Royal Horticultural Society

R3102
THE ROOT ENVIRONMENT, PLANT NUTRITION AND GROWING SYSTEMS

Level 3

Thursday 16 February 2012

13:30 – 15:00

Written Examination

Candidate Number:..

Candidate Name:...

Centre Number/Name:..

IMPORTANT – Please read carefully before commencing.

i) The duration of this paper is **90 minutes**.

ii) **ALL** questions should be attempted.

iii) **EACH** question carries **10 marks**.

iv) Write your answers legibly in the spaces provided.

v) Use **METRIC** measurements only.

vi) Where plant names are required, they should include genus, species and where appropriate, cultivar.

vii) Please note, sufficient lined space is provided. It is not necessary that all lined space is used in answering the questions.

Ofqual Unit Code M/601/1007

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ANSWER ALL QUESTIONS

MARKS

Q1 a) State the range of particle sizes of the mineral fractions of which soil is composed. **3**

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b) i) Define ‘buffering capacity’. **1**

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MARKS

ii) Compare the buffering capacity of **EACH** of the mineral factions stated in a). **3**

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c) State **SIX** factors which affect the amount of lime required to correct acidity in a soil. **3**

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MARKS

Q2 a) Define the term 'Available Water Content' of a soil. **2**

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b) Describe how 'Available Water Content' of soils is affected by texture. **5**

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MARKS

c) State **THREE** management techniques to improve the amount of soil water available for plant growth. **3**

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MARKS

Q3 a) State what is meant by the term 'green manure'. **2**

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b) Describe the processes involved in the breakdown of organic matter in the soil, in **EACH** case identifying the organisms involved. **8**

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MARKS

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MARKS

Q4 a) i) The 'Lime Requirement' of a garden soil is 4 tonnes per hectare of ground limestone with an NV (neutralising value) of 50.

State how much hydrated lime, with a NV of 70, would need to be applied to have the same effect. **2**

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ii) State how the material should be applied. **2**

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b) State **FOUR** exchangeable nutrient cations found in the soil. **2**

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MARKS

c) Compare the cation exchange capacity of a loam based compost and a peat based compost. **4**

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MARKS

Q5 a) State **TWO** suitable sources of potassium for outdoor grown vegetables. **1**

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b) Explain the difficulty of supplying sufficient potassium to a sandy loam soil used for growing vegetables. **3**

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c) Complete the table below for **EACH** one of the stated elements in a potting compost for organic growing. **6**

Nutrient/Element	**Fertilizer**	**Typical content (%)**
Nitrogen		
Phosphorus		
Potassium		

Total Mark

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MARKS

Q6 Review the use of **EACH** of the following materials in horticulture:

i) rockwool;
ii) vermiculite. **10**

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MARKS

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MARKS

Q7 a) State what is meant by 'no dig' systems in organic growing. **2**

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b) State, for organic growing systems:

i) **FOUR** reasons for cultivating the soil;
ii) **FOUR** limitations of soil cultivation. **8**

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MARKS

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MARKS

Q8 a) Describe the role of manganese in plant growth. **2**

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b) Describe the symptoms of manganese deficiency. **4**

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c) State **TWO** soil factors which limit the availability of manganese. **2**

d) State **TWO** ways of supplying manganese to plants. **2**

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MARKS

Q9 a) State **FOUR** major global reserves of carbon. **2**

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b) Describe the carbon cycle, with the aid of a labelled diagram. **8**

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MARKS

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MARKS

Q10 a) State what is meant by the term 'Air Filled Porosity' (AFP). **2**

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b) Explain why AFP is of particular importance in growing media. **4**

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MARKS

c) Describe **FOUR** materials suitable for including in growing media to raise the AFP. **4**

Total Mark

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RHS LEVEL 3 CERTIFICATE IN THE PRINCIPLES OF PLANT GROWTH, HEALTH AND APPLIED PROPAGATION WRITTEN EXAMINATION

13:30pm Thursday 16 February 2012

R3102

THE ROOT ENVIRONMENT, PLANT NUTRITION AND GROWING SYSTEMS

Candidates Registered	**131**		**Total Candidates Passed**	**68**	**66.02%**
Candidates Entered	103	78.63	Passed with Commendation	22	21.36%
Candidates Absent	16	12.21%	Passed	46	44.66%
Candidates Deferred	-	-	Failed	35	33.98%
Candidates Withdrawn	12	9.16%			

In this spring's paper, the ten questions were subdivided into 30 separate sections worth between 1 and 8 marks. Questions worth a single mark can never score more – however long or knowledgeable an answer is. Time may be more profitably spent on the longer sections.

