# Is genetic modification an avenue to turf grass improvement?

This month Dr Terry Mabbett looks at the possibilities genetically modified turfgrass could offer the turf manager – and the potential downsides

**Conventional plant breeding continues to advance grass varieties with genetic traits for enhanced plant performance in managed turf grass but genetic modification (GM) could steal a march.**

Access to and use of genetic material in conventional grass plant breed is limited to DNA (genes) within the genus (e.g. Agrostis) and perhaps within the wider grass family (Graminae) depending on the level of genetic compatibility and hybridization with other genera. With GM 'the world becomes an oyster' in the quest for DNA for insertion into the grass genome using a technique called 'gene transfer'. GM puts genetics into a whole new arena by opening up new avenues for scientists to explore and exploit using an apparently infinite spectrum of DNA.

Genes can now be accessed from literally anywhere and everywhere, from rats to roses, and inserted into grass genomes for phenotypic expression of new desired traits. Difference between the standard and modified genotypes is miniscule and is separated by a single gene. But the new phenotype will be completely different with an ability to overcome the pinpointed problem (for example a specific pest or disease or environmental conditions), whichever was the specific target factor for genetic modification.

**MAIN LEFT:** The risk of 'alien' genes escaping from managed turf and into the wider environment is reduced by the continual close mowing that prevents flowering, unlike cocksfoot (Dactylis glomerata) seen flowering here in uncut rough

**ABOVE:Turf grasses genetically modified for high salt tolerance would be of interest to coastal golf courses (Picture courtesy Kenny Liddell)**

**BELOW:** Scientists and regulators would have to be sure that GM grass did not impact on associated butterflies and moths

## Potential upsides and downsides of GM turf grass

Universal potential benefits of genetic modification appear as wide as the gene bank in the broader plant and animal world. Grass plant resistance to specific insect pests and plant pathogens such as chafer grubs and Microdochium nivale (Fusarium patch disease) immediately springs to mind.

Design and development of grass genetically modified for non-allergenic pollen is well advanced. Australian researchers have genetically modified perennial ryegrass (Lolium perenne) and Italian ryegrass (Lolium multiflorum) which do not trigger an allergenic response (hay fever) in humans. Though clearly not applicable to grasses used on tees and greens, where regular low-cut mowing removes the ability of grass plants to flower, this GM avenue could prove interesting for grasses used to seed rough areas.

With increasing interest in bee-friendly areas where the rough grass species are as important as the wild flower seed selection in securing 'bee friendliness' of the sward composition and therefore high pollination levels, genetic modification of rough grass species could be of interest.

It all sounds easy and the mechanics of genetic modification certainly are for appropriately qualified scientists with state of the art instrumentation at their fingertips. The real and sometimes seemingly insurmountable problems arise from public perceptions of GM fuelled by hyped up media coverage and scare stories about 'Frankenstein foods'. This has helped to build a strong anti-GM lobby with a large measure of public support.

Perhaps surprisingly first attempts at GM now around three decades old were targeted at food crops including wheat and maize as food crops and soya bean for animal feed. This appears to have been the initial undoing of GM in Europe. GM came in for an extraordinarily bad press especially in the

UK. Virtually no attempt had been made to carry the public along and get them on board. I can remember attending conferences on biotechnology in the early 1980's including GM where the only journalists were scientists from research publications and other 'learned' journals. The net result was blanket public distrust for GM in all its forms including grasses used in sports and amenity turf.

But many fears expressed about genetic modification of food crop plants, including members of the grass family – wheat, rice and maize - simply do not apply to sports turf because no human being is going to eat the genetically modified biomass. The only animals likely to do so are insect pests like chafer grubs. small wild mammals like rabbits and wild geese grazing greens and tees in spring for that early 'bite'.

However, there are factors presenting real or perceived environmental problems whether the GM plants are grown for human food and animal feed or used as a component of living sports surfaces. Primary factor is the escape of GM pollen into the wider plant environment with subsequent introduction of 'alien' genes into wild plants. Traits which are beneficial and safe in turf grasses could create serious problems in the natural environment. This will become clearer in the following case study featuring Agrostis stolonifera as the first grass species to be genetically modified for a specific application in managed turf.

## The great GM grass escape

The first work on genetic modification of a turf grass started around the year 2000 and produced a GM Agrostis stolonifera (creeping bentgrass) resistant to glyphosate, a systemically acting total herbicide which normally kills all green plants whether they are broadleaved weeds or turf grasses.

