RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 9th February 2010

MODULE A

Understanding of Plant Propagation Processes and 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.

ANSWER ALL QUESTIONS

MARKS

Q1 Define **EACH** of the following terms in relation to the nitrogen cycle:

i) mineralisation;
ii) immobilisation. **2**

……

……

……

……

……

Q2 List **FOUR** visual characteristics of a Brown Earth soil profile. **2**

……

……

……

……

……

Q3 State **FOUR** stock plant treatments to enhance the rooting of cuttings taken. **2**

……

……

……

……

……

Q4 State **TWO** reasons for taking a cutting just below the node. **2**

……

……

……

……

……

Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 List **FOUR** hazards that should be considered within a risk assessment for the storage and use of water. **2**

……

……

……

……

……

Q6 Name **TWO** plants from different genera that can be propagated by leaf petiole cuttings, stating why this method is possible with these species and not others. **2**

……

……

……

……

……

Q7 Name **ONE** major nutrient and **ONE** minor nutrient whose deficiency results in interveinal chlorosis. **2**

……

……

……

……

……

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q8 State **TWO** reasons for incorporating vermiculite in potting mixes. **2**

……

……

……

……

……

Q9 Name **FOUR** plants propagated by root cuttings. **2**

……

……

……

……

……

Q10 State why it is important to apply the correct rate/level of fertiliser to crops growing on organic soils. **2**

……

……

……

……

……

****

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 9th February 2010

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 a) Explain the effects of **EACH** of the following physiological processes on the germination of seed:

i) respiration;
ii) water uptake. **8**

b) Describe, using **NAMED** plant examples, a range of methods available to the propagator to break seed dormancy, using **EACH** of the following headings:

i) scarification; **6**
ii) stratification. **6**

Q12 Explain, using **NAMED** plant examples in **EACH** case, the use of the following in plant propagation:

i) mist unit; **5**
ii) fogging unit; **5**
iii) plastic covers; **5**
iv) heated bins. **5**

****

Please see over/…..

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

Answer TWO questions from this section

MARKS

Q13 a) i) Summarise the processes involved in soil cation exchange.

ii) Explain how these affect the ability of soil to supply plants with adequate nutrients. **8**

b) Describe how **EACH** of the following contribute to cation exchange in soils:

i) silt;
ii) humus. **4**

c) Discuss under **EACH** of the following headings, **FOUR NAMED** bulky components:

i) cation exchange capacity;
ii) nutrients. **8**

Q14 a) i) Define the term ‘bulk density’ in relation to soil.
ii) Explain how ‘bulk density’ is determined. **6**

b) Discuss **TWO** horticultural situations that require the bulk density of soil to be taken into consideration. **4**

c) Discuss how the bulk density of soil affects plant growth. **10**

Q15 a) Describe **FIVE** adverse effects of irrigation of nursery plants in containers and in open ground. **10**

b) Describe management techniques that could be employed to maximise the effectiveness of irrigation. **10**

Please turn over/…..

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

Answer TWO questions from this section

MARKS

Q16 a) Compare and contrast the symptoms of iron deficiency with magnesium deficiency in plants, stating reasons for the differences. **4**

b) Describe the roles of **EACH** of the following nutrients in plant development:

i) copper;
ii) boron;
iii) manganese;
iv) zinc. **12**

c) Name **ONE** plant nutrient that can become toxic in soils or growing media, stating the toxicity symptoms and a common reason for its occurrence. **4**

****

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

10:00am Tuesday 9th February 2010

MODULE A

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

Candidates Registered	**210**		**Total Candidates Passed**	119	66.48%
Candidates Entered	179	85.24%	Passed with Commendation	46	25.70%
Candidates Absent	25	11.90%	Passed	73	40.78%
Candidates Deferred	5	2.38%	Failed	60	33.52%
Candidates Withdrawn	1	0.48%			

Section A – Short Answer Questions

Q1 Define **EACH** of the following terms in relation to the nitrogen cycle:

i) mineralisation;
ii) immobilisation.

A broad range of responses were seen, including some not related to the nitrogen cycle or given as definitions. General statements can be used after a definition is provided, not as a replacement.

(i) Mineralisation - organic nitrogen, from organic matter, converted back to ammonium by breakdown by microbes, eg. bacteria.

(ii) Immobilisation - Nitrate is used by bacteria, if not enough is available from organic matter breakdown, and is returned to organic nitrogen eg. occurs with an imbalance of carbon and nitrogen, when uncomposted woody material is applied as a mulch.

Q2 List **FOUR** visual characteristics of a Brown Earth soil profile.