Q1 a) State the range of particle sizes of the mineral fractions of which soil is composed.

b) i) Define ‘buffering capacity’.

b) ii) Compare the buffering capacity of **EACH** of the mineral fractions stated in a).

c) State **SIX** factors which affect the amount of lime required to correct acidity in a soil.

The first part was well answered with sand, silt and clay being generally specified. Choosing the correct decimal point was a challenge for some candidates.
Buffering capacity was almost universally understood, succinctly defined and the comparisons between clay and the other particles clearly made.
Soil factors were accurately repeated for *part c*, but not all candidates mentioned that the type of lime, and its state – granular or powder, how finely divided – would also affect the application rate.

Q2 a) Define the term ‘Available Water Content’ of a soil.

b) Describe how ‘Available Water Content’ of soils is affected by texture.

c) State **THREE** management techniques to improve the amount of soil water available for plant growth.

For a definition, the '*amount of water held between field capacity and permanent wilting point'* would have sufficed for speedy marks, but relevant statements about mesopores or capillary water were accepted. Reformulating the question as the answer, '*the water available for plant use*', was not satisfactory.

Although most candidates understood that sands drained quickly and clays held (some, not all) water hygroscopically, most did not follow up with practical conclusions. Sands have low total water but *almost all of that is easily available for plant use*, clays have high total water but as it is depleted, what remains is *held with increasing tension*. Fine sands and silts have a high proportion of pores which hold capillary water and therefore have high available water.

For the final part, relevant techniques included:

- improving the structure and therefore the percentage of mesopores, by *suitable* cultivations,
- avoidance of deleterious cultivations and removal of pans,
- addition of organic matter – for its structural benefits *and* for its intrinsic water capacity,
- mulching to reduce water loss.

Growing a crop to keep the soil covered has many benefits, but the inevitability of transpiration means that increasing the amount of water in the soil is not one of them.

Q3 a) State what is meant by the term ‘green manure’.

b) Describe the processes involved in the breakdown of organic matter in the soil, in **EACH** case identifying the organisms involved.

Although some may quibble about what is a green manure and what is a cover crop, most candidates answered this question well. It needed stating that a crop has to be dug in for full benefits to the soil. From a practical point of view it should have been pointed out that digging the crop in before maturity has practical advantages.

Answers to *part b)* were reasonably comprehensive although more distinctions could have been made between the favoured foods, moisture levels, temperature and pH preferences of bacteria, fungi and actinomycetes. Several scripts detailed the nitrogen cycle at length. This is only glancingly relevant – mention of mineralisation and the C:N ratio would have been sufficient.

Q4 a) i) The ‘Lime Requirement’ of a garden soil is 4 tonnes per hectare of ground limestone with an NV (neutralising value) of 50.

State how much hydrated lime, with a NV of 70, would need to be applied to have the same effect.

a)ii) State how the material should be applied.

b) State **FOUR** exchangeable nutrient cations found in the soil.

c) Compare the cation exchange capacity of a loam based compost and a peat based compost.

Several candidates did not attempt this first part of the question. The neutralising value of liming materials is analogous to the percentage of nutrients in fertilisers. The higher the neutralising value, the less material is needed. In this case 4 x 5/7 = 2.86 tonnes per hectare.

Although it is acceptable to spread and allow lime to wash into the soil, this means that there will be a pH gradient between the surface and the rooting zone. Incorporating the material into the top 150 to 200 mm gives more even distribution.

The expected ions in part b) were Ca^{++} Mg^{++} K^{+} and $NH4^{+}$. Other trace elements would have been acceptable, but H^{+} is not a nutrient.

The presence of clay in loam, giving it a good exchange capacity, was well understood. Several answers became convoluted when it came to peat. The cation exchange capacity of peat depends on how humified it is. The younger peats – ideal in a growing medium for their *physical* properties – are less reactive than older peats. Crucially, the bulk density of a peat based compost is low, so even if it has a respectable cation exchange capacity on a weight for weight basis, the capacity available in the limited volume of a container is very low.

Q5 a) State **TWO** suitable sources of potassium for outdoor grown vegetables.

b) Explain the difficulty of supplying sufficient potassium to a sandy loam soil used for growing vegetables.

c) Complete the table below for **EACH** one of the stated elements in a potting compost for organic growing.

Nutrient/Element	Fertilizer	Typical content (%)
Nitrogen		
Phosphorus		
Potassium		

Several suitable sources were suggested in part a). A common answer was blood fish and bone. Although incorrect on the basis of the nominal ingredients, this was accepted as commercial formulations can include potassium chloride. Other compound fertilisers which included potassium were also accepted.

