MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE

SEMESTER END THEORY EXAMINATION

Model Answer Sheet

B.Sc.(Hort.)

Semester	: II (Old)	Academic Year	:	2017-18	
Course No.	: II/SSAC-122	Title	:	Soil Fertility and Nutrient Management	
Credit	: 2+1				
Day & Date	:	Time	:	Total Marks	: 80

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 diagram wherever necessary.

SECTION "A"

Q.1 (a) State the factors affecting soil fertility. (4M)

Ans. Soil fertility integrates a number of factors. The factors affecting soil fertility are as follows.

1) Total nutrient content of soil
2) Available nutrients
3) Soil reaction
4) Soil moisture
5) Soil texture and structure
6) Microbial activity
7) Organic matter content

1) Total nutrient content of soil : The fertility of soil is related to the total nutrient content in the soil. The total nutrient content of soil is the capacity of a soil to maintain the continuous supply of plant nutrients for a crop until maturity. If the soils contain ample amount of total nutrients, a sufficient quantity of nutrients would become available during the growing season.

2) Available nutrients : The fertility of soil is directly related to the chemical composition of the soil in respect of the available plant nutrients. Soil fertility can be maintained only by efficient and judicious management of nutrient addition to the soil from external sources by adding organic manure or chemical fertilizer.

3) Soil reaction (pH) : Soils differ markedly in their reaction. The soil micro-organisms responds very markedly to soil reaction which has direct and indirect effect on soil fertility. The soils with low pH are inadequate in supplying available Cu, P, Mo; on the other hand in saline alkaline soil, the deficiency of Ca, Mo, Zn, Fe, Mn is very common.

4) Soil moisture : Sufficient moisture is necessary for the proper utilization of the nutrients present in the soil since plants absorbs nutrients only in a

dissolved state. Water is the medium of all chemical reactions including those that take place in the soil. Further, in the absence of sufficient water, harmful salts are not leached out and accumulate in the soil resulting in the development of salinity.

5) Soil texture and structure : Physical condition of soil play an important role in fertility of the soil. The physical condition is a resultant of the size, shape, arrangement and mineral composition of the soil particles as well as volume and form of its pores. The availability of nutrients depends on the texture and structure of the soil.

6) Microbial activity : The decomposition of organic matter, fixation of microbial flora present in the soil, the physical and chemical nature of soil which influence the soil air, moisture and food supply of the micro-organisms, therefore affect the nature, type and abundance of microbial population and ultimately on fertility of soil.

7) Organic matter content : Organic matter is a good source of plant nutrients. It provides food for soil micro-organisms and the products of decomposition help to bring the mineral constituents of soil into solution. The practice of green manuring is also helpful to add organic matter in the soil.

(b) **Write the objectives of soil testing and plant analysis** (4

Ans. **The objectives of soil testing are :** (2

1) To assess the nutrient status / fertility status of soil.
2) To predict the amount of fertilizer needed in supplement the nutrient supply in soil.
3) To evaluate the nutrient status of soil of an area with the object of having an estimate of fertilizer requirement of the area.
4) To compare fertility status of two or more areas.
5) Soil analysis is an important diagnostic tool for evaluating and correcting or avoiding the problem.

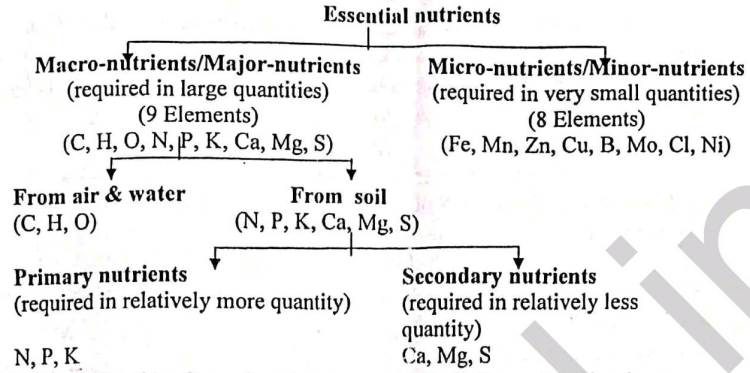
The objectives of plant analysis : (2M

1) Diagnosing or confirmation of the diagnosis of visible symptoms
2) Identifying hidden hunger
3) Locating areas of incipient deficiencies
4) Indicating whether the applied nutrients entered in the plants
5) Indicating interactions of antagonism among nutrients
6) Understanding the internal functioning of the plant

Q.2 (a) **What is mean by essential nutrients? Classify the essential nutrients.** (4M

Ans. **Essential nutrients** : A chemical element required for normal growth of plant without which plant cannot complete its life cycle. (1M)
Example: - C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B, Mo, Ni, Cl.

