



THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

FIRST SEMESTER FINAL EXAMINATION- 2020

DEPARTMENT OF AGRICULTURE

AG 311 SOIL FERTILITY AND SOIL MANAGEMENT

Thursday, 25th June 12:50 PM

PS R1/PS R3

3rd YEAR B.Sc.(Ag.)

TIME ALLOWED: 2 HOURS

INFORMATION FOR CANDIDATES:

1. You have 10 minutes to read the paper. You must not begin writing during this time.
2. Answer all questions in numerical order.
3. Answers must be written in the book provided. No other written materials will be required.
4. Rules, calculators and correction fluids are required in the examination room. Notes and text books are not allowed.
5. Write your name and student number clearly on the front page of your answer book and examination attendance slip. **DO IT NOW.**
6. The marks of each question are given at the end of question.
7. Maximum marks = **50.**

II Define any five terms.

10 Marks

1. Volatilization
2. Soil fertility
3. Plant critical nutrient concentration
4. Soil testing
5. Aluminium octahedra
6. Liming requirement

II Answer the following questions briefly.

30 Marks

1. Write the chemical forms (ionic formula required) of plant uptake for the nutrient elements Fe, Mo, Zn, N and P. 5 Marks
2. Name and explain different soil sampling designs/ methods used to assess the soil fertility. 5 Marks
3. Explain **any two** management strategies for ameliorating a sodic soil? 5 Marks
4. Explain the process of nitrification in soils with suitable equation/s. 5 Marks
5. Enlist **any four** major fertility evaluation techniques and explain **one of them**. 5 Marks
6. The fertilizer recommendation for the cassava crop is 100 kg N, 60 kg P₂O₅ and 60 kg K₂O per ha. In the fertilizer shop, a fertilizer with trade name 'NPKMIX' (10-26-26) and urea (46%N) are available. Calculate the fertilizer material for a 20 ha cassava garden? 5 Marks

III Chose the correct answer from the multiple options and write in your answer book

10 Marks

1. The product of industrial fixation of nitrogen is_____.
a.NO₂ b. NH₃ c. NO₃⁻ d.N₂O
2. The law of minimum was proposed by _____ in 1862.
a. Justus von Liebig b. Karl Bosch c. Black C. A. d. Olsen S. R.

3. An example for a mobile nutrient in crops would be _____.
 a. calcium b. sulfur c. iron d. nitrogen
4. Movement of nutrient ions through channel proteins is extremely rapid and could be about _____ ions per second.
 a. 10^6 b. 10^8 c. 10^{10} d. 10^4
5. An actinomycetes microbe capable of fixing N in non-legumes is _____.
 a. *Azotobactor* sp b. *Thiobacillus* sp c. *Frankia* sp d. *Aspergillus* sp
6. The P_2O_5 content of triple super phosphate fertilizer is _____.
 a. 16-22% b. 46% c. 10-20% d. 30-38%
7. The neutralizing value (NV) of calcite is considered as _____ for liming purposes.
 a. 100% b. 179% c. 136% d. 86%
8. A saline–sodic soil will have the following chemical characters:
 a. pH>8.5, ESP> 15%, EC<4 dS/m b. pH<8.5, ESP> 15%, EC<4 dS/m c. pH>8.5, ESP< 15%, EC<4 dS/m d. pH<8.5, ESP> 15%, EC>4 dS/m
9. The role of diphenylamine in the organic carbon determination is to _____.
 a. remove interference b. standardize ferrous ammonium sulphate c. act as an indicator d. oxidize the carbon
10. The instrument required to measure soil suspension pH is _____.
 a. conductivity bridge b. spectrophotometer c. polarimeter d. potentiometer



SOLUTION SHEET QP-2020

II Define any five terms.

1. Volatilization- *Gaseous emission of $\text{NH}_4^+\text{-N}$ in the soil to atmosphere as NH_3 gas*
2. Soil fertility- *Ability of a soil to supply all essential nutrients to crops in required amounts and proportions*
3. Plant critical nutrient concentration- *The critical nutrient concentration is the concentration of a plant nutrient in the biomass where growth is reduced 10% because of a shortage of the element in question.*
4. Soil testing- *It is the rapid chemical analysis of available nutrient status of soil and in broader sense it includes interpretation, evaluation and recommendations based on chemical analysis.*
5. Aluminium octahedral- *A basic structural unit of silicate clay minerals where an aluminium atom will be surrounded by six oxygen/hydroxyl ions or present in 6-fold coordination with oxygen/hydroxyl ions/atoms. The geometrical shape created by joining the centres of surrounding atoms shall have 8 triangular planes i.e. an octahedra.*
6. Liming requirement- *Amount of liming material required to increase pH of an acid soil to a predetermined near optimum pH level.*

