MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE 05
SEMESTER -END EXAMINATION
B.Sc (Hons.) Agriculture

Semester	: V (New)	Aca. Year	: 2019-20
Course No	: SSAC-353	Title	: Manures, fertilizers and Soil Fertility Management
Credits	: 3 (2+1)	Total marks	: 80
Day and Date	:	Time	: 3 hrs

Note : 1. Solve any EIGHT questions from section "A"
2. All questions from section "B" are compulsory
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

SECTION "A"

Q.1 a) State Arnon's Criteria of essentiality of nutrients. Classify the essential nutrients giving the forms in which they are absorbed by plants — Marks 4

Criteria for essentiality (Anon and Stout, 1939):

1. The plant must be unable to grow normally for completing its life cycle in absence of the nutrients.
2. The nutrient element is specific and cannot be replaced by another.
3. The element plays direct role in metabolism.

Forms and sources of essential plants nutrients :

Elements		Form	Sources
Carbon	C	CO_2	Air
Hydrogen	H	H_2O	Water and rest from soil solids
Oxygen	O	O_2	Air
Nitrogen	N	NH_4^+, NO_2^-, NO_3^-	Fixation (symbiotic and non symbiotic), added by rainfall
Phosphorus	P	$H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}	Apatite, Rockphosphate, fertilizers
Potassium	K	K^+	Felspar, Mica and illite, fertilizers
Calcium	Ca	Ca^{2+}	Limestone, calcite, Dolomite
Magnesium		Mg^{2+}	Dolomite, ferro-magnesium

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Mg		minerals i.e. Augite, Horn blende
Sulphur S	SO_4^{2-}, SO_3^{2-}	Iron pyrite, gypsum
Iron Fe	Fe^{2+}, Fe^{3+}	Iron pyrite, haematite, Limonite
Manganese Mn	Mn^{2+}	Pyrolusite
Zinc Zn	Zn^{2+}	Zircon
Copper Cu	Cu^{2+}	Copper pyrite
Boron B	$H_3BO_3^-$, $H_2BO_3^-$	Borosilicates, Tourmaline
Molybdenum Mo	MoO_4^{2-}, $HmoO_4^-$	Molybdates, Crystal lattice of primary and secondary minerals
Chlorine Cl	Cl^-	Halides, salts of chloride in water

Q.1 b) What is organic recycling? Give the chemical composition of undecomposed organic matter. 4

Organic Recycling : Returning the plant nutrients removed by crops from soil through additions of organic material of crop after harvesting crop is referred as an organic recycling. 1

Chemical composition of undecomposed organic matter:

1. Carbohydrates - 60 % , 2. Proteins - 10 %
3. Fats, Waxes & tannins - 5%, 4. Lignins - 25 % 1.5

Elemental composition :

1. Carbon - 44 %, 2. Oxygen - 40 %
3. Hydrogen - 8 %, 4. Ash - 8 % 1.5

Q.2 a) Define and classify bulky and concentrated organic manures. 4

Bulky organic manures : Organic material of natural origin having greater volume per unit nutrient content. C/N ratio may be about 20 : 1 examples - FYM, compost and green manuring. 2

Concentrated organic manure : Organic material of natural origin having small

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volume per unit nutrient content. These are generally undecomposed having C:N ratio may be less than 10 : 1. 2

Examples - oil cakes, blood meal, meat meal, fish and bonemeal.

Concentrated organic manures :

Types: 1. Plant origin – oil cakes : Edible and non edible,

2. Animal origin - Bone meal, fish & blood meal, poultry manure.

Edible oil cakes ; Suitable for feeding to cattles also. e.g. groundnut, cotton seed, linseed: sunflower, sesamum.

Non edible oil cakes : Not suitable for feeding to cattle. e.g. caster oil cake, Karanj cake, Mahua cake, neem cake.

Q.2 b) Define composting ? Explain. Bangalore method of compositing in detail. 4

Composting : It is largely a biological process in which aerobic and anaerobic micro-organisms decompose the organic matter and lower the C/N ratio of the refuse. 1

Pit method (Bangalore method) : It is an anerobic process. Anaerobic micro-organisms break down organic material, in absence of oxygen. Decomposition is not complete so methane and CO are also produced alongwith the CO_2. Reactions are as follows 3

i) Organic acids like $CH_3COOH \rightarrow CH_4 + CO_2$

ii) Organic N $\rightarrow$ NH_3

iii) Organic P $\rightarrow$ Reduced p.

