Including examiner comments

R3102

THE ROOT ENVIRONMENT, PLANT NUTRITION & GROWING SYSTEMS

Level 3

Wednesday 7 February 2024

13:30 – 15:10

Written Examination

Candidate Number: .....

Candidate Name: .....

Centre Name: .....

IMPORTANT – Please read carefully before commencing:

i) The duration of this paper is **100** minutes;
ii) **ALL** questions should be attempted;
iii) **EACH** question carries **10 marks**;
iv) Write your answers legibly in the spaces provided. It is **NOT** necessary that all lined space is used in answering the questions;
v) Use **METRIC** measurements only;
vi) Use black or blue ink only. Pencil may be used for drawing purposes only. Ensure that all diagrams are labelled accurately with the line touching the named object;
vii) Where plant names are required, they should include genus, species and where appropriate, cultivar;
viii) Where a question requires a specific number of answers; only the first answers given that meet the question requirement will be accepted, regardless of the number of answers offered;
ix) Please note, when the word 'distinct' is used within a question, it means that the items have different characteristics or features.

ANSWER ALL QUESTIONS

MARKS

Q1 a) Describe the characteristics of a platy soil structure. **4**

Please see over/…..

MARKS

b) Explain **TWO** ways in which a platy soil structure may lead to poor plant growth in horticultural situations. **6**

Total Mark

Please turn over/…..

MARKS

Q2 Describe how the characteristics of **EACH** of the following soil textures affect the amount of water held in that soil at field capacity:

i) clay 5
ii) sand 5

i)……………………………………………………………………………………

Please see over/…..

MARKS

ii)……

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Total Mark

Please turn over/…..

MARKS

Q3 a) A field has a soil moisture deficit of 63mm. State what this means. **2**

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b) Compare the use of the following irrigation techniques

i) overhead sprinklers
ii) porous pipe

by completing the tables below:

Irrigation technique	**Overhead sprinklers**	
Advantage 1		**1**
Advantage 2		**1**
Limitation		**1**
Appropriate horticultural situation		**1**

Please see over/…..

MARKS

Irrigation technique	Porous pipe
Advantage 1	
Advantage 2	
Limitation	
Appropriate horticultural situation	

1

1

1

1

Total Mark

MARKS

Q4 a) Describe **ONE** role of potassium within the plant. **2**

b) State **TWO** symptoms of potassium deficiency. **2**

Please see over/…..

MARKS

c) State **TWO** ways of rectifying potassium deficiency. **2**

d) Describe **TWO** effects on the plant of applying excess potassium. **4**

Total Mark

Please turn over/…..

MARKS

Q5 Describe the use of fertilisers within a hydroponic system. **10**

Please see over/…..

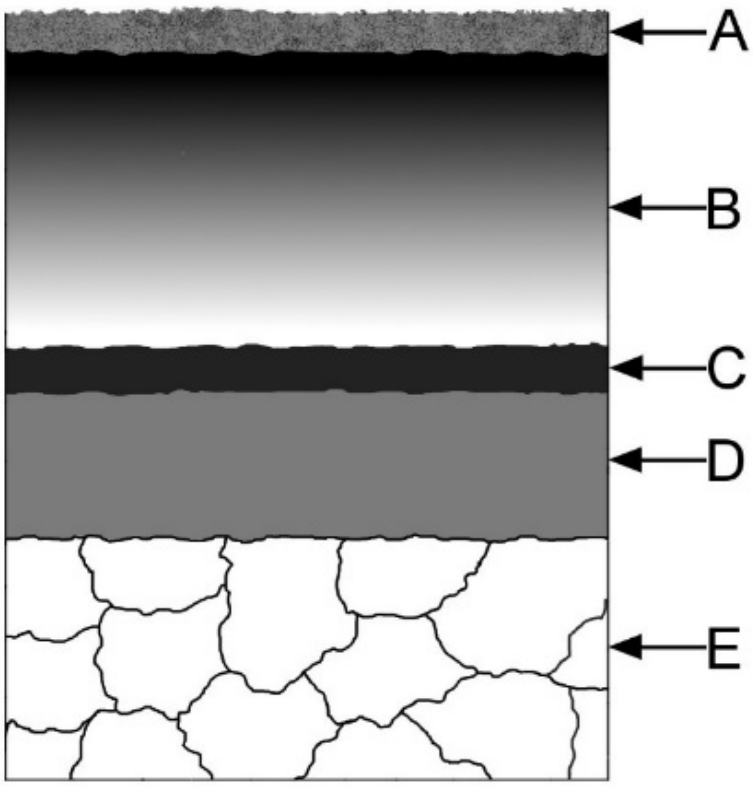
MARKS

Total Mark

Please turn over/…..

