Research
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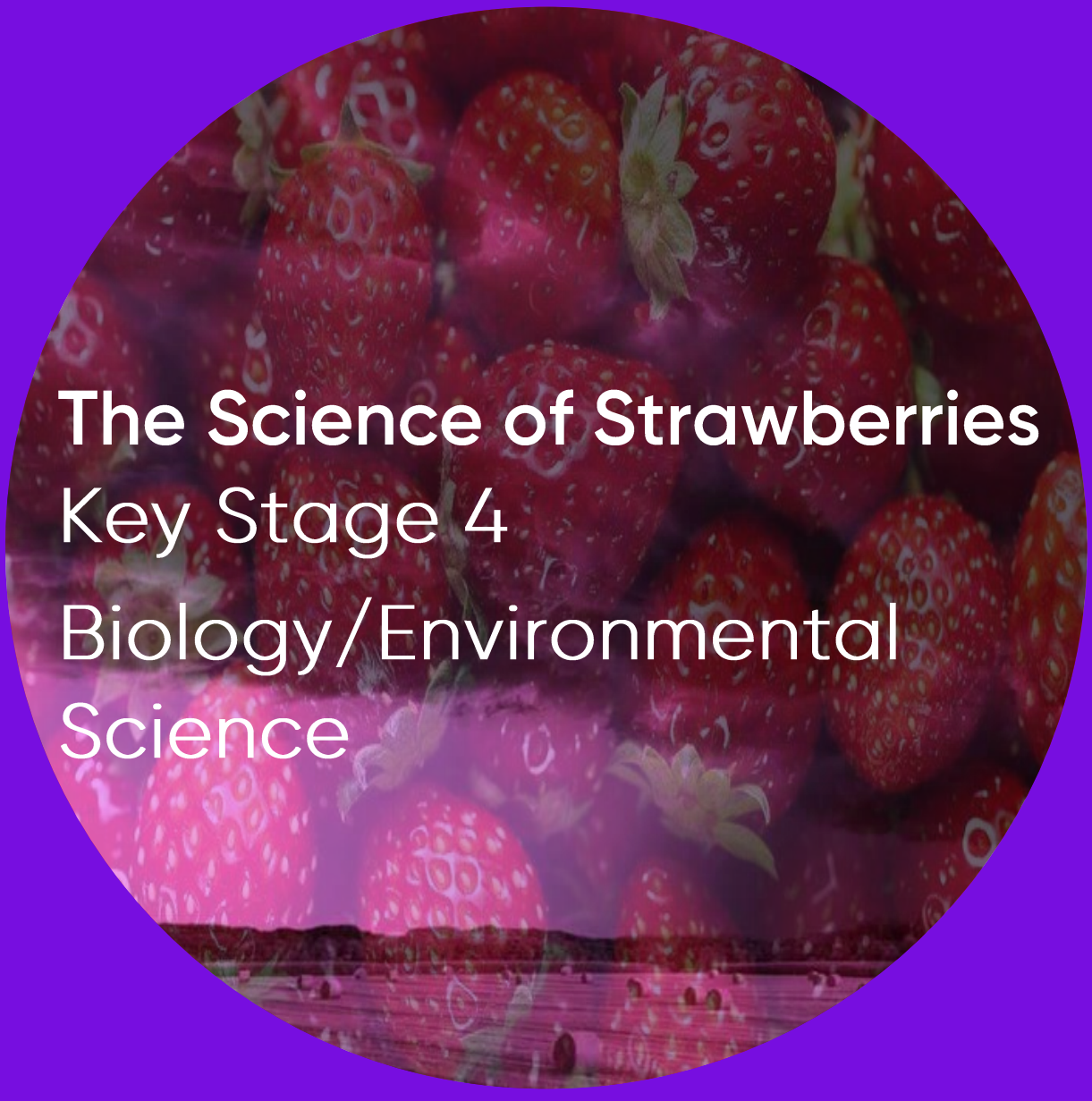
Curricula



