



MAXWELL



Sea ACTION SEAWEED



FOR TURF & ORNAMENTALS

ORGANIC GROWTH ENHANCER

▶ Understanding Seaweed

Algae are a diverse range of aquatic plants divided by size into two groups:

- 1 **Microalgae** – microscopic single cell organisms found in a range of sizes measured in microns.
- 2 **Macroalgae** – large multicellular organisms without true stems and roots, commonly referred to as seaweeds.

Ascophyllum nodosum (knotted wrack), is a common species of multicellular brown macroalgae, varying in colour from olive-green to olive-brown.

Ascophyllum nodosum grows in the northern Atlantic Ocean, usually in the littoral zone. This is an area of the sea close to shore including the intertidal zone. As a result, *Ascophyllum nodosum* has evolved effective metabolic processes to survive the stresses resulting from repeated exposure and submersion, as the tides advance and withdraw seawater back and forth. This trait combined with the large amounts of minerals and trace elements absorbed from seawater, has resulted in this species being used by people as an organic growth enhancer for centuries.

Today *Ascophyllum nodosum* is widely used across a range of agricultural and horticultural sectors, with modern scientific studies and analytical techniques, revealing the compounds and mechanisms seaweeds possess, and which consistently promote plant growth responses; both directly and indirectly at a cellular and genetic level.

Scientific studies have identified seaweed extracts to have several measurable beneficial effects on plant growth;

- Early seed germination.
- Enhanced quality of vegetative growth.
- Elevated resistance to biotic (organism induced) stress and abiotic (environmental) stress.
- Increased post-harvest shelf life.

Ascophyllum nodosum is also directly beneficial to soil structure and stimulates fungi and bacteria that are vital to soil health. Consequently, seaweed is categorised as a biostimulant.

“Biostimulants work to regulate and modify physiological activities within a plant so that it can: use nutrients more efficiently; tolerate stressful conditions; and have the capacity to combat pests and disease.”
(du Jardin, 2015).

A Product of its Environment

Due to repeated exposure to UV light, desiccation and temperature fluctuations, *Ascophyllum nodosum* has evolved to thrive in the extreme conditions of the intertidal zone. This causes the macroalgae to generate plant beneficial bioactive compounds.

These compounds mimic and elicit the same response as certain plant hormones (also known as phytohormones). Substances which act like or mimic a phytohormone are referred to as phytohormone analogues.

Due to these harsh conditions *Ascophyllum nodosum* is generally slow growing and over time it accumulates the bioactive compounds which make it an effective plant biostimulant.

“This [intertidal] habitat exposes the seaweed to stresses that stimulate the production of phytohormone-like compounds and defensive bioactive components”
(Zamani et al, 2013).

Bioactive
adjective

1. (of a substance) having a biological effect.

▶ Seaweed Extraction

The method of processing and extraction is a crucial factor, for maximising the plant beneficial bioactive compounds of seaweed.

The purpose of extraction is to release these compounds from inside the cells of the seaweed by bursting the cell walls.

- Most plant beneficial bioactive compounds found in seaweeds are hydrophilic, which is to say they favour interacting and bonding with water.
- Many of these substances are also classified as thermolabile - this is a term used to describe a substance (such as an enzyme) subject to destruction of loss of characteristics by moderate heat. In the case of seaweed 40°C is the temperature where many of these compounds begin to degrade.

Consequently, the composition and concentration of plant beneficial bioactive compounds in a seaweed extract, not only depends on the stresses the seaweed has experienced in its environment, but also the processes it goes through from harvest through to extraction.

Methods of Extraction



Chemical

The use of acids and alkaline solvents.



Heat

Boiling or microwave assisted.



Cold Pressing

Immersion in cold water, combined with pressure.

Each of the above methods will produce an extract with varying characteristics and concentrations of beneficial compounds and elements.

The method which produces the highest concentration of plant beneficial bioactive compounds, is cold pressing.



Cold Pressing



SeaAction bioactive compounds are retained...



Alkali or Heat extract



...whilst formulations that are extracted with heat or harsh chemicals lose some of these beneficial properties.

SeaAction Seaweed Extraction

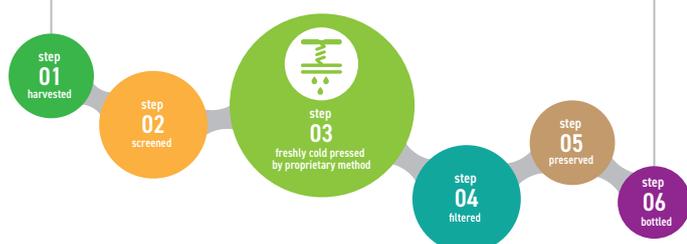
SeaAction seaweed is made from sustainably-sourced *Ascophyllum nodosum*, which is immediately wet processed at source, via a proprietary fresh cold press extraction method and without the use of harsh chemicals or heat.

