RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 6th July 2010

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** functions for **EACH** of the following terms in the development of germinating seed:

i) radicle;
ii) cotyledons. **2**

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Q2 State the importance of **TWO NAMED** physiological processes which could occur during seed germination. **2**

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Q3 State **FOUR** characteristics that make a bulky ingredient suitable for inclusion in a seed compost mix. **2**

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Q4 List **FOUR** effects of water in the process of soil formation. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 State **TWO** plants that can be propagated by **EACH** of the following:

i) leaf lamina;
ii) grafting. **2**

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Q6 List **ONE** benefit and **ONE** limitation provided by **EACH** of the following soils for the gardener:

i) chalky;
ii) organic. **2**

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Q7 State **ONE** role of **EACH** of the following in physiological processes:

i) nitrogen;
ii) phosphorus;
iii) magnesium;
iv) iron. **2**

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ANSWER ALL QUESTIONS

MARKS

Q8 State **TWO** situations where tissue analysis is used in horticulture. **2**

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Q9 State **TWO** advantages and **TWO** limitations of using recycled landfill (composted municipal waste) as a growing medium. **2**

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Q10 State **FOUR** factors that affect the rate of release of nutrients from controlled release fertilizers in growing media. **2**

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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

Q11 Review the use of **EACH** of the following seed treatments with reference to **NAMED** plant examples:

i) grading; **5**
ii) coating; **5**
iii) chitting; **5**
iv) priming. **5**

Q12 a) Describe how the routine care of stock plants is used to maintain juvenility and maximise the rootability of propagation material. **11**

b) Explain **THREE** critical factors to be considered when selecting cutting material from stock plants. **9**

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Please see over/…..

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

Answer TWO questions from this section

MARKS

Q13 a) Describe the origins of soil organic matter. **4**

b) Explain the changes that occur in plant remains due to the activities of soil organisms. **16**

Q14 a) Explain **EIGHT** problems for the gardener commonly associated with the soil of new houses. **12**

b) Describe methods of overcoming the problems identified in a). **8**

Q15 a) Explain how soil texture and structure affects the availability of mineral nutrients to plant roots. **8**

b) Explain how soil pH affects the availability of **NAMED** mineral nutrients. **8**

c) Explain how an excess of one nutrient in the soil affects the availability of other nutrients. **4**

Q16 a) Describe **FOUR** materials that may be used in hydroponic growing systems. **4**

b) State **FOUR** commercial crops that may be grown hydroponically and the technique used in **EACH** case. **4**

c) Discuss the benefits and limitations of using hydroponic methods to grow plants. **12**

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

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MODULE A

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

Candidates Registered	**267**		**Total Candidates Passed**	**171**	**76.34%**
Candidates Entered	224	83.90%	Passed with Commendation	41	18.33%
Candidates Absent	35	13.11%	Passed	130	58.04%
Candidates Deferred	7	2.62%	Failed	53	23.66%
Candidates Withdrawn	1	0.37%			

Section A – Short Answer Questions

Q1 State **TWO** functions for **EACH** of the following terms in the development of germinating seed:

i) radicle;
ii) cotyledons.

The key area required for this question were the functions of the items named. Usually, a good description of each was provided but this sometimes did not develop to cover the function. Responses such as these: anchorage and water transfer for the radicle and energy storage & supply in the seed, and photosynthetic area when above ground for cotyledons, were suitable.

Q2 State the importance of **TWO NAMED** physiological processes which could occur during seed germination

Most responses included the description of the physiological processes but these were not always named, which was highlighted in the question. Also these were often not related back to seed germination.
The action or result of inhibition or uptake of water was mentioned rather than the process osmosis. Also, detailed descriptions of respiration were often given but the process itself was not named.

Q3 State **FOUR** characteristics that make a bulky ingredient suitable for inclusion in a seed compost mix.

Clear identification of the required number of characteristics were needed, these included: low nutrient levels (this area was somewhat confused, with none to high being given); moisture retention; structurally stable; free from pest and diseases.

The role of temperature control or moderation was given an unexpectedly high profile for a less important item.

Q4 List **FOUR** effects of water in the process of soil formation.
A good review of the role of water was usually provided but the detail between statements was not always clearly made, due to using one word responses, e.g. weathering. Clear effects included: freeze and thaw action; physical displacement; chemical weathering; nutrient transfer; soil microfauna transfer.

Q5 State **TWO** plants that can be propagated by **EACH** of the following:

i) leaf lamina;
ii) grafting.

This question caused some confusion with the phrase “leaf lamina” being read as “leaf cutting”, resulting in a wide range of plants being recommended.

Suitable responses included: i) leaf lamina: Begonia rex and ***Streptocarpus x hybridus***

ii) grafting: Malus domestica 'Bramley's Seedling' and Acer palmatum 'Bloodgood'.