The Science of Strawberries

Key Stage 4

Biology/Environmental Science

2020

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Resource One Model Answers

Answers

1. Any three from: medicinal teas, syrups, ointments, used to treat kidney stones, bleeding and broken bones
2. Canada and Virginia
3. The discovery by French horticulturalists that *F. chiloensis* could be pollinated by *F. moschata* or *F. virginiana* to produce fruit.
4. *F. chiloensis* did not spread across Europe, since it produced strawberries that were poorer in taste, seedier and paler than other strawberry species at the time. Other factors that limited its spread include the climate, limited fertility, need for well-drained, sandy soils and soil pathogens.
5. *F. virginiana* and *F. chiloensis*
6. French botanist, Antoine Nicolas Duchesne
7. Any five from: high yield, large fruit size, deep red colour, long shelf-life, good flavour/high sugar content, pest resistance, disease resistance

Resource One Model Answers

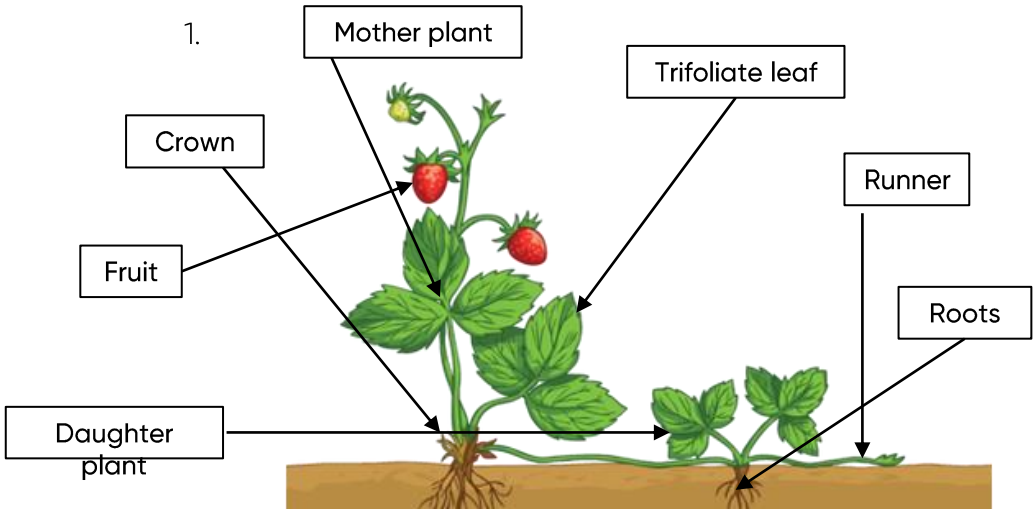
Answers

8. In your answer you should rank the qualities in the order that you think are most important for producing a strawberry variety that will be successful on the commercial market and will be profitable for strawberry growers. You need to give reasons for your choices which could include some of the below:
    - High yield – grower can produce a greater amount of fruit per unit of land so for the same input costs will produce more fruit to sell contributing to increased profits
    - Large fruit size, deep red colour – more attractive and appealing to customers, increasing sales
    - Good flavour/high sugar content, long shelf-life – increase consumer demand
    - Pest and disease resistance – reduce input costs required
9. Family: *Rosaceae*, Genus: *Fragaria*
10. The term 'species' describes a group of organisms in the taxonomic hierarchy that have similar traits and characteristics and are capable of interbreeding to produce fertile offspring. For example, *Fragaria vesca* and *Fragaria moschata* are two different species of strawberry so have distinctive features to each other, such as *Fragaria vesca* strawberries being much paler and smaller than *Fragaria moschata* strawberries. However, they share some of the same traits so are grouped under the same genus, *Fragaria*

Resource Two
Model Answers

Answers

1.



2. The palisade cells are the main site of photosynthesis in the leaves. They are adapted to their function by being densely packed with chloroplasts containing chlorophyll for light absorption, they are elongated in shape to enable this high chloroplast density, they have large vacuoles meaning the chloroplasts are positioned near the outer edge of the cell to maximise light absorption, the chloroplasts can move within the cells towards the light and they have thin walls for easy diffusion of gases.

3. A strawberry is classified as an accessory fruit since the fleshy part of the strawberry comes from the receptacle. The true fruit is what forms from the ovaries.

4. Achenes

5. Asexual reproduction is reproduction without the fusion of gametes or change in chromosome number. The offspring are clones of the parent. In plants, a 'mother' plant produces 'daughter' plants. Two structures which facilitate asexual reproduction in strawberry plants are: branch crowns and runners.

