

Assessment Schedule – 2018**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: Glasshouses**

| Achievement | Achievement with Merit | Achievement with Excellence |
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| Describes how carbon dioxide can be controlled in glasshouses. | Explains the effect of carbon dioxide enrichment on crop quality and yield. | Justifies the use of diffused glass or sprayed glass coatings in glasshouses in terms of economic and environmental factors. |

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| N0 | No response; no relevant evidence. |
| N1 | Some writing, but does not describe how carbon dioxide can be controlled. |
| N2 | Partial or insufficient description of how carbon dioxide can be controlled in glasshouses. |
| A3 | Describes how carbon dioxide can be controlled in glasshouses. |
| A4 | Describes how carbon dioxide can be controlled in glasshouses, with reference to plant growth. |
| M5 | Explains how carbon dioxide enrichment affects plant production and improves crop yield, in relation to plant processes. |
| M6 | Fully explains how carbon dioxide enrichment affects plant production and improves crop yield, in relation to plant processes <i>AND</i> growth rates. |
| E7 | Justifies a grower's decision to use diffused glass or sprayed glass coatings, taking into account the environmental and economic impact of the use of this technique. Clear evidence for superiority in regard to ONE impact, either environmental or economic, with the other impact well supported. |
| E8 | Justifies a grower's decision to use diffused glass or sprayed glass coatings, taking into account the environmental and economic impact of the use of this technique. Clear evidence for superiority in regard to BOTH impacts. |

| Q1 | Evidence |
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| (a) | <p><u>Describes</u> how carbon dioxide can be controlled in glasshouses.</p> <p>Carbon dioxide can be obtained by burning carbon-based fuels such as natural gas, LPG, coal, and kerosene. This is often used in conjunction with a heating system. Care must be taken that pollutants from incomplete combustion or contaminated fuels are not allowed into the glasshouse.</p> <p>Alternatively, carbon dioxide can be brought in from outside the glasshouse through ventilation; however, this cannot increase carbon dioxide to beyond atmospheric levels.</p> |
| (b) | <p><u>Explains</u> the effect of carbon dioxide enrichment on crop yield.</p> <p>Carbon dioxide is an essential component of photosynthesis. Photosynthesis is a chemical process that uses light energy to convert CO₂ and water into sugars in green plants. In greenhouse production, the aim of a grower is to increase dry-matter content and economically optimise crop yield. Carbon dioxide increases productivity through improved plant growth and vigour. Ways in which productivity is increased by CO₂ include earlier flowering and higher fruit yields.</p> <p>When plants are actively growing in a glasshouse, CO₂ levels can drop below outside levels (400 ppm). Carbon dioxide enrichment replaces the carbon used during photosynthesis and increases CO₂ levels beyond what is found outside the glasshouse up to 1,000 ppm, depending on the crop. This prevents carbon dioxide from being a limiting factor in plant growth.</p> |
| (c) | <p><u>Justifies</u> the use of diffused glass or sprayed glass coatings in glasshouses in terms of economic and environmental factors.</p> <p>Light is needed by plants for photosynthesis. The two main issues with light are when light intensity is too low or too high. In summer, light intensities can be too high and can lead to damage to the crop, while in winter, light intensity can be too low and lead to a reduction in photosynthesis and plant growth.</p> <p>A sprayed-on glass coating, such as whitewash, can be applied at the beginning of summer and removed at the end of summer. This blocks light and heat from entering the glasshouse, reducing the need for ventilation. The coating also diffuses the light coming in, preventing shadows forming over crops. This coating needs to be applied and removed each year. The coating does reduce the total amount of light coming into the glasshouse.</p> <p>Diffused glass is specially treated glass that scatters light, preventing shadows being formed and allowing light to penetrate deeper into the canopies of the crops, increasing photosynthesis and growth. While diffused glass does reduce the transmission of photosynthetic light, the reduction of shadows and the increased penetration of light into the canopy make up for it.</p> <p><i>Economic factors</i></p> <p>Diffused glass is more expensive than regular glass, and in an existing glasshouse it is not economical to replace existing standard glass. In a new glasshouse, it can be economically beneficial to use diffused glass, as while the initial cost is greater, it reduces the need for spray-on coatings, which need to be reapplied and later removed each year. The use of diffused glass also increases crop yield.</p> <p>Spray-on coatings can be applied to regular glass, and so, in an existing glasshouse, are more economically feasible than replacing the glass. However, they have annual application and removal costs, which can be considerable, as the coatings have to be sprayed on frequently, using a helicopter. The timing of the application and removal must be well planned, as an early or late hot spell can result in damage to the plants.</p> <p><i>Environmental factors</i></p> <p>The use of diffused glass has no greater environmental impact than a regular glasshouse. While the use of sprayed-on coatings requires regular applications of whitewash, this also needs to be removed each year with a chemical cleaner. The application needs to be timed to avoid spray drift, and the use of helicopters can cause noise and exhaust pollution.</p> |