MARKS

Q6 a) Label the iron pan podzol using the diagram below. **5**



A.....

B.....

C.....

D.....

E.....

Please see over/…..

MARKS

b) Describe the development of an iron pan podzol. **5**

Total Mark

Please turn over/…..

Q7 Summarise how the activity of bacteria in the soil is affected by **EACH** of the following:

MARKS

i) moisture content **2**
ii) temperature **2**
iii) oxygen **2**
iv) pH **2**
v) organic matter content **2**

i)……

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ii)……

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iii)……

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Please see over/…..

MARKS

iv)

v)

Total Mark

Please turn over/…..

MARKS

Q8 Compare the characteristics of **EACH** of the following materials by completing the table below:

	Perlite	**Composted Bark**	
Sterility			**2**
Stability			**2**
Water Holding Capacity			**2**
pH			**2**
Nutrient Content			**2**

Total Mark

Please see over/…..

MARKS

PLEASE TURN OVER FOR NEXT QUESTION

Please turn over/…..

MARKS

Q9 a) Describe the practice of using green manures. **4**

Please see over……

MARKS

b) Describe **THREE** benefits of using green manures.

Total Mark

Please turn over……

MARKS

Q10 Describe weed management systems used in organic growing under **EACH** of the following headings:

i) stale seedbed 4

ii) mulching, giving examples of **TWO NAMED** mulches 6

i)..

Please see over/…..

MARKS

ii)

Total Mark

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Q1	a)	Describe the characteristics of a platy soil structure.	4
	b)	Explain TWO ways in which a platy soil structure may lead to poor plant growth in horticultural situations.	6

Q1a) Candidates were required to describe the characteristics of a platy soil. Generally, the question was answered well and correct responses cited a horizontal plate like soil structure, or thin, flat peds arranged in a horizontal direction.

b) Most candidates were able to describe consequences of poor drainage, lack of aeration, compaction and water logging.

Candidates were required to explain how platy soil affected plant growth, most candidates recognised limited water uptake and lack of root growth through the platy / compacted layer – fewer candidates were able to apply further knowledge in terms of discussing anaerobic root respiration or the fact that as well as water, nutrient availability was also impacted.

Q2		**Question** Describe how the characteristics of **EACH** of the following soil textures affect the amount of water held in that soil at field capacity: i) clay;	**5** **5**

		ii) sand.	

Q2 The question required a knowledge of how clay and sand soil texture affect the amount of water held at field capacity. Most candidates were able to discuss the small particle size of clay, and the high proportion of micropores, which would retain water against the force of gravity; few candidates acknowledged the negative charge on clay particles (high CEC) as holding the water molecules to the surface. Many correctly stated the high amount of water held in a clay soil at field capacity.

With regard to sand, again this was generally well answered with candidates making reference to the macropores and inability of sandy soils able to hold water against gravity. In addition, correct reference was made to large particle size, the ability to drain quickly, low CEC and far less water held at field capacity.

A limitation of candidates' responses was a lack of reference to water held specifically at field capacity.

<table>
<tr><td>Q3</td><td></td><td>Question</td><td></td></tr>
<tr><td></td><td>a)</td><td>A field has a soil moisture deficit of 63mm. State what this means.</td><td>2</td></tr>
<tr><td></td><td>b)</td><td>Compare the use of the following irrigation techniques

i) overhead sprinklers
ii) porous pipe

by completing the table below:

<table>
<tr><td>Irrigation Technique</td><td>Overhead sprinklers</td><td>Porous pipe</td></tr>
<tr><td>Advantage 1</td><td></td><td></td></tr>
<tr><td>Advantage 2</td><td></td><td></td></tr>
<tr><td>Limitation</td><td></td><td></td></tr>
<tr><td>Appropriate horticultural situation</td><td></td><td></td></tr>
</table>
</td><td>2
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2
2</td></tr>
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Q3. a) The question required candidates to state what was meant by a soil moisture deficit of 63mm. A significant number of candidates were not able to demonstrate a full understanding of the concept. Responses often repeated a soil moisture deficit of 63mm from the stem of the question without any reference to this being the amount of water required to return a soil to field capacity. While some candidates recognised a deficit, many did not state the use of irrigation to return the soil back to field capacity.

b) The question required candidates to compare an overhead sprinkler irrigation system to that of porous pipe system by use of a table. Overall, the question was answered well, advantages of overhead sprinklers often included integration of fertigation and the ability to irrigate large areas; no credit was given for it being an automated system due to other irrigation systems also being capable of automation. Advantages of porous pipe often correctly referred to placement of water near the plant's or crop's roots, as well as far less water loss through evaporation, and hence greater efficiency.

