Including examiner comments

R3102

THE ROOT ENVIRONMENT, PLANT NUTRITION & GROWING SYSTEMS

Level 3

Wednesday 21 June 2023

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 what is meant by the term brown earth soil. **2**

b) Explain **FOUR** distinct horticultural advantages offered by brown earth soils. **8**

Please see over/…..

MARKS

Total Mark

Please turn over/…..

MARKS

Q2 a) Define the term Air Filled Porosity (AFP). **2**

b) Name **ONE** organic and **ONE** inorganic material which can be added to growing media to raise AFP. **2**

c) Describe the properties of the **TWO** materials named in b) when used in growing media. **6**

Please see over/…..

MARKS

Total Mark

Please turn over/…..

MARKS

Q3 a) State **ONE** horticultural situation in which an ebb and flow irrigation system (flooded bench system) may be used, giving a **NAMED** crop example. **2**

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b) Discuss ebb and flow systems under **EACH** of the following headings:

i) **TWO** distinct advantages **4**
ii) **TWO** distinct disadvantages. **4**

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Please see over/…..

MARKS

Total Mark

Please turn over/…..

MARKS

Q4 a) Describe the carbon cycle. **6**

Please see over/…..

MARKS

b) Explain the importance of the carbon: nitrogen ratio when adding organic material to the soil.

4

Total Mark

Please turn over/…..

MARKS

Q5 a) Describe how the pH of soil affects the availability of plant nutrients. **6**

Please see over/…..

MARKS

b) Describe what is meant by the term chelate. **2**

c) Describe **ONE** horticultural situation where the application of chelate is appropriate. **2**

Total Mark

Please turn over/…..

MARKS

Q6 a) State **TWO** situations where a gley soil may occur. **2**

b) Describe **THREE** ways in which the characteristics of an unimproved gley soil affect plant growth. **6**

Please see over/…..

MARKS

c) State **TWO** ways in which gleyed soil may be improved. **2**

Total Mark

Please turn over/…..

MARKS

Q7 Describe the advantages to the horticulturist of **EACH** of the following types of fertiliser:

i) granules **3**
ii) powders **3**
iii) prills. **4**

Please see over/…..

MARKS

Total Mark

Please turn over/…..

MARKS

Q8 Describe the use of the following drainage techniques in the management of a large garden area:

i) swales **5**
ii) sand slitting **5**

Please see over/…..

MARKS

Total Mark

Please turn over/…..

MARKS

Q9 a) Give a **NAMED** example of a 'prior approval required' fertiliser used in organic growing. **1**

b) Give **THREE** reasons for the classification of 'prior approval required' fertilisers. **3**

Please see over/…..

MARKS

c) State **SIX** methods by which organic growers can manage soil nutrient levels, other than by applying fertilisers. **6**

Total Mark

Please turn over……

MARKS

Q10 a) State what is meant by the following pest management practices in organic growing:

i) cultural control **1**
ii) biological control **1**
iii) chemical control **1**
iv) use of beneficial organisms **1**

Please see over/…..

MARKS

b) Give **TWO** examples of how pests of organically grown crops can be controlled by using beneficial organisms. **6**

Total Mark

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**The Royal Horticultural Society, Wisley, Woking, Surrey GU23 6QB.
Charity Registration Number: 222879/SC038262**

R3102

THE ROOT ENVIRONMENT, PLANT NUTRITION & GROWING SYSTEMS

Level 3

Wednesday 21 June 2023

Candidates Registered	**78**		**Total Candidates Passed**	45	71%
Candidates Entered	63	81%	Passed with Commendation	16	25%
Candidates Absent/Withdrawn	9	12%	Passed	29	46%
Candidates Deferred	6	7%	Failed	18	29%

General comments

Where a plant example is chosen, it is important to write the FULL botanic name and not just a partial name, following the correct naming protocols. Where named plant examples are required, common names are not credited at Level 3.

Spellings of scientific terms and botanic plant names need to be full and accurate - poor spellings may be penalized.

Questions - It is essential to read the question carefully and to note the **key words** before starting to write to ensure answers are relevant. Candidates should take account of the command statements in the question e.g. 'list', 'describe', 'explain', together with the mark allocation, to judge the depth of the answer required. Extra information, even if it is accurate, does not gain extra marks.
Where a number of answers were specified in the question and a candidate gave a list with more than that number, **only the first answers** in the list were marked, e.g. where the question stated 'Name **TWO** locations' or 'State **TWO** ways' only the first **TWO** answers were marked even if the correct answers were given further down. It is helpful (but not essential) if the answers are numbered in the text or separate paragraphs or bullet points are used.

