RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 10th February 2009

MODULE A

Understanding of Plant Propagation
Processes & Application of Soils, Growing Media & Plant Nutrition

Section A – Short Answer Questions

Candidate Number:……..

Candidate Name:……..

Centre Number/Name:……..

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **A** is **2 hours**.
ii) Answer **ALL** questions in Section **A**.
iii) **ALL** questions in Section **A** carry equal 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.

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q1 State **TWO** primary agents of soil weathering. **2**

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Q2 Define **EACH** of the following terms:

i) perched water table;
ii) soil capping. **2**

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Q3 Name **FOUR** plants that can be propagated successfully by root cuttings. **2**

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Q4 Explain how the bacterium Rhizobium affects soil nitrogen levels. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 State the role of macropores in a good structured soil. **2**

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Q6 State **FOUR** differences between a mist unit and a fogging unit in plant propagation. **2**

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Q7 State **FOUR** methods by which nutrients can be permanently, or temporarily, lost from soil or growing media. **2**

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Q8 State **TWO** advantages and **TWO** limitations of growing plants by hydroponic methods. **2**

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ANSWER ALL QUESTIONS

MARKS

Q9 Explain the role of nitrogen in the metabolism of a plant. **2**

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Q10 State **TWO** reasons for grading plant material used in propagation. **2**

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RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 10th February 2009

MODULE A

Understanding of Plant Propagation, Processes & Application of Soils, Growing Media & Plant Nutrition.

Sections B & C – Structured Questions

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **A** is **2 hours**.
ii) Answer **ONE** question from Section **B** and **TWO** questions from Section **C**.
iii) **ALL** questions carry equal marks.
iv) Write your answers legibly in the answer booklets provided.
v) Use metric measurements **ONLY**.
vi) Where plant names are required, they should include genus, species and where appropriate cultivar.

Please turn over/…..

Section B – Understanding of Plant Propagation

Answer ONE question only from this section

MARKS

Q1 a) State **FIVE** reasons why horticultural plants may be propagated by budding or grafting. **5**

b) With reference to the quality of the grafting operation and to the particular plant tissues involved, describe the successful healing of a graft union. **7**

c) Describe **EACH** of the following grafting techniques and state its purpose:

i) top working;
ii) use of an inter-stock. **4**

d) Name **FOUR** distinct species and their cultivars, which are commonly propagated by grafting and for **EACH** cultivar, **NAME** a suitable rootstock. **4**

Q2 a) Explain why it is important to maintain hygiene and optimum storage conditions for seed. **8**

b) Describe how storage conditions affect the maximum viability of seed. **4**

c) Describe the preparation for storage and the maintenance of ideal conditions for maximum viability of a **NAMED** native **OR** naturalised tree seed. **8**

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Please see over/…..

Section C – Processes & Application of Soils, Growing Media & Plant Nutrition

Answer TWO questions only from this section

MARKS

Q3 a) Describe the main components that make up high quality propagation composts for use by a grower. **10**

b) Explain the difference in the management of plants growing in **TWO** distinct types of growing media. **10**

Q4 a) Describe the conditions in a soil/compost which affect the availability of nutrients for plants. **10**

b) Explain the importance of cation exchange with reference to soils/compost. **10**

Q5 a) Define **EACH** of the following terms:

i) rhizosphere; **2**
ii) mycorrhiza. **2**

b) Compare the role of **EACH** with reference to healthy plant growth. **16**

Q6 a) Evaluate **TWO** materials and methods used for **EACH** of the following:

i) raising the pH; **8**
ii) lowering the pH; **8**

in order to provide optimum growing conditions.

b) Name **TWO** plants/crops requiring **EACH** of the following:

i) high pH ie 7.5; **2**
ii) low pH ie 5.5; **2**

in order to provide optimum growth.

