Including Examiners Comments

R3102

THE ROOT ENVIRONMENT, PLANT NUTRITION & GROWING SYSTEMS

Level 3

Wednesday 19 June 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.

Ofqual Unit Code M/505/2839

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ANSWER ALL QUESTIONS

MARKS

Q1 a) State **TWO** sources of colloidal material in the soil. **2**

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b) State **TWO** characteristics of soil colloids. **2**

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MARKS

c) Describe **THREE** distinct ways soil fertility is affected by soil colloids. **6**

Total Mark

Please turn over/…..

MARKS

Q2 a) Describe **TWO** differences between sedentary and non-sedentary (transported) soils using **NAMED** examples. **6**

Please see over/…..

MARKS

b) Describe the formation of **ONE** non-sedentary soil. **4**

Total Mark

Please turn over/…..

MARKS

Q3 You have been asked to advise a garden owner on the best irrigation system for their large, south facing garden on a sandy soil.

a) Name **TWO** irrigation systems that would be suitable for this garden giving a reason for **EACH** choice. **4**

Please see over/…..

b) Describe how a water balance sheet can be used to manage the efficient use of water for an irrigation system.

MARKS
6

Total Mark

Please see over/…..

MARKS

Q4 a) State what is meant by the following pest management practices in organic growing:

i) biological control **1**
ii) cultural control **1**

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b) Describe **FOUR** organic practices to control Aphids. **8**

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Please see over/…..

MARKS

Total Mark

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MARKS

Q5 a) Describe **ONE** role of nitrogen within plant metabolism. **2**

b) Describe the effect of **FOUR NAMED** soil bacteria on nitrogen availability. **8**

Please see over/…..

MARKS

Total Mark

Please turn over/…..

Q6

MARKS

a) State what is meant by the term mycorrhizae. **2**

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b) State **THREE** ways by which mycorrhizae can benefit plant growth. **3**

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c) State **THREE** situations in which the treatment of root zones with added mycorrhizae is beneficial. **3**

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MARKS

d) State **TWO** limitations (excluding cost) of the use of added mycorrhizae. **2**

Total Mark

Please turn over/…..

MARKS

Q7 a) Explain the concept of neutralising value. **2**

b) State the neutralising value of **TWO** distinct **NAMED** liming materials. **4**

Please see over/…..

MARKS

c) Explain how low pH can influence nutrient availability in plants. **4**

Total Mark

Please turn over/…..

MARKS

Q8 a) Define the term Air Filled Porosity (AFP). **2**

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

Please see over……

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

Total Mark

Please turn over……

MARKS

Q9 The owner of a large garden, who is considering converting their garden to run on organic principles has asked you to advise them on gaining certified organic status.

a) State **TWO** limitations involved in the conversion of a large garden to organic status. **2**

b) State how **TWO** distinct **NAMED** inputs into the system would have to change to achieve organic status for this garden. **4**

Please see over……

MARKS

c) Describe **TWO** ways in which the use of organic soil management techniques affect garden soil structure. **4**

Total Mark

Please turn over……..

MARKS

Q10 a) Name a situation where sand slitting is used to improve soil aeration. **1**

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b) State **FOUR** benefits of sand slitting. **4**

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		MARKS
c)	Describe site requirements for the successful use of a mole drainage system.	**5**

Total Mark

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General points:
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 penalised.*

*Where a number of answers are asked for e.g. **THREE** environmental conditions, only the first three in a list will be marked.*

Question 1

Section a) of this question required candidates to state TWO sources of colloidal material in the soil.

Strong candidate responses stated clay, humus or silt as sources of colloidal material in the soil.

Weaker candidates' responses often correctly stated clay as a source of colloidal material, but then stated organic matter. This was not credited with a mark unless qualified with statement that it will eventually break down to form humus, which is colloidal.

Section b) required candidates to demonstrate a deeper knowledge of soil colloids by stating two characteristics.

Stronger candidate responses stated characteristics such as:

- high surface area to volume ratio
- an electrically (predominately negatively) charged surface
- increased water holding in the soil
- buffering capacity or cation exchange capacity

Weaker candidate responses tended to provide less detailed statements, for example attracts positively charged ions, or stated the same characteristic, (using different wording) which was treated as a repeat of information with only one mark being awarded.

Section c) of the question required the candidates to demonstrate further knowledge and understanding of soil colloids by describing three distinct ways that soil fertility is affected by soil colloids.

