

Research
Based
Curricula



**How do plants fight against
diseases and pests?**
Key Stage 4 Biology
Resource 5

2019



Resource Five Overview



Topic	Protecting plants
A-Level Modules	Plant tissues, Plant organ system, Communicable diseases, Factors affecting farming, Farming techniques
Objectives	<p>After completing this resource, you should be able to:</p> <ul style="list-style-type: none">✓ appreciate that climate change might affect health of food and commodity crops.✓ understand the nomenclature for different pesticides is based on the type of organism it targets.✓ understand the use of chemicals in the farming industries and some of the positives and negatives.✓ appreciate the inefficiency of spraying chemicals and the role of adjuvants to help.✓ give examples of biological control methods in organic farming.
Instructions	<ol style="list-style-type: none">1. Read the data source2. Complete the activities3. Explore the further reading



Resource Five

Data Source



Section A

Plant protection



Plant protection is the modification of farming techniques to try to improve plant health, particularly of crop plants needed for food including: fruit, vegetables, salad and cereals or commodities such as cotton, coffee. As the world population is increasing, there are more people to feed and less land available to do it. As climate change causes more unpredictable weather, we are starting to see more droughts due to less rainfall at some times, more flooding due to high rainfall at other times and generally higher temperatures causing heatwaves for longer. It is expected that food crops will be negatively affected by these changes and scientists are working very hard to work on ways that we can produce more food with less land and less water.

Increasing global temperatures means that we may face more issues of pathogens and pests in the future. Fungi require high temperature and wet conditions to reproduce and make spores to spread disease. Aphids are killed off by frost periods and without this, would continue to reproduce quickly and damage more crops for longer. Pests and pathogens might also start to become successful in areas which they weren't previously found as the conditions were previously unsuitable.

Growing food crops is already problematic as disease can spread quickly when the same plant type is grown close together on a piece of land or if a pest/pathogen finds its way into a greenhouse. Many of our food crops are also not well adapted to cope with pests and pathogens and don't have the correct defences to fight them off. Currently, on average about 35% of total food crops which could help feed the population is lost due to pests and disease.

Figure 14
Lost crops



Resource Five

Data Source



Section B

Chemicals

One method which has been used by farmers for the last 70 years is the use of agrochemical sprays. These are chemicals which inhibit or kill insects, fungal, bacterial or viral pathogens or kill other plants (weeds) which grow faster and outcompete our crops of interest. These different chemicals are grouped according to what they kill for example: insecticide, fungicide, bactericide, insecticide, virucide and herbicide all use the root word from the organism they target and use the suffix -cide which means to kill. The group of all these chemicals together are called pesticides as they kill one plant pest or another.

Pesticide sprays are sprayed either on the soil or onto the plant leaves. When spraying the soil the pesticide needs to be dissolved in water so that it is soluble and taken up by the plant roots and transported to the rest of the plant. If the pathogen or insect is damaging the leaves this is a slow process to get the chemical to where it needs to be in large enough amounts to be able to work. An additional problem is that useful micro-organisms or insects such as worms in the soil may be killed by the pesticide sprays. Spraying the leaves can be more beneficial if the pest or pathogen targets the leaves, if there is limited water in the area or the chemical is not soluble in water. Spraying the leaves has its own problems, one of the main ones being that plants naturally have defences such as the waxy cuticle, cell walls and cell membranes to limit which chemicals can move in so it is not easy to get chemicals into the leaves without understanding more about the types of chemicals that plant leaves absorb and which they allow to penetrate through them.

Spraying crops is a very wasteful process. Many droplets from the spray are vapourised into water vapour and don't reach the target leaf/soil. Some of the droplets may run off the leaf or be carried by wind and be lost to the environment. On a wet day when leaves are already wet, the spray droplets cannot stick to the leaf and run off more easily. Harsh chemicals lost to the environment may end up in water sources and damage aquatic organisms or they may accumulate in soils and kill soil organisms.

Resource Five

Data Source



Section C

Adjuvants

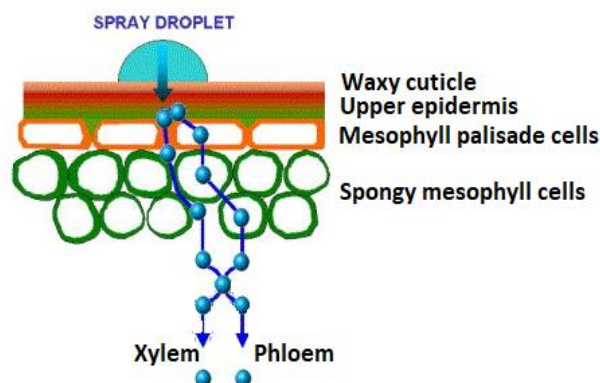
One way to make the spraying process more efficient is to use adjuvants with pesticides. Adjuvants are additives which help the pesticide reach its target location so that it can work better at killing the target pest. If powdery mildew is on the leaves, then the fungicide needs to be in contact with the fungus on the leaf so a farmer might need to use an adjuvant which helps the fungicide stick to and spread over the leaf to give high surface area of coverage. Glycerol is a good example because it is very thick and sticky and retains water well.