Classification : (3M)



(b) Define fertigation. State the advantage and limitations of fertigation. (4M)

Ans. **Fertigation :** Application of fertilizers through irrigation water is known as "fertigation". (1M)

Advantages : (3M)

1) Small quantity of fertilizer is needed
2) Fertilizer is applied evenly and equally
3) Nutrient deficiencies are avoided
4) Fertilizer use efficiency increase.
5) Labour saving
6) Minimum soil contact and no soil compaction
7) Less volatilization and fixation of nutrients

Limitations ;

1) Requires investment for additional cost for appliances
2) Clogging and choking problem
3) Back sucking of water in tanks
4) Fertilizers applied through irrigation must be non corrosive, completely soluble, safe to handle, non reactive with irrigation water, with low salt index.

Q.3 (a) What is 'A' Value technique ? (4M)

Ans. **'A' Value technique (i.e. Tracer technique) :-** (4M)

Tracer technique is passed on the assumption that if a plant derived a particular nutrient from the soil as fertilizer added to it, the amount available from soil can be calculated if that derived from the fertilizer is known.

By using radioactive isotopes, it has become possible to calculate the available nutrients in the soil. **Fried and Dean** (1952) defined A-value technique as that amount of a nutrient in soil which behaves in a similar way as the applied fertilizer nutrient doses.

$$A = B \frac{1-y}{y}$$

where A - Available soil nutrient
B - Amount of added fertilizer
y - The fraction of the nutrient in the plant which is derived from the fertilizer contained in the plant.

(b) Define soil pollution. Write kinds of pollutants.

Ans. **Soil Pollution**

Soil pollution usually originates from the development of industry, intensive agriculture associated with modern systems of cultivation like use of high analysis chemical fertilizers, use of pesticides, use of sewage, sludge, city composts and other industrial wastes etc.

Kinds of pollutants :

There are generally five different kinds of pollution namely :

1. Pesticides pollution in soil: Those are mostly used as soil application for agricultural purposes and all of which reach the soil.

e.g. Herbicides, insecticides, fungicides, nematcides, rodenticides etc.

2. Inorganic contaminants or pollutants : mostly heavy metal pollution in the soil.

viz. mercury, cadmium, lead, etc

3. Organic wastes : those from concentrated feed lots and food processing plants along with municipal and industrial wastes, some of which may be dumped on soil.

4. Salts : Contamination of soils with salts is one form of soil pollution primarily agricultural in origin.

5. Radio-nuclides :

6. **Acid rains :** Acid precipitation, popularly called acid rain, is apparently due to the oxidation of nitrogen and sulphur containing gases that dissolve in the water vapour of the atmosphere to form nitric and sulphuric acid.

Q.4 (a) Define soil fertility evaluation. Enlist different method of soil fertility evaluation.

Ans. **Soil Fertility Evaluation :** The assessment of nutrient supplying capacity of a soil is called soil fertility evaluation.

The various methods to evaluate soil fertility are classified as follows.

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

I) Chemical methods

A) Soil analysis

1) Total nutrient analysis
2) Available nutrient analysis
3) Rapid soil testing

B) Plant analysis

1) Total elemental analysis.
   a) Crop log technique
   b) 'A' Value technique (i.e. Tracer Technique)
2) Tissue testing

II) Biological methods :

A) Using higher plants

1) Neubauer seedling
2) Pot culture experiments
3) Field experiments

4) Mitscherlich pot culture method
5) Jenny pot culture test
6) Sunflower pot culture technique for boron

B) Using micro-organisms

1) Azotobacter
2) Aspergillus niger
3) Cunninghamella plaque method

III) Visual symptom method :

Diagnosis of deficiency symptoms of nutrients by visual observations in fields.