Plant names - Where named plant examples were asked for, **full botanical names are required** to achieve full marks: genus, species and where appropriate variety, cultivar etc. needed to be written and spelt correctly. Where genus alone was given, all species in that genus need to show the characteristic asked for to gain any credit. **Common names were NOT accepted** and misspellings were penalised. Candidates needed to use unambiguous plant examples from sources such as the RHS Plant Finder and/or the RHS A-Z Encyclopaedia of Plants together with examples given in the syllabus and avoid obscure or difficult to verify plant examples, which risked being not credited.

Labels on diagrams must be carefully and correctly positioned to avoid ambiguity. Marks can be easily lost if this is not followed. Labels must actually touch the appropriate part of the diagram and must not be left hanging in mid air. Annotations on diagrams can be accepted as an alternative to description in the text as long as these are clear and answer the question. No marks were awarded for artistic merit or for unlabelled diagrams.

Continuation sheets - Where these have been included, it is vital that the relevant question number is included in the left hand margin if information written here is to be considered. These should also be attached to the answer booklet in the appropriate place and candidates should indicate in their answer booklet that they have written part of their answer on the attached sheet/s.

Q1 a) Describe what is meant by the term brown earth soil.

b) Explain **FOUR** distinct horticultural advantages offered by brown earth soils.

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Q1 a) Candidates were expected to describe the meaning of the term brown earth soil.

Candidates who provided strong responses stated:

- brown earth soils are well drained
- the soils are characterised by having a brown colouration to the subsoil
- these soils form under broadleaf forests
- these soils are rich in organic matter
- these soils are classed as sedentary.

Candidates could also describe the profile of the brown earth soil including the characteristics of the main horizons.

Candidates who provided weak responses made generic statements relating to soils, for example stating that brown earth soils contain textural elements such as sand, silt, and clay. These candidates were not awarded marks as the statement did not describe the meaning of a brown earth soil.

b) Candidates who provided strong responses gave explanations that included:

- brown earth soils have strong structures allow good root penetration, leading to good anchorage
- the ease of root penetration allows the plant to forage for water and nutrients
- these soils have high populations of macro and micro-organisms leading to a rapid recycling and release of plant nutrients to enhance plant growth
- the strong structure allows for diffusion of oxygen into the root zone, enhancing root growth
- these soils are rich in humus, and so have a high cation exchange capacity, making nutrients available for the plant.

Candidates who provided weak responses repeated the points made in a) without stating the horticultural advantage.
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Q2 a) Define the term Air Filled Porosity (AFP).

b) Name **ONE** organic and **ONE** inorganic material which can be added to growing media to raise AFP.

c) Describe the properties of the **TWO** materials named in b) when used in growing media.

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Q2 a) Candidate responses that included the formal definition of Air Filled Porosity 'the relative amount of air that a soil/growing media can hold as a percentage of its volume' gained full marks.

Some candidates offering explanations rather definitions (for example the amount of air in the soil) gained 1 mark.

Other candidates gave incorrect responses, for example general statements relating to the importance of air being present in the root environment. These responses did not provide a direct answer to the question and so were not credited with marks.

b) Candidates who gained full marks correctly named one organic and one inorganic material that can be added to a growing media to raise AFP.

Organic materials included:

- Coir fibre, wood fibre
- Inorganic materials included:
- Grit, perlite, vermiculite

Incorrect candidate responses included confusion with regards to the classification of a material as organic or inorganic, for example the classification of vermiculite as organic. Other incorrect responses included discussions about soil and cultivation, or the naming of chemical compounds for example sodium carbonate.

c) Strong candidate responses gave three technically correct properties for each material.

If coir fibre was chosen as the organic example, its properties are a high water holding capacity, pH of 6.0-6.8, and it is lightweight.

Vermiculite could be suggested as an inorganic material, with its properties described as having a high cation exchange capacity, being lightweight, being inert, or adding water holding capacity.

Candidate responses that discussed how the property impacted on AFP were not credited with additional marks, as this property was required in the naming of the product in part b).

Incorrect candidate responses included a description of materials that were not consistent with those named in b), or that relisted the materials suggested in b) with
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Q3 a) State **ONE** horticultural situation in which an ebb and flow irrigation system (flooded bench system) may be used, giving a **NAMED** crop example.

b) Discuss ebb and flow systems under **EACH** of the following headings:

i) **TWO** distinct advantages
ii) **TWO** distinct disadvantages.

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Q3 a) Candidates who gained full marks stated a precise horticultural situation, for example the production of pot grown plants in a glasshouse. In this scenario the named crop could have been given as culinary herbs, or as a named herb appropriate to this cultivation system.

Candidates who scored low marks stated a horticultural system as 'growing plants on a nursery' or 'growing tomatoes'.

