The University of Melbourne

The Institute of Land and Food Resources

Semester 2 Assessment 2003

202-203 Soil and Water Resources

Reading Time 15 minutes
Examination Duration 3 hours
This paper has 5 pages including this cover.

Authorized Materials
Hand held calculators are allowed

Instructions to Invigilators
Students will require script books only (initially 3)

Examination paper can be deposited in Baillieu Library

Instructions to students
This paper contributes 50% of the total subject mark.
You are to answer six (6) questions. There are three (3) sections. You must answer two (2) questions from each section.
Separate script books are to be used for each section

All questions are of equal value.

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Section 1

1. The following is an extract from a soil test report.

Available phosphate (Colwell P)	20 mg/kg
Available phosphate (Olsen P)	11 mg/kg
pH (water)	4.9
pH ($CaCl_2$)	4.3

Exchangeable cations

Calcium	7.20 meq/100 g
Magnesium	1.25 meq/100 g
Sodium	2.90 meq/100 g
Potassium	1.00 meq/100 g
Aluminium	1.95 meq/100 g

(Note – 1 meq/100 g is equivalent to 1 cmol charge (+)/kg)

(a) Perform whatever calculations are necessary on the above results to determine if the soil is likely to require gypsum, and give reasons for your conclusion.
(b) What other factors are likely to limit productivity in this soil? Make a recommendation as to how each limitation could be remedied?

2. Describe the principles on which soil and plant tests for plant nutrient deficiencies are based and how these tests should be used. include reference to a perennial crop such as a fruit orchard or a tree plantation, and an annual crop such as wheat. Give an example of one common practical method used to test for a nutrient deficiency.

3. Describe the key distinguishing properties of five of the main soil orders, recognized in the Australian Soil Classification of Isbell (1996), which are found in Victoria. Indicate how an appreciation of soil management issues can be inferred from these soil properties.

4. Why does the surface of a Vertosol (black clay soil) crack when it is dry, and swell when it is wet? Contrast this behaviour with that of a Ferrosol (sometimes called a krasnozem). Explain your answer with reference to the types of minerals – their crystal structure and properties, which are normally found in the clay fraction of these soils.

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Section 2

5. Provide a brief definition of the following terms as they relate to soil:

- isomorphous substitution (with two examples)
- duplex
- hydraulic conductivity
- cation exchange capacity, and give two examples of important cation exchange reactions in soil

6. Describe how the nature and composition of soil organic matter may differ between two land management systems. Include reasons for these differences and implications for soil chemical and physical conditions.

or

Discuss the mineralization and immobilization of nitrogen (N) in soil, and the key factor determining whether net mineralization will occur. Describe the process of nitrification and the implications of this process for N loss from the soil, and soil acidification.

7. Explain the difference between soil water content and soil water potential. Describe each component of water potential, and give 2 examples of how soil properties affect these potentials.

8. A wastewater disposal scheme is proposed with irrigation to use the excess water. Name the key chemical properties of the soil and water that need to be considered so as to maintain the soil physical structure. How do these chemical properties interact with the soil physical properties.

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Section 3

9. Describe the hydrologic cycle for a small, wooded catchment. Identify the main processes involving water movement and its change of state (from liquid to vapour phase). Explain how knowledge of the hydrologic cycle can be applied to the harvesting of water for various uses, such as public water supplies or irrigation?

Or

You are a land manager converting a long term pasture to a tree plantation. Explain how this land use change may affect the local hydrologic balance, with reference to each of the factors in the water balance equation.

10. An irrigator in the Goulburn Valley has applied 10 ML of irrigation water per hectare per year to 25 ha of perennial pasture. The annual average evapotranspiration from the pasture is 850 mm. For simplicity, assume there is no rainfall during the irrigation season.

(a) What is the potential depth of water accession to groundwater each year, assuming no runoff occurs?

(b) What is the leaching fraction for the site?

(c) What is the potential volume of groundwater accession for the 25 ha of pasture?

(d) If the electrical conductivity of the irrigation water is 0.9 dS/m, what would be the predicted annual salt load to groundwater for the site? (Assume that the concentration of dissolved salts (in mg/L) = 640 dS/m).

(e) Comment on whether you think this irrigation practice is sustainable in the long term.

11. What are the principal water management issues facing the Murray-Darling Basin Commission, and what strategies are being implemented by the Commission to counter obvious threats?

12. Describe the factors affecting on-site soil erosion rates, and distinguish these from the factors affecting off-site water quality. Considering either cereal cropping or native forestry, which of these factors can you best influence to protect water quality, and how?

13. Describe in detail the sequence of changes that have lead to dryland salinity problems in Australia. What are the options for controlling dryland salinity, and what are the factors that will determine how effective it will be to improve salinity problems? What factors determine the rate of remediation?

End of exam