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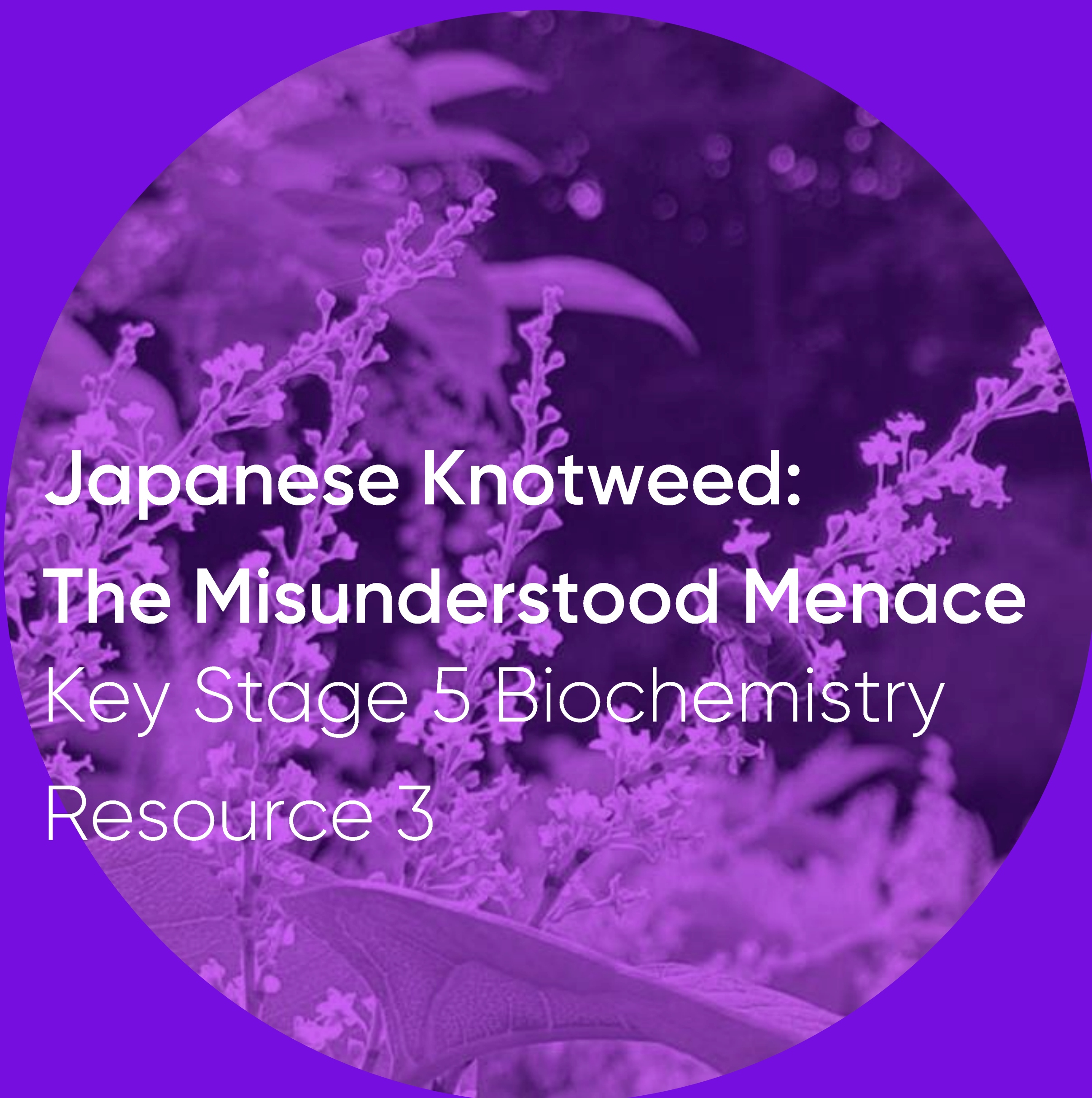

Japanese Knotweed: The Misunderstood Menace

Key Stage 5 Biochemistry

Resource 3

2019

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Resource Three Overview

Topic	Biocontrol
A-Level Modules	Populations in ecosystems

Objectives

By the end of this resource, you will be able:

- ✓ To define biocontrol
- ✓ To understand how population numbers are controlled in a complete ecosystem
- ✓ To be able to explain the drawbacks of different control methods, chemical and biological, and explain the risks involved.

Instructions

1. Read the data source
2. Complete the activities
3. Explore the further reading

Context

Biological control is a method of controlling pests such as insects, mites, weeds and plant diseases using other organisms. It relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role. This resource introduces the ongoing research into biocontrol as a method of tackling the invasive species Japanese knotweed.