Aphids poke in their stylet and feed from the phloem so in this case a farmer might use an insecticide spray with an adjuvant to help it penetrate into the leaf quickly and get into the phloem of the leaf and stem and to kill aphids as they feed from the phloem sap.

To understand absorption and penetration we need to understand how chemicals behave on the leaf. Do they get absorbed quickly or slowly, in large amounts or small amounts? Do they through the cuticle or do they come in through areas of the leaf near to stomata? We also need to know how transport around the plant works. Is the chemical soluble enough in water to be able to be transported with water in the plant cells via osmosis? Finally, we need to know how quickly all of this happens and how well it helps with plant protection against attacking pests and pathogens.

Figure 15

Spray droplet on a leaf



Resource Five

Data Source



Section D

Biological control

Another way that organic farmers might try to control a pest or pathogen infection is to use other live organisms. Organic farming is defined as using methods of farming which don't use any chemicals. This way of farming is becoming more popular especially because pests and pathogens can develop resistance to chemicals which means they are able to avoid being killed by them.

Using natural predators is one way of biological control. Aphids are eaten by ladybirds so by planting plants nearby that are a habitat for ladybirds, the predator/prey relationship can be used to lower the population of aphids. Farmers can also use micro-organisms as a method of biological control. Different species of a bacteria called *Bacillus* which are harmless to plants, make natural toxic compounds which can kill feeding insects like butterfly and moth larvae so the products made by *Bacillus* can save plants under attack. Certain types of fungi are also able to reduce moth pests on crops. A fungus called *Trichoderma* is safe to plants but releases toxic compounds to kill pathogenic fungi harming the plant.

The biggest problem of using biological organisms as a leaf spray to help with pest and pathogen problems is that the micro-organisms need to be kept alive. The micro-organisms can be damaged on the leaf in times of high temperatures and UV light which dry out and damage the cells, so they no longer work. New research is focusing on adjuvants which come from nature that can be added to biological organisms which help them retain moisture or protect them from UV light.

Figure 16

Ladybirds as a form of biological control



Resource Five Activities



- Activities**
1. How might climate change negatively influence plant health?
 2. Match up the following organisms which cause problems for food crops with their labels and the type of pesticide that farmers would use to kill them.

Aphids

Japanese knotweed

Powdery mildew

Slug

Tobacco mosaic virus

Xanthomonas

Herbicide

Virucide

Molluscicide

Bactericide

Fungicide

Insecticide

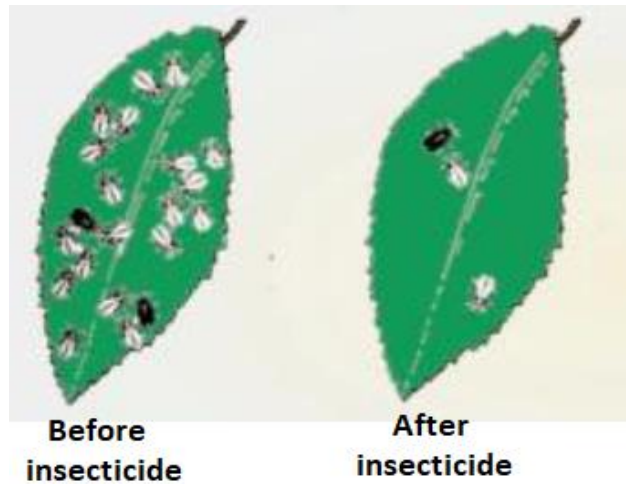


3. Describe how chemical droplets from a spray bottle: a. get to the leaf and b. get into the phloem. Include the different tissue types of the leaf to describe this process.
4. Why would a farmer decide not to spray infected plants with a chemical spray on a wet and windy day?
5. What is the purpose of using an adjuvant?
6. What is biological control of plant protection? Give examples in your answer.

Resource Five Activities



Activities 7. Below is an image of a leaf before and 24 hours after insecticide spray treatment.



- How many black insects are on the leaf before and after treatment?
- How many white insects are there on the leaf before and after treatment?
- Which insect species did this insecticide control the best and how do you know this?
- Suggest a reason why some of the insects have not been killed by the treatment?
- What other methods might a farmer use to try and kill the remainder of the insects?

Resource Five

Further Reading



Explore



- History of using agrochemicals in farming

https://agrochemicals.iupac.org/index.php?option=com_sobi2&sobi2Task=sobi2Details&catid=3&sobi2Id=31

- Recent news article detailing new types of garden pests in the U.K and Europe.

<https://www.telegraph.co.uk/news/2019/01/17/gardeners-warned-never-before-seen-pest-covers-trees-unsightly/>

- Extension activity: Make a poster and choose one of the following insects as a case study: caterpillars, vine weevil, thrips, gall mites, carrot root fly. Include a picture of your pest, where it lives, what its life cycle is, how it causes damage/disease, what plant it effects, what predators eat it, how farmers try to get rid of it and any other interesting information you can find about your pest.



www.researchbasedcurricula.com



www.access-ed.ngo



[@_AccessEd](https://twitter.com/_AccessEd)



hello@access-ed.ngo



100 Black Prince Road
London, SE1 7SJ



AccessEd is a non-profit company
registered in England (#10383890)