With grafting, the rootstock was sometimes included, with the scion names, which is a good practice but these were not required in this case. Please remember that full botanical names are required for the Level 3 qualifications.

Q6 List **ONE** benefit and **ONE** limitation provided by **EACH** of the following soils for the gardener:

i) chalky;
ii) organic.

An overall understanding of the required soils was usually given, such as:

a) quick to drain but subject to nutrient 'lock up',
b) high level of nutrients (including cation exchange capacity) present but subject to loss by erosion.

However, stronger linkage back to the soil types was required, rather than general benefits and limitations.

Some confusion was shown with the term”organic” being related back to organic growing methods rather than the soil type. This gave rise to general responses, such as free from pesticides, which is not always the case with organic soils.

Q7 State **ONE** role of **EACH** of the following in physiological processes:

i) nitrogen;
ii) phosphorus;
iii) magnesium;
iv) iron.

Clear understanding of the role provided be each nutrient was usually given, such as,
i) nitrogen: process of photosynthesis;
ii) phosphorus: energy transfer;
iii) magnesium: transport of phosphate and
iv) iron: formation of chlorophyll.

However, sometimes the level of detail provided was at Level 2, e.g. nitrogen for quick growth, rather than at the required Level 3.

Some confusion was seen, especially with magnesium and iron, and their respective roles in chlorophyll. Care must be taken also not to repeat the information given.

Q8 State **TWO** situations where tissue analysis is used in horticulture.

A wide range of responses were provided with the word “situations” being taken to mean different things, any suitable responses were rewarded. These included: NFT (nutrient film technique) systems, rockwool production and / or hydroponic containers to check nutrient levels within the plants, not in the media. Also testing and confirming the presence of diseases for the plants/crops in any growth system.
The clear identification of plant species where doubt exists was also included.

Q9 State **TWO** advantages and **TWO** limitations of using recycled landfill (composted municipal waste) as a growing medium.

A clear understanding of the situations was needed: two advantages, e.g. reducing landfill & adding organic matter and two limitations e.g. variable seasonal content & possible contaminants, i.e. plastics or heavy metals.
However, further detail was required where one word responses were given, as to the fact that it was being recommended for use as a growing medium, rather than soil improver.

Q10 State **FOUR** factors that affect the rate of release of nutrients from controlled release fertilizers in growing media.

Where the full requirements of the question were read and noted, then clear explanations were given. With the phrase “controlled release fertilizers” being included in the question the type of product was only one of the factors to be considered.

Others could have included: CEC (cation exchange capacity) of media; temperature level; moisture level; bacterial activity; nutrient form & state; plant growth rate & nutrient demand and antagonistic relationships between nutrients.

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

Sections B & C – Structured Questions

Section B – Understanding of Plant Propagation

Q11 Review the use of **EACH** of the following seed treatments with reference to **NAMED** plant examples:

i) grading;
ii) coating;
iii) chitting;
iv) priming.

Question Aims and Scope

This question is designed to test the candidate's knowledge of four techniques designed to improve seed quality and germination.

Examiners comments and recommendations

This question was generally well answered and candidates who considered the structure of the question and provided similar amounts of appropriate information for each section gave themselves the best chance of scoring highly. In general each section requires the candidate to provide ten pieces of information and included in each section must be a botanically correct named example.
Candidates who mentioned flotation testing, ease of handling both mechanical and manual and uniformity of germination and subsequent growth, scored well when answering part 1. Similarly to score well when reviewing the technique of coating, a candidate is required to explain the role of pelleted seed and the possible sowing advantages it may provide, and express an understanding of the addition of pesticides as part of the coating process.
Chitting in some instances was confused with chipping and candidates then went on to explain a range of techniques used for seed scarification, leading to few marks allocated for this answer. Candidates who understood that chitting is a technique devised to provide even germination with the emergence of the radicle ahead of sowing scored well.
Priming was also confused, but this time with the technique of chitting. Priming commences the germination process but does not reach root elongation beyond the testa.
Though few candidates chose this question, those that did generally answered it well, with some showing in depth knowledge while at the same time there was some confusion,most especially when reviewing chitting and priming.
Good information on seed treatments is contained within the publication Hartmann and Kester's Plant Propagation Principals and Practise, and a full list of IPPS conference papers relating to seed treatments and germination including abstracts can be found by going to www.ipps.org
One further very useful source of information is the seed catalogues of for example, Thompson and Morgan, Ball Colgrave or Syngenta.

Q12 a) Describe how the routine care of stock plants is used to maintain juvenility and maximise the rootability of propagation material

b) Explain **THREE** critical factors to be considered when selecting cutting material from stock plants

This question is designed to test the knowledge of the student in respect of growing stock plants for propagation by cuttings. This could include material for both root and shoot cuttings but does not extend to division or the production of scion wood for grafting. It is important that the student makes an informed judgement as to the critical nature of the factors that he or she describes in respect of cutting material selection and this question does not allow the student to express more than three factors. A student choosing less critical factors will inevitably score less well.