Resource Two
Model Answers

Answers

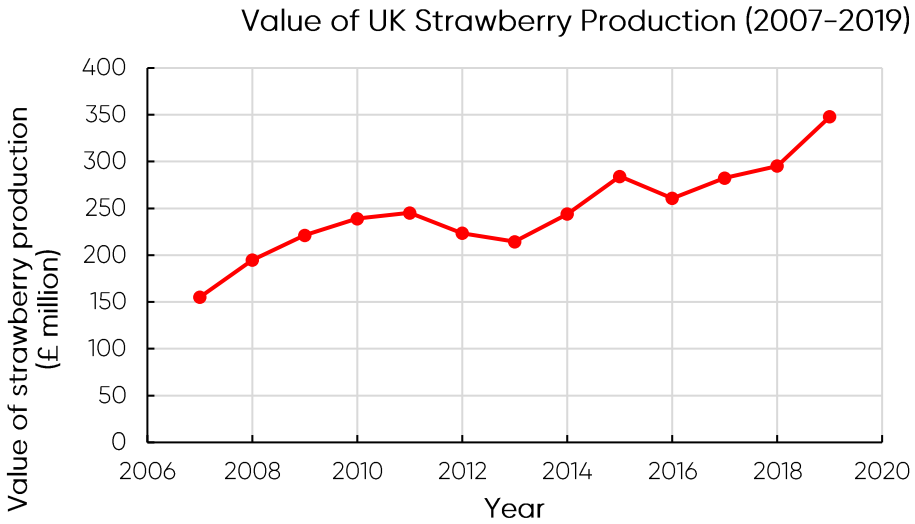
6. Cool temperatures and short days
7. Pollen is produced in the anther and lands on the stigma.
8. In an ovule in an ovary
9. Strawberry growers add beehives to their strawberry crop to facilitate insect pollination since cross-pollination produces higher quality fruit and stronger plants. It increases hybrid vigour.
10. Removing runners allows the strawberry plants to put more of their energy into developing their fruits, therefore helping to increase yields and fruit quality. This is beneficial to growers as a greater yield of high quality fruit means increased profits.

Resource Three Model Answers

Answers

1. Reduced fruit yield resulting in reduced home (UK) production and reduced imports

2.



3. There has been an overall increase in the value of the UK strawberry industry from £155.1 million in 2007 to £347.8 million in 2019. However, during this period there has been a couple of times when the value of the industry has dropped between 2011 and 2013 and 2015 and 2016. The most significant year-on-year increase occurred in the most recently recorded years between 2018 and 2019. This overall increasing trend matches what you would expect due to the increase in demand for local produce, particularly in recent years, and the development of technology enabling increased production. The dips in value might be unexpected, but perhaps could be explained by a possible pest or disease outbreak or poor weather conditions affecting outdoor strawberry crops.

4. ((347.8-155.1)/155.1) * 100 = 124.24%

5. Improved growing methods have enabled increased yields.

Resource Three Model Answers

Answers

6. One advantage of growing strawberries in polytunnels and glasshouses, is that they provide protective cropping protecting the strawberry plants from the changing climate and adverse weather conditions e.g. hard frosts. This enables the strawberry plants to be planted earlier and therefore, fruit earlier which can help growers extend their production season. Another advantage, is that this protective and uniform, controlled environment has resulted in approximately a 40% increase in Class 1 strawberry production which represents increased fruit quality.

7. In your answer you need to talk about some of the other possible factors contributing to the success of the strawberry industry including the development of new cultivars, LED lighting and a substrate growing medium. You need to rate these in priority order and conclude what you think has had the most significant impact on the modern strawberry industry in terms of increasing production (yields), improving fruit quality and extending the season.

8. Reduced soil-borne pathogens and increased uniformity in composition of the growing material

9. The key factors that have driven increased strawberry consumption are: increased governmental focus on public health with campaigns such as the 'Five-a-day' campaign, increased concerns about obesity, increased disposable incomes allowing people to buy more expensive products, increased demands for locally produce fresh produce and increased environmental awareness and environmental campaigns.

    - You should consider all of these factors and conclude which one you think has had the most influence on increased strawberry consumption in the UK, giving reasons for your answer.