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The Royal Horticultural Society, Wisley, Woking, Surrey. GU23 6QB

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

Tuesday 10th February 2009

MODULE A

Understanding of Plant Propagation
Processes & Application of Soils, Growing Media & Plant Nutrition

Section A – Short Answer Questions

Candidates Registered	**184**		**Total Candidates Passed**	**113**	**68.07%**
Candidates Entered	166	90.22%	Passed with Commendation	32	19.28%
Candidates Absent	12	6.52%	Passed	81	48.79%
Candidates Deferred	6	3.26%	Failed	53	31.93%
Candidates Withdrawn	0	-			

Section A – Short Answer Questions

Q1 State **TWO** primary agents of soil weathering.

The term 'agents' caused some confusion with the expected responses of physical, chemical and biological not always being given. However, reduced marks were awarded for rain, water, freeze & thaw and wind even though all were in the same area of physical weathering.

Q2 Define **EACH** of the following terms:

iii) perched water table;
iv) soil capping.

The definitions of each term were usually very suitable and clear, eg.

i) An accumulation of water held above the natural level by an impervious layer, eg. a cultivation pan.
ii) A solid surface level that develops due to the breakdown of the soil structure by heavy rain.

Some responses confused the required terms with soil water terms such as soil saturation and permanent wilting points.

Q3 Name **FOUR** plants that can be propagated successfully by root cuttings.

Any suitable plant examples, given with full botanical names, such as, *Rhus typhina, Acanthus spinosa, Phlox paniculata* and *Primula denticulata,* were required. Any unsuitable plant selection, common or unfinished names led to a reduction of marks.

Q4 Explain how the bacterium Rhizobium affects soil nitrogen levels.

Clear explanations of the actions of Rhizobium were given, eg. forming root nodules on plants of the *Fabaceae* family, using energy from the host plant and receiving nitrates in return, fixed from atmospheric nitrogen. However, the full benefits are seen when the roots of the host break down increasing nitrogen levels. Some responses confused this with a description of the whole nitrogen cycle or the rhizosphere.

Q5 State the role of macropores in a good structured soil.

The role was clearly understood, eg. the largest pores, only full of water when the soil is at field capacity, assisting with quick drainage and pulling oxygen in to the soil. They also encourage the movement of plant roots, earthworms, gases and soil organisms within the topsoil.

Q6 State **FOUR** differences between a mist unit and a fogging unit in plant propagation.

Clear differences were provided, eg. size of water droplet; working pressure of system; control mechanisms and whether additional watering is required.
Please note that mist units can also be closed and rotting of plant material is more common compared with fogging units. The health and safety requirements of both systems were also highlighted.

Q7 State **FOUR** methods by which nutrients can be permanently, or temporarily, lost from soil or growing media.

A strong list of loss methods were given, eg. leaching; uptake by plants; used for bacterial activity; locked up by low or high pH levels and nutrient antagonisms. Physical soil loss by things like heavy rain fall was included as a form of leaching.

Q8 State **TWO** advantages and **TWO** limitations of growing plants by hydroponic methods.

The required detail was well described for growing by hydroponic methods, eg. close control of nutrient levels; crop production independent of growing season; high set up costs and the requirement for highly skilled staff.
Some statements, however, were less clear, eg. comments on quality of flavour would depend on the nutrient availability and uptake into the plant.
Also virus diseases still can be a problem, depending on the quality of plant material and vector numbers.

Q9 Explain the role of nitrogen in the metabolism of a plant.

A clear explanation was usually provided, eg. used for the synthesis of amino acids; proteins; chlorophyll and in the process of photosynthesis.

However, some responses wandered off into general statements on the nitrogen cycle and the symptoms of nitrogen deficiency.

Q10 State **TWO** reasons for grading plant material used in propagation.

Two reasons for grading were normally given, eg. matching the diameter of scion and understock when grafting and selection of plant size at propagation to provide the same time periods for production activities, ie. rooting of cuttings, potting up and subsequent sales.

