The University of Melbourne

Semester 2, 2005 Assessment

School of Agriculture and Food Systems

208320 - Fertiliser Management - Parkville

208341 – Fertiliser Management - Dookie

Student Number: _____

Reading Time: **15 minutes**

Writing Time **3 hours**

This paper has eleven (11) pages.

Authorised Materials:

Non programmable Calculators may be used.

No other materials are authorised to be used in this examination.

Instructions to Invigilators:

Students will require script books each to answer this examination paper.

The examination paper **CANNOT BE REMOVED** from the examination room.

The formulae pages may be removed form the examination paper (pages 6-11)

Instructions to Students:

Answer each question in an examination booklet

Students are required to answer **ONLY eight (8)** questions on this examination.

All questions are of equal value.

Total Marks 160

Paper to be held by Baillieu Library and Dookie College Library:

This paper may be held with the Baillieu Library and Dookie College Library.

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Question 1.

"The Cation Exchange Capacity (CEC) is an important characteristic of a soil that affects plant nutrition". Explain this statement. In your answer a) define what CEC is; b) discuss the major factors affecting the CEC and c) the reasons for the order of the lythotropic series (order of retention of cations).

(7+6+7 = 20 marks)

Question 2.

a) Describe the manufacturing process in making Nitrogen based inorganic fertilisers

b) Describe the manufacturing process in making Phosphorus based inorganic fertilisers

(10+10 = 20 marks)

Question 3.

Explain the main causes and treatments of acidification in relation to the H^+ ion.

(20 marks)

Question 4.

Reuse of waste material (manures, food processing waste, effluent treatment solids etc) is becoming an important industry to agriculture.

a) Explain the gradings of these wastes

b) What are benefits of utilising these waste from the agricultural production side

c) What are the issues that need to be managed when using these waste materials?

(7+6+7 = 20 marks)

Question 5.

"Remote sensing of data is likely to be the next major step forward in broad acre agriculture". Explain this statement and include in your answer the current research technologies using remote sensing for broadacre agriculture.

(20 marks)

Question 6.

On 1 September, a grower is deciding whether to topdress a wheat paddock that was sown to Chara wheat on 1 May aiming at 11.5% protein. Is topdressing required? Is topdressing economical and what are the chances of the crop benefiting from topdressing? The crop is presently just past fully tillered and is expected to be mature in Nov 19.

Deep N test taken August 2003

Depth	NO_3	NH_4	Bulk density
0-10 cm	24	10	1.3
10-60	15	8	1.4

Soil moisture 90 mm, OC% 2.3%. Assume there will be 5% screenings in the grain.
Assume an acidification cost of $0.12/Kg N and an application cost of $10/ha
Utilise formulae and information provided at the end of the examination paper.

(20 marks)

Continued on next page

Question 7.

Prior to sowing you have soil sampled and received the results below. Prior to sowing determine the crop nitrogen demand, phosphorus maintenance level and fertiliser requirement for a wheat crop at Dookie College based on the rainfall given in the formulae page. What fertilisers would you use? Explain your answer, including the final rate of fertilisers to be used.

Sown in June, Mature in November

Wheat protein level = 11.5 %

Soil test

Depth	NO_3	NH_4	Bulk density
0-10 cm	12	8	1.3
10-60	2	3	1.4

0 - 10 cm P Colwell = 34 mg/kg

Organic carbon = 2.0 %

pH_w = 5.1

Utilise formulae and information provided at the end of the examination paper.

(20 marks)

Question 8.

In a dairy farm what are the annual maintenance requirement of phosphorus, potassium and sulphur?

Effective dairy area = 50 ha

Soil type - clay loam

Cow numbers - 200 head

Milk fat kg/ cow = 200 kg /cow

Grain feed = 250 tonnes DM

Fodder feed = 100 tonnes DM

Utilise formulae and information provided at the end of the examination paper.

(20 marks)

Continued on next page

Question 9.

Compare and contrast the management of plant nutrients between dryland cropping, dryland pasture, irrigated pasture, vegetable production, perennial horticulture and glass house horticulture

(20 marks)

Question 10.

Form a table on the examination answer paper listing all the plant essential nutrients, the movement of nutrients to plant roots, the relative amounts that they occur in plants, and their mobility within plants

Eg:

Plant Nutrient	Uptake form	Movement to plant root	Amount within plants	Mobility within plants

(20 marks)

Question 11. In horticulture and more recently in broadacre agriculture there has been a tendency to move to the use of fluid fertilisers. (a) What are three main types of fluid fertilisers? (b) What are the advantages and disadvantages of fluid fertilisers? And (c) How do growers overcome compatibility problems with some mixtures of fluid fertilisers?