This process is specifically engineered to extract and maintain the bioactive components from inside the cells of the algae.

Cold pressed seaweeds may be extracted in various ways...

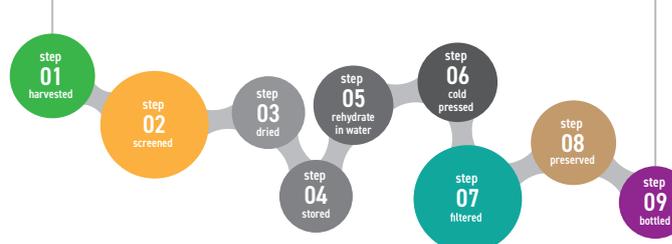
Fresh cold pressed - SeaAction Seaweed

06 step process | SeaAction Seaweed



Other cold pressed Seaweeds

09 step process | Other cold pressed Seaweed



SeaAction Seaweed Characteristics

Appearance

SeaAction Seaweed is light brown to green in colour and has a pleasant smelling odour, with a natural pH range of 4-6. These characteristics reflect the quality of the extract and the proprietary cold pressed extraction process.

Dark liquids which smell more like chemicals, have an unnaturally high pH, high concentration of potassium, high soluble solids (i.e. 30%) and a black hue all of which indicate the use of alkaline extraction, resulting in a product with an unnaturally high pH. Consequently, these products will be lacking in some beneficial substances, such as Vitamin B12 (a source of cobalt) which is sensitive to alkaline conditions.

Natural Nutrition

Some seaweed products are unnaturally high in plant macronutrients such as nitrogen or potassium. This indicates macronutrients have been supplemented into the formulation, or are present at higher levels due to a chemical extraction process.

The low percentage of macronutrients in SeaAction Seaweed is deliberate. SeaAction Seaweed is formulated in its raw form, without additional nutritional supplementation. SeaAction stands on its own merits as a superior extract, allowing managers the flexibility to control nutritional inputs and be confident in precisely what compounds are eliciting a visual effect.

Knowledge Leads to Informed and Skilful Use

By understanding what the plant beneficial bioactive compounds in seaweed are, what they do, how they do it, and where in the plant/soil ecosystem they operate: managers arm themselves with a greater level of insight when making decisions.

For example, it is accepted and understood that applying nitrogen when conditions actively favour *Microdochium nivale* (Microdochium Patch Disease) is likely to weaken the plant and exacerbate the disease.

Similarly, applying biostimulants such as carbon energy or seaweed, when conditions are in favour of fungal pathogens, runs the risk of stimulating those diseases.

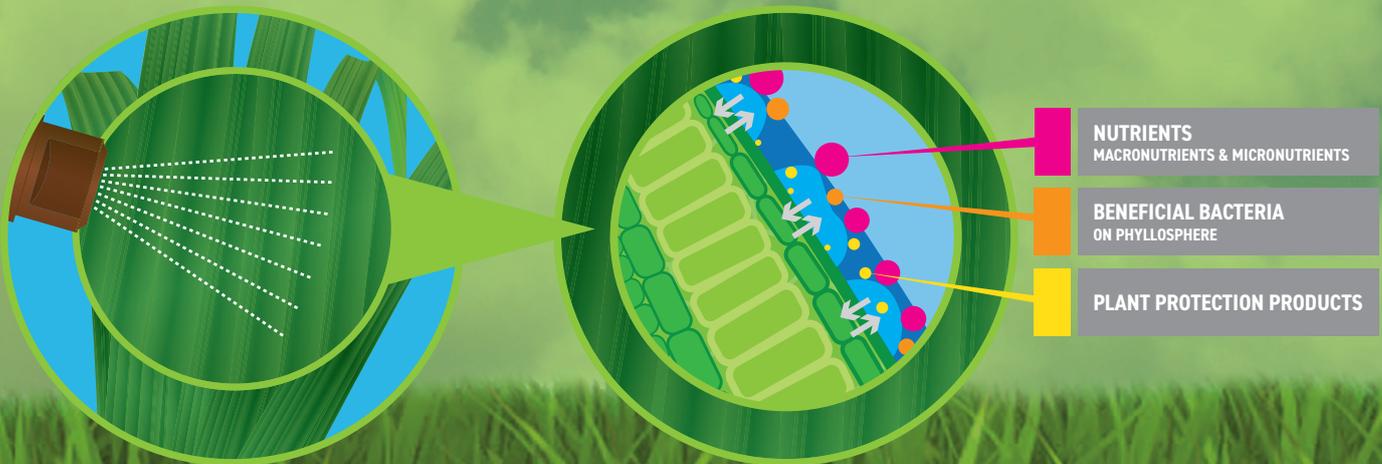
However, if applied ahead of conditions which favour the disease, the plant's natural defence systems and associated beneficial microorganisms, get a head start in readiness of any upcoming disease pressure.

