**Transcript of Integrated Pest Management (IPM) for A-level video**

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Integrated pest management (IPM) aims to protect crops through keeping pests below an economically damaging level, rather than attempting total eradication. Through understanding the ecology of both crop and pest, and considering all the factors relevant to crop production, a cost-effective strategy can be designed, monitored and adapted throughout the year. Charlotte Jack and Emily Lane, final year B. Sc. Biological Sciences students at the University of Liverpool have produced this video to help students studying A-level Biology understand IPM. Working with staff at Sir John Deane’s Sixth Form College, Northwich, Cheshire, UK and research staff from the Institute of Integrative Biology at the University of Liverpool as well as Oxitec Ltd, they planned, filmed and edited this short video.  After describing the IPM cycle, there are two examples of the use of these concepts. The first is in the glasshouses at the University, where monitoring and biological control is used to counter red spider mite. The second describes methods being developed by a company, Oxitec, to use outdoors to control insect pests. The video shows an IPM strategy to control the olive fly (*Bactrocera oleae*), a major pest of world-wide olive production.

Timings:

Introduction to content of video and integrated pest management concepts: 0 - min

Animation explaining IPM: 2.03 - 4.48 min

Video of how IPM is used to control red spider mite and other pests in the glasshouses at the University of Liverpool, introduced by Dr Meriel Jones: 4.57 – 7.03 min

Video of how integrated pest management concepts are used by the firm Oxitec to control insect pests. Dr Luke Alphey and Dr Martha Koukidou describe problems caused by the olive fly for olive growers around the world, and how the genetic strategies of the company adds to current control methods: 7:10 min – 12.31 end

**[0 min] *Introduction to content of video and integrated pest management concepts***

Welcome to the University of Liverpool.

[Pictures of University buildings - Victoria Building, Guild of Students building; Cohen Science Library; Bioscience Building]

This is the building where most of our research takes place and where we are going to learn about integrated pest management.

[Picture of Charlotte Jack in Bioscience Building]

Integrated pest management, or IPM, is an approach to pest control that uses a combination of biological, chemical, cultural and mechanical controls. The aim of IPM is to reduce crop damage to economically tolerable levels rather than just totally eradicating the pest.

However, sometimes IPM can take a while to take effect. Therefore it is quite handy to have a good knowledge in crop and pest ecology. This will obtain the best results. If an IPM programme is well designed, it can reduce the costs and pesticide use by up to 50 - 90 %. It will also reduce the use of fertilisers and help to slow the development of pesticide resistance. IPM also emphasises the use of environmentally sensitive pesticides. These are pesticides that aim specifically at the pest and not other species. This can help reduce pesticide resistance and is much more cost-effective.

But why would people bother to use IPM? Well, one of the main reasons is that it is safer. This is because people and the environment are less exposed to chemicals that they don't really need to be exposed to. This in turn helps to reduce pesticide resistance meaning we can use these chemical controls when we really need them.

Next is that it is more effective as it really gets to the root of the problem that is causing these pests to be persistent. Lastly it is more cost effective. This is because it reduces the need for pests and fertilisers so why it may cost more in the short term it saves more money in the long term.

We are now going to look at the IPM cycle.

***[2.03 - 4.48 min] Animation explaining IPM***

IPM is essentially a cycle of several stages. The first stage in this cycle is **soil preparation**. Growers often give their plants a head start by several activities including choosing the proper site, testing the soil beforehand, rotating crops, creating raised beds where necessary, and providing sufficient organic matter. Also, the environment can be disruptive for pests, often by just sterilising greenhouse tools.

The crop is then **planted**. Growers plant crop varieties that tolerate common problems. They can also alter planting time and spacing to discourage certain diseases and insects.

The following stages are continuous throughout the growth of a crop and should therefore be viewed as possibly being applied all at the same time.

Specialist **weather forecasts** for farmers can help with pest management decisions while the crop is growing that helps time the application of pesticides and fertilisers to get the best results.

Also, it can help by just looking out for a pest on the crop. These pests are trapped and the damage is **monitored**. Pest trapping helps growers pinpoint when pest have arrived and to decide whether a control is justified. Before treating, growers must wait until pest populations reach a scientifically determined level that could cause economic damage. Until that threshold is reached, the cost of the yield and quality loss will be less than the cost of control.

One method of control in IPM is **cultural or mechanical controls**. An example of such a control is weeding or manually removing insects from a plant. It is important to remember, however, that throughout this whole process the use of controls is strongly influenced by the weather forecasts and threshold levels.

Another method in IPM is **biological control**. Biological control is a form of pest control that uses other organisms. An example of this will be discussed later in this video.

If the pests still persist above economically tolerable levels, then **chemical control** such as pesticides, herbicides or fungicides have to be introduced. However, this chemical control has to be species specific so as to not cause damage to the rest of the ecosystem.

The crops are then harvested and the management system is recorded and evaluated. Record keeping of the weather conditions, pest traps and treatments is important as it can allow faster future decisions.

The cycle is complete.

We are now going to look at two ways in which IPM is being used in the UK. The first example is a home use of IPM.