Some confusion was also noted with the mis-reading of the word ‘material’ for ‘media’, resulting in compost based responses. Careful reading of the questions is recommended before responding to prevent misunderstanding.

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Understanding of Plant Propagation, Processes & Application of Soils, Growing Media & Plant Nutrition.

Sections B & C – Structured Questions

Section B – Understanding of Plant Propagation

Q1 a) State **FIVE** reasons why horticultural plants may be propagated by budding or grafting.

b) With reference to the quality of the grafting operation and to the particular plant tissues involved, describe the successful healing of a graft union.

c) Describe **EACH** of the following grafting techniques and state its purpose:

iii) top working;
iv) use of an inter-stock.

d) Name **FOUR** distinct species and their cultivars, which are commonly propagated by grafting and for **EACH** cultivar, **NAME** a suitable rootstock.

Question Aims

The aims of the question are to test: the candidates' plant knowledge, understanding of why grafting takes place and how the process leads to a successful graft union. This last aim combines a need for the candidate both to understand the practical process and the science underpinning that process.

This question was generally well done with those candidates closely observing the mark allocation doing best.

Taking the time to read and understand the question is essential and to gain the maximum marks, answers need to be supported with examples of plants using full botanical names.

Candidates showing a clear understanding of the grafting process and, where appropriate, referencing modern horticultural practices scored well.

Diagrams need to be relevant and clearly annotated.

Candidates who grasp that the number of marks available relates to the amount of information required scored well. Writing all that you know about the subject will not gain additional marks. Where the question asks for four examples, and the number of marks available are four, producing more than four examples will not increase the marks allocated, nor will providing less than four examples allow the candidate to gain maximum marks.

In section b) where the candidate is asked to describe a process, in general, the examiner will be looking for two pieces of relevant information per allocated mark.

It is important for the candidate to review their answer and be able to see the required pieces of information to gain maximum marks.

Recommendations

No amount of reading is a substitute for practical experience so it is worthwhile contacting the RHS Education Department to learn of the range and location of practical workshops that take place throughout a network of gardens and colleges.

Gain work experience on your local commercial nursery.

Check the following website www.ipps.org for an insight into the world of the commercial propagator.

The following texts would prove useful:-

RHS Propagating Plants (Alan Toogood)
Plant Propagation principles and practices (Hartmann, Kester, Davies and Geneve)

Q2 a) Explain why it is important to maintain hygiene and optimum storage conditions for seed.

b) Describe how storage conditions affect the maximum viability of seed.

c) Describe the preparation for storage and the maintenance of ideal conditions for maximum viability of a **NAMED** native **OR** naturalised tree seed.

Question Aims

The main aims of this question are to test a candidates understanding of seed storage and the effect that this has on seed viability. The candidate is then asked to place this in a practical context by describing the process of collecting and storing a named seed.

This question was less well done and only those candidates who read and understood the question gained good marks.

This question is not about breaking seed dormancies nor is it about germination, though reference to both is required to gain maximum marks. Those candidates who understood that the question related mainly to seed storage did well.

To gain maximum marks each section needs to be answered in line with the question asked. Candidates who understood the different information required in a) and b) scored well. Many candidates did not understand the question and wrote similar answers for both sections. In a) a candidate needs to provide reasons for maintaining hygiene and optimum storage conditions and not just examples of them, while in b) candidates need to review the effect of the storage conditions on viability.

Answers to part c) require a full botanical name to gain maximum marks.

Section c) also required the candidate to select a tree species native to, or naturalised within, the UK. Scoring well in this section requires a candidate to select the appropriate tree species.

Recommendations

No amount of reading is a substitute for practical experience so it is worthwhile contacting the RHS Education Department to learn of the range and location of practical workshops that take place throughout a network of gardens and colleges.

Gain work experience on your local commercial nursery.

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The following texts would prove useful:-

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Hardy Woody Plants from Seed (McMillan Browse) This text was first published in 1979 but contains very useful information on collecting, storage and growing a range of woody plants from seed.

