth made of brick walls and floorwith mud plaster. Leave holes in the tank walls for aeration (about 4 holes along each side wall and two holes in each enclosure wall). Build a temporary shed of thatch and bamboo to shield compost tank from direct sunlight and rain. After 3-4 mon., digestion is complete and compost is ready having dark colour and pleasant smell. Sieve through a thick mesh and use the compost.

3. Enriched compost:-Enrich compost is a natural product made by composting recycled green materials such as garden cuttings, crop residues. Enrich compost is a great way of putting life back into poorly performing soil.

Enriched compost can be prepared by means of addition of fertilizer materials into compost. This way they are having varying amount of NPK content.

It is a soil improver which is suitable for mixing with soil but can also be used as topdressing, mulch or in "no-dig" approaches

4. Vermi compost:- The technique of breeding and raising earthworms in controlled conditions scientifically is called vermiculture, and making compost with the use of earthworms is called vermicomposting. Vermicompost is prepared by decomposition of organic material using various species of earthworms (*Eisenia foetida* and *Lumbricusrubellis*). Materials consumed by worms undergo physical breakdown in the gizzard resulting in particles of size < 2 μ, giving thereby an enhanced surface area for microbial processing. This finely ground material is exposedto various enzymes such as protease, lipase, amylase, cellulase and chitinase secreted into lumen by the gutwall and associated microbes. These enzymes breakdown complexbio-molecules into simple compounds. The earthworm assimilate 5-10 per cent of the substrate and rest passes through the alimentary canal and is excreted as cast. About 1,000 adult earthworms can convert 5 kg waste into compost per day. Theturnover of the compost is 75 percent of the total material accommodated in the pit, suppose 1,000 kg; the out turn will be 750 kg.

Vermicompost is rich in nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25% micronutrients, beneficial soil microbes and also contain plant growth hormones & enzymes. Vermicompost is a stable fine granular organic matter, when added to clay soil loosens the soil and provides the passage for the entry of air. The mucus associated with the cast being hygroscopic absorbs water and prevents water logging and improves water holding capacity.

In the sandy soils where there is problem of water retention, the young strong mucus coated aggregates of vermicompost hold water for longer life.

Fig : PROCESS OF VERMI COMPOST

5. Vermiwash liquid manure: collected after the passage of water through a column of worm action, very useful as a foliar spray to enhance the plant growth and yield and to check development of diseases. It is a collection of excretory products and mucus secretions of earthworm along with nutrients from the soil organic molecules.

