The word ‘mycorrhiza’ is beginning to enter the language of greenkeeping. It now appears in several advertisements for companies selling biostimulant products. Here, I explain just what a mycorrhiza is, what it does, and what my research group at Royal Holloway is doing with it.

**Definition**

The word ‘mycorrhiza’ (pronounced mike- o- riza) comes from the Greek and literally means ‘fungus root’. It is a generic term, given to any intimate association between a fungus and the roots of a plant. It is important to realise that use of the word on its own means little; it as specific as using the word ‘grass’ to describe the species of plant growing in a golf green. Now, plenty of disease-causing fungi could also be said to form intimate associations with plant roots, yet they do not fall under the description of mycorrhiza. The thing that sets this fungus-plant association apart from all others is that both fungus and plant gain from the relationship. The scientific term used to describe such a relationship is mutualism. Clearly, in a plant-pathogen situation, there is no benefit for the plant and so it is not a mycorrhiza.

**Orchids** are totally dependent on their mycorrhiza for survival.
Types of mycorrhiza

A common misconception is that there is only one type of fungus formed by one type of fungus with virtually any old plant. Nothing could be further from the truth. In fact there are seven distinct types of mycorrhiza. Only four of these are at all common and of much relevance ecologically, and they are briefly outlined below. Another important point to realise is that the fungi which form any one type of mycorrhiza are taxonomically very different from those which form another type.

Orchid mycorrhizas

Everyone is probably familiar with the fact that orchids must have a fungus in their roots to enable them to grow. All orchids pass through a relatively long, seedling stage during which time they are unable to photosynthesise and thus cannot fix their own supply of carbon from the atmosphere. As a result, they are totally dependent on the mycorrhizal fungi in their roots, which supplies the plant with its entire carbohydrate need at this time. For most orchid species, the fungus continues to supply carbon and mineral nutrients to the plant, throughout its life.

Ectomycorrhizas

Ectomycorrhizas are very common. In fact virtually every woody plant forms an ectomycorrhizal association. As with the Ericoid association, the fungus envelopes the mycorrhizal fungus in their roots, which supplies the plant with its entire carbohydrate need at this time. The fungi which form these mycorrhizas can live perfectly happily without a plant, as they are decomposing organisms. This means it is possible to culture them in the laboratory. Most of the toadstools that you see in a woodland in autumn are the fruiting bodies of these fungi. A few produce decomposing bodies below ground—these are the famous truffles. In autumn, turn over some leaf mould and you will see the strands of fungal mycelium (the ‘roots’ of the fungus) within. If some of this mycelium encounters the roots of a tree, then it forms the ectomycorrhiza, in which strands of the fungi penetrate the cells of the root. As with the Ericoid mycorrhiza, there is then an exchange of nutrients, with mineral nutrients (mainly nitrogen and phosphorus) moving from fungi to plant and carbon compounds moving the other way. Clearly, it is beneficial for the fungus to do this; it involves much less energy to obtain carbon from a host plant than it does to secrete enzymes which decompose leaves. It is important to realise that these mushroom- or toadstool-forming fungi do not form mycorrhizal associations with turfgrass. This was brought home to me quite recently when I was walking a golf course with the greenkeeper. “Look", he said, pointing to some fly agaric toadstools, growing in the rough. “I've got mycorrhizal fungi - they're beneficial to the grass, aren't they?" I replied that the only thing they were benefiting was the silver birch tree we were standing beneath, and which, five minutes earlier, he had been complaining was growing too quickly! Arbuscular mycorrhizas

From the turfgrass point of view, these are the important ones. On encountering the roots of a plant, the fungi do not form a coat or sheath, instead many individual strands of fungus (known as hyphae) penetrate the roots. These hyphae grow within the roots and inside the cells form structures which under a powerful microscope look like small Christmas trees, called arbuscules. These are the sites of nutrient exchange, with nitrogen and phosphorus moving to the plant and carbon compounds moving to the fungi. Unlike all the previous types of mycorrhiza, the fungi which form this association cannot obtain their carbon by decomposition. They are utterly dependent on the plant and so cannot be cultured on agar in a laboratory. Neither can you add carbon to the soil to feed these fungi. These fungi never produce toadstools, their spores are invisible to the naked eye and are formed in the soil. Arbuscular mycorrhizas are the type which associate

Above: Heather depends on its mycorrhiza for growth in acidic, poor soils

Above right: Fly agaric toadstools are the fruiting bodies of an ectomycorrhiza, which associates with trees, not grasses
with grasses and herbs and therefore of importance to turfgrass. About 70% of the herbaceous plants of the world form an arbuscular mycorrhiza.