Resource Three
Data Source

Section A

The Biological Control of Japanese knotweed

Japanese knotweed is an invasive plant species which can cause environmental and socio-economic damage. There are three main methods for control. One method is to dig up every bit of rhizome, this is known as manual control. Manual control must be very thorough because a new plant can grow from a tiny fragment of rhizome left in the soil. Chemical control is another option which uses herbicides to interfere with the plant's growth. The third option is known as biocontrol. This is still under the research by an organisation called CABI and is not widely used yet. Biocontrol is when one biological organism can cause a reduction in the population of another unwanted organism.

CABI is researching an insect called a psyllid to see if it can control Japanese knotweed. A psyllid is known as a 'sap-sucking' insect. The sap refers to the liquid in one of the plant's transportation vessels. Plants have two main transportation systems, the phloem and the xylem, see Resource 4 for more details. The phloem contains a nutrient rich sap which provides the plant with the energy to grow. Some insects piece the phloem vessel and steal the plant's nutrients in order to survive, which damages the plant.

The following information source is an extract from a Science Summary produced by the Environment Agency, explaining what CABI are doing, and why.

Environment Agency

Extract

Source Analysis

A sap sucking insect and a fungal disease could form the basis for a highly effective and environmentally friendly way to control an invasive plant known as Japanese knotweed, according to a new study. Funded and managed by a variety of different organisations, including Defra, Welsh Assembly Government, South West Regional Development Agency, the Environment Agency, Network Rail, CABI Bioscience UK and British Waterways, the study investigated the potential for using a safe and sustainable natural pest or pathogen to debilitate knotweed and lessen the current environmental and economic problems associated with it.

Resource Three
Data Source

Japanese knotweed (*Reynoutria japonica*) is a large, vigorous weed that is native to Japan, Taiwan and China. It was introduced into the UK in the early 19th century as an ornamental plant, but is now abundant in the wild. It is regarded as a pest in many parts of the country because of its quick growth, which allows it to dominate habitats and exclude other plants. In Japan, the plant is held in check by natural enemies, but these enemies are not naturally found in the UK.

This dense weed also poses a risk to flood management. This is both because it can damage river banks when it dies off in the autumn and because the dead stems can fall into a watercourse, reducing its capacity to carry flood water. In addition, Japanese knotweed can cause damage by growing into concrete or other materials making up flood defences. This all means that land must be cleared completely of the weed prior to building a flood defence scheme, creating huge costs for the Environment Agency.

Current methods for controlling Japanese knotweed involve applying chemicals (herbicides) and physically removing the weed (cutting stems and grazing by cattle). Both methods have major drawbacks. Chemical control can be detrimental to sensitive, non-target plants, while, for complete control, herbicides need to be sprayed repeatedly over a period of years, making this an expensive option. Even then, there is still a potential for the weed to spread. Cutting and cattle grazing do not eradicate the plant, which will continue to grow if grazing stops.

To try to find more effective control methods, a team of scientists looked into the possibility of using biological control methods to limit the growth of Japanese knotweed in the UK. Using living organisms to control pests in this way is known as biological or natural control. The main advantage of this form of control is that, once recognised, an effective natural enemy provides control of the pest indefinitely, without further cost or intervention.

Resource Three Data Source

The scientists began by visiting Japan to examine the plant in its native area. They found that Japanese knotweed is much less of a pest in Japan than in the UK, because it is controlled by native natural enemies. So they brought samples of these enemies, including insects and fungi, back to the UK for testing under quarantine.

At the same time, they conducted a literature review on all information relating to Japanese knotweed and its natural enemies, as well as undertaking further studies in Japan.

In the UK, investigations addressed whether the insects and fungi brought back from Japan were specific to Japanese knotweed, to ensure that they wouldn't attack native UK plants. To do this, they first identified 70 UK plant species that are closely-related to Japanese knotweed. These 70 species included all UK species in the same family as the Japanese knotweed. This included ornamental species, rare species and important crops. They then tested these species under quarantine to see whether they were attacked by the natural enemies.

From these tests, the scientists identified a highly specialist sap sucking insect, Aphalara itadori, and a leaf spot fungus, Mycosphaerella polygoni-cuspidati, as potential control agents, with the data suggesting that they would not pose a threat to non-target, native plants.

The scientists are now looking to test these two natural control agents on other native UK plant species. They also intend to conduct more in-depth studies on the interaction between the leafspot fungus and the plants Persicaria vivipara and Polygonum aviculare to establish the extent of its development and reproductive ability. But the scientists are confident that they have found a new method for controlling Japanese knotweed and approval is currently being sought to release Aphalara itadori. This has been approved by the Advisory Committee for Releases into the Environment and will now undergo a period of public consultation prior to consideration by the Minister for the Environment for approval to release.