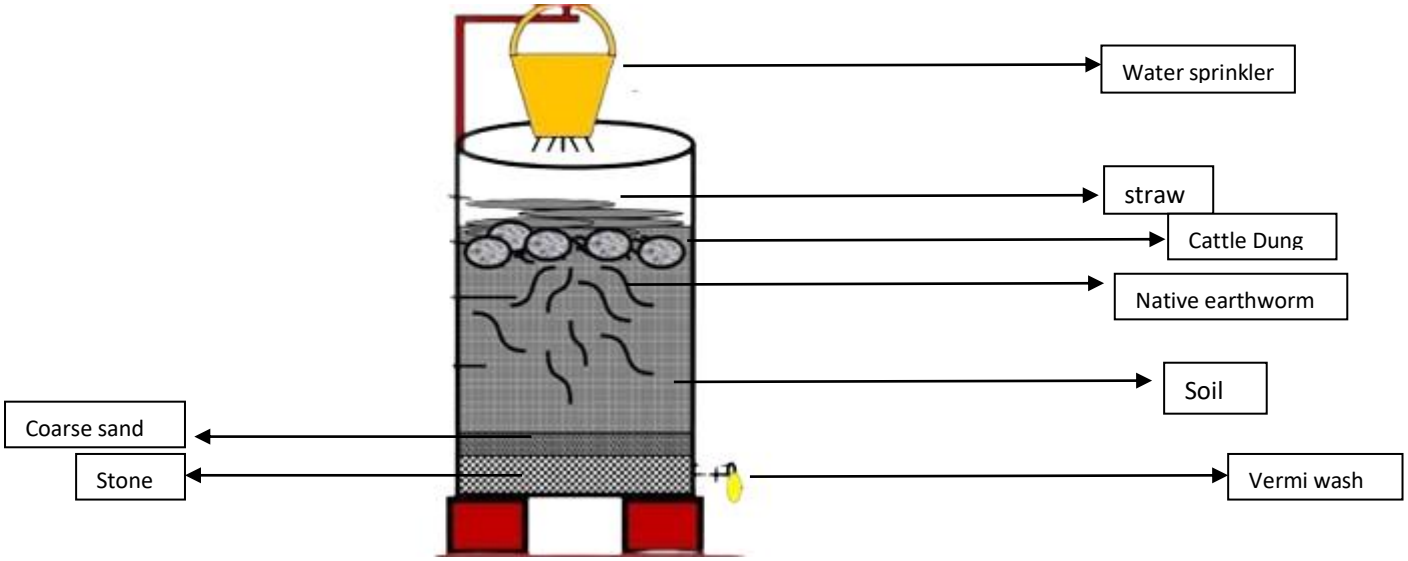


Fig:- VERMI WASH PROCESS

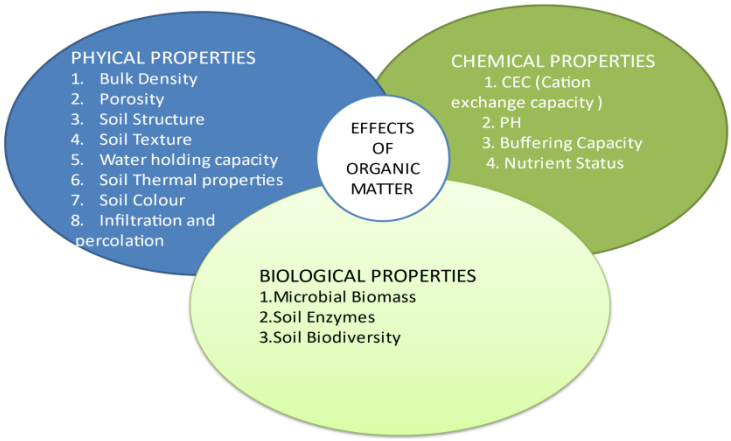
6. Greenmanuring: Green manuring can be defined as a practice of ploughing or turning into the soil undecomposed green plant tissues for improving physical condition of soil as well as soil fertility.

Green Manuring In-situ: In this system green manure crops are grown and buried in the same field which is to be green-manured, either as a pure crop or as an intercrop with the main crop. Plants at the flowering stage contain the greatest bulk of succulent organic matter with a low carbon/ nitrogen ratio. Incorporation at this stage allows a quick liberation of nitrogen in the available form. Important green manure crops are Dhaincha, Sesbania, Sun hemp, Wild indigo, Indigo and Pillipesara.

Green Leaf Manuring: Green leaf manuring refers to turning into the soil green leaves and tender green twigs collected from shrubs and trees grown on bunds, waste lands and nearby forest areas.The common shrubs and trees used for green leaf manuring are *Glyricidiamaculata* (glyricidia), *Pongamia glabra* (Karaj), *Azadirachta indica (*neem) *Cassia auriculata* (Avaramsenna), *Thespesia populnea* (Portia tree) and *Ipomoea carnea* (Besharam).

7. Biofertilizer: -Biofertilizer are substance that contains microbes, which helps in promoting the growth of plants and trees by increasing the supply of essential nutrients to the plants. It comprises living and latent cells of organisms which include mycorrhiza fungi, blue-green algae, and bacteria.These microbes form either symbiotic relation with plants or living free into the soil and provide nutrients in available form to plants.Mostly used biofertilizer formulations are *rhizobium sp.* In *leguminacae* family. These bacteria form nodules in the roots of these plants and fixes atmospheric nitrogen.Another example of biofertilizer is PSB (phosphorus solubilizing bacteria) namely, *Pseudomonas, Bacillus, Micrococcus,* are helpful in increasing availability of phosphorus. Some fungi (*Aspergillus,Fusarium*) are also used for phosphorus mobilization and increasingavailability.

EFFECT OF ORGANIC MANURES:-



On Soil Physical properties

1. Bulk Density: - Since organic matter is lighter than an equal volume of solid soil and is more porous, hence a soil with higher organic matter will have lower bulk density.

2. Porosity: -They could have increased the looseness of soil resulting in increased soil volume and this way increasing macropores and porosity percentage of soil. Due to the influence of soil fauna whose burrowing and feeding activity form new pores.

3. Soil Structure: - Organic matter causes soil particles to bind and form stable soil aggregates, which improves soil structure. Mostly clay humus complex are formed and these will further form porous granular structure of soil also known as crumby structure. This crumby structure is best for agriculture.

4. Water holding Capacity: - The addition of organic matter to the soil usually increases the water holding capacity of the soil. With better soil structure, permeability (infiltration of water through the soil) improves, in turn improving the soil's ability to take up and hold water. This is because the addition of organic matter increases the number of micropores and macropores in the soil either by “gluing” soil particles together or by creating favourable living conditions for soil organisms.

