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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Agricultural and Horticultural Science 2023

91290 Demonstrate understanding of techniques used to modify physical factors of the environment for NZ plant production

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of techniques used to modify physical factors of the environment for commercial plant production in New Zealand.	Demonstrate in-depth understanding of techniques used to modify physical factors of the environment for commercial plant production in New Zealand.	Demonstrate comprehensive understanding of techniques used to modify physical factors of the environment for commercial plant production in New Zealand.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 20

QUESTION ONE: Greenhouses

Source: https://www.tomatoesnz.co.nz/assets/Uploads/EJJ9595.jpg

(a) How do commercial greenhouses allow the grower to modify TWO physical factors to improve crop production?

Physical factor (1): Carbon Dioxide Enrichment

Photosynthesis formula: ~~Carbon D~~

Carbon Dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Glucose + oxygen

Physical factor (2): Heat Pads.

(b) Justify the use of greenhouses for a commercial crop in terms of crop yield and timing.
In your answer consider the economic and environmental impacts.

Question 1 (a):

Physcial Factor 1: Carbon Dioxide Enrichment.

Greenhouses enable a grower to modify the physical factor of carbon dioxide. They do this, by buying bottles of carbon dioxide, and connecting them to a carbon dioxide enrichment system. This system is a stream of pipes leading from the bottles on the exterior of the greenhouse, into the interior of the greenhouse. The grower can control how much carbon dioxide they would like to be inserted into the air inside the greenhouse, but usually 1% is the most effective amount. Anything above that will cause a plant to reach its optium photosynthesis level, meaning it is pointless to add anymore as no more photosynthesis can occur. This improves crop production because it increases the level of photosynthesis occuring. As shown on the accompained exam paper with the equation of photosynthesis, if the level of carbon dioxide increases, then so does the amount of glucose produced. This improves crop production, because more growth can now occur with this extra glucose, creating bigger and healthier plants. Also, this extra glucose makes fruit sweeter, as glucose is sugar, improving their quality and production.

Physcial Factor 2: Heat Pads

Black heat pads can be layered along the floors of the greenhouse and under plants to increase their growth rates. Heat pads are black to attract and absorb sunlight, maintaining a warm environment. They are also accompained with a thermostat, so the grower can alter the heat they're admitting. This improves the production of the crop, because this increased heat increases enzyme energy. This heat charges these enzymes up, giving more energy, and creating more movement. Using the collision theory, if more enzymes are moving, they'll bump into each other, creating more movement. This is relevant and improves crop production, because enzymes are vital in the life processes of photosynthesis, and respiration, along with growth and repair inside the plants. Referring to the equations of photosynthesis and respiration, written in the accompained exam paper, if photosynthesis and respiration increases, then so does the levels of glucose and energy/38ATP. If there is more energy and glucose, the crop will produce sweeter, larger, and healthier plants and fruit, overall improving the crop.

Question 1 (b):

To justify, greenhouses are very effective to produce plants, as they increase the crop yeild and timing. As mentioned above, greenhouses enable carbon dixoide enrichment, along with heat pads, and also light control which hasn't been mentioned. All these three factors, increase photosynthesis, and respiration. More sunlight increases photosynthesis, because as shown on the equation, on the arrow, sunlight is needed for photosynthesis to occur. More sunlight is introduced to the greenhouse, using artificial lights to simulate real light, and reflective white wash, reflecting light onto all areas of the plant. If photosynthesis and respiration are increased by these three factors, then crop yeild is going to increase. This is because, plants now have more energy from increased respiration (as shown in the equation) for growth, meaning they'll be able to grow bigger, increasing the crops yeild. Also, the timing of production will decrease, as fruit is growing faster due to more energy/38 ATP, and ripening/sweetening faster as more glucose has become avalible. This has an impact on the economic side of the horticultural business, because if crop yeild has firstly increased, then the grower will have more crop and items to sell to the market, increasing his overall revenue. Furthermore, if timing has decreased, as fruit are ripening and becoming sweeter faster due to increased glucose, then cost for the horticulturist will decrease, and revenue will increase. Costs will decrease because the fruit and crops are in the greenhouse for a shorter amount of time, using less resources which cost money. Revenue will increase because in a greenhouse, due to heat mats and artificial lights, temperature and light can be maintained constantly all throughout the year, regardless of what season it is. This means, when fruit are in off season, the greehouse grower will recieve premium prices as he'll be able to sell his fruit and crops fresh when they're not in season. Therefore, the gap between revenue and cost will increase massively, as due to a greenhouse being used, cost has decreased and revenue has increased, resulting in an increase in profit for the business. In environmental terms, greenhouses are very good for the environment, because they are contained, use less space, and don't risk damaging water ways. In a greenhouse, shelves and walls can be made, decreasing the amount of land a crop of a large size normally would require. This means more land isn't being used when it doesn't have to be, increasing efficency. Also, due to a greehouse being contained, there is no risk to any chemicals, fertilizers or spray used in the process of production to get into any water ways or areas where it is not wanted. Hence why it is better for the environment.