Q.3 a) Define green manuring. Explain decomposition of green manuring in soil. 4

Green manure : Plant material incorporated into soil while green or soon after maturity, for improving the soil. 1

Decomposition in soil :

a) Aerobic : 1) Changes in carbon compounds

2) Changes in nitrogen compounds 3

3) Changes in mineral constituents.

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b) Anerobic: 1) Changes in carbon compounds
2) Changes in nitrogen compounds.

Q.3 b) Write down in detail about sewage and sludge along with their composition 4

Sewage : Liquid collected from closed drains usually contains urine and washings, the night soil and other solid ingredients. 2

Composition : N - 6 to 10%, P_2O_5 3 to 4% & K_2O 3 to 4% 2

Sludge : Settled sewage solids combined with varying amounts of water and dissolved materials removed from sewage by screening sedimentation. Chemical precipitation or bacterial digestion.

Composition:

N - 1.5 to 3.5%, P_2O_5 0.75 to 4.00 % and K_2O 0.3 to 0.6%.

Q.4 a) Define complex fertilizers. Write down the characteristics of complex fertilizers. 4

Complex fertilizers: The commercial fertilizers containing atleast two or more of the primary essential plant nutrients (N, P, K) are called complex fertilizers. 1

Characteristics *of* complex fertilizer:

1. High analysis fertilizers
2. Have Uniform grain size
3. Cheaper on the basis of nutrient content per Kg.
4. Transport and distribution cost is less
5. Safe for storage
6. Desirable as these contain balanced nutrients *for* applications.
7. Non caking and non hygroscopic. 3

Q.4 b) Define fertilizers? Classify nitrogenous fertilizers with suitable examples 4

Fertilizers : Any organic or inorganic material of natural or synthetic origin added to a soil to supply certain elements essential for the growth of plants. 1

Classification of nitrogenous fertilizers: Nitrogenous fertilizers are classified into four groups on the basis of chemical form in which nitrogen is combined with other elements. 3

Nitrate fertilizers : Nitrogen is in oxidized form i.e. NO_3

e.g. a) Sodium nitrate ($NaNO_3$) - 16% N

b) Calcium nitrate ($Ca(NO_3)_2$ - 15.5% N

Ammonical Fertilizers : Nitrogen is in reduced form i.e. NH_4 – N **e.g.**

a) Ammonium sulphate $(NH_4)_2SO_4$ -20% N

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b) Ammonium chloride (NH_4Cl)- 26% N
c) Anhydrous ammonia - 8.2% N
d) Ammonium phosphate ($NH_4H_2PO_4$) -20%N+20% P_2O_5
or16% N + 20 % P_2O_5

Nitrate and ammonium fertilizers : Nitrogen is in the form of $NO_3 - N + NH_4 - N$

e.g. a) Ammonium nitrate (NH_4NO_3) -34% N
b) Calcium ammonium nitrate -26% N
c) Ammonium sulphate nitrate -26% N

Amide fertilizers : Organic nitrogenous fertilizers, nitrogen in amid (NH_2) from e.g.

e.g. a) Urea $CO(NH_2)_2$ -46% N
b) Calcium cyanide ($CaCN_2$) -21% N

Q.5 a) What is Integrated Nutrient Management? Enlist advantages of INM 4

Integrated nutrient management is a system approach and give equal emphasis to use of chemical fertilizers , biological sources and systems of nutrients and soil fertility enhancing cropping pattern 1

Advantages

1.Increase soil organic matter through application 3

2. Efficiently cycle the nutrients and solubilities unavailable nutrients , fixes atmospheric nitrogen

3.Reduces leaching losses of nutrients

4.Increase number of favourable microorgnanisms

5.Improve physico-chemical and biological condition of soil

6. Reduces erosion hazards.

Q.5 b) Explain the mechanism of transport of ions from soil to roots. 4

1) Mass flow 2) Diffusion 3) Root interception 4

1)Massflow : Movement of solutes alongwith water to root surfaces in response to hydraulic gradients.

2)Diffusion : Originally conceived by Grahm and Fick. It is the process of transport of ions or molecules in response to concentration gradient. It is expressed by following equation.

3)Root interception : Ions in soil that are intercepted by the growth of roots through the soil and hence cannot have to move to the root before absorption.

0.6 a. Describe in detail nitrogen fixation in soil. 4

Nitrogen Fixation- 1

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The process in which atmospheric nitrogen is converted to formused by plant and micro-organism is called nitrogen fixation.