**How arbuscular mycorrhizas benefit plants**

Unlike the other mycorrhizal types, the arbuscular mycorrhizal (AM) fungi can confer a variety of benefits on a plant. These are:

- Increased uptake of phosphorus
- Increased uptake of nitrogen (nitrate and ammonium)
- Increased trace mineral uptake, e.g. zinc and copper
- Increased resistance to drought
- Increased resistance to insect pests
- Increased resistance to diseases

It is a common mistake to think that the only benefit to a plant is the uptake of P. This misconception has arisen because in all natural ecosystems, plants are limited by P availability, because this nutrient is immobile in soils. There are thousands of experiments which show that the AM fungus increases plant P uptake and therefore growth. However, in turfgrass, this is virtually irrelevant. Most turf soils have very high P levels and the plant can obtain its needs on its own. Therefore, in turf, the benefits of forming a mycorrhiza are mainly the last three items in the list above. I have found this misconception to be widespread; in fact some professional scientists have tried to tell me that AM fungi are irrelevant in turf, because they thought that P uptake was the only benefit conferred.

It is an interesting quirk that in the 30% of plants that do not regularly form an arbuscular mycorrhiza, the fungus may still try to enter the root. Sometimes it succeeds and is able to remove carbon, thereby acting as a parasite. When it does, plant growth is reduced.

**AMfungi in turf grass**

Research at Royal Holloway has found that the levels of AM fungi in turfgrass are much lower than in natural grasslands. An often cited reason for this is the amount of fungicide applied. However, in recent experiments, we could detect no short term effect of fungicides on the mycorrhiza in a golf green. There was a detrimental effect in a football pitch, though. The reason? The putting green had a well developed thatch layer, which was lacking in the football pitch. Thatch is a remarkably good biological filter and bacteria within it rapidly degrade the fungicide before it reaches the mycorrhiza in the root. Probably the main reason why mycorrhizal fungi are rare in fine turf is the amount of compaction this environment receives. We are continually being told that aeration is of the utmost importance for the health of the grass. It is also of importance for the health of the fungus. I and my students continually perform surveys of AM fungi in golf greens, to elucidate the factors which determine the occurrence of the mycorrhiza.

Our research has also revealed that the fungi appear to be able to reduce the growth of annual meadow grass. This grass happens to be one of the 30% of non-mycorrhizal species. If one grows Poa annua with a mycorrhiza then the growth of the plant is reduced. One of the major parts of our research programme is to find out the mechanism for this. However, this does add another unique benefit to mycorrhizas in turf - they have the potential to control the growth of this weed.

**The future**

The current situation is that we know that AM fungi are rare and sporadic in turf. We also have found that they can be inoculated into turf, resulting in better seedling establishment of bentgrass and reduced growth of Poa. We are currently investigating how effective they are in enhancing the disease resistance of grasses. There is much we need to learn about these strange fungi, but my prediction is that they will become one of the standard biostimulant products in years to come.
Focus on the USA

Capital: Washington DC

Golf Clubs: According to the National Golf Foundation, there are 16,588 golf courses in the United States (June 99).

Practical Information:
Visa requirements: UK: Visa not required for a stay of up to 90 days.

Chief tourist attractions:
Many cities of interest including New York with its skyscrapers, Washington DC with its monuments, Boston, San Francisco and New Orleans: enormous diversity of geographical features - the Rocky Mountains, the Everglades of Florida, the Grand Canyon; hundreds of national parks, historical parks and reserves including Redwood, Yosemite and Death Valley (all in California); Disneyland (California) and Wait Disney World (Florida).

Did you know...?
There are 50 states and one district? The 50 small white five-pointed stars on the flag represent the 50 states? The 13 stripes on the flag represent the 13 original colonies; known as Old Glory?