Resource Three Model Answers

Answers

10. Political uncertainty surrounding Brexit, might cause a decline in the strawberry industry if foreign workers are less able/enticed to come from other countries to take on their usual seasonal harvesting roles. This could lead to a shortage of workers in the industry either resulting in fruit going to waste due to being left unharvested or resulting in reduced initial acreage being planted. On the other hand, it could be a benefit for UK employment, opening up more jobs for UK workers. If British people were to take on these jobs there would be no reason for a decline in the strawberry industry.

Resource Four Model Answers

Answers

1. High light intensity stimulates flower differentiation and increases vegetative growth of the crown, runners and leaves.
2. A grower should choose the 350-PPF light intensity, since there was no significant difference in the number of stolons produced at the 350-PPF and 450-PPF treatments. Therefore, a grower should opt for the 350-PPF light intensity as this lower light intensity will be a more cost-effective treatment for the grower due to its lower energy usage.
3. The best light colour for vegetative growth is blue and the best light colour for flower and fruit development is red. Plants appear green because green light is not absorbed by the plant and is instead reflected off the plants into our eyes.
4. Dormancy describes a period when the growth and development is temporarily halted in a plant's life cycle, strongly influenced by environmental conditions.
5. Increasing CO2 concentration between 300 and 900ppm increases the dry matter biomass of the roots, stems and leaves. The most significant increase in biomass is seen in the leaves, whereas the least significant difference is seen in the roots.
6. *See page 11 for completed table.*
7. A glasshouse strawberry grower might decide to start their strawberry crop at 24 °C to maximise the initial vegetative growth of their plants to create strong, well-developed plants that can support the later crop load. They might then decrease the temperature to 17 °C during flowering and fruit set, to optimise fruit set, yields and berry weight.

Resource Four Model Answers

Answers

8. Junebearers require a short day of less than 14 hours and cool temperatures of below 15 °C. If the temperature is greater than 15 °C, then a shorter daylength of between 8 and 12 hours is required.

9. The flower induction and flower initiation processes take place from September to December in Junebearers when natural daylength and temperature decrease. The plants remain dormant over the winter period through to February/March. As the natural daylength and temperature begin to increase, dormancy is broken and bud break of the autumn-initiated flowers is triggered. The plants start flowering in March with fruiting beginning around May. Junebearers produce a single fruit crop continuing to July. Runner production occurs during the summer period with the longer natural daylength and warmer temperatures.

10. A strawberry grower could plant both Junebearers and Everbearers in their growing system to extend the growing season, since under natural conditions, Junebearers produce a single fruit crop from mid-May to early July and the Everbearers produce their second flush of fruit from August to September. Combined with other practices such as artificial lighting and photoperiod extension, these two peak fruiting periods could be further extended.

Resource Four Model Answers

Answers 6.

Advantages	Disadvantages
Increased photosynthesis = increased growth rates	Increased production costs due to high costs of CO2 supplementation & additional costs needed to make glasshouse suitable e.g. extra sealing
Earlier flowering and fruiting = potential to save costs through reduced energy for heating and fertilisers required	CO2 may not have a beneficial effect if other factors in the glasshouse are limiting
Increased number and size of flowers and subsequent fruit quality	CO2 supplementation has greater benefits on younger plants – effect decreases as plants mature
CO2 supplementation can provide extra heat which can reduce costs of winter heating	Surplus CO2 can be toxic to plants and humans
Reduced transpiration and increased water use efficiency	Harmful gases e.g. nitrous oxides formed by incomplete combustion = can cause necrosis and flower/fruit malformation
	In warmer temperatures, optimal CO2 levels are difficult to maintain due to venting used to maintain the temperature

Resource Five Model Answers

Answers

1. A macronutrient is a mineral element needed in large amounts by a plant for its growth and development, whereas a micronutrient is a mineral element only needed in trace amounts.
2. *See page 14.*
3. pH, electrical conductivity, alkalinity and trace element concentrations e.g. chloride, sulphate and iron
4. A Junebearer starter feed needs to have a high nitrogen content relative to the other nutrients to promote growth and leaf area. When the crop ripens, the nitrogen supplied needs to be decreased and potassium increased. After fruiting, the nitrogen should be further reduced. On the other hand, the starting nitrogen levels need to be higher in an Everbearer and as the fruit sets, both nitrogen and potassium need to be increased.
5. Crop growth stage, weather conditions and time of day
6. High carbonate/bicarbonate levels
7. The main functions of boron are its role in cell division, meristem development and carbohydrate transport. It is important to get the levels just right as boron deficiency causes chlorosis and distortion of leaves and small, malformed fruit, but too high levels of boron can result in boron toxicity leading to necrotic leaves.
8. This high pH reading indicates that the water might have a high carbonate/bicarbonate content. A grower should add 60% nitric acid to the water to neutralise some of the carbonates/bicarbonates with the aim of leaving 50-60mg/l bicarbonate in the water.

