**Plant Pathogens – Control**

**Teaching Notes**

### ****Introduction and context****

### **Ideas about communicable diseases in plants are included in the updated programmes of study for Key Stage 4 biology published in December 2014. These ideas will be included in GCSE science courses from 2016 (for first assessment in summer 2018).**

### **This bundle of resources will help develop the following learning outcome at KS4:**

### **explain how the spread of communicable diseases may be reduced or prevented in plants.**

### **Note that this learning outcome is required in both GCSE Biology and GCSE Combined Science.**

### Teaching Notes

### **The poster ‘Plant Pathogens – Control’ illustrates ideas about methods that are commonly used to control plant pathogens and pests, and therefore reduce or prevent the spread of disease in plants.**

### **The poster is accompanied by a presentation, which can be used as a step-by-step walkthrough of the ideas in the poster.**

### ****Notes to accompany the presentation****

The order in which the control methods appear in the presentation (chemical controls, crop rotation, biological controls, polyculture farming, and controlling movement of plant material) reflects the relative significance of each measure in Western agriculture. Students could be made aware of this, or could be challenged to suggest what they think the order of significance is, and how it might differ for e.g. a subsistence farmer in East Africa.

In the following notes relating to specific slides, there are suggestions of how students’ knowledge and understanding could be probed; these suggestions **could be used as the basis for class or small group discussion as students work through the presentation or perhaps at the end.**

*Slide 2:* Students could be asked to suggest examples of staple foods (as opposed to luxuries we could live without) and important materials derived from plants. It may be interesting to give some statistics; for example, according to the Food and Agriculture Organization (FAO) of the United Nations online database rice, wheat, and maize are the three leading food crops in the world and together they supply more than 50% of the calories consumed by the world population; approximately 50% of the world’s population relies on rice alone for their primary calorific intake. Students could also be challenged to suggest other ecosystem services contributed by plants (including but not limited to: habitat, medicines, cycling of substances, and aesthetic benefits). Again, some statistics could be given; for example, in 2015 it was estimated that woodland was worth £270 billion to the UK economy, not just in timber and related products but also because of factors such as flood management and recreation (Woodland Trust *Broadleaf* 85, 2015).

*Slide 3:* The impact of plant disease on human food security could be illustrated with some statistics, for example: it has been estimated that plant pests and diseases reduce the global harvest by 10-16% (US$220 billion) per year. In terms of our ability to feed the human population, the Food and Agriculture Organization (FAO) of the United Nations has reported that approximately 1 billion people (1 in every 7) went hungry in 2009; global food production will have to increase by 50% to feed the projected world population in 2050.

*Slide 5:* Ensure students understand the difference between pathogens and pests. Pathogens are microorganisms such as bacteria, viruses, fungi and protists that cause disease. Pests are typically insect vectors for pathogens, and also cause damage to crops in their own right. Other animals, including people, can also act as vectors for plant pathogens.

*Slide 7:* “Pesticides” is an umbrella term that includes, for example, insecticides, insect repellents, bactericides, fungicides and other antimicrobials.

*Slide 9:* Students could be asked to suggest and explain the risks and potential negative impacts of introducing new chemical substances into ecosystems; for example harm to species other than the intended target, bioaccumulation within food chains, and run-off into watercourses which could cause eutrophication. They could also be asked to discuss the environmental issues associated with supply of the chemicals, including depletion of natural resources, and use of energy and production of waste during synthesis and transport (students may be familiar with the concept of a Life Cycle Assessment from their GCSE Chemistry course and could apply that kind of thinking here).

*Slide 11:* Spores are resistant structures made by some bacteria and fungi that can survive in unfavourable conditions (e.g. over winter) and will grow again when conditions are more favourable.

*Slides 14 and 15:* These slides are not directly related to the control of pathogens, but summarise some additional benefits of crop rotation. From 2016, students are no longer required to know about the nitrogen cycle in GCSE Biology and GCSE Combined Science; therefore, it is not necessary to go into detail about nitrogen-fixing bacteria in the root nodules of legumes, but it is interesting to note that legumes are a useful inclusion in a crop rotation because they add nitrogen to the soil. Successive planting of row crops is bad (because they have shallow roots so do not add much biomass to the soil, and the rows leave surrounding soil exposed to weathering and erosion); growing a cereal crop as part of the rotation adds biomass to the soil and provides cover, which helps to improve soil quality and structure. These ideas tie into curriculum points about the interdependence of organisms in an ecosystem (fertile soil as an ecosystem service we depend on for our survival), and agricultural solutions to the problem of how to increase food yields (through sustainable farming, which is an example of a positive human interaction with ecosystems).

*Slide 19:* Students could be asked to suggest and explain the risks and potential negative impacts of introducing new species into ecosystems; for example predation on species other than the intended target, and competition with native species leading to possible extinction of native species. The new species themselves may bring new pathogens into the ecosystem.

*Slide 21:* Much of modern agriculture in the West relies upon a monoculture approach; students could be asked to suggest the pros and cons of this in the context of human food security (for example: monoculture makes planting and harvesting easier (and therefore cheaper), but makes it much easier for diseases to spread).

*Slides 22 and 23:* Examples of polyculture farming include multi-cropping, intercropping, companion planting and the inclusion of ‘beneficial weeds’.

*Slide 25:* Students could be challenged to explain why the co-existence of plants and pathogens in the same ecosystem would lead to a form of co-evolution (for example: there is variation between individuals within the plant and pathogen populations; the emergence of pathogenic traits in pathogens and resistance in plants is due to random mutation; the infection and destruction of plants by pathogens leads to natural selection of plants better adapted to resist the pathogens; and plant resistance leads to the natural selection of pathogens better adapted to infect the plants; students should appreciate that this is a cyclic and ongoing process). Students could also be asked to discuss the selective breeding of resistant plants by humans (plant breeders are constantly searching for plants that appear to be resistant to pathogens i.e. show few or no symptoms of disease), and why this is important in controlling the spread of plant diseases and ensuring human food security. They could also be challenged to think about how modern genome technologies could be helpful, such as genome sequencing to identify disease resistance genes in plants, and genetic engineering to introduce disease resistance genes into widely grown plants (that are susceptible) to make them resistant. Students should consider the arguments for and against the use of genome technologies, including the potential for them to reduce reliance on techniques such as chemical control.

*Slide 28:* Students could be challenged to think about actions they and their families could take to help control plant pests and pathogens to reduce the spread of plant diseases. Examples may include application of some of the techniques discussed in the presentation to home/school gardens and allotments. Reference could also be made to recent outbreaks of plant disease in the UK, such as *Chalara* ash dieback, and the need to avoid moving plant material to and from woodland and farms, clean soil and mud from clothes, footwear, tyres and pets after visiting the countryside, and follow the instructions on any signs in the countryside during such outbreaks.

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