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# **Manures , Fertilizers and Soil Fertility Management**

## **11. History of Soil Fertility**

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# 11.1

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.









## 11.2

- ❑ 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) was first to classify “Land” based on specific crops.
- ❑ Columella (A.D. 45) emphasized the usefulness of turnips for soil improvements.
- ❑ Jethro Tull (1731) and Francis Home (1757) claimed that Nitre (Nitrate Salts), water, air, earth, Epsom salt ( $\text{MgSO}_4$ ), Saltpetre (Sodium & Potassium Nitrate), Vitriolated tarter (Potassium sulfate) and Olive oil increased plant growth.



## 11.2

- ❑ In the early 19th century Nicholas Theodore de Seussure (1804), a Swiss Physicist and Jean Baptiste Boussingault (1834), a French Chemist & Agriculturist, were first to report that plants need mineral nutrients for growth and development. J.B. Boussingault was the first to start field plot experiments on his farm.
- ❑ 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<sub>2</sub> 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; .
  - A 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”



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## 11.2

- ❑ John B. Lawes (1837) of the Rothamsted Experiment station, England was first to make and use Super phosphate on his farm (1840). Both J.B.Lawes & J.H. Gilbert (1852) applied the principles of Liebig. They further elaborated the chemistry of plant nutrition.
- ❑ A. Gris (1844) discovered that the 'Chlorosis'.
- ❑ By 1860, German Botanist Julius Von Sachs and others, established the essentiality of 10 nutrient elements.

Discovery of other five nutrients was made after more than 60-70 years, while the last one in the group "Chlorine" has established to be essential for plant growth only in 1954.



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## 11.3

### What is Soil fertility?

❑ 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

II. Edaphic factors or Soil management factors



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# 11.4

## What is 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”***





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# 11.5

## Criteria of Essentiality of Nutrients

❑ This concept was propounded by Arnon and Stout (1939) and they considered 16 elements essential for plant nutrition. For an element be regarded as an essential nutrient, it must satisfy the following criteria;

1. A deficiency of an essential nutrient element makes it impossible for the plant to complete the vegetative or reproductive stage of its life cycle.
2. The deficiency of an element is very specific to the element in question and **deficiency can be corrected /prevented only by supplying that particular element.**
3. The element must **directly be involved in the nutrition** and metabolism of the plant and have a direct influence on plant apart from its possible effects in correcting some micro-biological or chemical conditions of the soil or other culture medium.



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## 11.6

**Nutrient:** Nutrients are substances required by an organism for their normal growth and reproduction.

**Plant Nutrient:** The plant nutrient is a “food” which is composed of certain chemical elements often referred to as ‘plant nutrient’ or plant food elements considered very essential for growth and development of plants.

**Nutrition:** The supply and absorption of chemical compounds needed for growth and metabolism of an organism.



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## 11.7 Essential elements:

•Plants absorb or utilize more than 90 nutrient elements from the soil and other sources during their growth and development and about 64 nutrients have been identified in plants by their tissue analysis.

•But all are not essential for their growth and development. They require only 17 elements/nutrients. These 17 have been recognized as essential elements. They are;

1. Carbon (C)	10. Iron (Fe)
2. Hydrogen (H)	11. Manganese (Mn)
3. Oxygen (O)	12. Zinc(Zn)
4. Nitrogen (N)	13. Copper (Cu)
5. Phosphorous (P)	14. Boron(B)
6. Potassium (K)	15. Molybdenum (Mo)
7. Calcium (Ca)	16. Chlorine (Cl)
8. Magnesium (Mg),	17. Nickel (Ni)
9. Sulphur (S)	



# 11.8

## Classification of essential nutrients

Essential nutrients are classified into two major groups based on relative utilization or absorption by the plants and also based on their biochemical behavior and physiological functions. I. Based on relative utilization or absorption by the plants;

- A. Macro or Major Nutrients
- B. Micro nutrients

Further Macronutrients are classified into two types

**1. Primary Nutrient:** Nitrogen, Phosphorus and Potassium. These three elements are also called as fertilizer elements.

**2. Secondary Nutrients:** Calcium, Magnesium and Sulphur.

**Beneficial elements** are the mineral elements which stimulate the growth and have beneficial effects even at very low concentration. They are not essential or essential only for certain plant species under specific conditions. They are also known as 'potential micro-nutrients'.

Eg: Silicon (Si) for rice, Sodium (Na), Aluminum (Al), Cobalt (Co), Selenium (Se), Iodine (I), Gallium (Ga) and Vanadium (Va).





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## 11.9

### II. Classification based on their biochemical behaviour and physiological functions.

Group	Nutrient elements	Biochemical Functions
Group I	C,H,O, Ca	They are basic structural elements. They are Major constituent of plants (carbohydrates, proteins and fats) and organic matter. These elements are also involved in enzymes process. They provide energy for growth and development by oxidative break down.
Group-II	N,P & S	Accessory structural elements of the more active and vital living tissues. Essential component of metabolically active compounds like amino acids, proteins, enzymes and non-proteinaceous compounds. They involve in energy storage (ATP & ADP) and transfer (Phosphate esters).
Group-III	K, Ca, Mg	Regulators & carriers for the most part of plant metabolism. They involve in synthesis and translocation of carbohydrates, maintain ionic charge balance and induce enzyme activation.
Group-IV	Fe, Mn, Zn, Cu, B, Mo, Cl.	Catalysts and activators. These elements Involve in oxidation-reduction reactions, chlorophyll synthesis and also exists in organic combinations.



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**Thank you**