Resource Five Model Answers

Answers

9. Acid dosing systems monitor the pH of the water entering the system and automatically inject acid to maintain a set pH (5.8-6.2).

10. A bespoke mix is designed especially to meet the specific conditions in a grower's system which helps to optimise yields. On the other hand, proprietary mixes are designed for average conditions so are not as accurate for a specific growing system and straight fertilisers require precise measuring by the growers themselves to mix up the liquid feeds. This lower accuracy and precision of the proprietary and straight fertilisers, might result in lower yields.

Resource Five
Model Answers

Answers 2.





Iron

Zinc

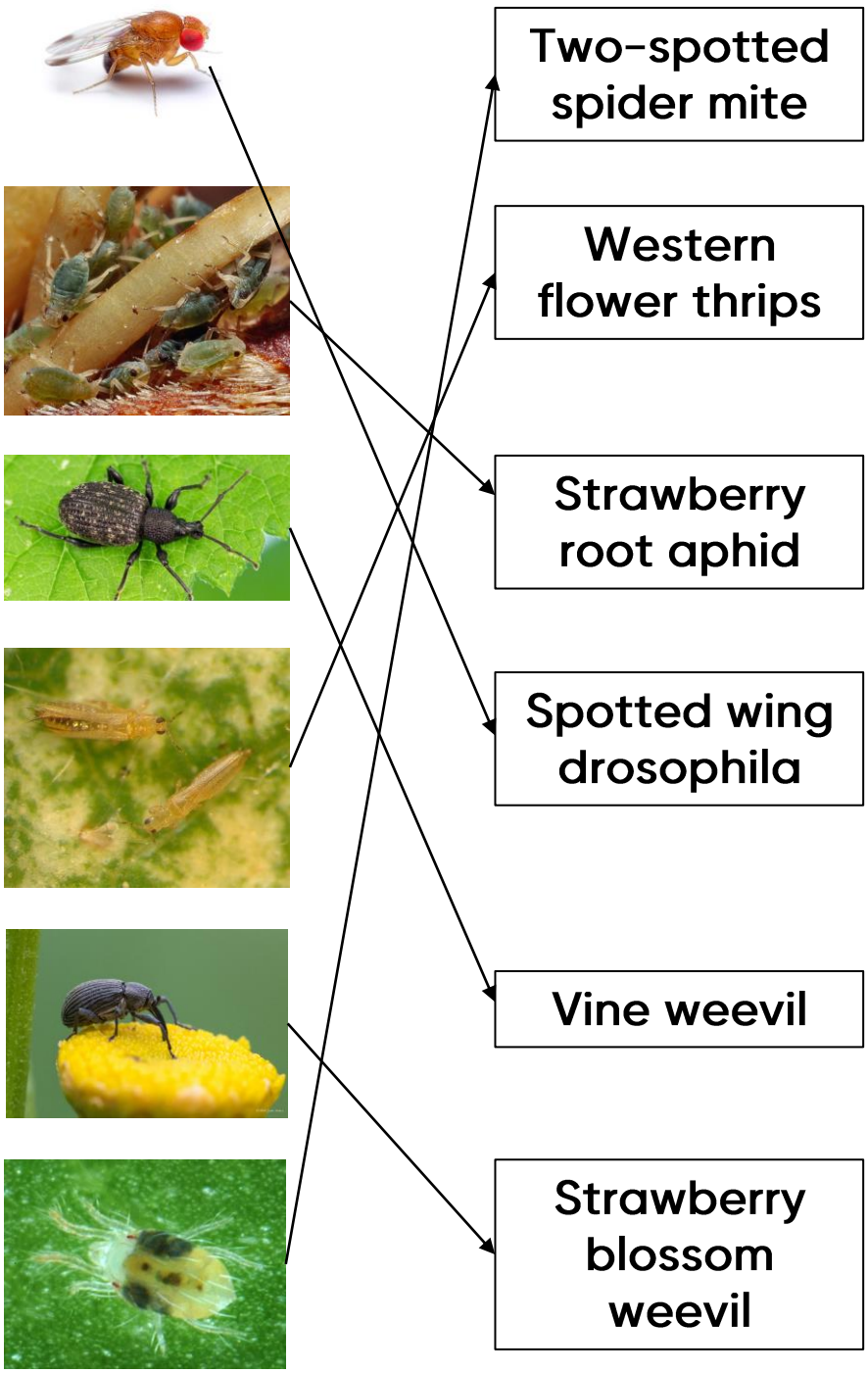
Magnesium

Nitrogen

Calcium

Resource Six
Model Answers

Answers 1.



Resource Six Model Answers

Answers

2. Bronzed, small, seedy and misshapen fruits
3. By the presence of leaf curling, a white coating on the leaves and fruits and purple blotches on the leaves
4. The primary aims of IPM are to minimise pesticide use, prevent pest and disease outbreaks and to grow strong, healthy, disease-resistant plants with increased survival chances in the presence of a pest or disease.
5. Biological, cultural, mechanical & physical and chemical
6. One advantage of using IPM is that it slows the rate of pesticide resistance development and another is it reduces the non-target species that are harmed by pesticides due to the reduced use of the chemicals. Reduced pesticide use also helps reduce the environmental impact as pesticides cause water contamination if they enter water sources. IPM is also a more cost-effective method as the chemicals are expensive and need applying regularly. However, IPM does require use of more resources due to the variety of techniques employed as well as needing an increased knowledge base to apply these different techniques. Due to a number of different methods being used to control each pest and an increased importance of regular monitoring, it is a more time-consuming method of pest control.

- When you are drawing your own conclusion, you will need to consider which factors you think are most important for a strawberry grower. For example, whether you think a strawberry grower would prioritise long-term control (reduced resistance), environmental protection and reduced chemical costs over the increased time, knowledge and resources needed to practice IPM.

Resource Six
Model Answers

Answers

7. Since significant production and movement of infective zoospores occurs only during periods when the soil is completely saturated, the key to control is drainage. Strawberries should not be planted in low-lying or heavy soils where water accumulates or is slow to drain. On marginal soils, planting strawberries on beds raised at least 10 inches high will bring much of the root system above the zone of greatest pathogen activity and the severity of red stele root rot should be significantly reduced.

