

Assessment Schedule – 2014

Agricultural and Horticultural Science: Demonstrate understanding of techniques used to modify physical factors of the environment for NZ plant production (91290)

Evidence Statement**Question ONE: Protective environments**

Achievement	Achievement with Merit	Achievement with Excellence
Describes how plastic or glass houses modify TWO physical factors of the environment for commercial nursery production.	Explains how the use of plastic or glass houses modifies TWO physical factors of the environment for commercial nursery production in terms of plant quality.	Compares and contrasts the two protective environments of glasshouse and plastic house, for improved plant growth AND quality in nursery production in terms of economic AND environmental impacts.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how plastic houses or glasshouses modify physical factors of the environment for commercial nursery production.
N2	Partial or insufficient description of how plastic houses or glasshouses modify physical factors of the environment for commercial nursery production.
A3	Describes how plastic houses or glasshouses modify TWO physical factors of the environment for commercial nursery production.
A4	Fully describes how plastic houses or glasshouses modify TWO physical factors of the environment for commercial nursery production, with reference to growth rates.
M5	Explains how the use of plastic houses or glasshouses modifies TWO physical factors of the environment for commercial nursery production, in terms of how improved plant processes improve plant quality.
M6	Fully explains how the use of plastic houses or glasshouses TWO modifies physical factors of the environment for commercial nursery production, in terms of how improved plant processes affect growth AND improve plant quality.
E7	Compares and contrasts the two protective environments of glasshouse and plastic house, for improved plant growth AND quality in nursery production in terms of economic and environmental impacts. Comprehensive evidence given for superiority of ONE technique with both factors, with the other technique well supported with both factors.
E8	Compares and contrasts the two protective environments of glasshouse and plastic house, for improved plant growth AND quality in nursery production in terms of economic and environmental impacts. Comprehensive supporting evidence of superiority is given for BOTH techniques, with both factors.

Q1	Evidence
(a)	<p>Describes how the use of a plastic house modifies physical factors of humidity and carbon dioxide for nursery plant production</p> <p><i>Humidity</i></p> <p>High humidity (over 80%) is when there is a high amount of water vapour inside the plastic house. Often combined with very low or no movement of the air and high temperatures. Vents are windows in the plastic house that can be opened to let in and increase air movement, reducing temperature and humidity. Ceiling fans are turned on to increase the amount of air movement in the plastic house. When humidity levels become too high, excess moisture can be flushed out by raising the temperature and opening vents. When humidity levels are too low, reduce the temperature and close the vents. Venting the plastic house to reduce humidity means that heat is also escaping, and at the same time carbon dioxide can be drawn in at lower levels. If humidity is being removed by flushing, in which a burst of heat is driven upwards, taking humidity with it, then a reduction in temperature will also occur.</p> <p><i>Carbon dioxide</i></p> <p>When the carbon dioxide levels are low during the day, the doors and vents are opened to increase the air flow, allowing carbon dioxide to enter the plastic house. Vents are not opened during the night, as no photosynthesis is taking place. Carbon dioxide injection can take place during daylight hours via tubes at ground level, when the carbon dioxide levels are below the optimum.</p> <p>Explains how the use of a plastic house modifies physical factors of humidity and carbon dioxide to improve the plants' growth and quality</p> <p><i>Humidity</i></p> <p>Production requires a level of humidity that leads to retention of water for photosynthesis, so improving plant growth and producing a higher-quality end product. Humidity is a combination of warmth and water, which increases cell division and elongation, increasing plant growth. However, humidity cannot be too high, or it would increase the chances of disease. If diseases occur on the leaves, then leaf area for photosynthesis is reduced, while diseases in the stem reduce the transport of water and photosynthesis. High humidity decreases transpiration. The plant also uses energy resources to fight infection, due to high humidity, which decreases yield and plant quality. High moisture (78% can cause Botrytis) and temperature levels encourage bacteria and other micro-organisms to multiply, which can often cause disease, and this shows up as rotting and other imperfections. With low humidity (under 60%), spores dry out, reducing spread of disease.</p> <p><i>Carbon dioxide</i></p> <p>The carbon dioxide level in the atmosphere is about 400 ppm; this can reduce to 300 ppm in an unvented glasshouse, where the other factors are at their optimum, ie water, light, and temperature. When carbon dioxide injection occurs, the levels can be increased to 700 ppm. Increasing the carbon dioxide level from 400 ppm to 500 ppm increases the plant growth by 15–25%, while an increase from 400 ppm to 700 ppm potentially increases plant growth by 30–40%. Beyond 700 ppm, the effect of more carbon dioxide becomes smaller, and increasing the level above 1,000 ppm produces almost no further beneficial effect. Up to that practical limit, increasing the volume of carbon dioxide increases the rate of photosynthesis, which increases glucose levels in the plants which improves plant growth (bigger, better looking) and therefore produces a higher quality end product for sale or for planting outside.</p>