Next month: Germany

Meet the members

Peter Bacon, Wyantenuck GC
R Terry Buchen
Stephen Cadenelli, Cape Cod National GC
Stuart Cagle, Old Oakland GC
David P Davies, Tiaro Rado GC
Mark L Esposito, Hinckley Hills GC
Jean L Esposito, Hinckley Hills GC
Alan G Fitzgerald, Pine Valley GC
Deen M Groves, Bethedia CC
Gary Grigg, Royal Poinciana GC
William Hamilton, Manon Creek GC
James Hillier, Pine Grove Springs CC
Jonathan Jennings, The Patterson Club
Mark Kuhns, Oakmont CC
Robert Mailbout, Hinckley Hills GC
Richard Matteson, Pendleton CC
Eamonn McCarthy, Southward Ho CC
Neil McLoughlin, Southward Ho CC
Richard Mcnab, Palmers GC
William P Montague, Oakwood Club
Walter C Montrose, Westwood CC
Patrick M O’Brien, Wolverine GC
David A Oatis, USGA
Simon W Parlin
Paul Petchard, Winkwyc GC
Kevin Ross, Rockies CC
Troy Russell, Bandon Dunes Resort
John A Scott, Pinehurst Resort & CC
Gordon Seliga, Lake View CC
Richard J D Smith, Muirfield Village GC
Brian T Sullivan, Bel Air CC
Todd Voss, Double Eagle Club
Bruce R Williams, Los Angeles CC
John Yakesis, Rolling Rock Club

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- Iron (Fe): 4.0%
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Derived from Dipotassium Phosphate and Iron Phosphate Citrate

Non-plant-lead ingredients
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- Cold Water Kelp Extracts: 2.0%
- Vitamin C (Ascorbic Acid): 2.7%
- Vitamin B₁₂ (Thiamine): 0.3%
- Vitamin E (Alpha-tocopherol): 0.1%
- Myo-Inositol: 0.4%
- Glycine: 0.9%

Contents 10 litres

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Full text should be included here.
Saltex '99, the outdoor, summer, southern relation of BTME drew many familiar faces to Windsor Racecourse and served up the usual array of new products, machinery demonstrations, press launches and gossip.

BIGGA's new improved 1999-2000 Golf Directory was launched at the Show and received rave reviews from everyone who saw it. For the first time, the Directory lists the names of BIGGA members and their golf clubs, and as a result it will be invaluable for people looking to track down old friends or acquaintances. Coupled with the company listings it is sure to become recognised as the yellow pages for golf... except it's green!

Please accept your own copy, free, this month, with our compliments.

As is tradition the BIGGA Chairman is invited to be a stand judge on the first morning of the Show. Gordon Child is seen admiring the Town and Country Turf stand which went on to win a Gold Medal in category 3.

From record entries throughout the UK and Ireland, The RAC Golf & Country Club, Epson, was drawn as this year's winner of the annual Blazon "Spray Watch" campaign and received the first prize of a brand new Gambetti Barre AMK 300 Tractor Mounted Sprayer. Presentation of the prize to the winning club's Course Manager Bob Wiles was made by Neil Thomas, BIGGA's Executive Director. Attending the ceremony also was Chris Rudkin of Avoncrop Amenity Products whose company supplied the Blazon and entered the RAC Club into the draw. "We have been using Blazon since it was first launched and it continues to be an essential part of our spraying programme," said Bob Wiles.

Pictured left to right are Chris Rudkin, Bob Wiles, Neil Thomas and Richard Fry, Blazon Europe.
2.5m in transport mode. Available with either Magna 4 or 6-Knife fixed head cutting units or Sportcutter 8-Knife floating head cutting units, the Hydraulic 5/7 features individual control over the four outer units enabling variations in working width to be achieved.

The Iseki TR63 provides the ideal partner generating 63 hp from a Perkins direct injection diesel engine that gives a cleaner burn and low exhaust and noise emissions. The air-conditioned cab with wide opening doors for easy access offers superb comfort and excellent visibility especially for trailed equipment. PTO and four-wheel drive are electro-hydraulically engaged with push button control.
John Deere’s new utility vehicles unveiled at Saltex

John Deere’s new E-Gator utility vehicle is powered by a whisper-quiet electric motor. For anyone concerned about noise levels and exhaust emissions in the workplace, the E-Gator provides a clean, quiet, durable and efficient option for a variety of turf and golf course applications.

This four wheel, two seater electric utility vehicle offers the same advantages as the established petrol and diesel Gator models: low ground pressure to help prevent ground compaction; simple, smooth and reliable operation; and easy access to all service points for convenient maintenance.

Designed for quick acceleration and steady performance between charges, the E-Gator offers numerous safety features, including overspeed and roll-away control. This prevents the vehicle from free-wheeling down a slope when either carrying a light load or left unattended with the parking brake off; an anti-rollback function also prevents it from free-wheeling in the opposite direction.