It should be noted that to be correct the horticultural situation had to be appropriate to the use of a flooded bench system. This required candidates to state for example, the production of young strawberry plants in pots, rather than just offering the word strawberry as a response.

b) i) Candidates who scored high marks gave distinct advantages, (as defined by the rubric, and as discussed in the first page of this report) including:

- the ebb and flow system provides watering to the whole crop, with no areas being missed or duplicated
- the ebb and flow system allows for fertigation, which increases efficiency and allows for the production of higher quality crops
- the system reduces water usage as it recycles the irrigation water, making ebb and flow more sustainable.

Candidates who scored low marks gave incorrect information, or used language that is not consistent with the technical language requirements at Level 3. Examples of such responses include:

- allows for the irrigation of plants at field capacity
- is a better option than a watering can.

ii) Candidates who correctly stated the disadvantages of ebb and flow flooded bench irrigation systems gained full marks. These responses included:

- the recirculation of irrigation water can spread diseases such as *Pythium* spp.
- the startup costs are higher than with other systems, such as overhead spray lines.

Candidates who scored low marks stated that the system is:

- not suitable for propagation, a use it is not designed for
- one that needs monitoring, which is true of every irrigation system.
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Q4 a) Describe the carbon cycle.

b) Explain the importance of the carbon: nitrogen ratio when adding organic material to the soil.

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Q4 a) Strong candidate responses included six of the following points:

- carbon is present in the atmosphere as carbon dioxide
- carbon is assimilated into plants through photosynthesis
- carbon is released by plants and animals through respiration as carbon dioxide
- carbon is released through the burning of fossil fuels, wood and organic materials
- carbon is locked up in the soil in humus
- carbon is added to the soil through animal waste/plant residues
- carbon is released through the decomposition of plants and animals.

Incorrect candidate responses included:

- discussing the merits of peat free growing media
- the role that carbon dioxide plays in climate change.

b) Candidates who scored full marks were able to explain:

- the ideal carbon:nitrogen ratio is 24:1 and ideally not greater than 30:1
- that outside of this range the decomposition of organic matter slows down
- that soil organisms require nitrogen for growth and development
- that limited supplies of nitrogen in organic material results in the nitrogen being removed from the soil
- that this removal leads to less available nitrogen for plant growth.

Weak candidate responses included:

- general discussion relating to the role of bacteria in composting, or discussions of the composting process
- candidate confusing the carbon:nitrogen ratio with Cation Exchange Capacity
- statements that it is important to get the ratio right, without stating any factual information that could be awarded marks.
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Q5 a) Describe how the pH of soil affects the availability of plant nutrients.

b) Describe what is meant by the term chelate.

c) Describe **ONE** horticultural situation where the application of chelate is appropriate.

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Q5 a) Candidates who scored high marks were able to describe:

- the optimum pH for nutrient availability in most plants as being pH 6.5 – 7.0
- low pH (acidic conditions) can release Iron, allowing uptake in calcifuge plants
- high pH (alkaline conditions) reduces Iron availability
- low pH (acidic conditions) can cause a release of Aluminium, which can reach toxic levels
- how lower pH influences the activity of soil-micro and macro-organisms, which release nutrients from organic matter
- at a neutral pH microbial conversion of ammonia to nitrate is comparatively rapid, at low soil pH this process slows.

Candidates who scored lower marks:

- stated that pH can influence plant growth
- discussed cation exchange capacity
- did not tailor their answers to the requirement of the question.

b) Candidates who described the term chelate by either by explaining that this is a product that maintains nutrient availability in extreme conditions where the nutrient would otherwise be locked up or defined it as a complex of metal ions, such as Iron bound to an organic molecule gained full marks. All technically correct descriptions that were expressed with appropriate technical language for Level 3 were credited with full marks.

Some candidates provided incorrect responses confusing chelates with materials that are used to change or amend the pH of the soil.

c) Strong candidate responses named a horticultural situation, for example the cultivation of *Camelia* spp. in alkaline soils, where the chelate could provide Fe in a form that the plant is able to access.
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Q6 a) State **TWO** situations where a gley soil may occur.

b) Describe **THREE** ways in which the characteristics of an unimproved gley soil affect plant growth.

c) State **TWO** ways in which gleyed soil may be improved.

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Q6 a) Candidates who stated that gley soils form over heavy, impervious sub soils, or that gley soils form in areas which are subject to prolonged or seasonal flooding gained full marks.

b) Candidates who linked characteristics of a gley soil to their impact on plant growth scored high marks.

Examples of correct responses include:

- a high water content reduces the air content in the soil, which reduces root respiration and growth
- the high water content can lead to nutrient leaching, which reduces nutrient availability to the plant and causes poor growth
- the high levels of the water in the soil, slow the warming of the soil in the spring, which delays plant growth due to the lower soil temperature.