This question was generally well answered and those candidates who focussed on routine care of stock plants rather than for example one off care and concentrated on juvenility scored best. Routine care includes pruning, nutrition, watering and pest and disease monitoring and control.

The second part of the question requires the candidate to consider three crucial factors relating to cuttings selection and these three factors could include the health and vigour of the cutting material, trueness to type, turgidity, juvenility and wood ripeness. This question does not require a candidate to go beyond cutting selection and describe propagation environments or cutting types and or propagation compost. Candidates who adopt this approach will gain no additional marks.

Excellent information on stock plant care and cutting selection is contained within the publication Hartmann and Kester's Plant Propagation Principals and Practise, and a full list of IPPS conference papers relating to stock plant maintenance and propagation including abstracts can be found by going to www.ipps.org

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

Q13 a) Describe the origins of soil organic matter.

b) Explain the changes that occur in plant remains due to the activities of soil organisms.

The aim of the question is for candidates to demonstrate their knowledge of the different types of flora and fauna that contribute to the organic matter found in soil. Then, in detail, provide an explanation of the various ways in which plant remains are changed and processed, by soil organisms, to eventually end up with the re-cycling of organic matter into plant nutrients and useful compounds.

Part a, in the main, was answered in terms of the macro and micro organisms that live and die, in or on soil, contributing to soil organic matter. However, there was a lack of detailed knowledge of the range of relevant organisms. Some answers were a simple basic statement. Most marks were gained by describing in detail the full range of soil organisms that live in soil plus the larger organisms that contributed to organic matter via bodily processes, or by their demise. An alternative and acceptable answer, given by a few candidates, described the formation of soil starting with the weathering of parent rock along with the colonisation of lower plants, through to the formation of deep brown earth soils.

Answers to part b expanded on the information provided in part a. Many candidates described the action of earth worms and the bacteria associated with the nitrogen cycle. Soil fungi and other micro organisms were not so well covered.

Some of the less good answers contained little technical information or technical terminology. Some stages of the nitrogen cycle were the wrong way round and other processes, such as the carbon cycle were not mentioned at all.

Candidates awarded the highest marks tended to provide answers written in a logical, organised way with good use of technical language. They covered the changes in organic matter from the role of macro-organisms through to the final stages of organic matter breakdown to humus, humic and fulvic acids, and in some instances the release of plant nutrients into the soil.

To summarise the highest marks were gained by candidates that provided detailed information about a good range of soil organisms and the specific role they play in organic matter breakdown.

Clear and accurate diagrams, for example the nitrogen cycle, also gained marks.

Q14 a) Explain **EIGHT** problems for the gardener commonly associated with the soil of new houses.

b) Describe methods of overcoming the problems identified in a).

This aim of this question was for candidates to list and discuss the solutions to some of the many problems that beset owners of newly built houses and the gardens they are left with by builders.

Most candidates answered this question very well and were able to list eight realistic problems and provide the corresponding solutions/recommendations to provide suitable growing conditions for plants. The candidates that gained the highest marks for part a gave expanded answers and provided detail, explanations, and gave examples of each aspect of each specific problem.

Problems cited included; compaction, water logging, contamination by rubble/building materials/chemicals, poor structure, non-ideal texture, slope, lack of top soil, shallow top soil/sub soil, mixed soil horizons, low levels of plant nutrients and organic matter, low levels of macro and micro-organisms, non-ideal aspect as it affects soil, imported and/or poor quality top soil, weeds, capping, perched water tables, soil pans, excessive drainage, problems associated with storing soil incorrectly.

One or two problems cited by some candidates were not so realistic e.g. contamination with serious levels (possibly illegal levels) of toxic compounds such as heavy metals and radioactive materials.

Part b, in most instances, was also well answered. The highest marks were given to candidates who demonstrated a detailed knowledge of soil management and made recommendations based on sound horticultural principles and used technical language. Ideal answers were realistic for most gardeners; they stated the specific benefits of the action recommended and the care that needed to be taken when undertaking the action, timing, additional benefits brought about by the action, the realistic outcomes and they also gave examples of the materials and equipment that may be used.

Acknowledging that there were different problems associated with different soil textures (not only heavy clay), structure, depth of horizons etc. also gained marks.

Good answers were presented in a well-structured and logical format.

Q15 a) Explain how soil texture and structure affects the availability of mineral nutrients to plant roots.

b) Explain how soil pH affects the availability of **NAMED** mineral nutrients.

c) Explain how an excess of one nutrient in the soil affects the availability of other nutrients.

This question examines the presence of nutrients in the soil and how the availability of nutrients for plant use is modified by the physical and chemical characteristics of the soil.