Some excellent responses were provided, including the following:

(i) Interconnecting cracks moving through the topsoil into the subsoil
(ii) Merging between top and subsoil horizons
(iii) Even soil colouring down the profile
(iv) Deeply penetrating plant roots
(v) Active presence of soil macrofauna, eg. earthworms.

Statements related to climax or lush vegetation were not accepted, as they do not relate to the visual characteristics of the profile.

Q3 State **FOUR** stock plant treatments to enhance the rooting of cuttings taken.

This question was unfortunately mis-read by some candidates, with the word "**stock"** being missed. This resulted in a range of treatments being listed for the cuttings, rather than the stock plants.

Correct suitable responses included:

(i) Pre-propagation pruning treatments
(ii) Plant or branch spacing for even light
(iii) Seasonal weed control
(iv) Seasonal fertiliser programme, with high potassium or nitrogen levels, depending on season or response required.
(v) Seasonal control of pests and diseases.
(vi) Irrigation programme.

Q4 State **TWO** reasons for taking a cutting just below the node.

A number of successful reasons were provided, including:

(i) Higher natural hormone levels
(ii) Site of active meristematic tissue
(iii) Reduction of dieback
(iv) Quicker rooting
(v) Standard production point for grading
(vi) Easier to instruct workers to a known point.

Q5 List **FOUR** hazards that should be considered within a risk assessment for the storage and use of water.

Some Candidates are still having problems with the term "**hazards**" and are giving responses such as "suitable signage". Hazards that could be, and were, highlighted include:

(i) Slips, trips and falls
(ii) Weils' disease
(iii) Legionnaire's disease (Legionellosis)
(iv) Electrical risks, eg overhead power lines
(v) Cuts from sharp edges
(vi) Access to deep water

Q6 Name **TWO** plants from different genera that can be propagated by leaf petiole cuttings, stating why this method is possible with these species and not others.

The **full** botanical name of any suitable examples, eg. *Peperomia caperata* and *Saintpaulia ionantha,* was required. The petioles of these plants possess active meristematic cells. Some confusion was noted with plant examples being included for **Leaf Bud** cuttings, rather than **Leaf Petiole**.

Q7 Name **ONE** major nutrient and **ONE** minor nutrient whose deficiency results in interveinal chlorosis.

Any fully named suitable examples of a major nutrient, eg. magnesium and any fully named suitable examples of a minor one, eg. iron, manganese, zinc and boron, were accepted.

Other nutrients wrongly named were:
nitrogen, where deficiency usually results in pale green leaves which then go yellow all over, and calcium, where a **toxicity** results in interveinal chlorosis, rather than a **deficiency**, which shows as tip or root burn.

Q8 State **TWO** reasons for incorporating vermiculite in potting mixes.

Any suitable TWO reasons, eg. retaining moisture, light in weight, free from pest and disease, drainage & supplies an amount of magnesium (Mg) and has a Cation Exchange Capacity (CEC), were accepted.

However, light reflection given as a reason, when used as a surface covering, was not acceptable, as the question stated “in potting mixes”.

Q9 Name **FOUR** plants propagated by root cuttings.

A very wide range of plants were given using both botanical and common names or sometimes a mixture.
The **full** botanical name of any suitable examples, eg. *Papaver orientale; Acanthus mollis; Phlox paniculata* and *Primula denticulata* were required.

However, tree and shrub examples were cross referenced with the *Nursery Stock Manual* to confirm whether root cuttings were an included method, after consultation with the Senior Examiner.

Q10 State why it is important to apply the correct rate/level of fertiliser to crops growing on organic soils.

This question was unfortunately mis-read or mis-interpreted by some candidates, with the word **organic** being taken as soils of Organic Growing Status, eg. Soil Association Approved. rather than soils with an organic matter level greater than 15%.

Any suitable reasons were accepted, eg.

(i) Uptake of nutrients on to the organic matter within the soil with none, or little, remaining available for direct plant use.

(ii) Leaching of excessive nutrients as the organic matter breaks down leading to eutrophication.

(iii) Disruption or death of soil micro-flora and fauna due to nutrient imbalances.

(iv) Disruption or death of growing crop by ex-osmosis due to over application.

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

Sections B & C – Structured Questions

Section B – Understanding of Plant Propagation

Q11 a) Explain the effects of **EACH** of the following physiological processes on the germination of seed:

i) respiration;
ii) water uptake.

b) Describe, using **NAMED** plant examples, a range of methods available to the propagator to break seed dormancy, using **EACH** of the following headings:

i) scarification;
ii) stratification.