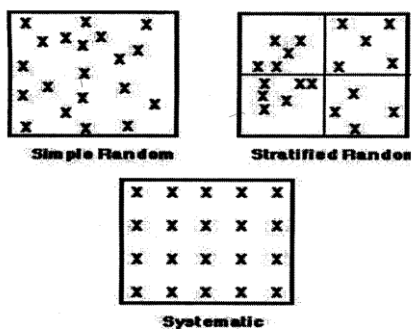
II

1. Fe- Fe^{2+} , Mo- MoO_4^{2-} , Zn- Zn^{2+} , N- NO_3^- , NH_4^+ and P- H_2PO_4^- , HPO_4^{2-} .

2. Simple random sampling

Stratified random sampling

Systematic sampling



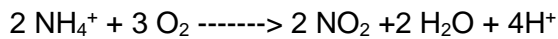
3. a. Organic matter application and residue management-to improve soil

physical properties

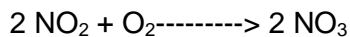
b. Gypsum or S application to replace/exchange with excess Na present in the soil.

4. The biological oxidation of NH_4^+ released by the process of ammonification to nitrate is known as nitrification. This process is carried out by nitrifying bacteria referred to as nitrifiers. Nitrifying microorganisms are chemoautotrophs and derive energy by oxidizing inorganic substances. Nitrification is an aerobic process. Nitrification is an acidification reaction. It is a two-step process in which NH_4^+ is first converted to nitrite (NO_2^-) and then to nitrate (NO_3^-).

Conversion to nitrite is brought about largely by a group of obligate autotrophic bacteria known as *Nitrosomonas* sp. as:



The conversion from nitrite to nitrate is affected by *Nitrobacter* sp. as follows :



Agriculturally, important for many reasons.

- a) Absorbed by the plants.
- b) Utilised by soil microorganisms
- c) Lost through excess water by leaching because of its high mobility- has environmental impacts
- d) Escapes from soil in volatile condition through nitrate reduction referred to as denitrification.

5. Foliar diagnosis

Plant analysis- can be of tissue tests or of total analysis of plants grown

Biological tests- in which growth of either higher plants or certain microorganisms is used to measure soil fertility

Soil analysis

Growing crops provide an idea of contribution of all growth factors. Careful inspection of the crop foliage can help identify a specific nutrient stress. If a plant is lacking a particular nutrient element characteristic symptoms appear. Due to deficiency or toxicity of a particular element normal metabolic process gets impaired resulting in either accumulation or shortage of certain organic compounds. This leads to the abnormal conditions recognized as symptoms.

Visual evaluation of nutrient stress is generally used as a supplementary

tool to other more reliable diagnostic techniques like soil and plant analysis. Practical applicability of this method of diagnosis is rather limited. The symptoms are very often vitiated by the interaction of the elements and also by the infestation of the pests and pathogenic diseases. Even when the symptoms have been diagnosed properly, it may be too late to remedy it and get a reasonable yield by applying the nutrient in question.

6. The fertilizer recommendation for the cassava crop is 100 kg N, 60 kg P₂O₅ and 60 kg K₂O per ha. In the fertilizer shop, a fertilizer with trade name 'NPKMIX' (10-26-26) and urea (46%N) are available. Calculate the fertilizer material for a 20 ha cassava garden?

$100 \times 60/26 = 231$ kg NPKMIX will supply 60 kg P₂O₅/ha

231 kg NPKMIX will also provide for 60 kg K₂O/ha

Amount of N met by 231 kg NPKMIX is-

$231 \times 10/100 = 23.1$ kg N. N required is 100 kg N/ha So, balance amount to be supplied is $100 - 23.1 = 76.9$ kg N which is now considered through urea.

$100 \times 76.9/46 = 167$ kg Urea/ha

For 20 ha cassava field fertilizer required is

$231 \times 20 = 4620$ kg NPKMIX

$167 \times 20 = 3340$ kg Urea

III

10 Marks

1. b
2. a
3. d
4. b
5. c
6. b
7. a
8. d
9. c
10. d