- (b) **Compares and contrasts** the glasshouse and plastic house protective environments for improved plant growth and quality in nursery production; **compares** the economic and environmental impacts of each environment

Glass requires a greater financial outlay, but is longer-lasting. It has been the preferred traditional protective environment, because of its permanence. However, glass is one of the least efficient materials for retaining heat, due to its high heat transfer rate (ie allowing heat energy to be conducted through the glass very easily), and consequently, poor insulating characteristics. Toughened safety glass offers more thermal efficiency than normal glass, and will more than likely last a lot longer, due to its strength and durability. However, it is more expensive to use. Glass provides better light quality, resulting in increased photosynthetic rates, so plants will mature more quickly to meet market windows. As glass is significantly heavier than the materials used in a plastic house, the glasshouse frame will obviously need to be substantially stronger and designed specifically for glass. Glass doesn't diffuse light, and therefore there is a risk that plants might burn. It also has a lower impact resistance when compared to plastic coverings, and therefore can break much more easily. Glass is very rigid, and does not allow for movement or shift in the glasshouse frame and/or foundations. It lasts for a long time, has a more pleasing look to the eye, reducing visual pollution, and has good light clarity.

A plastic house provides good clarity but, at about 89% clarity, is not quite at the level of glass. It is also strong and durable, making it a long-lasting option. Plastic has to be replaced more regularly than glass. It can be used in a double-layered configuration, separated by flutes. This provides a double glazing effect and improves the thermal insulation of this product. Commercial plastic houses are commonly made of a triple coating of plastic. If a plastic house is used, the plastic house frame must be designed to accommodate the panels securely, ensuring they will not blow out, and are sealed around the edges to maximise the thermal efficiency of the house. It will also keep the moisture, mould, and bugs out of the inner cavity; otherwise, pests and disease can be spread to plants, and humidity levels can become an issue. It has good longevity and holes can be easily patched, although it is prone to scratch damage. Plastic is more readily recycled than the heat-treated panes of glass used in a glasshouse. Therefore, using a plastic house may not only be cheaper, but may also have less impact on the environment, due to lower carbon dioxide emissions and better use of environmental resources. However, seedlings grown in lower light quality may become etiolated and lose quality.

Question TWO: Shelter belts

Achievement	Achievement with Merit	Achievement with Excellence
Describes how shelter belts modify TWO physical factors of the environment in commercial fruit production.	Explains how shelter belts modify TWO physical factors of the environment to improve the timing of harvest in commercial fruit production.	Justifies the use of a natural shelter belt over the use of shelter cloth in the production of fruit, by explaining why natural shelter belts are likely to cause fewer environmental impacts.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how shelter belts modify physical factors of the environment in commercial fruit production.
N2	Partial or insufficient description of how shelter belts modify physical factors of the environment in commercial fruit production.
A3	Describes how shelter belts modify TWO physical factors of the environment in commercial fruit production.
A4	Fully describes how shelter belts modify TWO physical factors of the environment in commercial fruit production with reference to growth rates.
M5	Explains how shelter belts modify TWO physical factors of the environment to improve the TIMING of harvest in commercial fruit production, in relation to plant processes.
M6	Fully explains how shelter belts modify TWO physical factors of the environment to improve the TIMING of harvest in commercial fruit production, in relation to plant processes <i>AND</i> growth.
E7	Justifies the use of a natural shelter belt over the use of shelter cloth in the production of fruit, by explaining why natural shelter belts are likely to cause fewer environmental impacts. Comprehensive evidence given for superiority of ONE technique, with the other technique well supported.
E8	Justifies the use of a natural shelter belt over the use of shelter cloth in the production of fruit, by explaining why natural shelter belts are likely to cause fewer environmental impacts. Comprehensive supporting evidence of superiority is given for BOTH techniques.