(i) Yellowing (ii) Purling
(iii) Local necrosis (iv) Stunting (4M)

(b) Define green manuring, give its types and advantage. (1M)

Ans. **Green manuring**

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 the soil. (2M)

Types of green manuring :

a) Green manuring in situ :- In this system, green manure crops are grown and buried in the same field which is to be green-manured, either as a pure crop or as intercrop with the main crop.
e.g. Sanhemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata*), Pillipesara (*Phaseolus trilobus*), Guar (*Cyamopsis tetragonoloba*)

b) Green leaf manuring :- Green leaf manuring refers to turning into the soil green leaves and tender twigs collected from shrubs and trees grown on bunds, waste lands and nearby forest areas.
e.g. Glyricidia (*Glyricidia maculate*), *Sesbania speciosa*, Karanj (*Pongamia pinnata*) (1M)

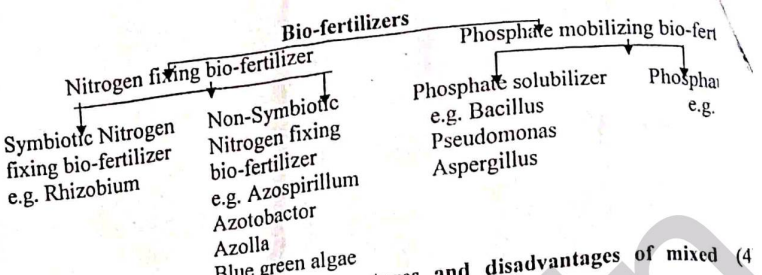
Advantages of green manuring : (Any two)

1) It adds organic matter to the soil. This stimulates the activity of soil micro-organism.
2) The green manure crops return to the upper top soil, plant nutrients taken up by the crop from deeper layers.
3) It improves the structure of the soil.
4) It facilitates the penetration of rain water, thus decreasing run-off and erosion.
5) The green manure crops hold plant nutrients that would otherwise be lost by leaching.
6) When leguminous plants, like sanhemp and dhaincha are used as green manure crops, they add nitrogen to the soil for the succeeding crop.
7) It increases the availability of certain plant nutrients, like phosphorus, calcium, potassium, magnesium and iron.

Q.5 (a) Define bio-fertilizers and give its types with examples. (4M)

Ans. In general, **bio-fertilizers** are defined as the preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulytic microorganisms used for the application to seed, soil or composting areas with an objective of increasing numbers of such micro-organisms and to accelerate certain microbial processes to augment the extent of availability of nutrients in a form which can be easily assimilated by plants. (1M)

Types of bio-fertilizers : (3M)



(b) Define mixed fertilizers. Write advantages and disadvantages of mixed fertilizers. (4

Ans. **Mixed Fertilizers**: Mixed fertilizers are physical mixtures (without chemical reactions) of straight fertilizers which contain two or more major fertilizer nutrients. (1 (

Advantages of Mixed Fertilizer :

1) Less labour is required than to apply nutrients separately.
2) It gives balanced fertilization for proper crop growth.
3) The residual acidity of fertilizers can be effectively controlled by using proper quantity of lime in mixtures.
4) Micro-nutrients can be incorporated in fertilizer mixtures to fasilitate the uniform application.
5) These have better physical conditions and are more easily applied.

Disadvantages :

1) Their use does not permit application of individual nutrient which may suit the needs of crop of specific time
2) The unit cost of plant nutrients in mixtures is usually higher than straight fertilizers,
3) Farmers often use mixtures without careful study of their needs thus applying too little of some nutrients and much more of others.

Q.6 (a) Explain nutrient management in acid soils.

Ans.

- Soil acidity alters kind, number and activities of micro-organisms and subsequent availability of mineralized N. Also soil acidity inhibits biological N-fixation. So higher dose of N split applications and foliar sprays are useful.
- Phosphorus content of acid soils is low and P–fixation capacity is more. Therefore more phosphate quantities through rock phosphate and other acid P-soluble fertilizers are good for acid soils.
- Acid soils contain very low quantities of total and S available K. Therefore, K application is necessary in acid soils for all crops.
- Fe, Cu, Mn and Zn are soluble in low pH of acid soils hence their deficiency is uncommon in acid soils in general.
- Molybdenum deficiency is often associated with acid soils because it becomes less soluble as pH falls. Addition of Mo–salts and lining increases the uptake of Mo in acid soils.

***(b)* Define concentrated organic manure and give its type with brief description.**

Ans. **Concentrated organic manure** : are those that are organic in nature and contain higher percentages of major plant nutrients like nitrogen, phosphorus and potash,

compared to bulky organic manures like FYM and compost. These concentrated manures are made from raw materials of animal or plant origin.
These are generally un-decomposed. C:N ratio may be less than 10:1.
Examples - Oil cakes, blood meal, meat meal, fish manure and bone-meal.

Types Concentrated organic manures : (3M)

1) Plant origin – Oil cakes are the quick-acting organic manures. Though oil cakes are insoluble in water, their nitrogen becomes quickly available to the plants in about a week or ten days after application. Oil cakes should be well-powdered before application, so that they can be spread evenly and are easily decomposed by micro-organisms.
Oil cakes can be grouped into two classes, namely.