5. Soil Texture: -Organic manures improve the soil texture both heavy and light soils. They provide food substances to microorganisms and enhance their activity thereby increasing macro pore space in soil; this will improve drainage in heavy soil. Whereas in light soil organic manures increase water holding capacity by increasing micro pore space.

6. Soil Thermal Properties: - Soil thermal properties are considered a function of soil organic matter and soil carbon pool. Soil organic matter alters the thermal properties of soil because of its black dark nature. The albedo of soil gets reduced by the potential increase of dark colour and more heat gets absorbed. The soils with good amount of organic matter have ample germination and higher crop growth because of the favourable temperature.

7. Soil Infiltration and Percolation: - The important characteristic of soil affecting the soil infiltration is porosity of soil. The organic matter has a direct impact on the soil porosity and as the soil organic matter increases the porosity of the soil is also enhanced.

Percolation or downward movement of water is reliable on uninterrupted pore space in soil. Again organic manures increase the total pore space specially macro pore space this way enhance percolation rate in soil.

8. Soil Colour: - . The application of soil organic matter darkens the soil. The dark colour soil having high amount of the organic matter applied by various organic farming systems holds a largeamount.

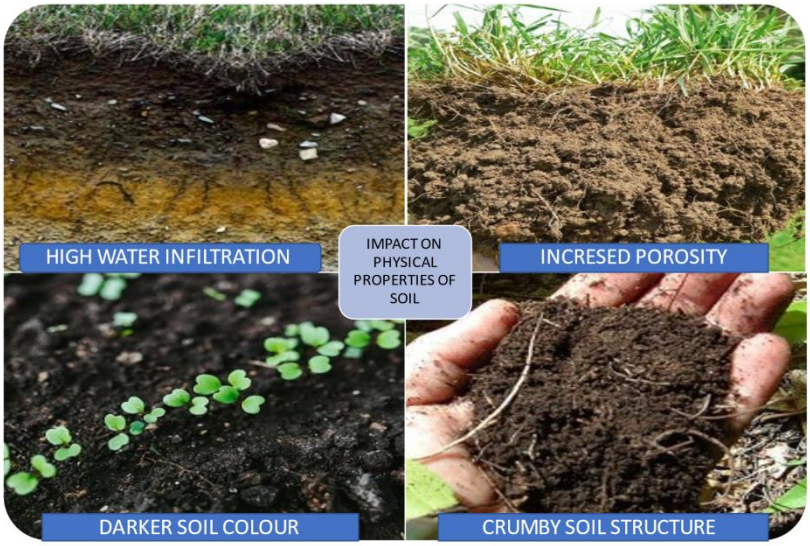


Fig :EFFECT ON DIFFERENT SOIL PHYSICAL PROPERTIES

On Soil Chemical properties

1. Cation exchange Capacity: - Organic manures have very high CEC. In addition to this organic manures have porous structure this way increase the effective surface area and improve CEC of soil.

2. pH :- organic manures application decreases the pH of soil because by the decomposition of organic matter, microorganisms produce organic acids and decreases soil pH.

3. Nutrient status of Soil: - organic manure significantly improves the soil's capacity to store and supply essential nutrients such as nitrogen, phosphorus, potassium, calcium and magnesium etc. because organic matter improves the CEC of soil. Micro nutrients are become more available to plants due to chelating action of organic manures.

4. Buffering Capacity: - The buffering capacity of soil is the resistance to change in pH when an acid or base is added. At the pH value between 5 and 7.5, soil organic matter and clay acts as a sink for H and OH and the buffering capacity is governed by exchangeable reaction. soil organic carbon was reported 300 times in comparison to kaolinite. The presence of various

functional groups (amine carboxylic, alcohol, phenolic, and amide) in soil organic matter allows it to act as a buffer over a wide range of soil pH.

5. Adsorption and Complexation: - . The complexation of soil organic matter with inorganic material enhances the soil fertility as it increases the availability of soil phosphorus by blocking iron, aluminium, and calcium adsorption sites. The presence of functional groups (COOR, NH_2, OH, NHR, $CONH_2$) are very important for adsorption of ions on humus particles. Organic manures increase the absorption of heavy metals (Cadmium, arsenic, and led) by forming insoluble complexes. These insoluble complexes decrease the soil pollution and make them contamination free.

On Soil Biological properties

1. Microbial Biomass: - organic matter provides food, nutrients and habitat for microorganisms. In the presence of adequate organic matter microorganisms grows well and flourish.

2. Soil Enzymes: - These microorganisms produce specific exudates or secretions rich in enzymes as well as nutritive vitamins and minerals. These secretions play an important role in nutrient cycling and making them more readily available to plants.

