



# MACHAKOS UNIVERSITY

University Examinations for 2018/2019 Academic Year

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF AGRICULTURAL EDUCATION AND EXTENSION

**SECOND YEAR, SECOND SEMESTER EXAMINATION FOR BACHELOR OF AGRICULTURAL EDUCATION AND EXTENSION, BACHELOR OF EDUCATION SCIENCES AND BACHELOR OF EDUCATION (SPECIAL NEEDS)**

**SOL 201: SOIL FERTILITY AND PLANT NUTRITION MARKING SCHEME**

**Date:**

**Time:**

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**Instructions: Answer question one and two other questions**

**Section A: 30 MARKS (COMPULSORY)**

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**Question ONE:**

(a) Explain the following factors that affect availability of nutrients in the soil

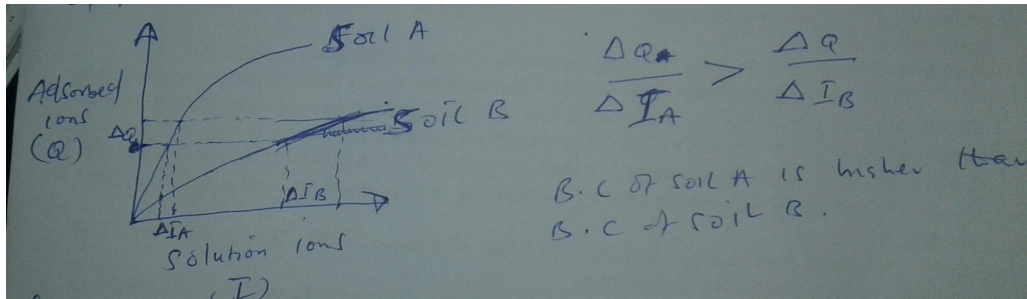
(i) Complementary cation effect

(5 marks)

- It is the influence of one adsorbed cation on the release of another from the surface of a colloid
- $\text{NH}_4^+$  will replace much more  $\text{Na}^+$  than  $\text{Al}^{3+}$  and  $\text{Ca}^{2+}$
- The soil will be rich in  $\text{NH}_4^+$  which goes into solution
- The  $\text{Al}^{3+}$  and  $\text{Ca}^{2+}$  ions will be the complementary cations in this case
- $\text{Na}^+ > \text{K}^+ = \text{NH}_4^+ > \text{Mg}^{2+} > \text{Ca}^{2+} > \text{Al}^{3+}$  i.e Sodium ions will be released most easily than Al ions.

(ii) Soil buffering capacity

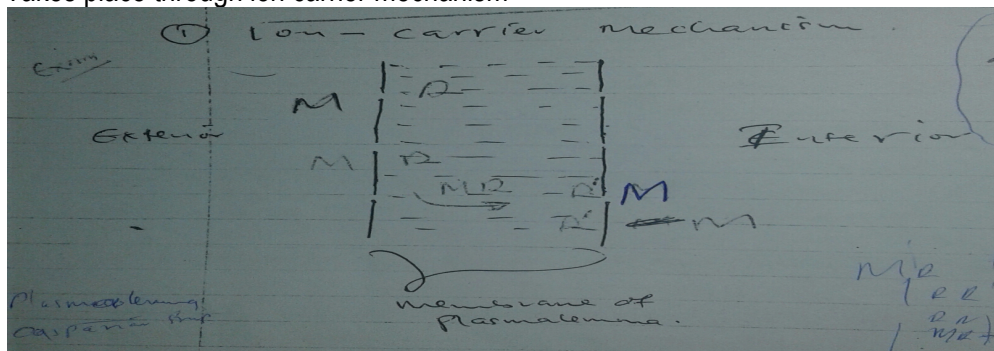
- It is the ability of soil to replenish nutrients absorbed by plants (1 mark)
- Described as the ratio of concentration of adsorbed ions to solution ions (1 mark)
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- Amount of ions in adsorption complex is called quantity factor (Q) (1 mark)
- 
- Amount of ions in soil solution is called intensity factor (I) (1 mark)
- 



(3 marks)

(b) Differentiate between passive and active ion uptake in plants (10 marks)

- Active ion uptake
  - Occurs at plasmalemma membrane
  - Transport occurs against electronic chemical gradient
  - It requires energy
  - Takes place through ion carrier mechanism