A.**Non biological fixation-** During lightening storm and electrical discharge, extreme temperature and pressure created which oxidises dinitrogen of atmosphere to nitric oxide or nitrite.$N_2+O_2 \rightarrow 2NO \rightarrow 2NO_3$ 1

B.**Biological Fixation-**Majior amount of nitrogen is fixed by biological sources. Among the biological sources two groups are mainly involved in nitrogen fixation.

Nonsymbiotic nitrogen fixation- Free living organisms exist independently in soil, which fix nitrogen in their body in form of organic molecules.The non symbiotic organism obtain energy from decomposing organic matter of soil or from photosynthesis. 1

Anaerobic organism-Clostridium spp.
Aerobic organism- Azotobacter
Photosynthetic-Rhidospirilium rubrum
Algae

Symbiotic nitrogen fixation- In system first , the nitrogen fixing micro-organisnm are either bacteria belonging to genera Rhizobium or Actinomycetes. 1

Associative nitrogen Fixation – In case of association the partnership is more casual and nitrogen transfer move indirect.This bacteria use rootexudates from the host plant as source of energy.Azospirillium, Azotobacterand Pseudomanas genera

0.6 b) Write in brief the reactions of micro-nutrients in soil. 4

Reactions of micronutrients in soil: 4

1. Micronutrient cations interact with silicate in two ways
   a) They may be involved in cation exchange reaction
   b) They may be more tightly bound or fixed to certain silicate clays (2:1 typ
2. Zn, Co, Mn & Fe ions are found as elements in crystals of silicate clay.
3. Depending on the conditions they may be released from the clays or fixed.
4. The fixation may be serious in the case of cobalt and sometimes Zn.

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5. The uptake of Fe & Zn may be reduced in the presume of excess P.
6. Micronutrient cations may be held in the Organic collaboration (Protein, aminoacids, Humus, citric and tartaric acid).
7. When an. inorganic iron salt such as $FeSO_4$ is added to calcareous soil most of the Fe is quickly rendered unavailable by reaction with hydroxide.

   $Fe^{3+} + 3OH^- \longrightarrow FeOOH + H_2O$

   Available ←---------- Unavailable

8. If iron is added in the form of Fe chelate the iron remains in the chelate form which is available to plant.

   FeEDDHA + 3 OH^- ------→ FeOOH + EDDHA-3 +

   Available ←---- Ethyl Diomine Dihydroxy pheylactic acid. H_2O.

9. Zinc chelate is added to a soil with significant quantities of available Iron.

   Zn Chelate + Fe ------→ Fe chelate + Zn

Q.7 a) What is mean by soil fertility evaulation? Enlist the methods of Soil fertility evaluation . 4

Soil fertility evaluation: It is the assessment of nutrient supplying capacity of soil. 1

Methods : I) Chemical II) Biological III) Visual symptoms

I) Chemical 1

1)Soil Test
2)Plant Analysis

II)Biological methods

A) Using higher plants :1) Neubauer seedling 1
2) Pot culture experiments
3) Field experiments
4) Mitscherlichs technique
5) Jenny's pot culture test
6) Sunflower and lettuce technique

B) Using micro-organisms:1) Azotobacter
2) Aspergillus niger
3) Cunninghamella plaque method

III) Visual symptoms 1

Nutrient deficiency symptoms

Q.7 b) Give sources of phosphorus to soil and describe phosphorus fixation in soil. 4

Sources : a) Commercial fertilizers b) Native compounds of P in Soil 2

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i.e. i.e. apatite and rock phosphate c) Plant residues, animal manures and green manures d) Human, industrial and domestic wastes.

Forms : **1) Organic :** a) Inositol phosphates
b) Nucleic acids
c) Phosphates of calcium (Apatite)

2) Inorganic : a) Phosphates of calcium (Apatite)
b) Iron phosphate (strengite)
c) Aluminium phosphate (Variscite)

Phosphorus fixation : 1) Precipitation by Fe, Al and Mn ions, hydrous oxides and silicate clays in acidic soils 2) Fixation of P by calcium compounds in alkaline soil. 2

Factors affecting /controlling availability and fixation of P in soil

Soil pH, nature and amount of soil components, effect of aging soil organisms, temperature and quantity / intensity factors.

Q.8 a) Enlist different approaches for plant analysis and Describe DRIS in detail 4

Plant Analysis- 1

This involve two approaches.

1)Analysis of plant in laboratory

2)Tissue test on fresh issue in the field.

