

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.

Myco what?

Orchids are totally dependent on their mycorrhiza for survival

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.

Myco what?

Types of mycorrhiza

A common misconception is that there is only one type of mycorrhiza, formed by one type of fungus with virtually any old plant. Nothing could be farther 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 fungus 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.



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

Ericoid mycorrhizas

As its name suggests, this type of mycorrhiza only associates with members of the Ericaceae, or heather family. The fungi grow in soils and when they encounter the roots of a plant of this family, they form an enveloping sheath over the tips. Some elements of the fungus from this sheath penetrate the roots of the plant. Inside there is an exchange of nutrients, with mineral nutrients moving from fungus to plant and carbon compounds moving from plant to fungus. It is thought that the presence of this mycorrhiza in soils allows heather to grow on acidic, nutrient poor soils. These soils have very low

concentrations of essential nutrients such as nitrogen and phosphorus and if the fungus was absent, the plant root system is simply too inefficient at taking up sufficient quantities of these ions from the soil solution. However, the fungus is remarkably good at doing so, and the passing of these to the plant enables the plant to grow. There is a further added benefit of the fungus which is that it also has a remarkable ability to take up metal ions which would normally be toxic to the plant. Examples are aluminium and iron which become very soluble at low pH and could occur at levels high enough to kill the plant. The fungus takes up these metals and stores them, thus reducing their toxic effect on the plant.

Ectomycorrhizas

Ectomycorrhizas are very common. In fact virtually every woody plant forms an ectomycorrhizal association. As with the Ericoid association, the fungus envelops the roots of the plant, giving rise to its name (ecto meaning outside). 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 their fruiting 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 fungus 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 fungus. 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



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 ecosys-

tems, 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.

AM fungi 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.

BIGGA has over 200 international members situated throughout the world. Here, we welcome our members from the USA, and give some interesting facts about their country.

Meet the members

- Peter Bacon, Wyantenuck GC
- R Terry Buchen
- Stephen Cadenelli, Cape Cod National GC
- Stuart Cagle Cgcs, Old Oakland GC
- Steven Cook, Oakland Hills 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
- Dean M Graves, Bethesda CC
- Gary Grigg, Royal Poinciana GC
- William Hamilton, Maroon Creek GC
- James Hillier, Pine Grove Springs CC
- Jonathan Jennings, The Patterson Club
- Mark Kuhns, Oakmont CC
- Robert Maibusch, Hinsdale GC
- Richard Matteson Cgcs, Pendleton CC
- Eamonn Mccarthy, Southward Ho CC
- Neil Mcloughlin, Southward Ho CC
- Richard Mcnabb, Palmetto GC
- William P Montague, Oakwood Club
- Walter C Montross, Westwood CC
- Patrick M O'Brien, Wolverine GC
- David A Oatis, USGA
- Simon W Parkin
- Paul Pritchard, Wiltwyck 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 Yakubisin, Rolling Rock Club

Focus on the USA

Location: Bordering both the North Atlantic Ocean and the North Pacific Ocean

Currency: US Dollar (\$)

Population: 267,954,764 (est)

Official Languages: English, Spanish

Time Zone: GMT -5 -11

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 Walt 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

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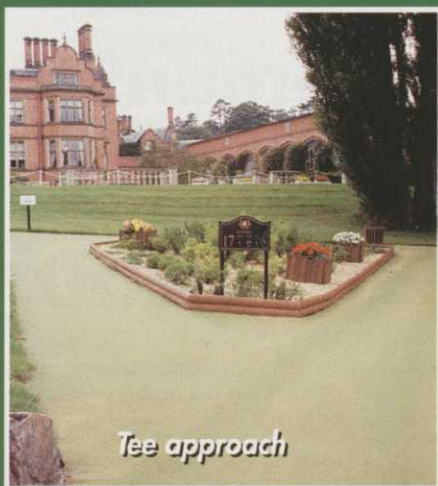
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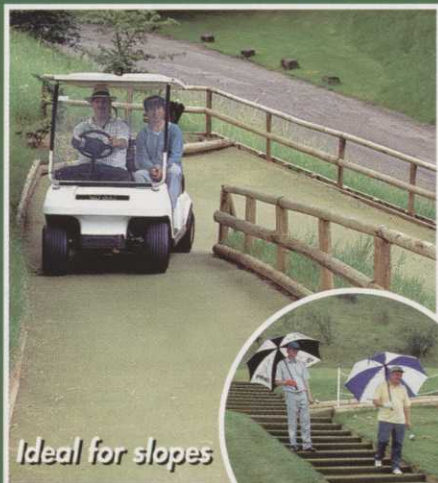