Stronger candidate responses stated the way that soil colloids affect fertility, with their description demonstrating technical knowledge of the subject.

Examples of stronger responses included:

- because of the negative electrical charge, potassium cations can be held in the soil colloid
- the humification of organic material creates soil colloids, which improve nutrient retention
- soil fertility is reduced in soils with low levels of colloids, possibly due to leaching.
- Soil colloids can lead to an increase in water holding that enables access to soil nutrients/uptake of soil nutrients

Weaker responses restated points from part b) without further development or discussed the impacts of soil colloids in plant growth, which was not the focus of this question.

Question 2

Part a) of this question required candidates to describe two differences between sedentary and non-sedentary soils using named examples.

Stronger candidate responses provided technically correct named examples, for example Loess for a non-sedentary soil. These candidates were then able to describe two differences between sedentary and transported soils.

Examples of strong responses included the sedentary soil, such as a rendzina, being formed in situation, developing from the parent rock, and so sharing its characteristics both physically and chemically, while the non-sedentary soil, such as an alluvial soil, is formed from a variety of parent material, and so can be very different physically and chemically from the underlying rock.

Weaker candidate responses did not correctly name sedentary and transported soils, suggesting rendzina, or podzols as examples of transported soils. Weaker responses also often gave erroneous differences between sedentary and non-sedentary soils, demonstrating gaps in their knowledge of this subject area.

In part b) of the question candidates were asked to describe the formation of one non-sedentary soil.

Strong candidate responses gained marks for naming the non-sedentary soil, and discussing the way the parent rock is eroded, the vector of transportation, and how the rock particles are deposited.
For example, loess forms from wind-blown sands and silts eroded from parent rock which are deposited in a graded manner as the wind slows.

Weaker responses described the formation of sedentary soils or provided responses which lacked the required level of technical detail for a Level 3 qualification.

Question 3

Part a) of this question required the candidate to advise a garden owner with a south facing garden on a sandy soil with advice on the most appropriate irrigation systems.

Strong responses named two suitable systems, for example, sprinklers, pop up sprinklers, porous pipe, or drip irrigation. Strong responses also gave factually correct reasons that informed their choice of system.

For example, a drip irrigation system, which would provide a source of water into the rootzone of the plant, minimising evaporation and reducing water usage.

Pop up lawn sprinklers would be suitable for a lawn area, if planned correctly they deliver water when and where required eliminating wastage.

Weaker responses suggested inappropriate systems, for example a watering can, which is not a formal irrigation system, or overhead sprinklers, which are not appropriate in garden situations, however overhead systems require support, are unsightly, and mainly used in production horticulture.

b) The second part of this question required candidates to describe how a water balance sheet can be used to manage the efficient use of water for an irrigation system.

Stronger candidate responses gave a detailed description on the use of water balance sheets that included key points, for example:

- soils are regarded as being at field capacity on the 1st April
- the amount of rainfall added to the soil is recorded
- losses of water from the soil, for example as a result of evapotranspiration are calculated and recorded
- a soil moisture deficit can then be calculated to show how much water in mm is required to being the soil up to field capacity
- water can then be applied by irrigation to bring the water content of the soil up within 25mm of field capacity.
- additions of water to the soil in the form of irrigation are recorded

Weaker responses discussed irrigation or fertigation in general.

Question 4

a) This question, which related to the control of pests in organic settings required candidates to state the meaning of two pest management practices.

i) Biological control
ii) Cultural control.

Strong candidate responses stated precise, technically correct definitions, for example the use of natural predators/parasites to control pests, or the use of specific growing techniques to reduce the potential of pests.

b) In the second part of the question, candidates were required to describe four organic practices to control aphids.

Most candidates gave strong responses, including practices such as:

- application of a biological control agent such as *Aphidius* parasitic wasp or *Aphidoletes* predatory midge or other biological control agent
- the use of an approved fatty acid or horticultural soap as a spray which blocks the aphids' spiracles
- companion planting of flowering plants to attract natural populations of predators such as hoverflies, lacewings whose larvae predate aphids.
- encouraging birds such as Blue Tits by providing nesting habitats
- monitoring/scouting to allow prompt action
- finger and thumb control
- the use of resistant cultivars such as *Solanum melongena* 'Bonica' which is less prone to attack from aphids
- reduced Nitrogen fertiliser inputs to reduce soft, leafy growth which would attract aphids
- adjusting the timing of planting crops to avoid high populations of aphids
- spraying off with strong jets of water twice a week to dislodge aphids

Question 5

Part a) of this question required candidates to describe the role of Nitrogen within plant metabolism.