Question Aims

The aims of the question are to test the candidate's knowledge of sexual propagation and in particular the processes that a seed undergoes on its way to successful germination. The question requires the candidate to have both a scientific and a practical awareness of seed germination.

Candidates following the structure of the question and answering each section with unique information rather than repeating information in more than one section, did best. It is important to note that a student should plan an answer carefully so that the relevant information is clearly stated and is written so that the answer can be read easily.

For part a) i) candidates were expected to discuss the process of respiration in the production of energy from stored food reserves for the various processes involved in germination. In part ii), mention should have been made of the role water has in hydration, mobilisation and transport of food reserves and on the subsequent increase in size of parts of the embryo.

In part b) some confusion of the terminology was evident and those students who stuck strictly to the question rather than extending the answer to describe dormancy conditions in general, faired best. Warm, moist stratification should have been mentioned as well as cold. To gain maximum marks named examples require latin names in full.

Taking the time to read and understand the question is essential and to gain the maximum marks a candidate needs to be aware of the number of marks available per section and to tailor an answer accordingly.

Diagrams must be relevant and clearly annotated.

Q12 Explain, using **NAMED** plant examples in **EACH** case, the use of the following in plant propagation:

i) mist unit;
ii) fogging unit;
iii) plastic covers;
iv) heated bins.

Question Aims

The aims of the question are to test the candidate's knowledge of propagation facilities and the way in which they can be utilised to ensure successful plant propagation. In each case a candidate who provided four distinct, named (using the latin name in full) plants, gained maximum marks.

Few candidates answered this question but those that did, in general did reasonably well. Key to answering the question successfully is to follow the question structure and in this case provide equal weight to each of the four sections. Those candidates who did this gave themselves the best chance of doing well. Always write clearly and in a hand that is easily read.

Implicit in the question is the different type of environment each facility creates. Those candidates who reflected their understanding of this in answering the question, did best. Some candidates struggled to differentiate sufficiently between each environment and so scored less well. Greatest confusion arose in the understanding of the use of heated bins with some candidates describing a cold frame with soil warming cables, rather than identifying the heated bin as a propagation facility predominately utilised in the large scale production of hardwood cuttings, particularly for fruit rootstocks.

In general candidates needed to express more in depth knowledge of fogging units and the types of polythene available to the propagator and how these affect the environments created.

Taking the time to read and understand the question is essential and to gain the maximum marks a candidate needs to be aware of the number of marks available per section and to tailor an answer accordingly.

Diagrams must be relevant and clearly annotated.

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 for Questions 11 and 12

No amount of reading is a substitute for practical experience, so it is worthwhile contacting the Garden and Estates Events Manager 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.

Make use of the following texts :-
RHS Propagating Plants (Alan Toogood)
Hartmann and Kester's Plant Propagation Principles and Practices
Ask for advice on exam technique

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

Q13 a) i) Summarise the processes involved in soil cation exchange.

ii) Explain how these affect the ability of soil to supply plants with adequate nutrients.

b) Describe how **EACH** of the following contribute to cation exchange in soils:

i) silt;
ii) humus.

c) Discuss under **EACH** of the following headings, **FOUR NAMED** bulky components:

i) cation exchange capacity;
ii) nutrients.

Candidates who described cation exchange as the exchange of positively charged cations, with negatively charged sites on the clay-humus (colloid) faction of soil, gained good marks. Further marks were gained by describing cation exchange capacity as the capacity of soil, at a given pH, to hold cations making them available to plants and preventing nutrient leaching. Good answers gave examples of cations (plant nutrients) and identified that hydrogen ions, released by plant roots, contributed to cation exchange. Some candidates made good use of diagrams to explain cation exchange processes.

Marks were gained if candidates explained how these processes affected nutrient supply to plants, the main factors being the necessity for cations (and anions) to be in soil solution, the possibility of nutrient antagonism, the amount of clay / humus present in soil and the effect of pH on cation exchange.

Candidates gained marks for stating that silt is not normally associated with having any cation exchange capacity value. Good answers identified that soil colloids smeared on the surface of silt particles would be part of the cation exchange process. Good answers also stated that silt had a positive effect on soil porosity, thereby contributing to cation exchange.

High marks were gained for describing how humus is formed, its action as a soil colloid, its nutrient releasing potential, and its excellent contribution to soil cation exchange processes.

The best answers correctly identified bulky components (mainly organic) that could be added to soil and growing media e.g. garden compost, bark, municipal waste, farmyard manure, vermiculite, perlite. Fertilisers are not considered to be bulky components. High marks were awarded for correctly stating if materials had high/med/low cation exchange potential and for identifying the nutrients that may be released into the soil/growing media as the bulky component was broken down e.g. the release of nitrogen from well-rotted farmyard manure.