Q2	Evidence
(a)	<p>Describes how shelter belts modify TWO physical factors of the environment in commercial fruit production</p> <p>Shelter belts should be a continuous length, with no gaps. They provide protection from the wind by reducing wind speed and increasing the inside temperature. However, they can lower light levels. Shelter that is permeable acts as a wind filter rather than a wind block, reducing wind turbulence and wind speed. This reduces the chill factor, the mean wind speed, and the number of days with gale-force winds in the sheltered area.</p> <p>Explains how shelter belts modify TWO physical factors of the environment to improve the timing of harvest in commercial fruit production</p> <p>Warmer temperatures increase the rate of photosynthesis, which raises production of carbohydrates and improves the fruit health, size, colour, and sugar levels, therefore increasing crop growth and ripening. More fruit will mature more quickly, thus allowing harvesting to occur earlier.</p> <p>Porosity of shelter should be about 50%, as insects such as bees require relatively calm conditions for flight between hives and their target fruit crops. Shelter maintains these conditions, allowing bees to move from flower to flower, and in doing so, pollinate crops, resulting in optimum fruit set and the potential for earlier harvest.</p> <p>By providing shelter, the timing of harvesting of the fruit can be brought forward by speeding up the maturity of the fruit, by reducing wind speed and the impact of gales. With increased rates of photosynthesis, more glucose / carbohydrates are produced, therefore increasing the size and sugar levels of the fruit, bringing maturity on earlier. Reduced wind velocity means less physical damage to young delicate limbs, fewer bruised and damaged fruit, and an increase in growth, flowering, fertilisation, fruit set, and development, thus ensuring earlier maturity. Reduced wind velocity results in less evaporation from the soil and transpiration from the leaves, water stress is less likely, and fruit growth / size is not hindered.</p>
(b)	<p>Justifies the use of a natural shelter belt over the use of shelter cloth in the production of fruit, by explaining why natural shelter belts are likely to cause fewer environmental impacts</p> <p>Natural shelter belts have minimal environmental impacts. They are biodegradable, are aesthetically pleasing, have no disposal issues, do not need to be replaced regularly, and there is no chemical leaching. The soils are protected, as the topsoil is held in place by the roots of the natural shelter, and this reduces wind and water erosion. This promotes the natural cycling of nutrients, which improves the natural structure of the soil.</p> <p>Artificial shelter, such as the use of shelter cloth, may not be aesthetically pleasing to some people, is not biodegradable, creates disposal problems, and is produced from non-renewable resources. Disposal of old shelter cloth can cause environmental pollution, due to the breakdown of the cloth and chemical leaching from it into the soil. There is also chemical leaching from the tanalised posts used to hold up the cloth. The shelter cloth needs to be replaced periodically – about every 10 years on average, depending on weather conditions. Visually, artificial shelter appears bland (some may say unappealing), while green foliage has a naturally calming effect.</p>

Question THREE: Water scheduling

Achievement	Achievement with Merit	Achievement with Excellence
Describes how an irrigation technique can improve TWO physical factors of the environment for an export vegetable root crop.	Explains how an irrigation technique can increase the yield of an export vegetable root crop.	Compares the economics of management of the use of water scheduling in the selection of timing irrigation with that of daily irrigation using a gun irrigator.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how an irrigation technique modifies the physical factors of the environment when growing export vegetable root crops.
N2	Partial or insufficient description of how an irrigation technique modifies the physical factors of the environment when growing export vegetable root crops.
A3	Describes how an irrigation technique modifies TWO physical factors of the environment when growing export vegetable root crops.
A4	Fully describes how an irrigation technique modifies TWO physical factors of the environment when growing export vegetable root crops, with reference to growth rates.
M5	Explains how an irrigation technique modifies TWO physical factors of the environment when growing export vegetable root crops to allow an increased root production YIELD, in relation to plant processes.
M6	Fully explains how an irrigation technique modifies TWO physical factors of the environment when growing export vegetable root crops to allow an increased root production YIELD, in relation to plant processes <i>AND</i> growth.
E7	Compares the economics of management of the use of water scheduling in the selection of timed irrigation with that of daily irrigation using a gun irrigator. Comprehensive evidence given for superiority of ONE technique, with the other technique well supported.
E8	Compares the economics of management of the use of water scheduling in the selection of timed irrigation with that of daily irrigation using a gun irrigator. Comprehensive supporting evidence of superiority is given for BOTH techniques.