(i) Edible oil cakes : Suitable for feeding to cattle
e.g. groundnut, cotton seed, linseed, sunflower, sesamum

(ii) Non-edible oil cakes : Not suitable for feeding to cattle
e.g. caster cake, karanj cake, mahua cake, neem cake

2) Animal origin - Bone meal, fish meal & blood meal, Poultry manure

1) Bone meal :-

Bone-meal Raw or Untreated bone-meal : Bones collected from slaughterhouses and from the countryside are dried and crushed without treatment. Such raw bone-meal contains 2 to 4 % nitrogen and 20 to 25 % P_2O_5.

Bone-meal Steamed : The bones are sterilized with steam and then they are dried in warm, rotating ovens. After this process, the bones become brittle and can be fairly easily ground.

2) Fish meal :- Non-edible fish carcasses and fish offal are used to prepare fish-meal. The fish is dried, crushed or powdered and filled in bags. Small machines, like the fish boiler and squeezer, are used to speed up the work.
Fish manure contains 4 to 10 % nitrogen, 3 to 9 % P_2O_5 and 0.3 to 1.5 % K_2O.

3) Blood meal :- The blood is collected in the slaughter-houses. The blood clot is first treated with commercial copper sulphate at 125 g/100kg of clot. It is then evaporated to dryness on a sand bath. Next, it spread on a concrete floor covered over by a net, and allowed to dry in sun. When complete dried, it is powdered, bagged and sold as blood-meal.
Blood meal contains about 10 to 12 % nitrogen and 1 to 2 % phosphoric acid.

4) Meat meal :- The meat is cooked or digested in a special type of pan two to three hours. This meat is dried on a sand bath till it is brittle and then powdered.
Meat meal contains about 10.5 % nitrogen and 2.5 % phosphoric acid.

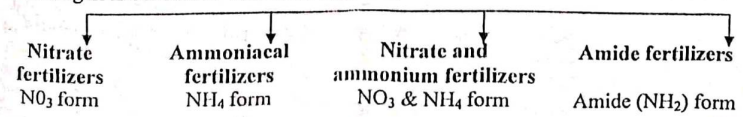
5) Horn and hoof meal :- Horn and hoof after cooking in the bone digester, are taken out, dried and powdered.

6) Poultry manure :- Excreta of the birds collected from poultry.

Q.7 (a) **Classify the nitrogenous fertilizers on the basis of chemical form of nitrogen along with one examples of each.** (4M)

Ans. **Classification of Nitrogenous fertilizers :** (4M)

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



1) **Nitrate fertilizers :** Nitrogen is in oxidised form i.e. NO_3.

i) Sodium nitrate ($NaNO_3$) – 16 % N

ii) Calcium nitrate [$(Ca(NO)_2$ – 15.5 % N

2) Ammoniacal fertilizers : Nitrogen is in reduced form i.e. NH_4-N

i) Ammonium sulphate – $(NH_4)_2SO_4$) – 20 % N

ii) Ammonium chloride (NH_4Cl) – 26 % N

iii) Anhydrous ammonia NH_3 N – 8.2 %

iv) Ammonium phosphate ($NH_4H_2PO_4$) – 20 % N + 20% P_2O_5 /16% N + 20% P_2O_5

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

i) Ammonium nitrate (NO_3-N + NH_4NO_3) – 34 %

ii) Calcium ammonium nitrate – 26 % N

iii) Calcium ammonium nitrate – 26 % N

iii) Ammonium-sulphate nitrate – 26 % N

4) Amide fertilizers : Organic nitrogenous fertilizers, nitrogen in amide (NH_2) form

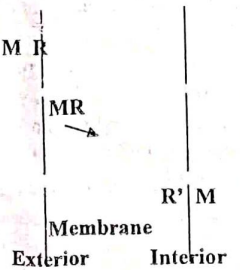
i) Urea [$CO(NH_2)_2$] – 46 % N

ii) Calcium cynamide ($CaCN_2$) – 21 % N

(b) Explain carrier hypothesis of mechanism of nutrient uptake.

Ans. **Carrier hypothesis :- Epstein and Hagen** postulated this hypothesis. According to this hypothesis there is a carrier present on the membrane which combined with the ion at the outer surface of the plasmalemma, the carrier-ion complex transverse the membrane, which is relatively impermeable to the ion alone. On the inner side of the membrane owing to some chemical change, the membrane–ion complex breaks, releasing the ion which can not leak because the membrane is impermeable to free ion. On releasing the ion, the carrier moves back to the outer surface of the membrane where it can again combine with an ion.