3. Soil Biodiversity: -The soil biodiversity is indicator of soil health, as greater biodiversity means greater soil stability in terms of certain functions, such as maintenance of soil structure, assimilation of organic wastes, and nutrient cycling.

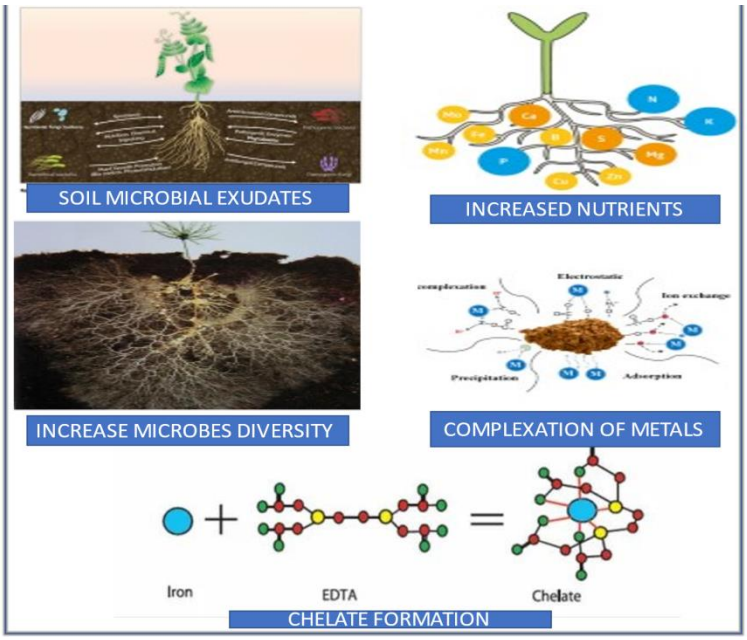


FIG: EFFECT ON SOIL CHEMICAL AND BIOLOGICAL PROPERTIES

CONCLUSION:-

Unjudious and unscientific use of inorganic fertilizers and wastage of all farm available organic sources leads to degradation of soil (low organic carbon, nutrient deficiency). Due to NBS farmers are incorporating higher doses to field, this creates a uneven distribution and shortage of fertilizers as well. For overcoming this land degradation as well as shortage of fertilizers at peak time, farmers have to integrate both inorganic as well as organic sources. These organic manures and bio fertilizers are not only supplying the nutrients to crop plants but also healing the degraded lands by improving their physical chemical and biological properties.Now trend is moving towards organic farming. Organic farming is labour intensive which creates more employment in rural areas. Moreover awareness of people for healthy and organic food increasing the demand, therefore in last decade organic farming area is increasing day by day.

References :-

1.Bashir, O., Kamran, K., Khalid, R.H., Naseer, A.M., Rather ,G.H. and Mohiuddin, R. 2016. Soil microbe diversity and root exudates as important aspects of rhizosphere ecosystem. In: Plant, soil and microbes. Springer International Publishing, pp 337–357

2. Bauer, A. 1974. Influence of soil organic matter on bulk density and available water capacity of soils North Dakota Agricultural Experimental Station. Farm Res 31 pp - 44–52

3. Beck, B., Fleige, H.and Horn, R. 2018. Compost quality and its function as a soil conditioner of recultivation layers – a critical review. Int Agrophys 32: pp- 11–18

4. Bloom, P.R. 1999 Soil pH and pH buffering. In: Sumner ME (ed) Handbook of soil science. CRC Press, Boca Raton, pp B333–B352

5. Celik, I., Gunal, H., Budak, M. and Akpinar, C. 2010. Effects of long-term organic and mineral fertilizers on bulk density and penetration resistance in semi-arid Mediterranean soil conditions. Geoderma 160 pp-236–243

6. Dar, G.H., Bhat R.A., Mehmood, M.A. and Hakeem, K.M. 2021 Microbiota and Bio fertilizers, Vol 2, doi:10.1007/978-3-030-61010-4

7. Dbska, B., Dugosz, J., Piotrowska, D.A., Banach, S.M. 2016. The impact of a bio-fertilizer on the soil organic matter status and carbon sequestration—results from a field-scale study. J Soils Sediments 16 pp - 2335–2343

8. Wang, X., Ciu, H., Shi, J., Zhao, Y. and Wei, Z. 2015 Relationship between bacterial diversity and environmental parameters during composting of different raw materials. Bioresour Technol 198 pp - 395–402

9. WEB:- https://sci-hub.se/https://doi.org/10.1007/978-3-030-61010-4_7