Tee approach



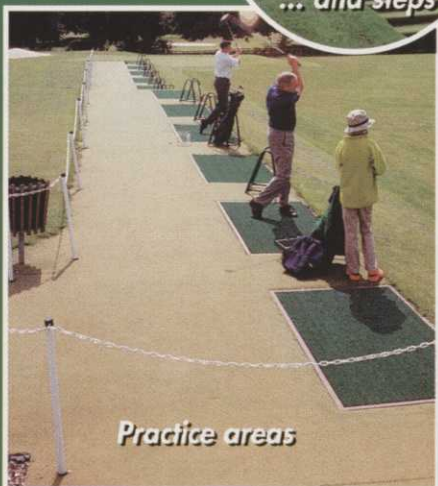
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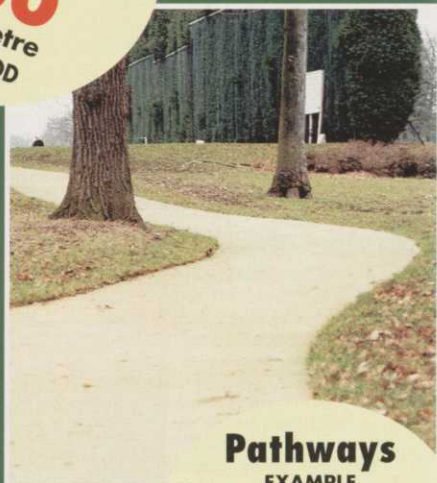


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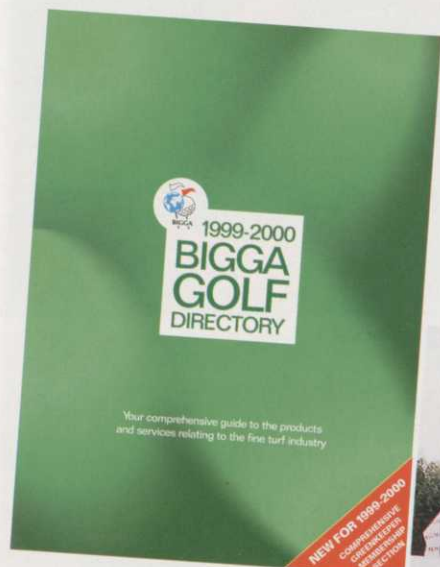
Durable Sure Step surround complete with tough, nylon driving mat and Plastee framework (visible or covered)

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SALTEX⁹⁹

Sports, Amenities, Landscaping
7-9 September '99 Windsor Racecourse

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, Epsom, 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.



Textron launch new stablemates at Saltex

Textron launched the Jacobsen HR-4600 Turbo triplex rotary mower which incorporates many design features already proven on the HR-Si 11 and HR-901 6 Turbo.

An adjustable, high backed suspension seat, gauges that are easy to see and all controls within reach. Three hydraulically powered cutting decks, each with two blades, provide a 92" cutting width with a cutting height. The front decks can be raised and lowered independently.

A single pedal controls speed and direction, with dynamic braking through the traction circuit when in operating mode and front disc brakes for parking. An adjustable weight transport system improves traction when and where it's needed and optional 4-wheel drive.

Adding to their range of turf care equipment Textron launched the Turfco SP-1 530 trailed top dresser. It has a spreading width of up to 9.14 metres and can achieve a top dressing output of 12.8 acres per hour. The distribution pattern is adjustable from 15-30 feet.

A large six cubic metre capacity hopper ensures fast loading using a front-end loader and the low centre of gravity together with large floatation tyres make it light on the turf.

Textron also recently launched Jacobsen HR-9016 Turbo rotary mower.

Highly manoeuvrable with a 16 foot cutting width, the HR-9016 Turbo can mow up to 16.5 acres per hour. Automatic four-wheel drive when mowing protects the turf in tight turns and on wet and hilly terrain and there are two-wheel and four-wheel reverse options.

The cutting decks consist of a 92 inch, 5-blade, out front multi-flex front deck and two 59 inch, 3-blade,

wing decks, providing cutting heights from 1 inch to 5.5 inches.

The Greens King V has also been improved and is now built at Ipswich, specifically for the European market.

Designed with operator comfort in mind, the control console provides clear sight lines in all directions and all controls are within easy reach. The one-touch lift and lower foot pedals make raising and lowering the cutting units a simple operation.