Strawberry varieties highly resistant to red stele should be seriously considered for planting in a marginally drained site or a field in which red stele has been suspected of occurring in the past. Only resistant varieties should be planted in a field where red stele is known to have caused losses within the last five to 10 years. The following June bearing varieties are reported to be resistant to Red Stele: Allstar, Delite, Earliglow, Guardian, Lester, Midway, Redchief, Scott, Sparkle, Sunrise, and Surecrop. The everbearing varieties are also reported to be resistant. All "resistant" varieties, however, are resistant only to certain common races of the red stele fungus and can become diseased if exposed to other races of the pathogen. New varieties are constantly being developed and released. Check with your nursery or local Extension educator to see if resistance to red stele and other diseases is available in new varieties.

It is important to minimize the chance of introducing the red stele fungus into a field where it does not already exist. Buy nursery stock only from a reputable supplier, and take care not to transfer soil on farm implements from an infested field into a clean one. New fungicides active against red stele also help in controlling this disease but are most effective when used in combination with good soil water management practices.

Source:
https://ohioline.osu.edu/factsheet/plpath-fru-34)

Resource Six Model Answers

Answers

8. *Neoseiulus cucumeris* and *Orius laevigatus*
9. Examples of cultural control that should be used are maintenance of crop hygiene, regular weeding, venting and careful handling of plants. These practices should be supplemented with the use of fungicides at specific growth intervals.
10. A system focussed on pest and disease prevention, should aim to practise good crop hygiene in the glasshouse from when the plants are first planted in the glasshouse to prevent the initial introduction of pests and diseases. This includes thoroughly checking the plants for signs of pests and disease prior to planting. Throughout the growth cycle of the strawberry crop, this crop hygiene should be maintained through practices such as regular weeding and removal of dead plant material which promote disease. Irrigation should also be carefully controlled, to prevent waterlogging and venting should be maintained to prevent high humidity, since these two environmental conditions cause pests and diseases to thrive.

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