Q3	Evidence
(a)	<p><u>Describes</u> how water scheduling can improve the physical factors of the environment for an export vegetable root crop</p> <p>Water scheduling is the process used by irrigation system managers to determine the correct frequency and duration of watering. The goal in irrigation scheduling is to apply enough water to fully wet the plants' root zone while minimising over-watering, and then allowing the soil to dry out in between waterings, increasing humidity and enabling the oxygen to enter the soil and encourage root development – but not so much that the plant is stressed beyond what is required for optimum growth. By providing optimum soil water, the soil temperature will be at an optimum level as well.</p> <p><u>Explains</u> how water scheduling improves the physical factors to increase the yield of an export vegetable root crop</p> <p>Water is needed for transport of nutrients, cell division and elongation, chemical processes, and physical support. All these are enhanced by increased water supply. An accurate water scheduling technique is important, so that plants receive optimum water at different stages of growth, and that the water resource is used efficiently. It ensures that water is consistently available to the plant, and that it is applied according to crop requirements. Proper irrigation scheduling will improve profitability and water use efficiency, by maximising the crop yield and quality and decreasing water lost through deep percolation and run-off. This ensures that optimum water is available to the plant, which will increase photosynthesis and root production, and therefore yield. The high humidity, good soil water air ratio (oxygen levels) and increased temperatures also provided by water scheduling promote rapid respiration, growth, and may induce earlier and higher yields.</p>
(b)	<p><u>Describes</u> how a gun irrigator can improve the physical factors of the environment for an export vegetable root crop</p> <p>A gun irrigator is an overhead, high-pressure sprinkler mounted on moving platforms. A large impulse sprinkler or gun rotates, and the irrigator also winches itself towards a fixed point at the other end of the paddock. This system requires higher water pressure, since it has only one outlet covering a wide area. The gun pumps out water to the pasture to ensure that there is water available in the soil for plant growth.</p> <p><u>Explains</u> how a gun irrigator can increase the yield of the root crop</p> <p>Water is needed for transport of nutrients, cell division and elongation, chemical processes, and physical support. All these are enhanced by increased water supply. A gun irrigator ensures that water is consistently available to the plant, and that the water is utilised to maximise the crop yield and quality, and decreases water lost through deep percolation and run-off. This ensures that optimum water is available to the plant, which will increase photosynthesis and root production, and therefore yield. High humidity, good soil water air ratio (oxygen levels) and increased temperatures are also provided by a gun irrigator, which promote rapid growth and may induce earlier and higher yields.</p> <p><u>Compares</u> the economics of management of the use of water scheduling in the selection of timed irrigation with that of daily irrigation using a gun irrigator</p> <p>Water scheduling is a timed form of irrigation, and for it to be successful, it is important to use localised readings rather than general climate information. Obtaining this data can be expensive, but without it the stress point is not known, and then it is a hit-or-miss affair, which is unacceptable when growing an export crop that will be subject to exacting quality requirements. If these requirements are not met, the crop may not be sold at a profit, even in New Zealand.</p> <p>(The following factors are taken into consideration: how quickly the water is applied; how uniformly the water is applied; how quickly the water is absorbed by the soil; slope (topography) of the land being irrigated; soil-available water capacity; effective rooting depth of the plants to be watered; current watering requirements of the plant; the amount of time in which water or labour may be available for irrigation; the amount of allowable moisture stress which may be placed on the plant; and the timing to take advantage of projected rainfall).</p> <p>Instead of using water scheduling, general daily irrigation can take place using a gun irrigator, however this is not based on weather or other environmental conditions. Gun irrigators can lead to expensive water wastage, as well as surface run-off and pollution issues. Loss of expensive soluble chemical fertiliser</p>

through leaching, due to excessive irrigation and additional rainfall, could occur on free-draining soils. Over-irrigation can result from the use of gun irrigators, because poor distribution uniformity or management wastes water, and may cause leaching of nutrients and chemicals, leading to water pollution which can incur environmental fines from regional councils. The gun irrigator's biggest advantage is its low capital cost compared with other systems. This allows growers to get into irrigation at relatively low cost. In addition, guns can be installed and maintained by the growers. However, because a single-orifice gun is used under high water pressure, this system is not efficient, due to poor distribution in windy conditions, resulting in uneven water application and sometimes a loss of water via wind drift. They can be moved between crop fields, but this is labour-intensive, and shifting time is significant.

The production of export vegetable root crops is a high-value activity, and therefore the cost of expensive water scheduling will be justified.

Cut Scores

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 7	8 – 12	13 – 18	19 – 24