Gene genies?

Wild turnip at a field site near Bath.

Rosie Hails looks back at the Gene Flow programme.

It might not seem obvious, but the genes that make up an organism's genetic blueprint can move around in the environment. Hybrids form between different plant species, and genes can move between different types of organisms. We know this can happen naturally over extremely long time scales (evolutionary time), as genes that originated from viruses have been found integrated into plants. Gene flow doesn't necessarily cause problems, but one worry is that genes from genetically-modified (GM) crops might be more likely to cause unwanted changes than natural movements. So should we be worried? To find out, the Biotechnology and Biological Sciences Research Council and NERC joined together to fund a £4.5m Gene Flow programme that ended this summer.

Whether farmers are growing conventional or genetically modified (GM) crops, it's important to have accurate information about gene flow between plant populations. Early measurements (made before this research programme) under-estimated the distances pollen, and hence genes, could travel. We now know wind or insects can carry pollen for up to several kilometres.

However, new research by Geoff Squires and colleagues at the Scottish Crop Research Institute found that most pollen doesn't get nearly that far, and the frequency of gene flow falls steeply from the edge of the crop. In practice, separating GM and conventional crops by 100m will restrict gene flow enough to meet most of the purity standards set by governments and regulators in the UK and European Union.

Genes can also flow between crops and their wild relatives growing close by. In England, wild turnip is particularly abundant alongside rivers, and occasionally oilseed rape is grown nearby. This creates 'hotspots' where gene flow may occur. Mike Wilkinson and colleagues from the universities of Reading, Southampton, Cambridge and Bath, the National Institute of Agricultural Botany (NIAB), Horticultural Research International, and the Centre for Ecology & Hydrology (CEH) conducted a national survey that estimated around 32,000 hybrids occur between conventional (non-GM) rape and wild turnip each year (although the numbers can vary considerably). So foreign genes put into oilseed rape could move to this wild species (see *Planet Earth*, winter 2003, pages 18-19).

Gene flow from plants to soil organisms has not been detected in any GMO field investigations.

Does that matter? It might do if gene flow made the wild relative more weedy and invasive, disrupting the established balance of plants in the riverside community. But is it likely? I, together with colleagues from CEH Oxford, CEH Dorset and NIAB have been collecting detailed data on the wild plants, and then using these data with mathematical models to pinpoint key properties of wild turnip that, if changed, could give the plant a competitive advantage. The work suggests that what constrains wild turnip populations is direct competition with other vegetation. Although genes modified to protect crops against disease or grazers might mean a hybrid could produce more seeds, these seeds will only germinate if they find a rare gap in the vegetation, so in this case would be unlikely to disrupt the community of plants and animals on river banks in the UK.

It is possible for foreign genes to move from plants to organisms in the soil. This sort of gene flow doesn't rely on the usual mechanisms of sexual reproduction (ie transfer of genetic material from parent to offspring), and we know it can happen over evolutionary timescales. But it is very unusual. Martin Day and colleagues from the University of Wales, Cardiff looked for such movement in natural and laboratory settings. They could only detect transfer of genes from plants to soil bacteria under the most favourable conditions in the laboratory. This sort of gene flow has not been detected in natural conditions in any of the GMO field investigations that have taken place.

But how can we be sure we know what will happen with modified genes? Could they make an organism's other genes function in unpredictable ways? Reassuringly, Peter Shewry and colleagues from Rothamsted and the universities of Nottingham and Bristol found that introducing genes with GM techniques into wheat had less effect overall on how other genes function than introducing genes in conventional breeding programmes.

The gene flow programme hasn't answered all the questions about GM technology, and only a flavour of the results have been presented here, but its findings have enhanced our knowledge of how genes move around in the environment, and the consequences of that movement. Research like this should help policy-makers considering GM crops, and put us on a surer footing for the future.

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