Many candidates referred to the Millennium Seed Bank. It would be a good idea to arrange a visit.

Section C – Processes & Application of Soils, Growing Media & Plant Nutrition

Q3 a) Describe the main components that make up high quality propagation composts for use by a grower.

b) Explain the difference in the management of plants growing in **TWO** distinct types of growing media.

The aim of the first part of the question was to test candidates' knowledge of growing media, materials and properties.

The aim of the second part of the question was to test detailed knowledge of the benefits and issues concerning plants growing in distinctly different media.

The term component was interpreted as either an ingredient in a recipe or as an element in a system. Both types of answer were acceptable.

Acceptable materials cited included: peat, coir, bark, grit, sand, perlite, vermiculite, fertilisers.

In their descriptions candidates were awarded marks for fully describing the materials and their function: air filled porosity, moisture retention/content, gaseous exchange, drainage, cation exchange value, low nutrients levels, root penetration, weight, consistency, sterility/hygiene, pH, pH regulation, appropriate nutrient content/supply e.g. phosphorus for root growth, toxicity, buffering capacity, anchorage/stability (for seedings and cuttings), physical stability, consistency, texture and structure.

Some candidates cited sustainability as a desirable property which was acknowledged in the overall mark.

Good answers were well structured, used technical terms and contained detailed technical information. Also, only propagation composts were cited not potting composts.

Generally candidates showed a good knowledge of the specific requirement growers have regarding propagation media. They quoted recipes for suitable compost mixes e.g John Innes which helped focus their answers on suitable materials.

The growing media cited for the second part of the question may have included the following: soil, loam based compost, peat based/peat alternative based compost, rockwool, coir, bark, perlite, sand, clay granules, water.

The explanations given by candidates covered: nutrient monitoring and supply, water and air availability, anchorage, temperature, pH, environmental control, pest and disease monitoring and control.

Good answers were well structured and for each plant management factor compared the two types of growing media with each other.

Some candidates cited very similar growing media which seemed to make it difficult to cite differences in plant management. Also, some candidates focused on propagation which limited the scope of their answers. Generally this question was not answered in enough detail to gain good marks.

Good answers also focused on plant management as opposed to just the management of the growing media.

Q4 a) Describe the conditions in a soil/compost which affect the availability of nutrients for plants.

b) Explain the importance of cation exchange with reference to soils/compost.

The aim of the first part of the question was to describe all the factors, both positive and negative, that aid or prevent plants from obtaining the optimum levels of nutrients from the soil or compost they are growing in.

The aim of the second part of the question was to test candidates' knowledge of cation exchange and its fundamental impact on plant nutrient availability in both soil and compost.

The descriptions given by candidates for the first part of the question covered: cation exchange capacity, water content, temperature, nutrient content, nutrient balance, texture, structure, soil organisms (including mycorrhizae) and pH.

Good answers covered all of the above in detail, used technical language and technical terms, and provided examples where appropriate.

Good answers were well structured and cited the both benefits and problems, to plants, associated with each factor listed above.

Generally candidates displayed a good knowledge of soil science and were able to show how some factors were linked.

Good answers to the second part of the question were well structured, written using technical terms and language and included the following:

- a definition of cation exchange;
- an explanation of the chemistry of cation exchange (soil colloids - clay and humus, chemical bonding, leaching of nutrients, soil water, cation and anion exchange, nutrient antagonism, solubility, nutrient uptake by plants, buffering capacity;
- pH – a brief definition plus the effect of pH on cation exchange and the subsequent availability of nutrients to plants;
- soil/compost texture and structure – clay soils, silty soils and sandy soil. Soil/compost fertility levels, use of fertiliser, organic matter and soil compost management to improve cation exchange.

Many candidates showed a good understanding of cation exchange and were able to give examples of how specific cations and anions behaved under various conditions. Good use was made of diagrams to show how cation exchange worked at colloid level.