M = Ion and R, R' = Carrier



Q.8 (a) Define organic farming. Write the merits-demerits of organic farming.

Ans. **Organic farming :** Organic farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. Organic farming emphasize using only organic fertilizers for fertility maintenance and banning nearly all chemical pest control methods.

Merits of organic farming :

- Improvement in the environment
- Organic matter built up

iv) Ammonium sulphate	:	Storage properties good, no difficulties in handling and storage
Phosphatic fertilizers :		
i) Single Super phosphate	:	i) It contains small amount of acid, which deteriorate gunny bags, hence, it should be stored in polythelene lined gunny bags. ii) Cakes formation in moist condition
ii) Di-calcium phosphate	:	Excellent physical condition
Potassic fertilizers		
i) Potassium sulphate	:	Excellent physical condition for storage and handling
ii) Potassium chloride	:	Protect all fertilizer bags from moisture, water and rains, Protect bags against excessive sunshine and heat by making use of shade of trees.

(b) Write in brief about visual method of soil fertility evaluation.

Ans. The principle of visual method technique is that plants expressed through visual growth characteristics, a certain symptoms that is associated with certain malfunctioning growth factor. Usually specific abnormal colours are developed in the leaves due to deficiency of plant nutrients. Developing symptoms show up in either old leaves or young parts of plant, depending on the ease of with which the plant can move the particular element.

Symptoms :

a) **Chlorosis** (Yellowing) : Centralized yellowing of old leaves or all leaves may indicate deficiency of N or S , though it may also indicate old age, water logging or lack of light. Chlorosis of part of the nature leaves is some time sign of P or Mg deficiency. Interveinal chlorosis (yellowing between veins, with the veins forming green pattern) is a symptom of a deficiency of Fe, Mn or some times Zn or Ca.

b) **Purling** (accumulation of anthocyanin pigments) : An overall dark colour with a purple, blue of red tints is the common sign of P deficiency. It can also occure in Al toxicity and draught. Some plant species and variety do not show this colouration when P deficiency, but become yellow instead.

c) **Local necrosis** (death of tissue) : Necrosis of patches of spots or margins on leaves is a sign of K deficiency, salt damage of some times Mn deficiency. It can also result from drought of frost.

d) **Stunting** : Overall stunting (reduced growth) is a sign of all nutrients disorders. It is hardest to detect unless normal plants are nearby for comparison. Acute stunting of growing points produce distinct growth patterns character of certain deficiency. Zn deficiency produces 'little leaf' (in which the youngest leaves do not grow as large as normally full grown leaves) and resetting (in which the stem calls to elongate at all the tip, so that the terminal leaves bunches). B deficiency commonly kills the growing point.

Q.10(a) Classify the phosphatic fertilizers with examples and P_2O_5 content. (4)

Ans. (4)

Classification of Phosphatic fertilizers :

1) **Water soluble/Monocalcium phosphate $Ca(H_2PO_4)_2$**

i) Single super-phosphate - 16 % P_2O_5

ii) Double super-phosphate - 32 % P_2O_5
iii) Triple super-phosphate - 48 % P_2O_5
iv) Ammonium phosphate - 20 % N + 20 % P_2O_5 /16% N + 20% P_2O_5

2) Citric acid soluble/ Di-calcium phosphate ($Ca_2H_2PO_4$)$_2$
i) Basic slag - 14 to 18 % P_2O_5,
ii) Di-calcium phosphate - 34% to 39 % P_2O_5
iii) Rhenania phosphate - 23 to 26 % P_2O_5.

3) Insoluble/Tri-calcium phosphate – $Ca_3(PO_4)_2$
i) Rock-phosphate - 20 to 40 % P_2O_5
ii) Row bonemeal - 20 to 25 % P_2O_5
iii) Steamed bonemeal - 22 % P_2O_5

(b) Describe the effect of organic manure on soil properties. (4M)

Ans. **Effect of organic manures on soil properties :** (4M)

A) Physical properties :

Direct effect

1. Granulation encouraged
2. Plasticity, cohesion reduced
3. Water holding capacity increased

Indirect effect :

1) Infiltration rate increases
2) Run-off decreases
3) Good aeration, heat and water balance

B) Chemical properties :

1) Increases cation exchange capacity
   a) Adsorption and release of nutrients governed/increased
   b) Leaching losses of nutrients decreased
2) Nutrient supply and availability increases

C) Biological properties :

1) Microbial population increases
2) Biochemical reactions make nutrients more available
3) Adds nutrient by symbiotic and non-symbiotic nitrogen fixation.
4) Maintenance of soil organic matter with manures help efficient use of inorganic fertilizers.