Fully floating cutting reels available with 11 or 7 blades and with Jacobsen's FlashAttach system they can be changed in minutes, without tools.

A fully enclosed fibreglass hood helps keep noise to a minimum and lifts to reveal all major components which are easily accessible.

Building on the Parkway 2250, the new PLUS derivative offers a choice of either Magna 250 6-knife, fixed head cutting units or Sport 200 8 or 11-knife, floating head units, both with direct hydraulic drive and variable reel speed control.

Powered by a Kubota 38hp liquid-cooled diesel engine the Parkway 2250 Plus has a mowing speed of 7.5 mph and a transport speed of 15.5 mph. Hydrostatic fail-safe disc brakes are used for parking and automatically engage when the ignition is switched off.

Turfcare professionals with large areas to maintain could find that Textron provides the solution with the factory-fitted combination of the new Iseki TR63 tractor and the Ransomes Hydraulic 5/7 gang mower. The pair are CE approved as one unit.

The seven cutting units of the Hydraulic 5/7 provide a maximum working width of 4.65m reducing to



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.

Toro's new signing becomes a part of the team

Toro applied its 'Red Iron' livery to its newly-acquired range of Multi-Core aerators, and showed the machines in public for the first time at Saltex. The move to swap Multi-Core aerators' familiar blue clothes for Toro's traditional red-and-black look follows the purchase by The Toro Company, of Minneapolis, USA, of the machine's British company.

The acquisition has brought the product into the full range of Toro turf maintenance machinery and greatly enhanced the company's aeration range with equipment.

All three of the large turf aeration units in the Multi-Core range are mounted to a compact tractor by the three-point linkage for fast, optimum core aeration. They are lightweight for use on sensitive turf areas such as sports pitches as well as fairways, tees and greens and come in working widths of 40, 60 and 80in respectively.

The new Toro Topdresser 1800 offers greater application control with a new belt design and improved brush performance. A redesigned, easy-to-change V belt improves performance even when handling wet sand or delivering fine applications. The faster-spinning brush and improved metering gate ensure that precisely the desired amount of sand is applied.

The 1800 topdresser is designed and built for use with the Toro Workman utility vehicle. It utilises the Workman's hydraulic system and is controlled with console-mounted levers. The unit has an 18cu ft hopper and can operate at speeds up to 8mph.

Another Toro product on show which is currently receiving a lot of interest is the Contour 82 Deck. This deck is fitted to the company's Groundsmaster 3000-D out-front rotary mower and is designed to produce an even cut without scalping on heavily-contoured ground. The spe-



cial deck comprises four independent, 22 inch-wide cutting chambers that are linked together to form a complete deck. Each section can flex

up and down by 20 degrees to 'float' over bumps and drop into hollows to hug the ground contours for a smooth, consistent cut.

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 freewheeling 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 freewheeling 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.

It runs on Hi-Flotation turf tyres and can tow up to 272kg, with a total payload capacity of 408kg. It will be available from spring 2000.

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 grounds care 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 synchronised 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.

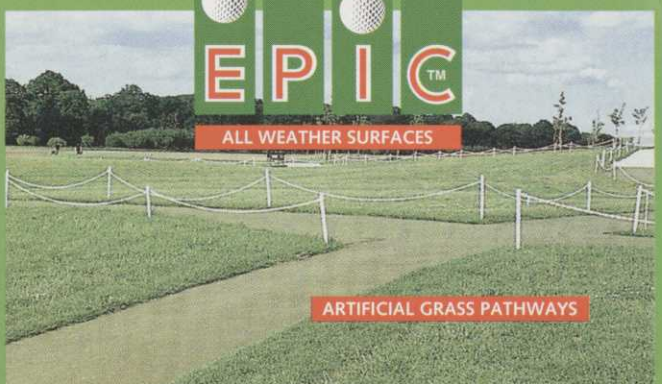
The standard tipping cargo box has a capacity of 876kg, and towing capacity at the rear hitch is 680kg.

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.









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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 either 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'.



The Show saw the launch of the Ecosol Aero-Fil System from Ecosolve Ltd. The drill and fill aerator is designed to relieve compaction instantly, penetrate the hardest soils, backfill accurately up to 30cm, improve water infiltration, increase root depth and is gentle on the turf which enables play to resume immediately. Launched at the same time was Ecosol Sportslite, a zeolite soil amendment designed to be used with the Ecosol Aero-fil system's drill and fill.

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.