Q5 a) Define **EACH** of the following terms:

iii) rhizosphere;
iv) mycorrhiza.

b) Compare the role of **EACH** with reference to healthy plant growth.

The aim of this question *is the evaluation of two soil phenomena which are closely involved with healthy root function.*

The **rhizosphere** *is the immediate area of the soil influencing and influenced by plant roots*. It includes minerals, soil water and gases, and organic matter. It is an area in which micro-organisms are highly active.
A **mycorrhiza** is a mutualistic association between a fungus and a plant root in which the plant root gains water and nutrients collected by the fungal hyphae and the fungus shares sugars from the plant.

These two definitions were allocated only 4 marks in total but some answers in this section were almost as long as those in part b) which was allocated four times as many marks. Information beyond a succinct definition would have been more effective in part b).

Part **b)** requires an accurate description of the role of each. To gain a maximum score the keyword 'compare' indicates that where relevant, the characteristics of one should be contrasted with the other.

Rhizosphere
Several candidates discussed characteristics such as air filled porosity, soil structure and macrofauna. These are applicable to the soil as a whole rather than to the rhizosphere which is a limited and specialized area of the soil indivisible from the plant roots (*-sphere*: region around, *rhizo:* relating to roots).

The characteristics of the rhizosphere include a relatively stable temperature and humidity, and a tolerance of various soil types and pH's. Root growth is influenced by the availability of moisture, nutrient ions, the actions of parasitic fungi & the effects of allelopathic chemicals. In turn, the roots have a major effect on the rhizosphere, being a source of colloidal material and organic acids which stimulate micro-organisms.

Bacterial activity is high in the rhizosphere, for instance, the bacterium *Rhizobium* multiplies near the roots of leguminous plants – unfortunately, some candidates used the names rhizosphere and *Rhizobium* synonymously.

Mycorrhiza
Whereas the rhizosphere is a location with various components, a mycorrhiza ("*fungus-root*") is a relationship between two specific entities – the root and the fungus.

Most candidates appreciated the mutualistic role of the two partners and the critical importance of the relationship in nutrient-poor, dry soils. Many pointed to the ubiquity of mycorrhizae and the existence of two distinct groups, one of which (*ecto*) forms a sheath found the roots of trees such as pine and birch (replacing

the root hairs) and the more prevalent (in terms of plant families) *endo* mycorrhizae penetrating the root directly.

Most candidates stated correctly that the large surface area of the fungal hyphae increased the volume of the soil that could be exploited, and thus facilitated the take up of water and nutrients – particularly phosphorous. Several also pointed to the role of the ectomycorrhizal sheath in resistance to plant disease.

Fewer candidates mentioned the importance of mycorrhizal inoculation in horticulture or that excessive fertiliser use (especially nitrogen) can be antagonistic to mycorrhiza.

Recommendations
Candidates should ensure that they are familiar with and can define all the terms used in the syllabus. The marks awarded for each section of a question gives an indication of the time that should be devoted to each part. It is especially important to be aware of this where a single section carries a significant proportion of the marks.

Q6 a) Evaluate **TWO** materials and methods used for **EACH** of the following:

iii) raising the pH;
iv) lowering the pH;

in order to provide optimum growing conditions.

b) Name **TWO** plants/crops requiring **EACH** of the following:

iii) high pH ie 7.5;
iv) low pH ie 5.5;

in order to provide optimum growth.

The aims of this question *are to evaluate practical ways of altering soil pH, and to give examples of plant preferences.*

Part **a)** seeks to identify practical and efficacious ways of altering the pH. It is imperative that candidates understand the orientation of the pH scale. Unfortunately a few candidates equated high pH with acid conditions with the result that they could not score points for section i) or ii).

Four *keywords* are: **evaluate**, **materials**, **methods** and **pH**. It is important that candidates stick to the effect on pH and do not wander off into other topics such as soil structure and water retention.