SECTION "B"

Q.11 Fill in the blanks. (8M)

1) In biological soil fertility evaluation method, Sunflower pot culture technique is used for determination of element **B**.
2) Copper is absorbed by the plant in form of Cu^{2+}.
3) To prepare mixed fertilizers in good drilling condition and to reduce caking, low-grade organic materials are known as **conditioner**.
4) **Potassium** element is essential in the formation and transfer of starch and sugar.
5) The terminology Soil **Productivity** explains the capacity of soil for producing a specified plant or sequence of plant under a specified system of management and it is expressed in terms of crop yields.
6) **Co/ Na/Si/ Sc/ V/ Al** is an example of Beneficial elements.

- ❖ Higher level of biological activity and increased microbial population
- ❖ Improve physical condition of soil like aggregate stability and porosity increased, aeration and water holding capacity increased, lower rates of run-off and soil erosion
- ❖ CO_2 emissions are lower

Demerits of organic farming :

- ❖ The benefit of organic practices are not seen immediately.
- ❖ Large quantity of organic inputs are required.
- ❖ Difficult to get organic fertilizers
- ❖ Preferential behavior of consumers towards organic food mot yet established.
- ❖ Economic loss due to transition (from traditional agriculture to organic agriculture)
- ❖ Un-organized market for organically grown produce

(b) Write Arnon's criteria of essentiality of nutrient and function of nitrogen. (4M)

Ans. **Arnon's criteria of essentiality :** (2M)

In order to distinguish elements which are essential from those which may be taken up by the plant but are not essential, Arnon (1954) has laid down the following criteria

1) The plant must be unable to grow normally or complete its life cycle in the absence of the element.

2) The element is specific and cannot be replaced by another

3) The element plays a direct role in metabolism.

Functions of Nitrogen : (Any Four) (2M)

- Imparts dark green colour to plants.
- Produces rapid early growth.
- Increases protein content of food and fodder crops.
- It improves the quality of leafy vegetables and fodder.
- It is an essential component of amino acids, proteins, nucleic acids, nucleotides, enzymes, co-enzymes, alkaloids etc.
- Nitrogen–containing chlorophyll in the presence of solar energy fixes atmospheric CO_2 as carbohydrates.
- Being a constituent of nucleic acids *viz.*, Ribo Nucleic Acids (RNA) and Deoxyribo Nucleic Acids (DNA), nitrogen is responsible for the transfer of genetic code to the off-spring.
- The proteins are the constituents of structural units and participate in catalysis of biochemical reactions.
- Nitrogen fertilization improves protein quality of the food grain by enhancing the proportion of glutamic acid, praline, phenylalanine, cystine, methionine and tyrosin and decreasing the amount of lysine, histidine, arginine, aspartic acid, threonine, glycine, valine and leucine in the grain.

Q.9 (a) Write about handling and storage of different fertilizers. (4M)

Ans. (4M)

Name of fertilizer	:	Ease of storage and handling
Nitrogenous fertilizers		
i) Ammonium chloride	:	Excellent, no difficulty in storage and handling
ii) Ammonium nitrate	:	Storage properties satisfactory but fertilizers hygroscopic so bags are firmly tied. As it is fire hazardous handle carefully. Hygroscopic bagged in polythene line jute bags.
iii) Urea	:	Storage properties satisfactory Hygrosocpic, store in polythene lined jute bags in dry place

7) **Amide** group of nitrogenous fertilizers are soluble in water and hygroscopic in nature

8) Hollow stem of cauliflower and gummy deposits in citrus are causes due to deficiency of **Boron** mineral.

Q.12 Match the following pairs. (8M

Part "A"	Part "B"
1) Sodic soils	e) ~~5~~) Gypsum
2) Akiochi disease	g) 7) Sulphur
3) Potash rich mineral	h) ~~8~~) Sylvite
4) Saline soils	a) ~~1~~) Salinization
5) Saline soil reclamation	c) ~~3~~) Pressmud
6) Neutralizer	b) ~~2~~) Lime stone
7) Non-edible oil cake	f) ~~6~~) Karanj
8) Crop log technique	d) ~~4~~) Dr. Clement

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