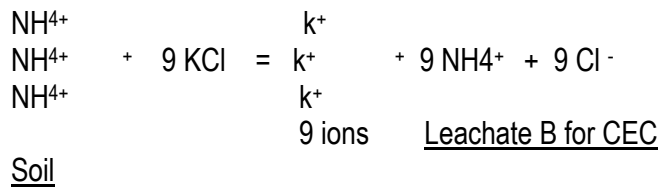
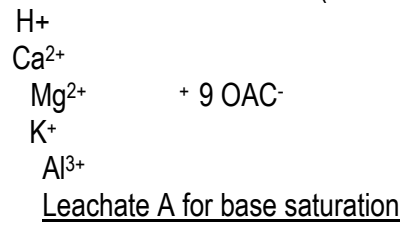
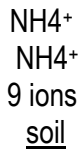
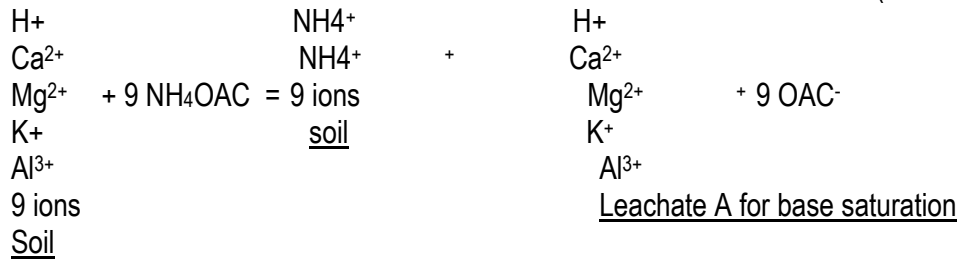
- Passive ion uptake
  - Does not go beyond casparian strip (occurs outside plasmalemma)
  - Epidermal and cortical cells form the apparent free space which provide negative charge
  - Uptake occurs through ion exchange and diffusion
  - It does not require energy and it is non-selective
  - Plasmalemma membrane and casparian strip are the boundary membranes of diffusion and ion exchange

(c) State the functions of nitrogen element in plants (3 marks)

- An essential element of all amino acids. Amino acids are the building blocks of proteins.
- A component of nucleic acids, which form the DNA of all living things and holds the genetic code.
- Nitrogen is a component of chlorophyll, which is the site of carbohydrate formation (photosynthesis).

(d) Certain grams of Oven dried soil was leached with 100 ml of 1 N Ammonium Acetate solution and the resultant solution (Leachate A) was filtered and stored for further analysis. The remaining soil was then extracted with 100 ml of 1 N Potassium Chloride solution and the Filtrate (Leachate B) was analyzed. Show the chemical reaction of the above experiment.

(5 marks)



## SECTION B: 40 MARKS (Answer any two questions)

### Question TWO:

(a) Explain the factors which influence the amount of nutrients leaching plant roots by mass flow (3 marks)

- Rate of water flow determined by soil moisture
- Water consumption by plants determined by transpiration and temperature
- Average nutrient concentration in the soil water

(b) Describe the factors that influence nutrient diffusion in soils (12 marks)

- Cross-sectional area of diffusion (It is influenced by the roots intensity)
- Concentration gradient (The lower the concentration the higher the gradient)
- Diffusion coefficient in water (How fast or slow the ion can move in water)
- Volumetric soil water content (As water content increases, diffusion rate increases)
- Soil buffering capacity (The higher the buffering capacity, the lower the rate of diffusion)
- Tortuosity factor (The higher the clay content, the higher the tortuosity)

(c) Explain why monocots survive in monocot-dicot intercrop system when potassium element is deficient in the soil (5marks)

Because legumes (dicots) tend to absorb divalent cations more preferentially over monocots (grasses) and vice versa.