Q14 a) i) Define the term 'bulk density' in relation to soil.
ii) Explain how 'bulk density' is determined.

b) Discuss **TWO** horticultural situations that require the bulk density of soil to be taken into consideration.

c) Discuss how the bulk density of soil affects plant growth.

Bulk density was correctly identified by many candidates as 'the mass per unit volume of dry soil'. Some candidates found slight confusion between bulk density and particle density.

The practical method of determining bulk density was frequently and accurately described, along with the calculation for obtaining the figure representing bulk density. Highest marks were gained if oven drying the soil was stated and also the correct unit of measurement given.

Horticultural situations requiring the consideration of bulk density were correctly discussed by most students. Frequently discussed situations included: roof top gardening, transporting soil, calculating correct fertiliser application, planning soil management, planning for crops, stating that bulk density reduces as volume increases during cultivation processes.

The effect of bulk density on plant growth was correctly answered by discussing: adequate aeration for root respiration, aeration for soil organisms, soil porosity, available soil water, root penetration through soil.

The highest marks were gained if candidates correctly understood that soil bulk density should not be confused with the terms commonly used to describe some of the physical properties of soil e.g. light sandy soil and heavy clay soil.

Q15 a) Describe **FIVE** adverse effects of irrigation of nursery plants in containers and in open ground.

b) Describe management techniques that could be employed to maximise the effectiveness of irrigation.

The first part of this question offered scope for a wide range of answers. Candidates were asked for five effects, maximum points were awarded where the stated effect included an explanation and an example. The question refers to containers and open ground – extra marks could not be expected for repeating the same effect under each heading.

Irrigation refers to the supply of water, from above or below, for the purposes of growth. Propagation units employing mist and fog are using water for a different purpose.

Irrigation is a beneficial, and in many systems, an essential horticultural operation. Adverse effects of irrigation can be caused by improper, excessive or inappropriate use. To answer this question satisfactorily, the candidate must appreciate the differences between overhead irrigation by sprinklers and sub irrigation methods such as capillary matting, sand beds and ebb and flood benches. The adverse effects have different emphasis in each system. However, some characteristics such as water quality are relevant to every system.

Most candidates correctly identified the major problems with **overhead systems** as being related to:

- poor coverage of the target area leading to wastage
- potential for leaching nutrients and physical erosion
- excess moisture causing fungal problems at leaf or root level, together with competitive weed growth.

In addition, most candidates referred to adverse effects from combining heavy irrigation with fine textured or capped soils and soils and composts that had impeded drainage.

A majority of candidates referred to the problems caused by insufficient or erratic watering, with general agreement that frequent minimal watering could cause shallow rooting which would lead to a plant lacking the ability to cope with future adverse conditions.

Overhead irrigation in relation to evaporative losses was much commented on, although these losses reduce considerably as the soil surface is wetted and irrigation continues.

Many candidates referred to the scorching effect of water acting as a lens on the leaf on sunny days. Although this phenomenon appears logical and is much quoted, it is something of a gardener's myth. Scorching only occurs on protected plants liquid-fed overhead, without washing off the foliage. Marks *could* be awarded for pointing out the aesthetic affect of calcium deposits on the leaves or physical damage caused by heavy irrigation especially of small plants.

In light of concern about the general availability of water in relation to increased demand, it was good to see that many candidates were aware of the cost of wasting water, although fewer mentioned the possibility of pollution of water courses and aquifers following run off or leaching. Knowledge of which nutrients are most subject to leaching was sketchy in some cases.

Fewer comments were made about possible adverse effects associated with **sub-irrigation**. One topic that came up in a number of scripts was that of the build up of salts and sodic soils. Sodic soils are characteristic of arid regions where there is no net downward movement of water; they are not typical of the UK. Marks could be gained by referring to salt build up in sand beds in hot dry summers or by the general problem of groundwater supplies contaminated by seawater inundation, the latter of rising significance in UK coastal areas. Although marks were awarded for any correct, relevant information, candidates are reminded that the syllabus refers to the nature and properties of *UK* soils.

Other topics which could have been discussed were: undrained capillary beds in winter causing lower root ball death; plants being liable to stress when removed from optimum conditions; 'rooting through' wasting material and labour, and the build up of algae and weeds on capillary matting and sand beds, also requiring labour or chemicals for removal.

For drip irrigation, over reliance on individual emitters could cause wilting due to blocked or lost emitters, and for ebb and flood there is a (potential) disease risk with recirculation methods.