It did not receive general public attention until 2006 when the press, including New Scientist magazine, reported how scientists had found this GM trait in the wild.

The grass had been designed and developed for easy-to-manage pure swards on golf courses but had escaped its managed turf niche and moved into the wild up to 3.8 km from where it was being trialled in the north western US state of Oregon, and before securing full USDA (United States Department of Agriculture) approval. Nine GM 'absconder' plants were identified. GM material had apparently escaped and established through pollination of non-GM plants and germination of the hybrid seed thus produced.

**ABOVE: Any change in pesticide usage from using GM turf grass clearly cannot be allowed to impact on the wider golf course environment and especially aquatic components**

Critics of the whole GM concept pointed to the perennial nature of Agrostis stolonifera claiming its persistence year after year actually poses more scope for escape, establishment and spread than for agricultural crops like maize (an annual 'grass' albeit a very large one) which is replanted as seed every year.

Others referred to numerous close relatives of A. stolonifera, like A. capillaris (colonial or browntop bentgrass), A. canina (velvet bentgrass), A. castellana (Highland bentgrass) and other truly wild bentgrasses with which it can hybridise and exchange the gene for glyphosate resistance. Research findings at the time reported hybridisation between creeping bentgrass (A. stolonifera) and other Agrostis species at frequencies of six hybrids thousand.

Others were concerned because the gene conferring glyphosate

resistance did not originate from another green plant but from a bacterium.

Be that as it may, of an Agrostis stolifera resistant to glyphosate herbicide becoming commercially available would have meant greenkeepers establishing pure stands on greens, tees and fairways which could then be sprayed with glyphosate to kill all 'contaminating' broadleaf weeds and rough grasses like timothy (Phleum pratense). Even other unwanted 'fine' turf species (e.g. Poa annua) would find their way into the sward one way or another.

The downside for greenkeepers would clearly have been the end of mixed turf grass species swards because anything other than the GM Agrostis stolonifera would be killed by the herbicide spray. Also grass clippings from the GM creeping bentgrass sprayed with glyphosate would be potentially toxic to other grasses and therefore requiring special handling and disposal.

**GM grass pushes on**

Further development of GM Agrostis stonifera was blocked but this did not deter the manufacturer (the seed company Scotts of Marysville in Ohio State and now called 'Scotts Miracle Gro') which is testing a new genetically modified turf grass in garden lawns of a small number of its employees during this 2014 growing season. The employees are testing a Poa pratensis (Kentucky bluegrass) genetically modified to withstand glyphosate in the 'Roundup' product developed, manufactured and marketed by Monsanto.

In January 2014 the Columbus (Ohio) Gazette said "If no one beats Scott's to the market it will be the first producer of what it calls 'enhanced turf grass'. Quoting Scott's they said the grass [GM Poa pratensis] is designed to grow slower, require less mowing, be easy to keep weed free and to require a lot less water.

GM turf grasses look set to make their mark in North America but obtaining approval in Europe and especially the UK may prove a much harder proposition. Not particularly due to scientific concerns in the EU, but general concerns articulated by the press and taken on board by broad swathes of the public.

Risk scenarios put forward against GM plant species are almost as varied as the gene transfer options offered to molecular biologists. Just imagine this invented scenario - "A bent grass (Agrostis) genetically modified for resistance to Fusarium Patch was approved and widely taken up by golf courses across the UK.

The gene conferring resistance was sourced from rhubarb and scientists said the 'rhubarb gene' caused the cells of the GM grass to manufacture a chemical that isolated leaf infections by Microdochium nivale. But the GM grass proved highly attractive to chafer grubs causing a population explosion and untold damage to golf courses throughout the country.

Foxes had a field day feeding on the chafer grubs but the chemical, transferred unaltered from chafer grubs to foxes, made these urban wild animals highly aggressive with reports of attacks on people all over London and other towns and cities throughout the country."

It clearly sounds contrived and is highly unlikely to happen but is just the sort of scenario bound to be used as an argument against, should development and approval of GM turf grass ever seem likely to happen in the UK.

**TOP LEFT:** Wild geese taking an early spring 'bite' among the few wild animals likely to eat GM grass

**TOP RIGHT:** 6 Changes in pesticide use brought about by the introduction of GM grass must not be allowed to add to environmental loading.

**ABOVE LEFT:** Turf grasses genetically modified for high salt tolerance would be of interest to coastal golf courses (Picture courtesy Kenny Liddell)

**ABOVE RIGHT:** There is always the fear that GM turf grass could impact on aquatic wildlife like the spawning frogs shown here