Stronger candidate responses included descriptions such as Nitrogen is used in the production of enzymes, to promote plant growth, or Nitrogen is used in the production of chlorophyll, which is used in the process of photosynthesis.

Weaker candidate responses either stated incorrect descriptions or did not relate their answer to plant metabolism.

Part b) of the question required candidates to describe the effect of four named soil bacteria on Nitrogen availability.

Strong candidate responses clearly named the bacteria, and accurately stated the role of this bacteria on Nitrogen availability.

Examples included:

Azotobacter, free - living bacteria, which fix nitrogen, making it available to plants.
Rhizobia, which live in root nodules of some legumes, which fix nitrogen to increase availability to plants.
Nitrobacter, nitrifying bacteria which oxidise nitrites to nitrates, making the nitrogen available to plants.
Thiobacillus, which are denitrifying bacteria, and reduce nitrogen availability to plants.

Weaker candidate responses often did not name the bacteria as required in the question.

Question 6

This question related to the use of mycorrhiza within horticulture.

Part a) of the question required candidates to state the meaning of the term mycorrhizae.

Strong candidate responses clearly stated that this was the name for a symbiotic relationship between a fungus and a plant root.

Weak candidate responses either contained incorrect information, or described the benefits of mycorrhiza, rather than describing or defining the meaning of the term.

Part b) of the question required candidates to state three ways by which mycorrhizae can benefit plant growth.

Stronger responses included:

- the fungal hyphae enhance water uptake by plant roots
- the fungal hyphae enhance nutrient uptake, particularly phosphorous ions
- the fungal hyphae can offer protection from pathogens

Weaker responses tended to give one or two advantages, rather than the requested three advantages.

Part c) of the question required candidates to state three situations in which the treatment of root zones with added mycorrhizae is beneficial.

Strong candidate responses stated appropriate situations to include:

- the planting of bare root roses
- the planting of bare root plants in nutrient depleted soils
- the use of *Trichoderma* spp. within the mycorrhizal mix as a crop protection product.

Weak, or incorrect candidate responses included incorrect information, for example reduces soil compaction.

The final part of the question required the candidate to state two limitations, excluding cost, of the use of added mycorrhizae.

Strong candidate responses included:

- the use of mycorrhiza is not compatible with the use of fungicides
- the use of a proprietary mycorrhizal product can damage soil ecology as it can outcompete the naturally occurring fungal species.

Weaker or incorrect candidate responses included;

- it is time consuming to apply the mycorrhizal product
- it might not work.

Question 7

This question related to soil pH and its impact on plant growth.

Part a) of the question required the candidate to explain the concept of neutralising value.

Strong responses clearly stated the definition of neutralising value, demonstrating an appropriate depth of knowledge required at Level 3. The correct response being, the effectiveness of a liming agent or material, expressed as a percentage of the neutralising value of pure calcium oxide.

Some candidates did not attempt to answer this part of the question.

In part b) candidates were required to state the neutralising value of two distinct named liming materials.

Candidates who scored high marks correctly named a liming material, for example ground limestone, with a neutralising value of 48-50, or ground magnesium limestone (dolomitic limestone) with a NV of 50 - 55 A tolerance of +/- 5 was allowed in the neutralising value.

Weaker candidates often gained marks for naming the liming materials, without stating/or correctly stating the neutralising value.

Part c) of the question required candidates to explain how a low pH can influence nutrient availability in plants.

Stronger candidate responses stated key concepts to include:

- there is a reduction in nutrient availability at low soil pH
- phosphorus as a nutrient becomes insoluble and unavailable
- there is a reduction in soil biota reducing nutrient availability
- aluminium, manganese and iron can become more available at toxic levels

Weaker candidates' responses related to higher soil pH, or contained general rather than specific comments, for example a low pH affects some nutrients, without stating how the nutrients are affected.

Question 8

This question was designed to assess candidates' knowledge relating to the formulation of growing media.

In part a) candidates were required to define the term Air Filled Porosity.