### Question THREE:

(a) Describe the classes of inorganic Nitrogen fertilizers. Give examples in each. (12 marks)

- Nitrate based fertilizer eg calcium nitrate and sodium nitrate
- Ammonium based fertilizers eg ammonium sulphate and ammonium chloride
- Ammonium nitrates based fertilizers eg ammonium nitrate, calcium ammonium nitrate(CAN), ammonium sulphate nitrates
- Amides based fertilizers eg Urea

(b) Explain the fate of Nitrogen fertilizers in the soil. (8 marks)

- *Adsorption in adsorption complex*
- *Get in to soil solution for plants or leaching*
- *Get fixed into layers of 2:1 clay minerals*
- *Undergo oxidation to form nitrates which is very mobile in the soil*

#### Question FOUR:

(a) Explain the advantage of compound fertilizers over single fertilizers (12 marks)

- There are fewer man hours required to apply compound fertilizers than individual fertilizers
- They have better physical conditions than individual fertilizers
- Residual acidity can be conveniently and effectively be controlled than when individual fertilizer is applied
- When small amounts are required can be evenly applied than when individual fertilizer is applied
- No filler material may be required when compound fertilizer is required
- Less care is needed when compound fertilizers are applied than individual

(b) State eight (8) factors that are considered in selecting an appropriate fertilizer application method (8 marks)

- The type of soil
- Soil moisture content
- Soil fixing power of different nutrients
- Soil previous management
- The crop to be treated
- Crop root development
- Crop ability to extract nutrients from the soil
- Kind and amount of fertilizer to be used

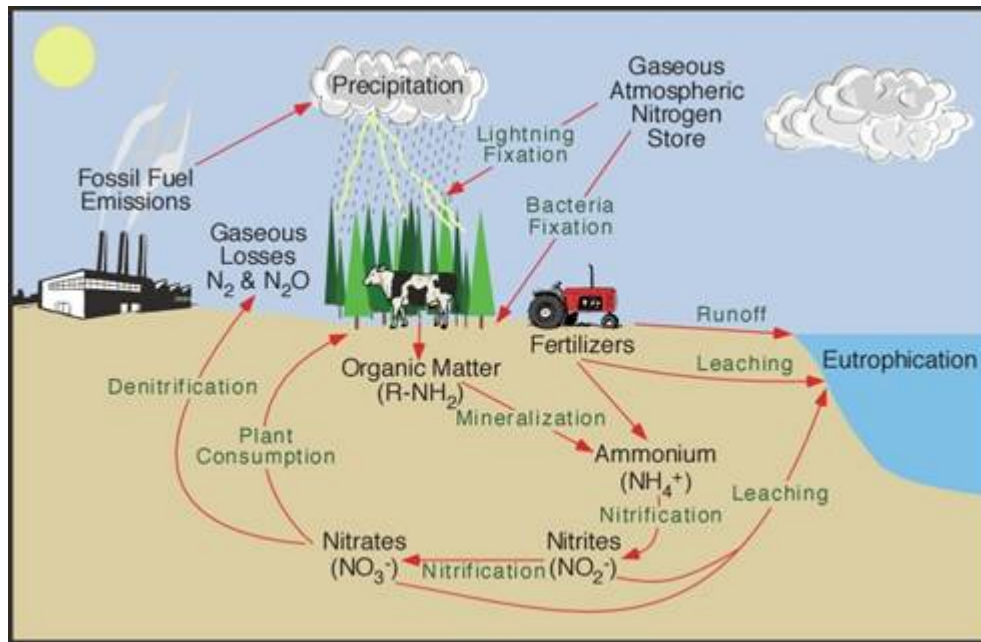
#### Question FIVE:

(a) Discuss how you can maintain and improve organic matter in the soil (8 marks)

- Through application of animal manure where farmyard manure can be applied which supply plant nutrients and improve soil structure
- Through incorporating straw into the soil which improves C:N ratio
- Through use of green manures which promotes rapid growth and vigorous root development
- Through use of compost manure which improve plant nutrients and increase crop yield

(c) Describe the Nitrogen cycle (12 marks)

## The Nitrogen Cycle



### Gains of Nitrogen to the Soil

- Biological and Atmospheric Fixation: Conversion of atmospheric nitrogen to ammonium which is subsequently available for plant uptake
- Direct additions of commercial and organic fertilizers

### Transformations in the Soil

- Mineralization: Conversion of organic nitrogen to ammonium
- Nitrification: Conversion of ammonium to nitrate

### Losses of Nitrogen from the Soil

- Denitrification: Conversion of nitrate to atmospheric forms of nitrogen
- Volatilization: Loss of gaseous ammonia to the atmosphere
- Run-off
- Leaching
- Consumption by plants and other organisms