BUGS AND ALL THAT - Do they work or don't they?

Stella Rixon follows up her questionaire of last month with an examination of how biologicals can be utilised.

This is my second article following the introduction of the STRI's national survey on use of 'biologicals' (see last month). A questionnaire has been sent to many Clubs around the UK with the aim of studying the exposure of bio-products, how, why and where they are used, what percentage of users have had positive results and where they have failed.

I will discuss the findings in future articles and the results will be made publicly available. In the meantime I'd like to examine how, when and where they might be successfully employed.

Firstly, we should address the use of the word 'they'. There are a number of 'bio' products on the market, referred to in all manner of ways such as biostimulants, microbial inoculants, organic products, bacterial liquids, bio-solubles, microbial composts, etc.

Each formula contains different ingredients, some may contain fertiliser components such as nitrogen and/or organic material, they may have one type of bacteria or a whole host of microbes (bacteria and fungi) and others may not contain any microbes at all.

Therefore, it is very difficult to discuss all these products under the single heading of 'biologicals'. The first step to understanding their possible use is to know WHAT you are using and WHY. For this we need some definitions:-

MICROBIAL INOCULANT vs. BIOSTIMULANT

Microbial Inoculant - contains living microbes (bacteria or fungi), specifically chosen for their beneficial properties, cultured up and put into the product in a stable form (i.e. inactive).

There are a range of formulations on the market but it would be fair to say that most manufactured microbial products contain bacteria as they are generally easier to culture and some species can remain dormant for several years, thereby giving the product a reasonable shelf-life.

Bacillus and Pseudomonas are the most common groups used, chosen for their plant growth promoting activities and as competitors to fungal plant diseases.

A few inoculants contain fungi eg mycorrhiza fungi (discussed later). Another beneficial fungal species - Trichoderma spp. are used quite extensively in horticulture - in both lab, glasshouse and field as they can repel diseases by producing anti fungal agents (no known Trichoderma-specific commercial products available in this industry as yet).

Products may contain a single species of bacteria or fungi or several species. Remember that many subspecies or isolates also exist so one product containing Bacillus subtilis may be different from another containing Bacillus subtilis in the same way as there are several varieties of browntop bent grass, they are all Agrostis capillaris but we have Lance, Heriot, Sefton, etc all with slightly different characteristics.

Attempting to manipulate an existing microbial community in an established soil by introducing new microbes is difficult. Studies using DNA tracers on introduced bacteria have shown that the indigenous population will quite quickly out-compete the newcomers. Nevertheless, in the short-term, ~2-4 weeks on average, it is possible to boost numbers of the desired inoculated microbe(s).

Biostimulant – this could describe anything that boosts bacterial numbers or activity – aeration is a very effective biostimulant!

In terms of products, biostimulant usually refers to those containing organic components such as seaweed, amino acids, composts, yeast extracts, molasses and even simple sugar which are all food for microbes and can increase their numbers.

If this organic material has not been sterilised, eg chicken manure, then it will still contain naturally occurring saprophytic microbes (those that degrade dead organic matter) and therefore actively inoculates the soil too.

If you add a biostimulant to soil, you generally see an increase in microbial numbers, e.g. via a bacteria count, in response to the increase in food supply, but as this extra food is used up, the numbers will drop again unless more is added.

However, remember that a simple increase in microbial numbers may not necessarily be a good thing – a biostimulant can be utilised by many types of microbes – some beneficial, some neutral and some detrimental to plant health.

Many formulations contain both an inoculant and biostimulant eg granular microbial products with an organic base such as seaweed. Some liquid formulations will be sold as two bottles – one containing the microbes and the other a biostimulant such as liquid seaweed/molasses, etc which are designed to be tank-mixed to get rapid reproduction before application.