(6 + 10 + 4 = 20 marks)

END OF EXAMINATION

FORMULAE

Element	Al	Ca	C	H	Fe	Mg	Mn	N	O	Na	Zn
Atomic Wt	27	40	12	1	56	24	55	14	16	23	65

2004 Actual Rainfall

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
33	228	6.4	12	5	110	44	74				

- Crop Nitrogen Demand (kg N/ha) =

Expected yield (t/ha) X protein % X N use efficiency factor X protein factor

- Harvest Index = Crop Yield/ Total Dry matter
- 2.5 tonne of lime / 1 pH_W unit.
- fertiliser N (kg N/ha) = Crop Nitrogen Demand (kg N/ha)- available soil N at sowing + mineralised soil N during crop)
- 10 kg P / 1 Olsen unit
- *Mineralised N* = GSR X OC % X 0.15

Crop Nitrogen Efficiency Table

Crop	Protein	N Use Efficiency Factor
Cereals	>11.5	***2.5***
	10-11.5	***2.0***
	<10	***1.7***
Canola	(65- oil %)	***1.5***

- Available soil N at sowing = soil test (ppm or mg/kg) X soil bulk density X no. of 10 cm strips in soil test
- (Rainfall in the month, 1month prior to sowing – 15) * 0.75 + (rainfall in the month, 2 months prior to sowing – 15) * 0.5+ (rainfall in the month, 3 months prior to sowing– 15) * 0.25.
- Total kg milkfat / effective milking area = kg milkfat/ha
- Kg milkfat/ha X nutrient % in milkfat/100 = Total nutrient exports in milk
- feed tonnes /milking area = tonne grain /ha

- Tonnes feed/ha X kg nutrient/ tonne = kg nutrient imported in feed
- Total imports = nutrients in grain + nutrients in fodder
- Maintenance nutrient level (kg/ha) = nutrients export in milk + nutrient soil requirement + losses in lanes & dairy - nutrients imported.
- Phosphorus Losses in lanes and dairy = 0.8 x Stocking rate
- Potassium Losses in lanes and dairy = 5 x Stocking rate
- Sulphur Losses in lanes and dairy = 0.8 x Stocking rate
-

Nutrients (P,K,S) in milk, grain and fodder

Nutrient	**Milk (%/kg milk fat)**	**Grain (kg/tonne DM)**	**Fodder (kg/tonne DM)**
Phosphorus	2.5	3	3
Potassium	3.5	4	17
Sulphur	0.8	2.5	2.5

Protein Factor

Wheat = 1.75

Barley, Triticale, Canola = 1.6

- *Potential Grain Yield Grain yield = WUE X (GSR +stored water - evaporation)*

Soil factors for maintenance fertiliser applications

	P	**K**	**S**
Sand	10	25	12
Sandy Loam	20	25	12
Clay loam	25	15	12
Clay/Red soils	30	15	12
Peats	35	15	12

Soil	**P**	**K**	**S**
Light	1.5 kg/ DSE	1.6 kg / DSE	1.0 kg / DSE
Heavy	1.0 kg DSE	3.0 kg / DSE	1.0 kg / DSE
Butterfat	1.0kg / 10 kg	1.6 - 3.0 kg / 10 kg	0.5 - 1.0 kg / 10 kg

Fertiliser costs and nutrient composition

	cost ($/t)	N%	P%	K%	S%	Ca%
DAP	485	18	20	0	1.5	0
MAP	485	10	22	0	1.6	0
Urea	430	46	0	0	0	0
SS	265	0	9	0	11	19
DS	405	0	17	0	4	15
TS	431	0	20	0	1	16
AN	474	34	0	0	0	0
CN	888	15.5	0	0	0	19
KCl	460	0	0	50	0	0
Lime	65	0	0	0	0	40
Gypsum	50	0	0	0	18	20

Crop Water Use Efeciency

Crop	**WUE (kg/mm/ha)**	**Evaporation**
wheat	20	110
barley	20	90
Canola	12	110
Legumes	15	130

	Element removed (kg/t product)					
Product	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Wheat prime hard	24.5	2.43	3.10	1.64	0.36	1.64
Wheat - hard	21.8	2.26	3.33	1.4	0.33	0.93
Wheat Standard	17.7	2.41	3.4	1.35	0.31	1.02
Barley	19.2	2.88	4.39	1.1	.035	1.08
Canola	40	6.5	9.2	9.8	4.1	4.0
Greesy wool	170	0.26	15.8	28.5	1.2	0.3
Cattle Live Wt gain	21	8.0	1.8	1.5	14.0	1.5