With the key words 'management techniques and effective irrigation', the second part of this question offered scope for a wide range of examples and the opportunity to score highly. Topics could include:

- the appropriate choice of method.
- accurate measurement of soil moisture deficit and irrigation applied.
- maximising the effects of irrigation.
- minimising irrigation losses.
- types of container and compost.
- maintenance issues.

Whilst practical solutions for using water effectively at a domestic level were accepted, the phrase 'management techniques' guided most candidates to emphasise commercial and amenity practice, informed (in the words of the syllabus) by a 'firm foundation in horticultural science and a good knowledge of horticultural practices'.

Answers scoring maximum marks described a range of techniques without dwelling for too long on any one of them. It was noted, in view of previous reports, that the majority of candidates had a good grasp of the concept of water balance sheets, describing in detail how monitoring of inputs, capacity and timing allowed control of irrigation. In some cases the detail entered reduced the amount of time available for listing other methods. Some candidates also spent much effort in describing methods of reducing water loss from leaves in propagation, a topic separate from irrigation.

Relating this answer to current horticultural practice the following topics were under emphasised: measuring devices (tensiometers, evaporimeters [*not* hydrometers]) moisture sensitive stages of crop development (eg legume pod swelling) and maximum yield from a given amount of water. Conversely most candidates did appreciate the effects of structure, texture and organic status on how effectively irrigated water was retained for crop use.

Q16 a) Compare and contrast the symptoms of iron deficiency with magnesium deficiency in plants, stating reasons for the differences.

b) Describe the roles of **EACH** of the following nutrients in plant development:

i) copper;
ii) boron;
iii) manganese;
iv) zinc.

c) Name **ONE** plant nutrient that can become toxic in soils or growing media, stating the toxicity symptoms and a common reason for its occurrence.

Many candidates showed good knowledge of plant nutrients. However, this question used precise wording and to score well the answer needed to precisely follow the question and be proportionate to the number of marks allocated.

Most candidates recognized interveinal chlorosis and most correctly identified whether the symptoms affected old or new leaves. However few offered any other characteristics such as the very pronounced nature of the chlorosis caused by magnesium deficiency, or the occurrence of wholly pale leaves in the case of iron.

'Compare and contrast' invites the candidate to find as many differences as possible.

'Stating the reasons for the *differences*' was read by many as 'stating the reasons for the *deficiencies'* which unfortunately, is quite another question.

Given that many nutrient deficiencies are not clear cut in symptoms, it is always useful to be aware of predispositions and subjects especially prone to deficiencies. For example, one could say that Mg deficiency could be expected in free draining soils, after high potash application and in apples, grapes, potatoes and tomatoes.

The second part of the question accounted for ¾ of the marks. Many candidates had a vague knowledge of the topic and were struggling to find more than one function for each nutrient. However, the role and function of nutrients in plants is prominent in the syllabus and a minority of candidates did show a detailed understanding.

The question asks for the role of each nutrient, *not* the symptoms or the cause of deficiency.

The following roles were used as a guide but points were awarded for any functions that could be confirmed by an authoritative source.

Copper

- present in several (oxidase) enzymes.
- metabolic reactions (carbohydrate & protein metabolism).
- precursor in production of iron compounds for chlorophyll.

Boron

- enzyme inhibitor
- involved in active transport across cell membrane.
- translocation of sugars (also N and P).
- new cell development, especially meristems.
- pollen tube growth (important in apple set).

Manganese

- enzyme activator in chlorophyll synthesis.
- enzyme activator in respiration reactions.
- influences uptake of other elements.
- nitrogen metabolism and assimilation.

Zinc

- involved in production and regulation of carbohydrates and chlorophyll.
- role in production of growth promoting compound (auxins).
- constituent of several enzymes.
- involved in seed development.

In the third part of the question, although ‘toxic’ strictly refers to poisonous effects, generally damaging effects were accepted. Expected nutrients to be mentioned were boron, sulphur (historically), manganese, and chlorine. Answers which correctly defined the effects of excess nitrogen (or ammonia), copper (following excess fungicide), iron (not common UK) and zinc were also accepted.

Unexpectedly the most chosen nutrient was nitrogen. Answers which referred to root problems caused by excess conductivity following high N application on dry soil or to ammonia or nitrite toxicity associated with organic fertilisers were accepted. Historically, ammonia and nitrite toxicity could also follow steam sterilisation.

Of the trace elements, high marks were scored by candidates who:

- pointed to the narrow range between deficiency and toxicity of boron and manganese.
- noted the relationship with pH.
- gave specific examples (eg Mn: measly bark of apples or black spotting of beans).