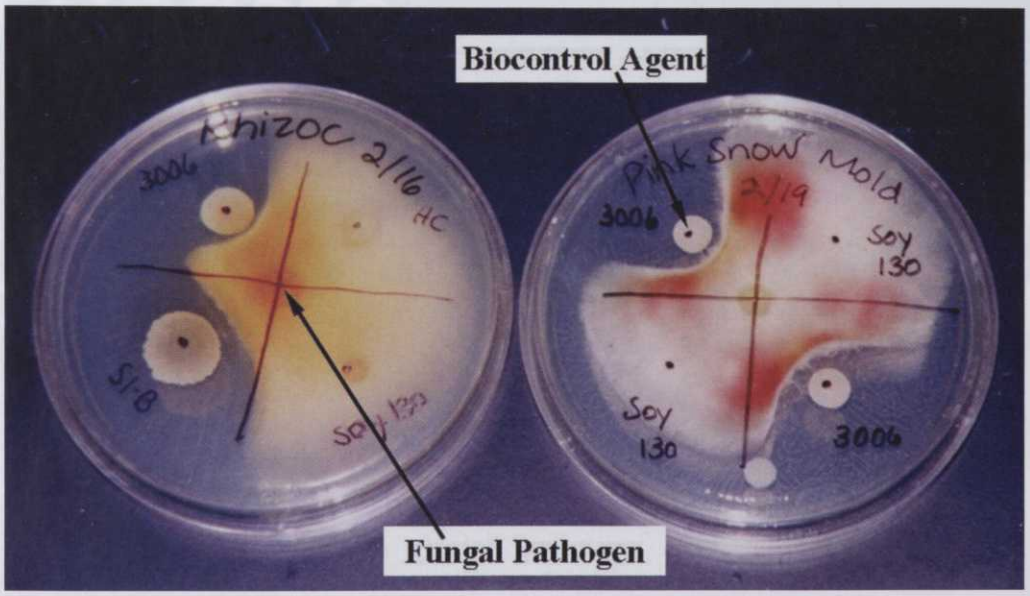
AND ENZYMES...

I should also mention that a few products also use enzymes. Enzymes are not actually living entities – they are protein molecules which are naturally produced by living organisms such as plants, bacteria, human digestive system, etc to catalyse chemical reactions such as breakdown of food.

In the turf industry, enzymes have a potential role in organic matter degradation/composting and thatch breakdown. Although they are non-living they are affected by some of the same factors as microbes such as temperature and pH.

Remember they are protein molecules.... think of them like an egg; just like an egg, if you heat an enzyme its consistency changes and for an enzyme this will mean it is no longer effective – it has to keep a particular shape to be active.

Note your biological washing powder at home will have a recommended maximum temperature! I won't discuss enzymes any further as they are only found in one or two products but keep in mind that if you do come across an enzyme product to trial ask questions such as what pH will it be effective in.



Biocontrol in labatory ▶

Picture kindly supplied by Novozymes

WHAT USE DO 'BIOLOGICALS' HAVE?

The important question is what problems are you trying to solve? You have to be clear on your objective before you can see if and how biological products may fit into that.

Sadly, there is no one 'super-bug' which can resolve all turf problems and it may be that biological products will have no benefit for your particular problems eg poor drainage. Their possible uses can broadly be separated into general turf health and biocontrol as discussed below:-

A.) GENERAL TURF HEALTH

New rootzones

New rootzones are relatively sterile; ie: little microbial content or biological activity, but they are not totally sterile unless they have recently been fumigated with a sterilant such as methyl bromide. Without good microbial activity, these rootzones are prone to three main problems:-

1. Leaching of nutrients –remember the grass plant takes in nitrogen predominantly in the form of nitrates and ammonia. If nitrogen is supplied in a complex form such as long-chain, slow-release molecules then in most instances the plant will not be able to access the potential nutrient available without microbial activity to convert it into a form which the plant can take up.
2. Thatch build-up – despite the turf managers best efforts, thatch and organic matter can quickly accumulate when there is little microbial activity in the soil to break it down.
3. Diseases –such as Take-All Patch (Gauemannomyces graminis) which is an opportunistic fungal pathogen, quick to colonise new, sterile ground but a poor competitor against other microbes. Therefore, this disease tends to decline over time as the microbial community develops, a phenomenon known as Take-All Patch Decline, however it may revive if environmental conditions favor its growth eg a rise in pH.

Therefore, it is the aim of the turf manager to stabilise and mature the rootzone as quickly as possible to avoid the above problems. Over time the rootzone will slowly establish its own microbial community but 'biologicals' can be added to speed up this process.

In this instance, the objective is to cultivate a whole community of beneficial micro-organisms rather than just one or two types and therefore if considering an inoculant - a cocktail of microbes would be more appropriate.

It will also be as important to add some biostimulants i.e. organic material to the rootzone, as a new sand environment is pretty low in microbial food sources in the first few months, until the grass plants start producing organic matter and thatch.

There are two important points to note here:-

Firstly, take care not to overload the system with organic material as the microbes will not be able to degrade it quickly enough and a build-up will occur, resulting in problems such as reduced drainage rates and anaerobic, black-layer soil conditions.

Secondly, when combating Take All Patch it is important not to increase the pH of the rootzone which would actually encourage the disease - some biological/organic products have an alkaline pH.

It is also worth mentioning mycorrhiza fungi again here as they have been found to improve grass establishment on new rootzones - most research concentrates on bent and rye grasses.