To achieve maximum marks in the question, candidates needed to note the allocation of marks and be guided by the form of the question.

In part a, a number of candidates lost time explaining texture and structure rather than concentrating on their effects on nutrient availability. Almost all candidates appreciated the relative importance of cation exchange capacity in clay and sandy soils but fewer discussed the inherent presence of mineral nutrients in soils of different texture and origin.

Most candidates appreciated that plants take up nutrients in solution and that these would be subject to leaching in coarse textured soils.

The answers relating to structure were more variable with many answers defining soil structure rather than relating it to nutrient availability. The quality of the structure controls how far the roots ramify through the soil and thus the volume of soil which can be exploited for nutrients. It also affects how well the soil is aerated: good aeration leads to healthy roots and maximum active transport of nutrients.
Poor structure or lack of structure minimises the volume of soil exploitable for nutrients. Through impeded drainage it may cause waterlogging and subsequent lack of oxygen, root death, and thus the plant loses the ability to take up nutrients. Aeration is also significant in the processes of nitrification and denitrification and thus the availability of nitrogen to plant roots.

In part b it was pleasing to see that almost every candidate in this paper correctly identified
low pH as being acid, and high pH alkaline.

Keywords in the question are ‘explain’ and ‘nutrient’. Aluminium is not a nutrient and stating an effect is not the same as explaining it. Candidates who gained the most marks looked at the effects on nutrients at both ends of the pH scale. For instance, phosphorus is sparingly available in the soil solution. Its availability depends on release from soil minerals or fertilisers. Acidity leads to iron and aluminium in solution forming insoluble aluminium and iron phosphates, whilst at high pH (especially on calcareous clays) insoluble tricalcium phosphate is formed.

Candidates tended to use the terms ‘deficient’ and ‘unavailable’ interchangeably: discussing phosphorus and calcium for example, there was a lack of precision. At low pH phosphate is present, but in the form of insoluble phosphates and therefore not (or sparingly) available, whereas acid soils are by definition, deficient in calcium.
In part c most candidates were aware of ion antagonisms and that cations were held on the soil colloids in an exchangeable form.

The question specifies the effect of an excess of one nutrient, so was looking for examples such as the leaching of calcium following heavy applications of ammonium fertiliser, or the unavailability of magnesium after feeding tomatoes with high potash, as well as specific ion antagonisms such as iron and manganese, or nitrogen and copper.

A small minority of candidates pointed to the potential harmful effects of excess mineral fertilisers on mycorrhizae – the latter being so beneficial in maximising the efficient use of nutrients in the soil.

Q16 a) Describe **FOUR** materials that may be used in hydroponic growing systems.

b) State **FOUR** commercial crops that may be grown hydroponically and the technique used in **EACH** case.

c) Discuss the benefits and limitations of using hydroponic methods to grow plants.

Hydroponics and substrate culture has grown in significance both in the amateur and commercial fields. This question sought a contemporary knowledge of hydroponic systems relating to techniques and crops.

In part a the question asks for a description: if the answer is ‘rockwool’, then a brief explanation should follow. For example: “…stone wool formed from molten spun basalt, hardened and cut into slabs and other forms. Horticultural forms include hydrophilic fibres making it easy for the grower to control moisture levels precisely”.

It was expected that rockwool, polyurethane foam, leca and perlite would form the majority of answers but materials more commonly used overseas were also accepted.

In part b this question specifies commercial crops and a technique, for example tomatoes:

- propagated on peat or rockwool blocks,
- set out on double row rockwool slabs placed on polythene sheet
- irrigation and nutrition by drip feed.

Strawberries, lettuce, tomatoes, cucumbers, peppers and roses were some anticipated answers but other crops of a commercial nature were accepted.

Several candidates demonstrated a knowledge of large commercial nurseries such as Thanet Earth growing tomatoes, cucumbers and peppers hydroponically.

It is recommended that candidates make themselves aware of the differences between growing commercial vegetable crops, the use of hydroponics for research and technical purposes, home growing systems for vegetable and other crops, and hydroculture pot plants and planters.

In part c, the phrase ‘benefits and limitations’ offers a wide scope for acceptable answers. However candidates needed to make points which outlined the benefits of hydroponic systems specifically. Answers such as ‘control of temperature’ would equally apply to any protected growing system.

Examples of relevant points include:

Benefits

- Consistency, accurate control of nutrition, optimum growth and yield
- Optimum water availability
- Reduced loss of water and nutrients.
- No nutrient run-off / pollution.
- Reduced labour costs
- Can speed crop turnaround.
- Maximum use of space; no crop rotation necessary
- Allows production in soil-less environments

Limitations

- High capital cost, favours large scale projects.
- Complex monitoring and dosing system requires technical expertise and supervision.
- Lack of buffering capacity means that any system defects can have severe consequences.
- Environmental: disposal of rockwool