DRIS(Diagnosis and Recommendation Integrated System)-It is a system that identifiesall nutrition factors limiting crop production and thus increases the chance to obtainhighcropyield by improving fertilisers recommendations. It is a mathematicaltechnique to apply plant analysis information for diagnosing the most limiting nutrient in production system. The evaluation is made by comparing the relative balance of nutrient content with norms established for that crop under high yield conditions. 2

1

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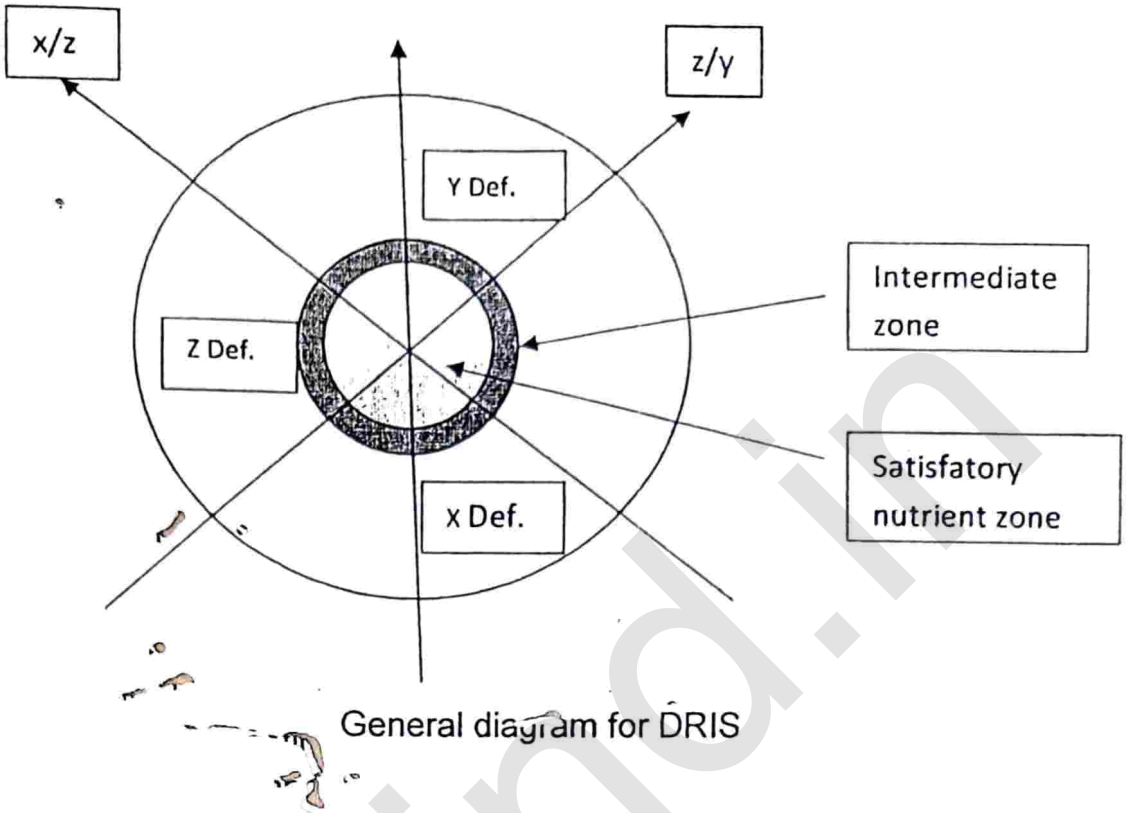

General diagram for DRIS

Q.8 b) Discuss about losses during handling and storage of fertilizers 4

Fertilizer differ in their ability to become moist or hygroscopic, as such they have to be handled during rainy season. 4

Nitrogenous Fertilizer-

i. Ammonium chloride -Excellent, no difficulty in storage and handling

ii. Ammonium nitrate-Storage properties are satisfactory but fertilizer is hygroscopic. So bags are firmly tied. As it is fire hazardous handle carefully. It is bagged in polythene lined jute bags as it is hygroscopic.

iii. Urea- Storage properties satisfactory. Hygroscopic, store in polythene lined jute bags in dry place.

iv. Ammonium sulphate & Sodium Nitrate- Storage properties good, no difficulties in handling & storage.

Phosphatic fertilizers:

i) Single super phosphate:

- It contains small amount of acid which deteriorate gunny bags, hence it should be stored in polythelene lined gunny bags.
- Cakes formation in moist condition.

ii) Dicalcium phosphate - Excellent physical condition.

Potassic fertilizers:

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i.Potassium sulphate- Excellent physical condition for storage and handling.

ii.Potassium chloride -Excellent physical condition for storage and handling

Protect all fertilizer bags from moisture, water and rains. Protect bags against excessive sunshine .and heat by making use to shade of trees structures & covers.