Question TWO: Citrus

| Achievement | Achievement with Merit | Achievement with Excellence |
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| Describes the effect of reflective mulches and the effect of drainage on plant growth. | Explains how drainage impacts on crop yield, quality, and timing. | Justifies the use of either mounding or subsurface drainage in a citrus orchard. |

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| N0 | No response; no relevant evidence. |
| N1 | Some writing, but does not describe the effect of reflective mulches on citrus. |
| N2 | Partial or insufficient description of the effect of reflective mulches on citrus. |
| A3 | Describes the effect of reflective mulches on citrus <i>OR</i> the effect of drainage on plant growth. |
| A4 | Fully describes the effect of reflective mulches on citrus <i>AND</i> the effect of drainage on plant growth. |
| M5 | Explains how drainage impacts on crop yield, quality, and timing, in relation to plant processes. |
| M6 | Fully explains how a drainage technique modifies physical factors of the environment to improve the crop yield, quality, and timing, in relation to plant processes. |
| E7 | Justifies the use of either mounding or subsurface drainage to improve the crop yield and quality, taking into account the environmental and economic impacts arising from it. Clear evidence is provided to justify choice, which may include the weighing up of environmental or economic factors, with the other aspect well supported. |
| E8 | Justifies the use of either mounding or subsurface drainage to improve the crop yield and quality, taking into account the environmental and economic impacts arising from it. Clear evidence is provided to justify choice, which may include the weighing up of environmental and economic factors. |

| Q2 | Evidence |
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| (a) | <p><u>Describes</u> the effect of reflective mulches.</p> <p>Reflective mulches reflect light into the underside of trees, allowing citrus to make use of light that would otherwise be absorbed by grass or soil. This increases the rate of photosynthesis in the trees, resulting in elevated brix levels in citrus fruit, and fruit that ripens earlier in the season.</p> |
| (b) | <p><u>Describes</u> the effect of poor drainage on plant growth.</p> <p>Poor drainage results in waterlogged soils, which have a low oxygen content, restricting respiration and root growth. Waterlogging of soil can result in the death of fine roots which absorb water, leading to reduced uptake of water needed for photosynthesis. Plants become susceptible to diseases, further reducing growth. Poor drainage can affect the availability of nutrients. Wet soils take longer to warm up in spring, slowing growth.</p> <p><u>Explains</u> how poor drainage impacts on crop yield, quality, and timing.</p> <p>Poor drainage results in slow growth; trees do not have the resources to devote to reproduction and producing high-quality fruit. Cooler soils result in delayed fruit production and ripening. Poor plant health means reduced crop yield and poor-quality fruit.</p> <p><u>Justifies</u> the use of either mounding or subsurface drainage in a citrus orchard.</p> <p>Mounds are formed in rows when an orchard is established. Citrus are planted at the top of these mounds. Water drains away from these mounds very quickly. The mounds are easy to install when the orchard is first established, and require very little maintenance. They allow the grower to accurately control the amount of water the citrus trees can access. Citrus tend to be very shallow-rooted, and even in the event of significant rainfall, the mounds do not become waterlogged, as the water drains away quickly. Mounding must be completed before the orchard is established.</p> <p>Subsoil drainage is normally installed before the orchard is established, but can be installed afterwards. Due to the use of specialised equipment, subsoil drainage can be expensive to install. Subsoil drainage, being beneath the soil, does not interfere with machinery. During heavy rainfall, the drainage may not be sufficient to drain water away quickly enough. Subsoil drainage requires ongoing maintenance and has a life shorter than the trees, so will need to be replaced. Care also needs to be taken that the drainage system does not interfere with plant roots.</p> <p>Both methods are effective and can be used in conjunction with each other.</p> <p><i>Environmental impact</i></p> <p>When setting up the mounding, considerable earth-moving needs to take place, and care needs to be taken not to destroy the soil structure. Dust and runoff can also be an issue until a new ground cover is formed.</p> <p>The above-ground impact of subsoil drainage is limited. Care needs to be taken that soil is not compacted when digging the drains.</p> <p><i>Economic impact</i></p> <p>Mounding has a one-time cost; when first establishing the orchard, it allows the grower to have a finer control on water availability for the citrus trees. Due to the shallow rooting of citrus trees, mounding is very effective at providing drainage for citrus, leading to healthier, faster-growing trees producing better-quality fruit.</p> <p>Subsoil drainage has a higher set-up cost and would achieve the same outcome.</p> |

