Drawing boundaries for biostimulants

Dr Terry Mabbett explores biostimulants and casts his eye over seaweed and compost tea

Behind the growth of biostimulants is a general agreement that the quality of above ground turf biomass is dependent on the health and vigour of the root system. For soil-structural, environmental, turf management and operational reasons, individual grass plants are unable to achieve full root growth potential. If the part you can't see isn't performing as well as it should, then the part you can see is not as good as it could be.

Biostimulant is a relatively new 'buzzword' describing a disparate collection of substances and micro-organisms claiming to stimulate plant growth and enhance turf quality.

Biostimulants are filling gaps left by old-fashioned pesticides and fertilisers as they become increasingly persecuted by EU legislators and shunned by some turf managers.

In a race to place wares on the biostimulant stall many which are clearly not biostimulant in function or effect are sneaking through.

Synthetic fertilisers and pesticides are just about the only things generally excluded from the politically acceptable collection of living and non-living things currently sheltering under the biostimulant umbrella.

What is a biostimulant?

To my mind, a biostimulant is a chemical factor (it all comes down to chemistry) acting directly on and through the plant's metabolism, to enhance plant growth (also development in the case of agricultural crops) for the overall benefit of individual grass plants and turf.

The defining terms of a biostimulant should encompass the capacity to mitigate stress caused by physical factors (e.g. drought or flooding; extremes of temperature; drying winds etc) and biological agents (insect pests, plant pathogens and weeds).

Whether the prefix 'bio' should denote the origins of the prospective biostimulant is another matter.

ABOVE: The quality of above ground turf biomass is dependent on the health and vigour of the root system. Healthy soil core with a strong root mass shown here and **MAIN ABOVE**: Good visual and play experience is essentially dependent on the health and vigour of that part of the sward you cannot see *(Pictures courtesy Syngenta)* **RIGHT**: Underperformance of turf above ground is a strong indicator of problems below ground.

Not in doubt is entry into the plant to deliver the effect, and not from an external position in the root zone or on the leaf surface.

In the absence of boundaries, the term biostimulant can be used to describe and justify just about anything and everything, including essential plant nutrients and even water which clearly stimulates grass growth during periods of drought.

Indeed a quick review of commercial products marketed as biostimulants reveals an 'all things to all men' collection of non-living (physical and chemical) and living (biological) things. These are plant hormones, enzymes, vitamins, yeasts and other 'friendly' fungi, nitrogen fixing bacteria, soil conditioners, amino acids, humic acids, fulvic acids, minerals, plant nutrients, trace elements, activated nutrients, growth simulators, chelates and carbon rich organics.

Seaweed and compost tea

Meaningful discussion on biostimulants clearly requires setting of boundaries and therefore deciding what's in and what's out. This can only be done by taking a closer look at prospective substances to see if they conform, pass the test and warrant that increasingly sought after and commercially valuable label.

What sort of active ingredients make a true biostimulant? A logical answer falls at the first hurdle because there are no generally accepted boundaries in this new, man-made collection of biological actives – it's still a grey area and open to individual interpretation.

Discussions around seaweed extract and compost tea, perhaps the two best known compositions, and containing many ingredients and actives some of which are biostimulants, best illustrates the non-definitive nature of the debate.

Seaweed is an alga containing significant amounts of alginic acid, highly beneficial substance which aids soil crumb formation which is clearly beneficial but not a direct biological property. Seaweed also contains plant hormones including auxin-like compounds and gibberellins. These appear to fit the bill as biostimulants but as a later focus shows these are actually plant growth regulators. Muddying the water auxin-like compounds found in seaweed but which are completely different to indolyl-acetic acid (IAA). Unlike natural and classical plant produced auxin (IAA) which stimulates shoot growth and inhibits root growth, these novel actives stimulate both shoot and root growth.

Compost tea is rich in nutrients. If you consider compost tea in its entirety to be a biostimulant then should you differentiate between its nutrients on the basis of origin? Some will have been an integral part of the plant tissue and released during decomposition, while others originating from fertiliser applications could have remained on the surface of the plant (root zone or leaves) as a fertiliser residue.

Compost tea is rich in microbes – bacteria, fungi, protozoa and nematodes – used as 'friendly fire' against pests, pathogens and diseases when compost tea is applied as a foliar spray. The effect

is biological but is directed against malign microbes and not via the plant's metabolism, and therefore not the action of a biostimulant.

But chemicals in compost tea which can enter plant to deliver a direct growth response will satisfy the criteria of a biostimulant. Compost tea contains humic substances, a general name covering a wide range of chemicals, such as fulvic acids, with their origins in the decomposition of plant and animal matter into humus. Larger humate molecules play an important role in soil crumb formation, an important property and function but not those of a true biostimulant. On the other hand, small molecules like humic acids and fulvic acids are thought to be vehicles and carriers of essential plant nutrients into the roots and as such are model biostimulants. Classic example is biostimulants applied in the run-up to winter, to enhance the availability and utilisation of tissue strengthening nutrients like potassium and calcium and the 'greening' benefits of iron.

Setting boundaries for biostimulants

In the absence of any formal boundaries the following is my take on the status of several key groups of factors which appear to be key and central to the biostimulant debate.

Plant hormones

Plant hormones immediately spring to mind when canvassing for the biostimulant or its 'bio' and 'stimulation' components. Plant hormones are used in agriculture and horticulture as plant growth regulators, targeted at plant development – fruiting, flowering and bulb initiation. But that dimension doesn't apply to turf grasses which are not expected to or required to flower and set seed.

