Program: M.Sc. (Ag.) Soil Science & Agricultural Chemistry 2nd Semester, 1st Year

SOILS-502: SOIL FERTILITY AND FERTILIZER USE

Unit No. 1

Soil fertility and soil productivity

Lecture No. 1

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Outlines

- Introduction
- Soil Fertility
  - ❖ Factors affecting soil fertility
- Soil Productivity
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- Difference between Soil fertility and Productivity
- History of development of Soil Fertility
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Soil Fertility:-

- Soil fertility is the ability of the soil to supply essential plant nutrients during growth period of the plants, without toxic concentration of any nutrients *i.e.* ***"the capacity of soil to supply nutrient in available form to crop"*.**
- It is defined as the **inherent capacity** of a soil to supply available nutrients to plants in an adequate amount and in suitable proportions to maintain growth and development. It is measure of nutrient status of soil which decides growth and yield of corp.

Factors affecting soil fertility:-

I. Natural factors or Pedogenic factors

a. Parent material.
b. Climate and vegetation
c. Topography and age of soil

II. Edaphic factors or Soil management factors

1. Physical conditions of soil

a. Texture of soil:
b. Structure of soil:
c. Soil water
d. Soil aeration:

2. Root growth and extension
3. Organic matter content of the soil
4. Cropping system:
5. Soil erosion

Soil productivity:-

- Soil productivity means the crop producing capacity of a soil which is measured in terms of yield (bio-mass). Productivity is a very broad term and fertility is only one of the factors that determine the crop yields. Soil, climate, pests, disease, genetic potential of crop and man's management are the main factors governing land productivity, as measured by the yield of crop. To be productive, soil must contain all the 13 essential nutrients required by the plants.
- The total quantity of nutrients is not only being sufficient but they should also be present in an easily "available" form and in "balanced" proportions. Over and above fertility, there are other factors deciding productivity.

"All the productive soils are fertile but not all fertile soils are productive"

Factors affecting soil productivity:-

- The factors affecting soil productivity include all those which affect the physical, chemical and biological conditions of the soil environment in which plants grow. They include all the practices that affect fertility, the water and air relationships and the activity of the biological agents such as insects, pests, diseases and microorganisms.
  1. **Internal factors:** may be called as genetic or hereditary factors which cannot be manipulated such as soil type, texture etc.
  2. **External factors:** may be regulated to certain extent, They include e.g. Climatic factors, Edaphic or Soil factors, Biotic factors, animals: earth worms, small and large animals, Physiographic factors anthropogenic factors etc.

Soil Fertility	Soil Productivity:
1. It is considered as an index of available nutrient to plants.	1. It is a broader term used to indicate crop yields.
2. One of the factors for crop production; the others are water supply etc.	2. It is the interaction of all the factors.
3. Can be analysed in lab.	3. Can be assessed in the field under particular climate conditions.
4. It is the potential status of the soil to produce crops.	4. Resultant of various factors influencing soil management.
5. 5. Depends upon physical chemical and biological factors of soil.	Depends upon location, fertility, physical conditions etc.

6. Soil fertility is the function of available nutrients of soil fertility = f (Nutrient status of Soil).	6. Soil productivity is the function of soil fertility, management and climate.
7. It is an inherent properly of soil.	Soil Productivity = f (Soil fertility + Management + Climate)
8. The fertility of a certain soil is same in all the climates.	7. It is not an inherent property of soil.
9. All fertile soils are not productive.	8. Soil productivity differs according to the variations in climate and location.
	9. All productive soils are certainly fertile

Some Terminology Related to Plant Nutrients:

Plant Nutrition:

Plant nutrition is defined as the supply and absorption of chemical compounds required for plant growth and metabolism. It is the process of absorption and utilization of essential elements for plant growth and reproduction.

Nutrients:

Nutrients may be defined as the chemical compounds required by an organism.

Deficient:

When an essential elements is at a low concentration that severely limits yield and produces more or less distinct deficiency symptoms. ***Extreme deficiencies will lead to death of the plant.***

Insufficient:

- Nutrient contents associated with only growth reductions and not accompanied by appearance of deficiency symptoms are termed insufficient.

Sufficient:

- Range of nutrient content in plant associated with optimum crop yields is called sufficient.

Toxic:

- When the concentration of a nutrient element rises too high to cause significant growth reductions, it is termed toxic. ***Severe toxicity will result in death of plants***.

Excessive:

- When the concentration of an essential plant nutrient is sufficiently high to result in a corresponding shortage of another nutrient.

Bioavailable nutrient:

- The nutrient available to the biological organism is termed as bioavailable nutrient.

Beneficial Elements:

- Beneficial elements are the mineral elements which stimulate plant growth, but are not essential or which are essential only for certain plant species or under specific condition.