This summary relates to information from Science Project [SC010100], reported in detail in the following output(s):-

Science Report: SC010100/SR2 Title: The Biological Control of Japanese knotweed

http://www.cabi.org/japaneseknotweedalliance/Default.aspx?site=139&page=463/

Project manager: Trevor Renals, Ecological Appraisal, South West Region
Research Collaborators: Defra, Welsh Assembly Government, South West Regional Development Agency, Environment Agency, Network Rail, British Waterways and CABI Bioscience UK, and coordinated through Cornwall County Council.

http://www.cabi.org/japaneseknotweedalliance/

Further copies of this summary and related report(s) are available from our publications catalogue or our National Customer Contact Centre T: 08708 506506 or E: enquiries@environment-agency.gov.uk. © Environment Agency

Section B

Psyllids

Since the release of this article, the psyllid was favoured over the fungus for further experiments. Permission was granted to release some psyllids into the wild, outside of a contained greenhouse experiment. The best-case scenario for the Japanese knotweed biocontrol program would be to see a steady increase in the psyllid population as they become established, a reduction in the Japanese knotweed population, and no negative impact on native UK wildlife.

The first release of the psyllid in 2010-2013 failed to establish large populations, and a lot of the psyllids did not survive the winter. However, the first release was deliberately cautious and located away from river-ways. Japanese knotweed is known as a riparian plant, meaning that it likes lots of water

Resource Three Data Source

and tends to live near canals and rivers. Therefore, the best conditions for the survival of the psyllid is likely to also be near rivers. Imagine a worst-case scenario for a first release however, and the problems which would be caused if the psyllid population grew out of control, spread across the country, and negatively impacted on UK wildlife. To avoid this, the first release was purposefully designed not to be located in the most favourable habitat for the psyllid and avoided waterways which allow a rapid means of geographical spread.

During the summer of 2015 and 2016 CABI conducted more experiments where they released the psyllids and counted how many survived throughout the season. In 2016, CABI confirmed that the psyllid had managed to overwinter at one southern site. Although there have been problems with getting the psyllid to survive the UK winters, on the upside there has been no observable negative impact on native wildlife to date.

Resource Three Activities

Activities

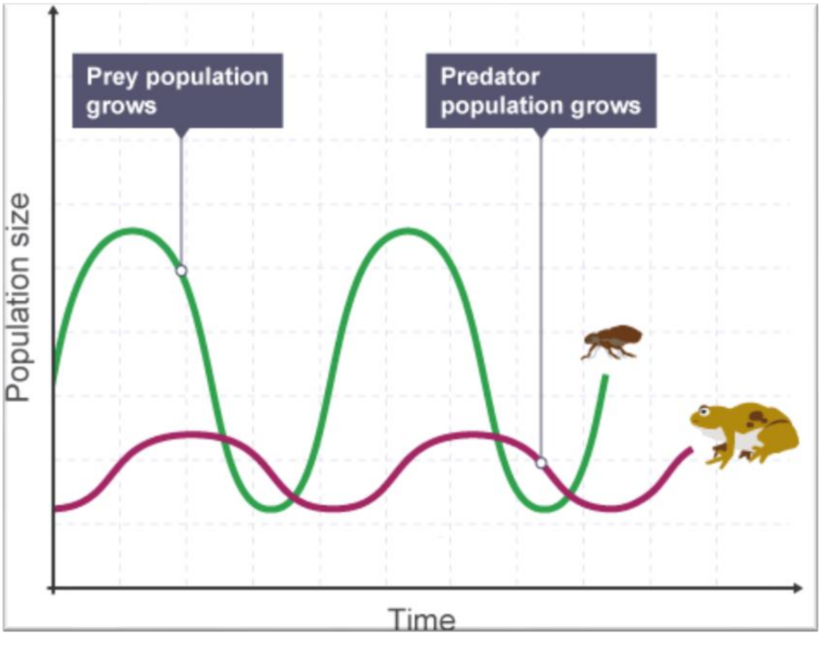
1. Explain biocontrol in your own words.
2. Explain in detail why Japanese knotweed is regarded as a 'pest' in the UK.
3. List THREE disadvantages of chemical control.
4. Why isn't Japanese Knotweed a problem in Japan?
5. Which of these are disadvantages of biological pest control? Pick two.
   a) It reduces the population of the pest without completely removing it
   b) The control species only eat the pest species
   c) The control species must come from the same country as the pest species
   d) Control species may not behave as expected and may become a pest itself.
6. Why was it important for the scientists to test the biological control agents on closely related species native to the UK?

Resource Three Activities

Activities

Data Interpretation

7. Look at the graph below. This graph depicts a predator-prey relationship. The predator-prey interaction is thought to keep the population of both species in balance. This is the key idea behind biocontrol. In the graph below, the insect is eaten by the frog.
    a) Explain why the two populations fluctuate and suggest how the relationship depicted in the graph can keep both populations in balance.
    b) Explain why the insect population is higher than the frogs
    c) Explain why the frog population peaks after the insect population



Resource Three
Further Reading

Explore

Independent research

For one of the most famous examples of biocontrol, see this short video clip about cane toads. Hawaiian cane toads were introduced to Australia from America, as a biocontrol agent to target cane beetles which were damaging sugar cane crops. They are now an invasive species which poison native Australian wildlife. As you watch, think about why biocontrol agents must be carefully chosen, and what the risks involved are : Cane Toads

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