Q.9 a) Define Soil Fertiity.What are advantages of soil testing and state various approaches for fertilizer recommendation on the basis of soil test. 4

Soil Fertility- It is defined as inherent capacity of soil to supply nutrients to plant in adequate amount and in suitable proportion. 1

Advantages of Soil Testing-

- To Maintain Soil Fertility
- To enhance crop yield
- To maintain Soil health
- To avoid indiscriminate use of fertilizer
- To reduce expenditure on fertilizer

2

Approaches for Fertilizer Recommendation on the basis of Soil Test

- General Recommendation adjusted to soil test rating
- Critical level Approach
- Targeted Yield Approach

0.9 b) Define nutrient use efficiency and explain factors influencing it. 4

Nutrient Use efficiency-It is defined as the amount of dry matter produced per unit of applied.

Factors affecting nutrient use efficiency-

a)Crop characteristics

b)Soil characteristics

c)Mangement practices

d)Climate

Q.10 1) **C/N ratio**: The ratio of the weight of organic carbon to the weight of total nitrogen in soil or organic material. 4

C/N ratio in plants & Microbes and soil :

Legumes and farms manures- 20:1 to 30:1

Straw residues - About 100 :1

Saw dust - 400 : 1

Microorganism - 4:1 to 9 : 1

Soil - 10:1 to 12:1.

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Significance of C/N ratio:

1. Effect on soil colour
2. Influence on physical properties.
3. High cation exchange capacity
4. Supply and availability of nutrients.
5. Effect on carbon cycle

2) **Potassium fixation :** In presence of vermiculite, smectite and other 2:1 type minerals. 4

Factors affecting K fixation :

1) Nature of soil colloids
2) Wetting and drying
3) Freezing and thawing
4) Presence of excess lime

3) Earth worms produce more compost in a shorter time with less effort than any other method of composting. 4

Definition : The compost which is produced by earthworms having the highest grade and containing greater amounts of available / stable nutrients and high percentage of casting.

Earth worm casting : It contains humus, micro-organisms harmones, enzymes, auxin and other biomolecules.

Types of earth worms

1. Red worms - Lumbricus rubellus
2. Brandling worms - Eisenia foetida
3. Field worms - Allolobophora caliginosa

Method of vermicomposting in pit : Pit should be under shade.

1. **Selection of earth worm :** Use exotic detrivorus / epigeous species e.g. *Eudrilus easental*, *Eisenia foetida*.
2. **Size of pit :** Any convenient dimension such as 2 m x 1 m x 1 m may be prepared. This can hold 10-40 thousand worms.
3. **Preparation of vermibed :** A layer of 15-20 cm thick of good loamy soil above a thin layer (5 cm) of broken bricks and sand should made.
4. **Inoculation of earth worms :** About 2000 earthworms are introduced as an optimum density into a compost pit of 2m x 1m x 1m.
5. **Organic layering :** It is done on the vermibed with fresh cattle dung. The compost pit is then layered to about 5 cm with shredded organic litter of dry leaves or hay. Moisture level is maintained (without flooding) by addition of water.
6. **Wet organic layering :** It is done after four weeks with moist/ green organic waste and can be spread over it to a thickness of 5 cm. Practice is repeated every 3-4 days till compost is nearly full.
7. **Harvesting :** At maturation moisture content is brought down. This ensures drying of compost and migration of worms into vermibed. Mature compost is removed, sieved dried and packed.

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Rate of application : Vermicompost is recommanded @ 5 t ha^{-1}. Nutrient status of vermicompost (E. foetida)

SECTION "B"

Q.11 Select the appropriate word and rewrite

1 Ammonium sulphate is ammonical fertilizer .

2. Chemical formula for citrate soluble phosphate is $CaHPO_4$.

3. Deficiency of iron is common in calcareous soils .

4. C:N ratio of saw dust is wide .

5. Rhizobia are symbiotic bacteria

6 K_2O content in biogas slurry is 0.8 to 1.2%

7 Soil test indicate the soil fertility .

8 Toxicity of calcium may lead to iron chlorosis .

Q.12 Match the pairs

1. Wheat straw-80-100:1 F
2. Boron- Tourmaline e
3. Ammonium Sulphate- 20%N h
4. Muriate of potash-56% K_2O b
5 In situ green manuring- Dhaincha c
6 Basic slag- Citric acid soluble g
7 Edible oilcake-Groundnut d
8 Poultry meal- Conc.Org. Manure a

HEAD
Head

(Nilam M. Kanase)
Assistant Professor
Section of Soil Science and Agril. Chemistry

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