Functional Nutrient:

- This term introduced by Nicholas (1961) is defined as an element that plays a role in plant metabolism, whether or not that role is specific or indispensable.

Trace Element:

- Trace element is an element found in low concentrations, perhaps less than one ppm or still less in soil, plant and water etc.

History of Development of Soil Fertility: -

The concept of soil fertility and its management to improve crop yields is not new perhaps it is as old as the development of agriculture by man. In ancient time also, they had knowledge of applying manures such as farm yard manure, green manure, night soil, bone, wood ashes, etc., to soil for the purpose of increasing crop yields.

- **Xenophan (430-355 B.C),** a Greek historian first recorded the merits of **green manure crops**. He wrote "But then whatever weeds are upon the ground, being turned into the earth, enrich the soil as much as dung "meaning incorporating weeds in to soils is as good as applying dung.
- **Cato (234-149 B.C)** wrote a practical hand book and recommended intensive cultivation, crop rotations, and the use of legumes for livestock farming. He was first to classify "Land" based on specific crops.

Columella (A.D. 45)

- emphasized the usefulness of turnips for soil improvements. He also advocated land drainage and the use of ashes, marl (lime deposits), clover and alfalfa to make the soil more productive.

Jethro Tull (1731) and Francis Home (1757)

- claimed that Nitre (Nitrate Salts), water, air, earth, Epsom salt ($MgSO_4$), Saltpetre (Sodium & Potassium Nitrate), Vitriolated tarter (Potassium sulfate) and Olive oil increased plant growth.
- Almost all of the present knowledge about the mineral nutrition has been acquired relatively recently during the last 135 years or so. These developments happened in a slow and gradual manner.

Justus Von Liebig (1840),

a German chemist, reported that growing plants obtain elements Ca, K, S and P from the soil, whereas carbon from CO_2 in the air and not from the soil. He also suggested that plants obtain H & O from air as well as from water and N from ammonia. He also established certain basic principles of sound soil management;

- cropped soil is restored to fertility only by adding to it all minerals & N removed by the plants.

- He established the theory of "**Law of Minimum**" in relation to plant nutrition. The law states that the productivity of a crop is decided by most limiting factor. He is regarded as the "**Father of Agricultural Chemistry**"

Francis Bacon (1591- 1624)

suggested that the principle nourishment of plants was water and the main purpose of the soil was to keep plants erect and to protect from heat and cold.

Jan Baptiste Van Helmant (1577 – 1644)

was reported that water was sole nutrient of plants.

Rober Boyle (1627 – 1691)

an England scientist confirmed the findings of Van Helmant and proved that plant synthesis salts, spirits and oil etc. from H_2O.

Anthur young (1741 – 1820)

- an English agriculturist conducted pot experiment using Barley as a test crop under sand culture condition. He added charcoal, train oil, poultry dung, spirits of wine, oster shells and numerous other materials and he conduced that some of the materials were produced higher plant growth.

- **Priestly** (1800)

  established the essentiality of O_2 for the plant growth.

- **J.B. Boussingault (1802-1882)**

  French chemist conducted field experiment and maintained balance sheet. He was first scientist to conduct field experiment. He is considered as ***father of field experiments***.

J.B. Lawes and J. H. Gilbert (1843)

- established **permanent manurial experiment** at Rothemsted Agricultural experiment station at England.

Year	Author	Issues
1600	Van Helmont	What can be used as food for plant growth
1772	Priestley	Plants release oxygen from leaves into the atmosphere
1804	De Saussure	Apart from CO_2, also water takes part in photosynthesis
1806	Thaer	First agricultural academy in Moglin (Germany)
After 1800	Thaer	The humus theory for plant nutrition
1834	Boussingault	The role of nitrogen in plant nutrition
1841	Liebig	Theory of mineral plant nutrition
1842	Sprengel, Liebig	Theory of minimum in agricultural chemistry; Liebig's Law of the Minimum
1842	Lawes	Patent: a way to obtain single superphosphate
1848	Lawes	First superphosphate factory in Liverpool
1886	Hellriegel and Wilfarth	Discovery of the phenomenon of nitrogen fixation by rhizobia
1911	Haber and Bosch	Synthesis of ammonia
1970	Borlaug	Green Revolution, technological capacity to feed the world
1994	Robert	Precision Agriculture
After 2000	Scientists	Innovative fertilizers

Learning Outcomes

- The student will be able to understand about essential nutrients there role in agriculture with respect to soil and crop production.

Student Effective Learning Outcome (SELO)

8. Ability to understand subject related concepts clearly along with contemporary issues.
9. Application of concepts of topic & it's technological application.

References

1. **Das (1996)** *Introductory Soil Science.* Kalayani Publishers.
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=7857


Thank You!