Strong candidate responses contained an accurate definition of Air-Filled Porosity, the percentage by volume of a growing media or soil, that is filled with air.

Weaker candidate responses provided a factually correct definition with less detail, for example 'this is how much air can be found in each grain of soil'.

In part b) candidates were required to name one organic and one inorganic material that can be added to growing media to increase AFP.

Stronger responses included an example of organic material as being coir, bark, or composted green waste, with perlite, grit, or vermiculite being appropriate inorganic materials.

Weaker responses included well-rotted manure as an example of an organic material, however this is not usually added to growing media to increase AFP. Other weaker responses included two organic, or two inorganic materials rather than one example of each.

Part c) of the question required candidates to describe the additional qualities of two materials named in b) when used in growing media.

Strong candidate responses stated clearly additional qualities to include:

- The pH of the product
- The impact of the product on water holding capacity
- The impact of the product on cation exchange capacity
- The impact of the product on buffering
- The weight of the product, i.e. lightweight, or heavy to increase stability.

Credited answers included:
For coir, an organic material, pH is between 5 and 6, it is lightweight, with a good water holding capacity, high cation exchange capacity, low in nutrients.

For grit, an inorganic material, it is horticulturally sterile, does not add nutrients, does not hold water, heavy so can add weight and improve stability

Weaker candidate responses gave vague or incomplete explanations or discussed the role of the product in increasing air filled porosity, which was specifically excluded from the question, having been considered in part b).

Question 9

This question required candidates to respond to a scenario where the owner of a large garden is considering converting the garden to run on organic principles. The candidate was required to provide advice to the owner of the garden on gaining certified organic status.

Part a) of the question required the candidate to state two limitations involved in converting the garden to organic status.

Strong candidate responses stated the conversion as being for two years, where the organic standards are applied, without the ability to define the garden or produce as being organic. Other factors correctly stated included the need to ensure that all inputs were from appropriate approved organic suppliers, or the need to review and change horticultural practices such as weed control, transitioning for example from the use of synthetic herbicide products to, for example mechanical weed control, or mulches.

Weaker or incorrect candidate responses included there being a considerable requirement for organic matter that might be hard to fulfil. This response is problematic as it is not necessarily the case. Other candidates stated that no chemicals will be allowed, which is incorrect, as natural chemical products are permitted. It is synthetic chemicals that are the issue. Equally 'no fertiliser is used' is an oversimplification with organic, natural fertilisers approved by the certification body being permitted.

In part b) of the question candidates were asked to state how two distinct named inputs into the system would have to change.

Strong candidate responses included the importance that fertiliser inputs may have to change to meet the awarding organisation criteria, for example ensuring that they are in the approved product list.
The same requirement would apply to pesticides which would need to be from the permitted organic list.
Any growing media or organic matter used would need to be from certified organic sources.
Weaker responses often incorrectly stated that the use of all chemicals would have to cease, this is incorrect are previously discussed.

a) The third part of this question required candidates to describe two ways in which the use of organic soil management techniques affect garden soil structure.

Stronger candidate responses included the naming of an organic soil management technique, for example the incorporation of green manures, with the specific impact on the enhancement of soil structure being stated. The use of mulches of organic materials, increasing soil moisture levels, to encourage worms, that in turn lead to stronger soil structures, or the use of minimal cultivation techniques to reduce disturbance to soil structure though cultivation practices were also popular, strong responses.

Weaker responses often lacked the technical detail required for a full mark allocation.

Question 10

This question related to soil drainage.

Part a) of the question required candidates to name a situation where sand slitting could improve soil aeration, with most candidates correctly stating sports turf.

In part b) candidates were required to state four benefits of sand slitting.

Stronger candidate responses listed four distinct advantages to sand slitting, while weaker candidate responses stated fewer than four advantages or confused drainage with irrigation.

Example of stronger responses include:

- improves rate of infiltration and speed of drainage
- the sports surface can be played on within approx. one month after treatment
- enhances sward quality
- reduces the cost of end of season renovations.

The final part c) of the question required candidates to describe the site requirements for successful use of a mole drainage system.

Most candidates were able to provide solid responses stating critical factors including:

- the clay content of the soil being sufficient to preserve the mole drain
- the soil having sufficient moisture status to be plastic and hold the tunnel shape.
- site access to tractors to allow for the mole drainage to take place
- a site that slopes, to allow the flow of water
- the presence of piped systems for interception