Conversely limitations of overhead sprinklers were often cited as inefficient systems through excessive water loss. Limitations of porous pipe were less understood by candidates and very few included blockages of pores by fertiliser salts or silt, or aesthetic issues surrounding their use in ornamental and garden situations.

In terms of the horticultural situation, a significant number of candidates were not specific enough in their responses suggesting use in a glasshouse or polytunnel – credit was given however where the context was provided, i.e. overhead sprinkler irrigation of container plants in a glasshouse or polytunnel, or use of porous pipe for the establishment of a hedge or in soft fruit such as raspberry production.

			MARKS
Q4		**Question**	
	a)	Describe **ONE** role of potassium in a plant.	**2**
	b)	State **TWO** symptoms of potassium deficiency.	**2**
	c)	State **TWO** ways of rectifying potassium deficiency.	**2**
	d)	Describe **TWO** effects on the plant of applying an excess of potassium	**4**

Q4. a) The question required candidates to describe one role of potassium in plants. Credit was not given just for stating 'for fruit and flowers' as this is not a description of the role of potassium in plants. Creditable responses included the role of potassium in energy pathways, enzyme activity or enhancement as well as the role of potassium in osmotic water regulation and in cold tolerance.

b) The question asked candidates to state two symptoms of potassium deficiency and most candidates were able to state chlorosis and brown necrotic areas on the edges of leaves for full marks. Other correct responses included reduced flowering and reference to the mobility of the potassium ion and where deficiency was most likely to be observed. Candidates often inaccurately stated a symptom of potassium deficiency as being interveinal chlorosis.

c) Most candidates were able to provide correct responses of how potassium deficiency was rectified through the use of fertilisers such as potassium nitrate, potassium sulphate, wood ash or seaweed-based fertiliser.

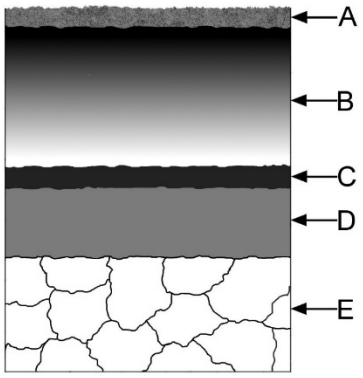
d) Candidates were less able to explain the consequences of over application of potassium with very few discussing scorching or reverse osmosis happening or indeed the ion antagonism between potassium and magnesium with over application of potassium resulting in lack of magnesium uptake.

			MARKS
Q5		**Question**	

		Describe the use of fertilisers within a hydroponic system.	10

Q5. A significant number of students were limited in their application of knowledge surrounding the use of fertilisers in hydroponic systems. While some students correctly referred to the need for regular monitoring of recirculating solutions for EC (electrical conductivity) and pH purposes, few candidates mentioned the idea that fertilisers had to be soluble whilst at the same time providing trace elements, as all nutrients must be added as fertilisers to the inert substrate. Likewise, very little knowledge was evidenced in the concept of the use of nitrate-based fertilisers as opposed to ammonium-based fertilisers. There was also little reference to the need for fertilisers to be pure and stable in order to reduce precipitation of salts.

			MARKS
Q6		**Question**	

	a)	Label the iron pan podsol using the diagram below  	5
	b)	Describe the development of an iron pan podzol	5

Q6. a) The question required candidates to label a diagram of an iron pan podsol. The majority of candidates were able to correctly identify each of the horizons/layers. There was some confusion at times with labelling the B horizon as the parent rock.
Expected answers were:

A. O layer or Organic layer
B. A horizon/leached horizon or Topsoil
C. Bir Horizon/Iron Pan
D. B horizon or Subsoil
E. C Horizon/parent rock

b) Candidates were invited to describe the development of an iron pan podsol. This was less understood overall by many candidates though where there were some correct responses, with the idea of iron pan podsols being formed in upland areas of acid nature – coniferous forests and heaths, in areas of high rainfall. The water percolating down through the organic matter removes humus particles and mineral ions from the upper layer (leaching) or eluviation, causing a bleaching effect. The organic matter and mineral ions are then deposited (illuviation) as a pan lower in the profile. Some candidates made generic comments relating to soil development without linking their answers to a podsol.