Question THREE: Viticulture

| Achievement | Achievement with Merit | Achievement with Excellence |
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| Describes a microclimate and its effect on plant growth. <i>OR</i> Describes how a helicopter or sprinkler prevents frost. | Explains a microclimate and its effect on a vineyard, and explains how helicopters or frost sprinklers modify the environment, preventing frost. | Justifies the use of a frost-prevention method and analyses its effect on the environment and the community. |

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| N0 | No response; no relevant evidence. |
| N1 | Some writing, but does not describe a microclimate and its effect on plant growth. |
| N2 | Partial or insufficient description of a microclimate and its effect on plant growth. |
| A3 | Describes a microclimate and its effect on plant growth, <i>OR</i> describes how a helicopter or sprinkler prevents frost. |
| A4 | Fully describes a microclimate and its effect on the growth of grape vines, <i>OR</i> describes how a helicopter or sprinkler prevents frost. |
| M5 | Explains a microclimate and its effect on production, <i>OR</i> explains how helicopters or frost sprinklers modify the environment to prevent frost. |
| M6 | Fully explains a microclimate and its effect on production, <i>AND</i> explains how helicopters or frost sprinklers modify the environment to prevent frost. |
| E7 | Justifies the use of a frost-prevention method and analyses its effect on the environment and the community. Clear evidence for superiority in regard to ONE impact, environmental or economic, with the other impact well supported. |
| E8 | Justifies the use of a frost-prevention method and analyses its effect on the environment and the community. Clear evidence for superiority in regard to BOTH impacts. |

| Q3 | Evidence |
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| (a) | <p><u>Describes</u> a microclimate and its effect on plant growth.</p> <p>A microclimate is a smaller area within a general climate zone that has its own unique climate. This can involve variations in soil, slope, aspect, wind speed, etc.</p> <p><u>Explains</u> a microclimate and its effect on a vineyard.</p> <p>Due to variations within a vineyard, certain areas are possibly more or less likely to be susceptible to frosts or wind damage. Vines on the upper part of a north-facing slope will be less likely to suffer frost damage. Planting vines north to south prevents shading of individual lines at midday, meaning more consistent growth and ripening.</p> |
| (b) | <p><u>Explains</u> how helicopters or frost sprinklers modify the environment to prevent frost.</p> <p><i>Helicopters</i></p> <p>Helicopters work by directing warmer air from above the inversion layer downward around the vines, and at the same time, they displace the colder air on the ground away from the vineyard. Helicopters will only work if there is an inversion layer present.</p> <p><i>Sprinklers</i></p> <p>Frost sprinkler systems involve spraying the vines with a continuous fine mist of water as the temperature falls to freezing. This water then freezes, encasing the canes and buds in ice. As the water changes to ice on the surface of the vine, it releases a small amount of latent heat that protects the vine from any damage.</p> <p><u>Justifies</u> the use of a frost-prevention method and analyses its effect on the environment and the community.</p> <p>The use of helicopters to prevent frost comes with no initial set-up cost, but when they are needed, the cost of hiring helicopters is very high. When frosts are infrequent, this can be an advantage. When frosts are forecasted, a number of producers in a region may require them and they may not be available for all growers. The use of helicopters to prevent frosts only works if there is an inversion layer, and so cannot prevent all types of frosts.</p> <p>Frost sprinklers come with a high establishment cost and so are useful when frosts are frequent, as they can be run whenever there is a risk of frost. In areas of infrequent frost, they may not be economically viable. In areas with water shortages, the cost of water to run the frost sprinklers can be high.</p> <p><i>Environment</i></p> <p>Sprinklers can use large amounts of water. For vineyards that are in water-scarce areas such as Central Otago, sourcing enough water can be an issue. Nutrient runoff can cause issues with neighbouring properties and waterways. Helicopters are large and noisy, and can disturb native species. They use large amounts of fuel, leading to CO₂ emissions.</p> <p><i>Community (social)</i></p> <p>Frost protection is needed, as if it isn't used, frosts can decimate a harvest, reducing local employment and export earnings. Sprinklers can cause nutrient runoff, affecting water supplies, and compete with local community water supplies. They are water-intensive and can cause issues with supply in water-scarce areas.</p> <p>Because frosts occur at night, helicopters need to be flown at night, potentially disturbing neighbours.</p> |

Cut Scores

| Not Achieved | Achievement | Achievement with Merit | Achievement with Excellence |
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| 0 – 7 | 8 – 13 | 14 – 19 | 20 – 24 |