TRENDS IN AGRICULTURE SCIENCE
Popular Article
Vol.3 Issue 03 March 2024, Page: 1636-1640

Soil Fertility Management in Organic Farming

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https://doi.org/10.5281/zenodo.10947273

Introduction

Organic farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic farming systems rely upon crop rotations, crops residues, animal manure, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral bearing rocks and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrition, and to control insects, weed and other pests.

Experiments from around the world have proved merits of organic farming. It is because organic farming is practiced without use of chemical fertilizers and pesticides; so, the soil becomes enriched by natural methods like rotation of crops, use of organic manures and vermicompost.

Need for Organic Farming

Increased population pressure and decreased land to man ratio forced many countries to use fertilizers and pesticides to increase food production for meeting its food demand. The prolonged and over-usage of chemicals has, however, resulted into human and soil health hazards *vis-a-vis* environmental degradation – soil pollution, air pollution and water pollution. Moreover, accumulation of excessive nitrogen in plants caused an infant disease – Methaemoglobinemia. Amines produced from the nitrogenous fertilizers spewed cancer in human beings. Accumulation of nitrate in drinking well water also caused Methaemoglobinemia. Its deposition along with phosphate in lakes yielded an Eutrophication. Residues of several chlorinated hydrocarbon pesticides creating a number of diseases in human beings have been detected in all types of agricultural produce. Such toxic residues have also been found in soils and water. In view of all these effects, there is need for "Organic Farming" which ensures good soil health, food security and reduces environmental pollution.

Soil fertility management under organic farming

Soil fertility is the status or inherent capacity of the soil to supply nutrients to plants in adequate

Published: 28 March. 2024
ISSN: 2583-7850

amounts and in suitable proportions. Restoration of the soil fertility is a constant problem. Maintenance of soil fertility should be considered both on a temporary and long-term basis. These measures include suitable practices like addition of organic manures, green manures, biofertilizers etc.

Organic matter and its role

Soil organic matter consists of any substance of organic origin, living or dead. The organic matter in the soil comes from the remains of plants and animals. These includes grasses, trees, bacteria, fungi, protozoa, earthworms and animal manures. The organic matter is applied through organic manures has a very complex effect on soils and plant growth. The effects of organic farming on soil properties are as under:

- **Physical soil properties:** improves soil structure, improves water holding capacity, improves soil aeration, buffers soil surface temperature, reduces soil losses due to erosion.
- **Chemical properties:** supplies essential nutrients in a balanced ratio, slow release of nutrients.
- **Biological activity:** stimulates soil flora and fauna.

Different organic sources of plant nutrients used for management of soil fertility under organic farming

1. **Green manuring crops**

Green manuring can be defined as practice of ploughing or turning into the soil undecomposed green plant tissues for the purpose of improving physical structure as well as fertility of soil. Green manures are those crops which are grown for restoring or increasing organic matter content and nutrients in the soil. These are of two types i.e. leguminous and non-leguminous. Leguminous green manures include Sesbania (*Sesbania speciosa*), Dhaincha (*Sesbania aculeata*), moong (*Vigna unguiculata*), Cowpea (*Vigna radiata*), Sunhemp (*Crotolaria juncea*), Guar (*Cyamopsis tetragonoloba*), Urd (*Vigna mungo*),Berseem (*Trifolium alexandrium*), senji (*Melilotus alba*). Non-leguminous green manures include: Jowar (*Sorghum bicolor*), Maize *(Zea mays*), sunflower (*Helianthus annus*).

Green manure crops contribute about 60-200 kg nitrogen per hectare in about 45-60 days. They add organic matter to soil, which stimulates the activity of soil microorganisms. The green manure crops return to the upper top soil, plant nutrients taken up by the crop from deeper layers. They improve the structure of the soil and increase the water and nutrient holding capacity of soil.

2. **Crop rotations/Intercropping**

Crop rotation, intercropping, sequence cropping etc. play significant role in maintaining soil health. The fertility of soil gets depleted by growing one single and the same crop year after year. Some leguminous crops like cowpea, green gram, soybean etc. fix good amount of nitrogen i.e. 30-60 kg

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N/ha are found suitable for intercropping. The ultimate aim of intercrop is not only to obtain additional income due to intercropping but to improve the fertility status in long term.

3. Organic manures

Organic manures including FYM, compost, crop residues, household wastes, industrial wastes etc. are best way to return to soil what has been removed from it by crop plants. Only the constraint is that these manures are required in bulk quantities but they supply the plant nutrients in small quantities. That's why these are called bulky organic manures which includes farm yard manure, rural and town compost, vermicompost etc. whereas those containing high percentage of major plant nutrients like N,P,K are called concentrated organic manures *i.e.* oil cakes, poultry manure etc.

Farmyard manure (FYM): Farmyard manure is traditional manure. The term 'FYM' refers to the decomposed mixture of dung and urine of farm animals along with the litter and leftover material from roughages or fodder fed to cattle. On an average, well rotten FYM contains 0.5% available nitrogen, 0.2% available phosphorus and 0.5% available potassium.