			MARKS
Q7		Summarise how the activity of bacteria in the soil is affected by **EACH** of the following:	

		i) moisture content; ii) temperature; iii) oxygen; iv) pH; v) organic matter content.	**2** **2** **2** **2** **2**

Q7. The question required candidates to discuss how the activity of soil bacteria was affected by a range of factors including moisture content, oxygen, temperature, pH and organic matter content.

On the whole the question was well answered by candidates with clear evidence that the activity of bacteria increased with moisture content but would decrease with excess water as not all bacteria were adapted to lack of oxygen in those conditions. Increased temperatures increased the activity of soil bacteria, an ideal range of 6-35 ^{o} C was allowed.

Reference to higher temperatures denaturing enzymes was also creditable. Optimum oxygen levels for aerobic respiration was credited though few candidates referred to anaerobic bacteria. A slightly acid to neutral pH was considered optimum for bacterial activity. Soil bacteria activity decreased with lack of water, low temperatures and low oxygen levels, (except for anaerobic bacteria). Reference was often made to populations of bacteria though fewer candidates were able to cite specific pH ranges or temperature ranges that would reduce or stop activity.

Most candidates recognised the need for optimum levels of organic matter and it being a source of food for bacteria.

			MARKS
Q8		Compare the characteristics of each of the following materials, by completing the table below	

			Perlite	Composted Bark	**2**
		Sterility			**2**
		Stability			
		Water Holding Capacity			**2**
		pH			**2**
		Nutrient Content			**2**

Q8. Candidates were required to compare the properties of both perlite and composted bark for sterility, stability, moisture holding capacity, pH and nutrient content.

Overall, the majority of candidates produced strong responses with candidates differentiating the organic material (composted bark) to that of the inorganic (perlite). Candidates, whilst recognising that bark may demonstrate having some sterile component especially if derived from conifers, knew that it was not wholly sterile unlike perlite.

The concept of stability was sometimes confused with candidates making reference to whether the plant was stable in that material from a 'support' aspect. However, the concept of stability is from whether the material decomposes; many candidates did correctly cite perlite as being stable and bark as unstable from this perspective.

Water holding capacity was generally understood correctly, perlite having a medium water holding capacity whilst composted bark has a lower water holding capacity, as was pH – perlite being neutral and composted bark being slightly acidic.

Finally, nutrient content was also understood by most candidates, recognising that perlite has virtually no nutrient content whilst bark has a little.

			MARKS
Q9		Describe the benefits of using green manure.	
	a)	Describe the practice of using green manures	**4**

	b)	Describe **THREE** benefits of using green manures.	**6**

Q9. a) The question required candidates to discuss the use of green manures. Overall, it was well answered, and credit was given to the idea of a cover crop being ploughed / dug in, in addition with incorporation before flowering, the idea of legume species included in the mix to increase soil fertility and often reference to sustainable practices such as sowing in the autumn to mitigate soil erosion over the winter period.

b) The benefits of green manures were also recognised by the majority of candidates. Common responses again included the idea of reducing leaching of nutrients and reducing soil erosion, suppression of annual weeds on bare soil by limiting access to light, as well as the idea of increasing biodiversity through attracting pollinators. Legumes were again often correctly referred to as adding nitrogen to the soil.

			MARKS
Q10		**Question** Describe weed management systems used in organic growing under **EACH** of the following headings: i) stale seedbed	**4**

		ii)	mulching, giving examples of **TWO NAMED** mulches	**6**

Q10. i) Candidates were required to describe the use of the stale seedbed technique. Responses were sometimes mixed, although in principle many recognised the idea of some cultivation followed by a period to let weeds establish / germinate and then subsequent control by minimal cultivation such as hoeing or by other means that minimises soil disturbance. This technique is used to reduce the population of annual weeds. Other candidates were not able to correctly answer this section, indicating gaps in knowledge.

ii) The practice of mulching was generally better understood, with candidates correctly naming a mulch for a mark, such as cardboard or bark – however it should be noted that the question referred to organic growing and so the idea of the mulch being from a designated organic source was a key to being credited. Coir, newspaper and mushroom substrates were allowed, provided none had any synthetic chemicals added to them previously.

Many candidates correctly referred to the timing of mulching which could be either in the autumn or spring depending on they type of crop grown, as well as often including the depth of mulch, 70-100mm was generally accepted. Overall, good knowledge was evidenced by most candidates. Some candidates discussed the wider benefits of mulching, for example conservation of soil moisture. These candidate responses were not credited with marks as the question related to weed control.