QUESTION TWO: Irrigation systems

Source: https://www.kirkirrigation.co.nz/k-line

(a) How can irrigation systems modify TWO aspects of the growing environment for commercial plant production?

Aspect (1): ~~Weather~~ Soil, Moisture

Aspect (2): ~~Water content~~ Shelter Belts.

Photosynthesis:

Carbon Dioxide + water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Glucose + Oxygen.

(b) Justify the use of an irrigation system in a commercial crop in terms of crop yield and quality. In your answer consider the environmental and social impacts.

Question 2 (a)

Aspect 1: Water content in soil

By a grower using irrigation, such as, k line irrigators, cannon irrigators, furrow irrigation, or drip irrigation, this increases the water content in the soil. The soil is an aspect of the growing environment. This is because, if irrigation is taking place, the correct amount of water is being distributed into the soil, providing the correct water content and water to air ratio in the soil, providing maximum growth to all the plants, pasture and trees.

Aspect 2: Shelter Belts

Another aspect of the growing environment that irrigation modifies is shelter belts. Shelter belts may be used to decrease any risk of wind damage to a crop, or orchard. By using irrigaiton, the growth of shelter belts increases, creating thicker and stronger shelter belts, making them more protective and useful. It does this because as shown in the accompained exam paper, water is required to produce glucose in the life process of photosynthesis. If there is more water provided by irrigation, then more photosynthesis is able to occur, increasing the amount of glucose produced in these trees. Therefore, if more glucose is avalible, then these shelter belts can grow thicker and taller, increasing their protectiveness over the crop/orchard, and modifying the environment.

Question 2 b:

To justify, irrigation is extremely benefical in the production of a commerical crop. This is because, irrigation increases the crops yeild, and quality. It does this, because in the equation for photosynthesis, which is written in the accompained exam paper, it shows that water is required to enable photosynthesis to happen. If more water is avalible in the soil to the plants in the crop/trees in the orchard, then more photosynthesis can occur. This means, if the right amount of water is applied, plants/trees will be able to photosynthesize at their optium rate, meaning maximum photosynthesis, and as a result, the highest quantity of glucose is produced. Glucose is very important for two things. Firstly, crop quality. If there is a higher level of glucose in the plants and trees, then the fruit and crops produced, will be sweeter, and ripen faster. This is because glucose is made up of sugars. If there are more sugars, then the fruit and plants becomes sweeter, increasing the quality of the crop. Secondly, the crop yeild. If there is more glucose, then more respiration can occur in the plants, as shown in the formula for respiration on the accompained exam paper. If glucose is at its highest level, respiration will be able to take place at its optimum level also, creating a maximum level of energy/38 ATP. This energy is then used for growth and development of the crop. If energy is high, then growth will be high, increasing the yeild of the crop. This increase in crop yeild and quality impacts New Zealand socially because now, people will be recieveing more fruit and vegetables, which decreases their price as there is a surplus of them, and producers want to clear this surplus, resulting in cheaper fruit and vegetables for people. Also, New Zealanders will recieve a higher quality of fruit, as it is sweeter. The environment is impacted because the soil and the ecosystem remains vibrant and healthy throughout peroids of dry weather, or lack of water. This is because, if the right amount of water is present in the soils all the time, then photosynthesis and respiration can preform to their optiums, creating flourishing growth, and color, as well as healthy plants and soils for the ecosystems.

