EXTENDED LECTURE OUTLINE

SAC6 121 **Soil Fertility Management** **(2+1)**

Extended syllabus

History of soil fertility and plant nutrition, including the establishment of Rothamsted Experimental Station and the founding of the International Institute of Agriculture, the Food and Agriculture Organization of the United Nations, and the International Society of Soil Science.

Soil fertility and productivity, and the difference between soil fertility and soil productivity. Factors affecting soil fertility.

Essential and beneficial plant nutrients - classification based on source, mobility and requirement. Nutrient status levels such as deficient, critical range, sufficient, and excessive or toxic, including the Steenberg effect and luxury consumption. Criteria of essentiality of nutrients, including Arnon's criteria of essentiality, and classification of nutrients based on relative requirements, biochemical behavior, physiological functions, content present in tissues, and mobility of nutrients. Forms of nutrients absorbed by plants and forms of nutrients present in soils.

Roles and functions of essential plant nutrients (N, P, K, Ca, Mg, S, Zn, Fe, Mn, Cu, B, Mo, and Cl), including their deficiency and toxicity symptoms.

Mechanisms of nutrient transport to plants, including mass flow, diffusion, and root interception, and factors affecting nutrient availability to plants.

Chemistry of macronutrients, including their gains and losses in soil: Nitrogen:

Forms of nitrogen absorbed by plants. Gains of nitrogen to soils. Losses of N in soils (N cycle). Transformation of N in soils. Mineralization of N (Aminization. Ammonification and Nitrification) in soils. Factors affecting nitrification.

Phosphorus: Forms of P in soils (organic and inorganic P). Gains of P in soils. Losses of P in soils. P fixation in soils (P cycle)

Potassium: Forms of K in soils. Gains of K in soils. Losses of K in soils. Transformation of K in soils. (K cycle)

Calcium, Magnesium and sulphur: Forms of Ca, Mg, and S in soils. Gains and Losses of Ca, Mg and S. Transformation of Ca, Mg, and S in soils (Ca, Mg, and S cycles in soils).

Zn, Fe, Mn, Cu, B, Mo (Micronutrients):

Forms of Micronutrients in soils. Transformation in soils. (Zn, Fe, Mn, Cu, B, Mo cycles in soils). transformations of micronutrients such as Zn, Fe, Mn, Cu, B, and Mo in soils.

Manures: Definition, classification, and importance of organic manures; bulky and

concentrated organic manures; farmyard manure (FYM), including methods of preparation such as pit method, heap method, and covered pit method; important characteristics and NPK content of FYM. Compost, including its NPK content, essential requirements for compost making, classification of composting (aerobic and anaerobic), and factors affecting the rate of composting. Concentrated organic manures of plant and animal origin.

Green manures: Green manures and green leaf manures; types of green manuring; characteristics of green manure crops; crops suitable for green manuring; benefits and disadvantages of green manuring.

Fertilizers: Definition and classification of fertilizers; classification of nitrogenous, phosphatic, and potassic fertilizers. Nitrogenous fertilizers: Classification, Composition and properties of major nitrogenous fertilizers viz., Ammonium sulphate, Urea, Calcium Ammonium Nitrate (CAN). Phosphatic fertilizers: Composition and properties of SSP, TSP and Basic slag. Potassic fertilizers: Composition and properties of MOP, SOP. Secondary fertilizers: Different sources of these nutrients and their contents. Micronutrient fertilizers: Different sources of these nutrients and their contents.

Complex fertilizers: Definition, types, classification, characteristics, and advantages of complex fertilizers. Mixed fertilizers: advantages and disadvantages of mixed fertilizers. Customized fertilizers: guidelines for manufacturing, and advantages and disadvantages of customized fertilizers. Water-soluble fertilizers: advantages and limitations. Nano-fertilizers and soil amendments. Fertilizer storage: methods of storage of fertilizers. Soil amendments- types of amendments like liming materials, gypsum and soil conditioners;

Fertilizer Control Order (FCO) and Fertilizer Control Act: importance and regulations. Specifications of fertilizers such as ammonium sulphate, urea (46% N, free-flowing), potassium chloride (muriate of potash), diammonium phosphate (18-46-0), and zinc sulphate heptahydrate ($ZnSO_4 \cdot 7H_2O$).

Soil fertility evaluation: Different approaches and methods for soil fertility evaluation, and diagnostic techniques for soil fertility assessment. Soil testing: concept, parameters tested, methods for estimating available nutrients, and critical levels of different nutrients in soil. Plant analysis: concept, methods, total and rapid tissue tests, critical levels of nutrients in plants, and indicator plants.

Fertilizer recommendation approaches: Methods of fertilizer recommendation, including soil test-based fertilizer recommendations for crops. Factors influencing nutrient use efficiency (NUE) with respect to N, P, K, S, Fe, and Zn.