Most candidates could identify two materials for raising pH, **calcium carbonate** being the most commonly mentioned. Several also mentioned the application of **magnesium limestone** as an effective method of raising pH as well as supplying Mg. **Calcium hydroxide** and **calcium oxide**, the latter now rarely used because of its caustic and reactive nature, were mentioned less frequently.

Few candidates mentioned **neutralising value** or discussed the fineness of

grinding of calcium carbonate and how it affects NV, or that quarry-produced liming materials are subject to a statutory declaration of content.

Gypsum was mentioned several times: the advantage of gypsum is that it supplies Ca *without* raising pH, (some students mentioned its use on sodium saturated soils, in this specialized case it would replace the strongly alkaline sodium ions effectively *lowering* the pH.)

The question *mentions methods as well as materials.* Most candidates opted for top dressing or digging in autumn or winter and not at the same time as applying FYM. Few mentioned that application rates (and timing) depend on soil texture and buffering capacity.

Health and safety was mentioned in several scripts. “Wear correct PPE” is a little vague. The main hazard with the most commonly used material, ground limestone, is the **dust nuisance** associated with fine materials. Calcium hydroxide is irritating to eyes and skin, especially if damp, but some candidates stated that it was caustic and a fire risk, qualities that apply to calcium oxide, not calcium hydroxide.

Section **ii** about acidifying soil was less well answered. A minority of candidates appreciated that acidifying the soil is more difficult than raising the pH but few mentioned that it is not a practicable proposition if free lime is present, nor that excessive or uneven application of the material almost universally mentioned, sulphur, can lead to pockets if extreme acidity and toxicity.

(Elemental) **sulphur** and **ammonium fertilisers** were mentioned by the majority of candidates. Some thought that the sulphate of ammonium sulphate acidified the soil rather than that the ammonium ion replaced Ca on the soil colloids. There was a general conclusion that excessive use of ammonium fertlisers would cause problems such as lush growth, high soil conductivity and pollution of ground water but little mention of the fact that the application rate for sulphur, as with lime, depends on the soil type. Several candidates thought that sulphur was poisonous or hazardous. Some sulphur compounds *are* toxic, but elemental sulphur is unlikely to be hazardous in normal use.

The question is specifically about pH: adding sequestered iron or chelates stops nutrients becoming unavailable but does not lower pH.

Many candidates stated that organic matter in its various guises would lower pH, conversely a few stated that it would raise pH. Organic matter is a beneficial material but not a universal panacea. A level 3 answer should be fairly precise about the effects of organic matter in the soil, especially as the topic has been raised in previous examiners' reports.

The decomposition of organic matter in the soil, especially coniferous and ericaceous material, leads to the release of humic acids. This is a long term process which can be enhanced by the leaching of bases and their removal in crops. This is *not the same* as saying that the addition of organic matter to the soil acidifies it. Leaf mould from deciduous trees, for example, is not likely to be acidifying (even though fresh oak leaves may be acid). To gain points for the use of organic materials, the candidate would have to specify a material such as composted pine needles or allude to the *long term effects* of humification in the

soil.

Filling a hole in an alkaline soil with ericaceous compost would have no effect if the ground water was alkaline. “Peat” as an additive was mentioned several times. Disappointingly, in view of previous reports, few candidates distinguished between sphagnum and sedge peat, although most did point to environmental considerations.

Question 6b)
For a student with a reasonable plant knowledge, this question offers the opportunity to gain 4 marks in 8 words. Unfortunately many plants specified were tolerant of a wide range of pH or, as in the examples of *Erica carnea* and *Magnolia stellata,* were atypical of their genera in being somewhat lime tolerant. For ornamental subjects a correct binomial, or genus and cultivar was expected.

Recommendations
Candidates should be aware of the exact wording of the question, of up to date techniques and the examiners’ comments on similar previous questions.