Mycorrhizal fungi are slightly different in that they actually attach to plant roots and form a close relationship with almost all plants including ~84% of all grasses. In most cases the relationship is a symbiotic one - that is both parties benefit - the fungal hyphae (fungi equivalent to roots) extend through the soil like a web and channel nutrients and water back to the fungi and into the plant. In return the fungi get sugars from the plant - a vital source of carbon.

There are 1000s of different species of mycorrhiza but those classified as endo-mycorrhiza are the only type to associate with grasses –there would be no benefit at all to putting ectomycorrhiza on turf as they only associate with certain tree species!

MATURE SOIL ROOTZONES

Although this type of rootzone is by far the most important in terms of sports turf area, it is also the field where research has been limited and results have been the most unreliable due to the large variability in soil environments.

Can 'biologicals' benefit an old soil rootzone such as clay-based, push-up golf greens or council football pitches? If the turf suffers from very few problems and has a rootzone with good oxygen levels, a low sand content, some organic matter and a thriving population of native microbes then the answer is probably very little! "If it ain't broke, don't fix it!"

However, it may be that, although the rootzone is mature, it has become unbalanced eg through over-use of pesticides, over-use of organic matter/fertiliser or through repeated sandy top-dressings the surface has become more akin to a new sand rootzone where microbial activity is lower and hence problems such as thatch build-up occur.

In these instances, there may be some benefit to using a 'biological' as part of an integrated programme, but remember - none will resolve a problem with underlying drainage or a poor aeration programme.

The most common problem is build-up of thatch - when the rate at which the grass produces organic matter exceeds the rate at which the microbes can degrade it (or the turf manager can remove it!).

◀ Fusarium close-up

In this instance, adding an organic biostimulant may be useless and could actually worsen the situation as the existing microbes are already over-loaded with organic material/thatch which they require oxygen to degrade.

If oxygen is the limiting factor, then adding more organic material is likely to create anaerobic soil conditions. The best solution for this problem does not lie in a packet but rather in your aeration machinery!

Inoculating the thatch with additional saprophytic microbes can increase the rate at which it is degraded, provided oxygen is not limited and obviously only if the introduced microbes survive and are active for a sufficient period.

If the environment into which you are adding them is not suitable e.g. too acidic (pH of < 5), too cold (<100C) or anaerobic then results will be poor. It should also be noted that some turf managers have experienced worse Fusarium (Microdochium nivale) disease following a late application of saprophytic microbes as the flush of growth resulting from the thatch degradation has promoted soft, lush grass growth which is then more prone to disease-attack.

B.) BIOCONTROL

Biocontrol is basically about using one living organism to control another and in the turf industry the aim is to identify antagonistic microbes which can prevent the growth of disease-causing fungi and then apply that specific microbe, as you would a fungicide, to actively control the spread of a disease. This is quite easy in a laboratory situation as the control agent and fungal pathogen are in ideal conditions for their growth and in close proximity to each other in a Petri dish!

However, in the real world the soil environment varies considerably - it may be unsuitable for the growth of the control agent or simply that conditions are particularly suited to the growth of the disease-causing organism, meaning that disease pressure is high.

Under these circumstances it is difficult to get sufficient numbers of the control agent to blanket cover the soil in order to stop the growth of the disease throughout.

However, for low to medium disease-pressure, biocontrol agents can be very effective, provided they are applied very regularly (every one-two weeks) through the disease period.

They can also be used in rotation with standard chemical fungicides to ensure complete control of the disease thereby avoiding the build up of tolerances within the disease population to a single product.

One such bacterial inoculant has been registered as a pesticide against Dollar Spot in the States and to gain registration the company must have proved its efficacy and safety for use in the environment. Trials are underway in the UK to gain sufficient data to register similar 'biofungicides' but as yet none have been released.

THE ROUTE TO SUCCESS!

As you may have gathered by now, dealing with living organisms is not an exact science and there is still much we have to learn about the world of soil. As research continues, we will understand more about this complex environment and how better to manipulate it to our advantage.

However, in the meantime if you are considering trying a 'biological', first ask yourself the following questions:-

- Q. What do you want to achieve by using such a product? Can you do a trial to actually assess the results with and without?
- Q. What's in your chosen product – does it actually address the problems you have? Check it cannot actually make them worse!
- Q. Is your soil environment suitable for microbes? Overly acid pH (<5) or anaerobic soil conditions are not suitable and require other cultural methods to resolve.
- Q. Are there underlying problems which need addressing first e.g. drainage, improved aeration programme? Remember the majority of microbes beneficial to plant health are aerobic, that is they require oxygen.
- Q. Consider the timing of the application – the soil needs to be warm for microbial activity (>50C).

Don't forget to fill out the questionaire which appeared in the May magazine and return it to Stella; whether you are a user of biological products or not.