Scripts pointing to the low cation exchange capacity, susceptibility of leaching of potassium from the rooting zone and the removal of nutrients in crops were able to score full marks for part b).

Six marks were on offer in the third part of the question for candidates who were aware of some common fertilisers. Not every candidate looked at the implication of 'o*rganic growing*' and '*potting compost*' in the question. Several materials unlikely to be used in practice, were accepted. The alkalinity and structural characteristics of wood ash make it unsuitable for use in growing media. Many candidates had optimistic assessments of the nutrient percentage of commonly used fertilisers.

Q6 Review the use of **EACH** of the following materials in horticulture:

i) rockwool;
ii) vermiculite.

This question offered wide ranging possibilities and many candidates scored highly. Some concentrated on physical and chemical characteristics, neglecting to specify any actual uses.

Expected answers for **rockwool** included soilless culture, hydroponics and NFT. Crop examples could be tomatoes, cucumbers or peppers. Specialist applications, lightweight substrates for roof gardens, for instance, could have been mentioned. Several scripts pointed to the environmental implications of manufacture and disposal.

Vermiculite: indispensable in seed coverings, it is also used in seed composts, is useful as a 'wetter' and in specialist situations such as lily scaling or seed stratification. It has very good water holding characteristics, good cation exchange capacity and contains some K, Mg and Fe. It has low bulk density but its effective capacity to aerate composts is limited by its fragile structure. Energy intensive to produce, this expensive material is best thought of for specialist use.

Q7 a) State what is meant by 'no dig' systems in organic growing.

b) State, for organic growing systems:

i) **FOUR** reasons for cultivating the soil;
ii) **FOUR** limitations of soil cultivation.

Rather than finding a way of reformulating the question as the answer, marks could be gained by pointing to organic matter added as a mulch and a reliance on worms and other organisms incorporating it into the soil. Sheet mulching would have been accepted as an answer but was not suggested.

Reasons for and limitations of cultivations were accepted within wide parameters even where the practical effect was likely to be low. **Cultivations** could be to:

- incorporate residues,
- promote aeration,
- relieve compaction,
- expose pests,
- prepare for the formation of a seed bed and
- undertake weed control.

The '*elimination of rocks and large stones*' as a purpose for cultivation, perhaps indicated personal experience of this thankless task.

Limitations could involve the:
- creation of plough pans,
- structure loss from careless or untimely cultivation,
- increase of bulk density,
- turnover and therefore loss, of soil carbon,
- energy waste.

Q8 a) Describe the role of manganese in plant growth.

b) Describe the symptoms of manganese deficiency.

c) State **TWO** soil factors which limit the availability of manganese.

d) State **TWO** ways of supplying manganese to plants.

A 'r*ole in metabolism*', '*influence on the uptake of nitrogen*', '*enzyme activator in oxygen production in photosynthesis*' could have been answers to the first part of the question.

'Inter-veinal chlorosis' and '*yellowing'*, '*spotting of older leaves'*, and comments about the temporary nature of symptoms and the specific symptom of marsh spot in peas, could have answered the second.

Availability is affected by regional deficits – areas like the fens, alkaline soils (especially if organic or sandy) and antagonisms especially with potassium or iron. Specific sources include bound fertilisers, frits and manganese sulphate (if the soil is not alkaline).

Several scripts specified magnesium, not manganese, and it is possible that others were also thinking of magnesium in their answers.

Q9 a) State **FOUR** major global reserves of carbon.

b) Describe the carbon cycle, with the aid of a labelled diagram.

This was generally well and comprehensively answered with several scripts scoring high marks.

Q10 a) State what is meant by the term ‘Air Filled Porosity’ (AFP).

b) Describe **FOUR** materials suitable for including in growing media to raise the AFP.

In stating the meaning of air filled porosity, it is not sufficient to refer to the pores filled with air – the '*percentage volume filled with air after a saturated soil has been allowed to drain*' distinguishes the relevant pores.

The question went on to ask about why air filled porosity was: '*of particular importance in growing media*'.

What distinguishes growing media from the soil is the:

- limited volume of substrate in which the roots grow,
- critical importance of the *physical* characteristics of the compost in containers,
- likelihood that heavy or erratic irrigation will reduce aeration in growing media,
- tendency of the *structure* of some substrates to weaken with time,
- possibility that the effects of waterlogging will be exacerbated by high fertiliser levels.

The final part of this question referred to specific materials. This is a complex topic as the pores in a well structured growing medium can be simply filled up by ameliorants putatively added to increase the aeration. Materials which could have been suggested (*and described*) included the coarser grades of moss peat, composted or aged bark of a specified size range, matured wood fibres, grit of specified size, coir, rockwool and perlite.