Plants generally contain optimum concentrations of individual plant hormones which are in balance. Any turf treatment which pushes a plant hormone over its correct level could have an over-stimulatory effect. This may occur through direct effect of the hormone on its target and function (e.g. promotion of cell division or cell elongation), or an indirect effect due to creation of imbalance with other plant hormones. Even under normal conditions a plant is not all things to all plant organs. Natural plant auxins stimulate growth of stems and shoots but at the same concentration will inhibit root growth.

Perhaps more pertinent and practical is the effect of environmental conditions on the production and behaviour of natural plant hormones. For instance, production of cytokinin in roots and its transport to shoots is known to be inhibited by flooding, drought and high temperature. Provided other hormones are maintained at correct levels, turf stressed by these factors could benefit from cytokinin treatments. In this case any positive response would qualify as biostimulation.

Clouding the issue is North American research showing effects obtained may depend on turf grass species. Application of gibberellic acid to Bermuda grass (Cynodon dactylon) swards during cool fall (autumn) conditions provided a

TOP: Biostimulants can play a vital role in keeping grass green and 'mean' during the harsh winter months.

SECOND TOP: Good-looking and playing greens in February, perhaps the 'leanest' month of the year for managed turf. Measured use of biostimulants will have played an important part in coming through winter in this condition.

RIGHT ABOVE: Seaweed extract is a 'treasure trove' of beneficial ingredients and actives including biostimulants

RIGHT BELOW: Clovers (white clover and bird's foot trefoil shown here) possess powerful nitrogen fixing properties via symbiotic relationships with nodule-forming Rhizobium bacteria. However, their weed status in managed turf far outweighs any biostimulant boost from the nitrate thus produced

very positive growth effect, although the same treatment applied to St Augustine grass (Stenotaphrum secundatum) under identical conditions had a negative and even toxic effect.

'Friendly' fungi and bacteria

Should any living organism claiming to boost and benefit grass growth be called a biostimulant? That will depend on whether action is direct (i.e. via the grass plant metabolism) or indirect, e.g. through the suppression of other potentially pathogenic microbes. Trichoderma fungi may antagonise Microdochium nivale (causal pathogen of Fusarium patch) to suppress the disease but are not acting directly through the plant.

Nitrogen fixing bacteria (Rhizobium) colonising clover roots conform more closely to a biostimulant model. By the same token mycorrhizal fungi in association with grass roots and especially endomycorrizal fungi are biostimulants.

Clovers are important beneficial components of agricultural grass swards but overall effect on turf is negative. Biostimulation of white clover (Trifolium repens) or bird's foot trefoil (Lotus corniculatus) prostrate, creeping and damaging weeds of professional turf, particularly during periods of moisture stress, far outweighs any marginal benefits of nitrogen containing compounds 'leaking' into the root zone or nitrate becoming available when clover plant material decomposes in situ.

Pesticide turned biostimulant

Pesticide compendiums are perhaps the last place you would look for a biostimulant but tucked away in the many thousands of commercial products developed over the last half century is at least one fungicide which clearly has biostimulant properties and model ones too.

Fosetyl-aluminium described as a phosphonate (a derivative of phosphorous acid) and discovered in the 1970's was developed as a foliar applied systemically acting fungicide to specifically control Oomycete fungi like Phytophthora and Pythium. These highly aggressive plant pathogens have since been grouped with the algae and are re-branded as fungus-like pathogens.

Fosetyl-aluminium caused confusion from the start because it provided excellent control of some species (e.g. Phytophthora fragariae causing red core of strawberry) but did virtually nothing against others such as Phytophthora infestans the causal pathogen of late blight of potato.

Scientists eventually discovered that fosetyl-aluminium was not a classic fungicide acting entirely and directly against the pathogen.

A significant part of its perceived 'fungicidal' activity was achieved by triggering an anti-fungal response in the plant host tissues.

On this basis fosetyl-aluminium has '5-star' biostimulant status, even though commercial products containing the active ingredient have approval for use as fungicides and are described as such. There is nothing 'cut and dried' or 'black and white' about biostimulants.

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1. Rhizobium bacteria form a symbiotic relationship with clover, but which family of plants?

2. What group of plants contain alginic acid

3. To which group of plant chemicals does cytokinin belong?

4. From which of these soil fractions is fulvic acid derived?

5. Which of the following fungi is known to antagonise Microdochium nivale and suppress Fusarium patch disease?

6. Which fungicide is known to act by triggering an anti-fungal response in the host plant under attack?

7. Which of these grass species is used for managed turf in the tropics and sub tropics?

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TOP. White clover is an important component species of agricultural grass swards but a highly competitive and seriously damaging weed of managed turf

SECOND TOP. Bird's foot trefoil is an important component species of agricultural grass swards but a highly competitive and seriously damaging weed of managed turf

INSET LEFT. Research with sub-tropical and tropical turf grasses showed the response and benefit from treatment with plant hormone (gibberellic acid) varied markedly with turf grass species

LEFT & BELOW. Trichoderma and other antagonistic fungi may help stall early infection with Microdochium nivale (left), and subsequently ameliorate the amount damage caused by Fusarium patch disease (below). The antagonistic fungus is this context is a biological control agent and not a biostimulant *(Picture courtesy Syngenta).*