Compost: In general, organic residues have a wide C:N ratio and cannot be used as such and must be composted before use. Composting is the microbiological conversion of biodegradable organic wastes to stable humus by indigenous microflora including bacteria, fungi and actinomycetes.

Sludge: The semi solid part of sewage that has been sedimented or acted upon by bacteria. Potential organic manure contains 1.5-3.5% N, 0.75-4.0% P_2O_5, 0.3-0.6% K_2O apart from micronutrients. It can also originate as industrial waste and carry toxic heavy metals.

Vermicomposting: It is the method of mass multiplication of earthworms. It is an excellent tool of organic farming, which is helpful in maintaining soil fertility status for a long time. It is the biological process to convert solid wastes of animal and plant origin into valuable manure through the action of earthworms. Depending upon the substrate, vermicompost contains 2.5-3% available nitrogen, 1-1.5% available phosphorus and 1.5-2.0% available potassium. The important species of Indian earthworms are *Eisenia foetida, Eisenia andrie, Perionyx excavates.*

Biogas slurry: The residual end product of a biogas plant is used as an excellent source of plant nutrients. Its composition is 1.4-1.8% available nitrogen, 1.1-1.7% available phosphorus and 0.8-1.3% available potassium.

Oilcakes: Residue left behind after oil has been extracted from an oilseed. Non-edible cakes used primarily as cattle feed. E.g.in groundnut cake, typical nutrient content is 3-8% available nitrogen, 1-2.8% available phosphorus and 1-2% available potassium.

4. Crop residues

Crop residues are bulk of the crop biomass left after the removal of the main produce. Rice, wheat, sorghum and barley produce a voluminous amount of straw, stalk, stubble, trash and husk, which can

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be used for compost making.

5. **Agricultural wastes**

Apart from crop residues, a lot of agricultural wastes are available. Some of them are: plantation industry waste (coconut industry, coir dust, tea waste, arecanut, coffee husk etc.), waste from field crops and trees (cotton stalks, tobacco waste, rice husk, bagasse, pressmud etc.), and fruit and vegetable wastes (peels of pineapple, citrus, guava, banana, potato, stalks of okra etc.) which can be used as source of organic manure.

6. **Biofertilizers**

The term biofertilizer refers to the preparation containing primarily active stains of microorganisms. They are ready to use live formulates of such beneficial microorganism which on application to seed, root or soil fix atmospheric nitrogen and solubilize/mobilize plant nutrients or otherwise stimulate plant growth substances. These biological activity in particular helps to build up the micro flora/fauna and in turn the soil health in general.

Group of biofertilizers

These microorganisms are either free living or having symbiotic association with the plants. These directly or indirectly contribute nutrition to crop plants. The organisms that live freely in the soil perform nitrogen fixation without any association with other organisms. Symbiosis is a process, which expresses the mutual beneficial partnership between the 2 organisms. The fixation of molecular nitrogen by the process is termed as symbiotic nitrogen fixation.e.g. *Legume-Rhizobium and Anabaena- Azolla* symbiosis.

Based on the type of microorganisms, biofertilizer can be classified as follows:

- **Bacterial biofertilizers:**

  Rhizobium: It forms nodules on the roots of leguminous plants, which fixes the atmospheric nitrogen in the soil. It fixes 50-200 kg Nitrogen/ha.

  Azospirillum: Chemoheterotrophic and associative N-fixing microorganisms, fixes 20-40 kg Nitrogen/ha. It also produces growth promoting substances.

  Azotobacter: Chemoheterotrophic and non-symbiotic N fixing microorganisms, fixes 20-40 kg Nitrogen/ha. Also produces growth promoting substances and may control some pathogens.

  Phosphate solublizing microorganisms: A group of heterotrophic microorganisms have the ability to solubilize P from insoluble sources. These include: *Bacillus megatherium, B. circulans, Aspergillus awamori, Tricoderma spp*. They can solubilize 20-30% of insoluble phosphate.

- **Algal biofertilizers:**

  Azolla: Azolla is a free-floating water fern, which fixes atmospheric nitrogen with *Anabaena*

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ISSN: 2583-7850

azollae. Azolla is widely distributed in rice growing tracts of tropics and temperate zones and grows well on irrigated rice fields. It fixes about 40-80 kg Nitrogen/ha.

Blue green algae: The fooded rice with a layer of standing water encourages the growth of BGA some species are: Tolypothrix, Nostoc etc. BGA are capable of performing photosynthetic activity as well as they fix the atmospheric nitrogen. The energy required for N fixation is met with photosynthesis. These are photosynthetic N fixers and fixes about 20-30 kg Nitrogen/ha.

- **Fungal biofertilizers:**

Vesicular Arbuscular Mycorrhiza (VAM): These are obligate fungal symbionts. These enhance uptake of P, Zn, S leading to uniform crop growth and increased yield. Mycorrhizal fungi infect and spread inside the root system. They possess the special structures known as vesicles and arbuscles. The arbuscules help in transfer of nutrients from the fungus of root system and the vesicles which are sac like structures, stores phosphorus as phospholipids.

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