Animal	D.S.E
Wether	1.0
Ewes	1.8
Rams	2.0
Milking cows	19.0
Dry Cows & steers	9.0
Cow & calf	13.0

Rainfall Deciles

	decile 1	decile2	decile 3	decile 4	decile 5	decile 6	decile 7	decile 8	decile 9
Apr to Oct	239	275	290	338	357	399	425	453	505
May to Oct	190	253	265	304	334	351	386	423	488
Jun to Oct	186	231	262	284	335	351	367	397.6	459
Aug to Oct	86	111	127	142	152	173	190	223	255
May to Nov	226	279	304	354	375	398	423	465	528
Jun to Nov	186	231	262	284	335	351	367	397.6	459
Aug to Nov	107	136	158	174	192	225	234	273	313
Sept to Nov	64.2	90	103	117	137	145	174	196	227
Sept to Dec	85	114	134	149	159	184	199	241	273

Crop Transpiration Rates (mm/ day)

Crop Transpiration Rates (mm/ day)

Jun – Aug	Sept	Oct – Nov
2 mm/day	2.5 mm/day	3 mm/day

Nitrogen rules

- Never have more than 25 kg N/ha with seed
- Set up crop with 60 – 80% total N demand
- Topdress never more than 70 kg N/ha

Pasture rules

Nitrogen Don't use more than 50 kg N/ha/application nor more than 200 kg N/ha

Potassium Never use more than 50 kg K/ha / application (grass tetany – Mg deficiency) & up to 3 application/year

Optimum Soil test Values

	wheat	canola	triticale	barley	pasture dryland	irrigated pasture
pH water	5.5 - 8.5	6.0 - 7.5	4.5 - 8.5	6.0 - 8.5		
pH Cacl2	5 - 6.5	5 - 6.5	4.5 - 8	5.5 - 8.0	5.8 - 7.0	5.8 - 7.0
NO_3 (mg/kg)	20 - 40	20 - 40	20 - 40	20 - 40		
olsen p (mg/kg)	13 -18	14 -18	15 -18	16 -18	"12 -30	20 - 25
colwell p (mg/kg)	30 - 50	40 -70	40 -70	30 - 50	30- 60	50 - 150
avail K (mg/kg)	60 - 160	60 - 160	60 - 160	60 - 160	150 -350	>200
avail S (mg/kg)	8 -15	12 - 20	8 -15	8 -15	10 - 25	10 - 25
EC (dS/m)	<0.17	<0.17	<0.25	<0.17	<0.3	<0.3
OC (%)	1.4 - 2.5	1.4 - 2.5	1.4 - 2.5	1.4 - 2.5	2.0 - 5.0	5.0 - 10
Al (meq/100g)	<4%	<4%	<4%	<4%	<4%	<4%
Ca (meq/100g)	55 - 80%	55 - 80%	55 - 80%	55 - 80%	60 - 85%	60 - 85%
Mg (meq/100g)	6 - 25 %	6 - 25 %	6 - 25 %	6 - 25 %	6- 18 %	6- 18 %
Na (meq/100g)	<6%	<6%	<6%	<6%	<6%	<6%
K (meq/100g)	0.26 - 0.4 meq	0.26 - 0.4 meq	0.26 - 0.4 meq	0.26 - 0.4 meq	0.5 - 0.9 meq	5- 7 %
Ca / Mg Ratio	3 -6	3 -6	3 -6	3 -6	3 -6	>2

Hard Wheat Base Rate $192.00 @ 5% screenings

tein %															
	7.0	8.0	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	15.0	16.0
.00)	(32.00)	(24.00)	(16.00)	(12.00)	(8.00)	(6.00)	(4.00)	base Rate	4.50	8.00	11.00	13.00	15.00	15.00	15.00

Grain Yield Response to P	Soil Plant properties	Economic Response mg/kg Colwell
High (> 1.5 t/ha)	Low OM and/or microbes	<60 to 80 mg/kg Colwell
	Moderate to large N response	30 – 40 Olsens
Responsive (1 - 1.5 t/ha)	Low OM and/or microbes AND low N Application	<45 to 60 mg/kg Colwell
	Soil treatments increasing root growth AND low N Application required	20 to 30 Olsens
Less responsive (<1.0 t/ha	High OM and/or microbes with low N Application required	<35 to 45 mg/kg Colwell
		12 – 18 Olsens

10 kg P/ha / 1 Olsen unit, 20 kg P/ha / Colwell***Dryland Pasture Maintenance table for Phosphorus***

Maintenance P kg / DSE

Animal Loss	very low	low	medium	high