Dynamic braking allows the motor to brake as the driver lifts a foot off the accelerator. The speed control governs the vehicle at a top forward speed of 15.5mph, or 8 to 10mph in reverse, and helps maintain a constant speed when travelling up or down slopes. In addition, a directional change control slows the vehicle to a stop when moving from forward to reverse.

The vehicle’s charger plugs into a 240V ac, 60Hz wall unit and draws the maximum amount of current allowed, to reduce charging time; the charger senses when the charge cycle is complete and shuts down automatically.

John Deere’s new Pro Gator utility vehicle was officially launched in the UK and Ireland at the Show. It can be used as a general materials transporter or with specialist turf maintenance equipment for a wide range of applications in the golf & turf and commercial groundcare markets.

Designed as a heavy duty addition to the Gator range, this four wheel, two seater vehicle is available with a 24hp diesel engine and a choice of two or optional four wheel drive.

The Pro Gator has a five forward, one reverse speed synchronized transmission, with full front and rear suspension, hydraulic drum brakes on all four wheels plus differential lock, hydrostatic power steering and a maximum speed of nearly 20mph. The tilting steering wheel has a choice of five positions for maximum driver comfort, and there is a large eight gallon fuel tank.

The standard tipping cargo box has a capacity of 676kg, and towing capacity at the rear hitch is 680kg.

In addition to the cargo box, it can be fitted with a range of different attachments utilising the vehicle’s hydraulic services and mechanical pto. These include sprayers, spreaders, top dressers, materials collection systems and adapter kits for other turf maintenance equipment.

An optional cab can also be fitted in place of the standard ROPS frame.
Sisis drift along with Ecospray

The new single unit SISIS ECOSPRAY has been designed for use on small areas of natural or synthetic turf, sites with restricted access and hard surfaces such as pavements, car parks etc.

One of the major problems of carrying out selective weed control is waiting for exactly the right weather conditions, particularly wind velocity. Spray drift can damage neighbouring properties, pollute water courses or affect ornamental flower beds. New MAFF codes of practice state that "all pesticides must be contained within the area intended for application" - in other words no drift.

The single-unit "no-drift" ECOSPRAY incorporates the same shrouded spraying unit as those used on the well established tractor models. The patented mesh shroud was developed following extensive research at Cranfield University and scientifically designed to allow the correct amount of air flow to reduce drift to a minimum, while maintaining the correct spray pattern. Bubble jet nozzles are fitted to give a hollow droplet which bursts to give a more uniform droplet size. The shrouded spraying head can be offset to left or right to ensure spray goes right to the edge.

All controls are on the handle which is spring loaded to ensure operator comfort. The spraying head lifts and locks for ease of transport, calibration, change of nozzles etc.

Fertiliser range expanded at Headland

Headland Amenity has expanded their range of fertilisers based on Multi-K potassium nitrate.

"Multi-K potassium nitrate has many advantages as a turf fertiliser and is ideally suited for use in our climatic conditions," said Mark Hunt, Headland's Fertiliser Product Manager. Headland has added a mini-prill formulation of Multi-K potassium nitrate, to its existing water soluble and coated products. Multi-K Mini Prill is 1.2mm prill suitable for application to all fine and close mown turf.

The prill breaks down quickly on contact with moisture and provides a rapid response even at low soil temperatures "Turf managers now have a choice when applying Multi-K," said Hunt, they can spray using the water-soluble formulation or apply the mini prill through a spreader as conditions dictate".

With an analysis of 13+0+46, Multi-K Mini Prill is ideally suited as an autumn/winter or spring starter fertiliser. All Multi-K products are sulphur free, and this linked with their oxidising nature, can help counteract the formation of 'black layer'.

Stihl launch their new scrub cutter

The introduction of a new scrub cutter from STIHL, allows tidy cutting alongside roads, paths, planted and play areas, as the cutting blades operate like a mower beam and material literally falls where it is cut.

The FH75 scrub cutter is operated in the same way as a brushcutter, with the cutter bar mounted on a long, loop-handled shaft which is swung in an arcing action close to the ground. The cutter bar can be set to nine different angles between zero and 90 degrees, enhancing the tool’s versatility as it can be instantly adapted to suit different cutting situations.

An additional benefit of the FH75 scrub cutter is the user’s ability to see the tip of the cutting head during operation enabling a more accurate cut around tender and static objects. The FH75 is highly versatile and clearly suited to a wide range of applications from road, rail and highway maintenance to park, nursery and garden care.