***[4.57 – 7.03 min] Video of how IPM is used to control red spider mite and other pests in the glasshouses at the University of Liverpool***

[Dr Meriel Jones] So, we are in one of the greenhouses at the University of Liverpool and we use this one for growing plants that are then fed to insects, for studying insect behaviour. We've got maize here, and broad beans here, and these are grown throughout the year, winter and summer, as food for insects. So the greenhouses are kept lit and warm, and obviously that is an attractive place for insect pests. So we keep a good eye out, looking at the leaves of the plants and then just general performance to see if there are any pests on them.

We also have sticky yellow strips that monitor flying insects and so we can see what is flying around in the greenhouse.

Then, if there are pests we usually use biological predators to keep them down because, of course, insecticides are not suitable for using on these particular plants since they might then damage the experimental insects later on.

So, one of the big problems we have is the red spider mite. It sucks the sap from plants and it likes warm, fairly dry surroundings. We use the mite *Phytoseiulus persimilis* which is a predatory mite that eats the eggs and the adults of red spider mite. When we notice that there is a mild infestation anywhere we introduce a supply of the predatory mites from a commercial supplier so that the predatory mites can then start eating the eggs and adults of the red spider mites.

[Charlotte Jack] We are now going to look at how the firm Oxitec is involved in producing a range of IPM products.

***[7:10 min – 12.31 end] Video of how integrated pest management concepts are used by the firm Oxitec to control insect pests***

[Dr Luke Alphey] Oxitec is a small biotechnology company, a spinout from Oxford University to develop some particular genetic control methods developed at Oxford University. We're in the general environment of integrative pest management, so by far the best known control method for insect pests is insecticides. So this involves the spraying of chemical insecticides and more generally the ideal control method would integrate all available control methods to have something that was environmentally friendly but also much better able to withstand the evolution of resistance in the pests that if you just use one treatment, the pest, insects will almost inevitably develop resistance to it. You could manage that by having several different treatments and think of what it is that you actually need which may not be complete elimination of the pest but keeping it below a certain economic threshold. And so, one of the agricultural pests we focus on is the olive fly. And you think about the damage that it can do, you can lose the whole of the crop to olive fly. Not that it eats all of it like a swarm of locusts leaving nothing in its wake. If you buy olives and you have a jar, or a few olives on your plate, if you bit into one of them and it had a maggot in it, you would not be too happy about that and you'd probably stop eating olives for some time. And it is like that, there is just no tolerance for damage from the olive fly, or its larvae, which are the maggot in the olive fruit.

So olive growers have to be really careful to control the olive fly and also sort their olives to avoid that sort of damage. But the olive fly injects its egg into the olive. It has a long sharp ovipositor with which it injects the egg into the olive which then develops inside. But that means that even if you had sprayed a chemical onto the surface of the olive, it probably would not kill the larva because it has bypassed it because of the female inserting it inside. So it is very difficult to control them with insecticides.

We've tried to use a genetic method to do that instead. If we can produce lots of sterile male olive fly - now of course the males don't lay eggs because they are males, but they'll mate with the females and then pass on the gene that kills the offspring and then there'll be fewer flies. It probably won't save the olive in which the female has laid the egg because that is damaged, but in the next generation there will be fewer olive flies and therefore less damage and that's some kind of control.

We can combine this with the other methods. The most simple method is to try not to leave infested fruit lying around on the ground under the olive trees. Using each of those methods in combination, we should be able to have a very specific, targeted. So in our method the males will only mate with females of the same species, so even other species of fruit fly are not affected. And a much cleaner, more precise control method than are available today.

[Dr Martha Koukidou] Olive fly is a big problem for all the countries where it has been introduced so that is mainly the Mediterranean Basin - and California and Mexico where it has recently been introduced in the last decade or so. Now, traditionally, the way of dealing with olive fly was by spraying the olive trees with insecticides. The problem that growers are facing today is that quite a lot of these insecticides have been phased out by the new EU regulation, and the olive flies have developed immense resistance to existing insecticides. Biological control has been tried in the Mediterranean Basin but it has not produced very good results.

Our solution relies on mass rearing a large number of artificially made olive flies here in our labs. We rear them, we release them in the environment so that the ratio of the released males is higher than the existing wild males in a given area. We release males only and not females. What the Oxitec males do, they will seek out the wild females, they will mate with those wild females but all the female progeny of those matings will die. We can imagine that since the reproductive capacity of any given population is determined by the number of females, and females alone.

The method is environmentally friendly. It does not leave any residues in the environment. It is not based on chemicals.

[Ends on final image of the IPM cycle and acknowledgements]

**Credits:**

*University of Liverpool, UK*: Charlotte Jack and Emily Lane (undergraduates taking B. Sc. Biological Sciences), Dr Meriel Jones (Senior Lecturer, academic supervisor of video production), Dr Luke Alphey and Dr Maria Koukidou, (Oxitec Ltd www.oxitec.com); Graeme Heerden (music https://soundcloud.com/grafa16)

*Sir John Deane’s Sixth Form College, Northwich, Cheshire, UK*: Pauline Lowrie (Head of Biology; Beverley Goodger (Biology teacher)

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