Methods and time of nutrient application under rainfed and irrigated conditions: Broadcasting, Band placement, Furrow application, Seed cum fertilizer drill, Foliar

application

Integrated Nutrient Management (INM): Integrated plant nutrient supply system, components, goals, and constraints in the adoption of INM technology.

Soil Fertility Management-SAC6 121 (2+1)

Lecture outline

Lectures	Topics
01	History of soil fertility and plant nutrition
02	Soil fertility and productivity and factors affecting them
03	Essential and beneficial plant nutrients - classification based on source, mobility and requirement. Criteria of essentiality.
04	Role of plant nutrients on crop growth, deficiencies and toxicity symptoms.
05	Nutrient transport mechanism in plants, *i.e.,* Mass flow and diffusion
06	Mechanism of nutrient uptake in plants, *i.e.,* root interception, ion pumps, carrier hypothesis
07	Factors affecting availability of major, secondary and micronutrients to plants
08	Transformation of major nutrients in soil, *i.e.,* nitrogen, phosphorus and potassium and forms of nutrients in soil
09	Transformation of secondary nutrients in soil, *i.e.,* calcium, magnesium, sulphur, forms of nutrients in soil
10	Transformation of Micronutrients in soil and their forms of nutrients in soil
11	Organic manures- Introduction, Definition, Importance and concentration of nutrients in manures. manures v/s fertilizers.
12	Classification and properties of manures (Bulky & concentrated), Importance of manures in soil fertility management.
13	Methods of preparation of bulky and concentrated manures: methods of composting, types and composition of concentrated manures.
14	Green/leaf manuring: Green manures, types, advantages and disadvantages, composition, characteristics of green manuring crops
15	Chemical fertilizers: Classification of chemical fertilizers with examples
16	Nitrogenous fertilizers: Classification, Composition and properties of major nitrogenous fertilizers viz., Ammonium sulphate, Urea, Calcium Ammonium Nitrate (CAN)
17	Phosphatic fertilizers: Composition and properties of SSP, TSP and Basic slag.
18	Potassic fertilizers: Composition and properties of MOP, SOP.
19	Secondary fertilizers: Different sources of these nutrients and their contents.
20	Micronutrient fertilizers: Different sources of these nutrients and their contents.
21	Complex fertilizers: Types, composition of DAP, MAP, UAP & important Nitro phosphates, advantages and disadvantages, materials used
22	Mixed fertilizers: Properties, composition, Advantages & disadvantages over straight fertilizers.
23	Customized fertilizers: Advantages & disadvantages over straight fertilizers.
24	Nano fertilizers: Advantages & disadvantages over conventional fertilizers.
25	Soil amendments- types of amendments like liming materials, gypsum and soil conditioners;
26	Fertilizer ratio, Fertilizer grade, Fertilizer Storage.

27	Fertilizer Control Order (FCO): its importance and regulations.
28	Soil fertility evaluation different approaches/methods for soil fertility evaluation
29	Soil testing Concept, parameters tested, methods for testing available nutrients, critical levels of different nutrients in soil
30	Plant analysis concept, methods, total and rapid tissue tests, critical, levels of different nutrients in plants, indicator plants
31	Fertilizer recommendation approaches: methods of fertilizer recommendations/ Soil test-based fertilizer recommendation to crops
32	Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn
33	Methods of application of Nutrients under rainfed and irrigated conditions
34	INM-Integrated plant nutrient supply system, components of INM, goals of INM, constraints in adoption of INM technology

Practical schedule

1. Introduction to analytical instruments and their principles
2. Calibration and application of colorimetry and flame photometry
3. Determination of pH in soil
4. Determination of Electrical Conductivity in soil
5. Determination of Organic Carbon in soil
6. Estimation of available nitrogen in soil
7. Estimation of available phosphorus in soil
8. Estimation of available potassium in soil
9. Estimation of exchangeable calcium and magnesium in soil
10. Estimation of available sulphur in soil
11. Estimation of DTPA extractable micronutrients in soil
12. Digestion of plant and manure samples for nutrient analysis
13. Estimation of total nitrogen in plant/manure sample
14. Estimation of total phosphorus in plant/manure sample
15. Estimation of total potassium in plant/manure sample
16. Estimation of total sulphur in plant/manure sample
17. Visit to Soil testing laboratory/Fertilizer testing laboratory

Suggested readings

1. Fundamentals of Soil Science published by ISSS, New Delhi
2. F J Stevenson and M A Cole, Cycles of Soil, Carbon, Nitrogen, Phosphorus, Sulphur and Micronutrients (2^{nd} edition), Wiley
3. Soil fertility and fertilizers – by Samuel L. Tisdale, Werner L. Nelson, and James D. Beaton, Macmillan Publishing company, New York
4. Kornal Mengel, Ernest A Kirby, Harals Kosergarten and Thomas Apple, Principles of plant nutrition, Springer Nature
5. Dilip Kumar Das, Micronutrients: their behaviour in soils and plants, Kalyani publications
6. N C Brady and R R Weil, The nature and properties of soils, 15^{th} edition, Pearsons education, London