Examples of poor/incorrect candidate responses include:

- low levels of plant nutrients may affect plant growth
- … have hard surfaces

c) Most candidates correctly stated that a drainage system could be installed, or that subsoiling to break up hard pans could be effective. Other correct responses included the incorporation of organic matter, or the application of lime to flocculate the clay.
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Q7 Describe the advantages to the horticulturist of **EACH** of the following types of fertiliser:

i) granules
ii) powders
iii) prills.

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Q7

i) The advantages of granules were well discussed by candidates to include:
- ease of weighing out
- ease of application
- low dust option
- accurate application
- use as a base dressing
- available as straight and compound.

ii) The advantages of powders were well discussed by candidates to include:
- solubility
- the ability to create lower cost liquid feeds
- can be used to create foliar feeds
- available as straight and compound.
-

iii) However few candidates scored high marks when discussing prilled fertilisers, showing limited knowledge and application.

While the correct responses could have included:
- all prills are the same size
- this uniformity offers accurate distribution
- suitable for use in oscillating fertiliser spreaders
- available as straight or compound fertilisers.

Incorrect candidate responses confused prilled fertilisers with controlled release fertilisers or with frits.
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Q8 Describe the use of the following drainage techniques in the management of a large garden area:

i) swales
ii) sand slitting

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Q8

i) Candidates who accurately described the use of swales in a garden setting gained high marks.

Strong responses included:

- defining a swale as a grassed depression within the garden
- that swales are often adjacent to hard surfaces to capture run off
- that swales provide temporary storage for storm water
- that swales can filter out pollutants
- that swales hold water within the garden to reduce downstream flood risk
- that swales can be part of rain gardens
- plantings can be used to slow water flow and enhance biodiversity.

ii) Candidates who accurately described the use of sand slitting in a garden setting gained high marks.

Strong responses included:

- defining sand slitting as being
- appropriate for high-speed drainage of lawns, tennis courts or other grassed surfaces
- that sand slitting is often installed over a piped drainage system
- provides a route from the surface to the primary drainage system
- that the slits are 30-75mm wide
- that the slits are 200 – 300 mm deep
- that the slits are installed at 1 – 2m spacings.

Poor candidate responses lacked technical detail, and contained statements such as:

- can be used in a suitable situation
- is a drain (which was in the stem of the question)
- can be used where drainage is required.
- which showed limited knowledge and application.
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Q9 a) Give a **NAMED** example of a 'prior approval required' fertiliser used in organic growing.

b) Give **THREE** reasons for the classification of 'prior approval required' fertilisers.

c) State **SIX** methods by which organic growers can manage soil nutrient levels, other than by applying fertilisers

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Q9 RHS Qualifications would like to issue a clarification and apology with regards to this question.

In the period of time between the examination question being set and the date of the examination, the regulatory framework has changed. It would be unfair to candidates to mark their answers in part a) and part b) of this question.

After careful consideration RHS Qualifications made the decision not to mark candidate responses to a) and b). This examination paper was therefore marked out of 96 marks, rather than 100 marks. Candidate scores in the examination will be calculated as a percentage, from the actual mark which is out of 96. So, a candidate scoring 48 out of 96 marks, will gain 50%.

c) Strong candidate responses in part c) made reference to the following methods by which organic growers can manage soil nutrient levels, other than by applying fertilisers:

- the incorporation of organic matter
- the incorporation of green manures
- the return of crop residues to the soil profile
- the use of organic mulches
- the use of vermicomposts
- the use of compost teas
- the amendment of soil pH to favour earthworm activity to release nutrients.
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Q10 a) State what is meant by the following pest management practices in organic growing.

i) cultural control
ii) biological control
iii) chemical control
iv) use of beneficial organisms

b) Give **TWO** examples of how pests of organically grown crops can be controlled by using beneficial organisms

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a) i) Cultural control
Correct candidate responses stated that cultural control is the manipulation of growing conditions to reduce the incidence of pest. Examples of such controls were also credited with a mark.

ii) Biological control
The use of specific introduced predator or parasite to control a named plant pest. Examples of such controls were also credited with a mark.

iii) Chemical control
The use of an approved chemical to control a pest. Examples of such controls were also credited with a mark.

iv) Use of beneficial organisms
The use of naturally occurring predators or parasites to control plant pests. Examples of such controls were also credited with a mark.

b) Candidate responses were expected to include the name of the beneficial organism, the name of the pest and the mode of action.

Correct responses included, the encouragement of blue tits by improving the habitat, to eat aphids and so control the pest. Other correct responses included the encouragement of frogs or toads, again by providing suitable habitats, to eat slugs and so control the pest.

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