QUESTION THREE: Light

Source: https://www.hortnz.co.nz/

(a) How are TWO management practices used to modify access to light in outdoor plant production?

Management practice (1): Reflective ~~Cloth~~ Chick Tarp.

Management practice (2): Pruning.

(b) Justify the use of one of these management practices in terms of crop quality and timing. In your answer consider the economic and social impacts.

→ Photosynthesis Equation

Carbon Dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{Sunlight}}$ Glucose + Oxygen

Question 3 (a):

Management Practice 1: Reflective White Tarp

One management practice used to modify light in outdoor plant production is a white reflective tarp. This is laid out under the trees, along the rows. The whiteness of the tarp attracts, and then reflects light straight up onto the bottom of the fruit. This creates even coloring and light exposure as the top of the fruit is exposed to direct sunlight and the bottom of the fruit is exposed to reflected sunlight..

Management Practice 2: Espalieing

Another management practice used to modify light in outdoor plant production is espalieing. This modifies light because it allows more light access into all areas of the leaves, and fruit. This is when the horticulturist ties brances onto a wire, making them grow along this wire. Therefore, the trees aren't bushy and more open, creating better light access.

Question 3 (b):

To justify, the use of reflective white tarp is very benefical because it increases the crop quality and timing. This is is because of a few reasons. Firstly, by looking at the equation for photosynthesis in the accompained exam paper, it shows that light is vital and nessecery, in order to make photosynthesis possible, as it is present on the arrow in the equation. If light is not only bestowed onto the leaves of the trees from above directly, but also from below reflectively, then the amount of photosynthesis will increase massively, as there is light being exposed to the leaves from above and below. This means more photosynthesis takes place, and more glucose is produced. If more glucose is produced, then the fruit becomes sweeter, because glucose contains sugar, which causes the fruit to ripen faster. This increases quality, as the fruit is sweeter, and decreaes timing, because it takes a shorter period to ripen. Also, reflective white tarp causes even coloring. This is because the fruit is not only being colored up nicely from direct sunlight above, but from reflected sunlight underneath as well. This means the quality of the fruit will increase, as they'll score higher, with an even coloring, compared to if no reflective mulch was used in apple production. The top of the apple may be nice and red, but the bottom could still be green, meaning it is not of high quality. This'll also decrease the timing required, as it'll take a shorter peroid of time to color up the fruit. Due this white reflective tarp increasing crop quality, and decreasing timing, this has a positive economic impact. This is because, if the fruit quality has increased, due to it being sweeter, the horticulturist will recieve a higher level of revenue. Also, if it can be ready for market in a shorter period of time, then costs will decrease, as the fruit are on the orchard for a shorter period of time, decreasing the resources used. This impacts economics positively because the level of revenue has increased, but cost has decreased, resulting in a higher profit. Also, it will have a positive impact socially, as consumers will be able to buy sweeter and nicely colored fruit, for the same price, increasing their level of satisfaction, and enjoyment. Therefore, increasing their attitude.

Excellence

Subject: Agricultural and Horticultural Science

Standard: 91290

Total score: 20

Q	Grade score	Marker commentary
One	E8	The candidate showed clear understanding and discussion about all the required attributes. The candidate was able to explain how the plant processes increase glucose production and therefore size and sweetness of the product. They talked about selling the produce out of season and therefore gaining a premium price. The candidate discussed the physical environment and how it changed with their chosen management practices well and was able to include other benefits as well.
Two	M5	While the candidate displayed exceptional knowledge about crop quality and quantity, due to the aspect of water application, but they did not expand this thinking well enough to include the environmental and social impacts. They were very close, but a deeper justification would have been needed. The candidate gave some good ideas about having cheaper produce due to higher yields, and as well as a brief discussion about vibrant growth. The shelterbelt discussion was not a good aspect to discuss with regards to modifying the physical environment of a commercial crop.
Three	E7	The candidate gave a very good explanation about how crop quality and timing is increased due to their chosen practice. The discussion about not only sweeter fruit, but better colouring, was very good. The discussion about how the light is reflected on both sides of the leaf was also very good.