In addition, seaweed helps plants to better cope with abiotic stress which can prevent diseases seeking to take advantage of stressed plants such as, *Colletotrichum cereal* (Anthracnose Leaf Disease).

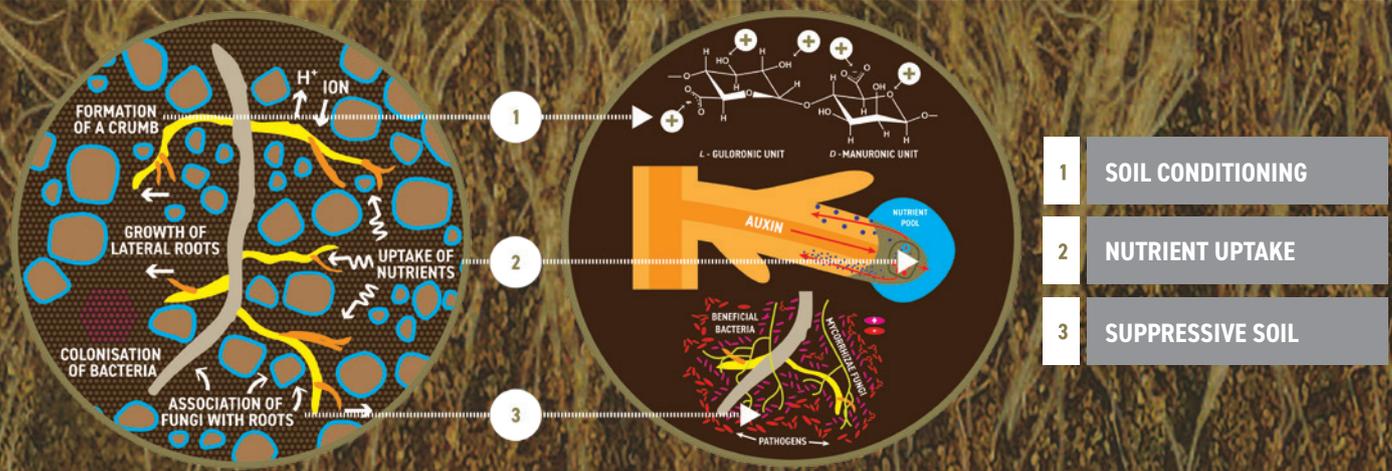
In these circumstances, by appreciating the details of an input and being mindful of prevailing conditions, managers can actively assist plants in combatting the stresses they are exposed to, by equipping them with resources to successfully fight their own battles.

► How The Bioactive Compounds In *Ascophyllum nodosum* Benefit Plants

Activity	Bioactive	Benefit
Phyllosphere (leaf and stem surface)		
External abiotic and biotic stresses impact plant function reducing overall health and appearance.	<ul style="list-style-type: none"> • Abscisic acid (ABA). • Cytokinin's. • Gibberellic acids. • Glycine betaine. 	Combat stress.
Drive cell organelle function and longevity.	<ul style="list-style-type: none"> • Cytokinin's. 	Maintain aesthetics.
Enhance uptake of nutrition, PPP's and feed defence promoting beneficial bacteria.	<ul style="list-style-type: none"> • Alginates. 	Enhanced uptake efficiency. Increased resistance to biotic stress.
Inside The Plant		
Gene activation leading to creation of plant metabolic proteins.	<ul style="list-style-type: none"> • Glycine betaine (Trimethylglycine). • Mannitol. 	Prevent cellular damage.
	<ul style="list-style-type: none"> • Auxins. • Coblamine (Vitamin B12). • Cytokinin's. • Mannitol. 	Drive cellular growth.
	<ul style="list-style-type: none"> • Mannitol. 	Combat plant stress.
	<ul style="list-style-type: none"> • Mannitol. • Coblamine. 	Nutrient assimilation.
	<ul style="list-style-type: none"> • Laminarin. • Glycine betaine (Trimethylglycine). 	Activation of defence signalling pathways.
Rhizosphere (region of soil directly influenced by root secretions and associated soil microorganisms)		
Enhancement of soil structure and nutrient uptake.	<ul style="list-style-type: none"> • Alginates. 	Condition soil.
	<ul style="list-style-type: none"> • Alginates. • Kahydrin. • Auxin. • Abscisic acid (ABA). • Gibberellic acids. 	Root growth activity and nutrient uptake.
Pathogenic defence.	<ul style="list-style-type: none"> • Alginates. • Fucoidans/fucans. • Laminarin. • Iodine. 	Promote beneficial microorganisms to suppress pathogens.



Seaweed forms a micro-colloid film on the leaf surface which allows greater absorption of nutrients and plant protection products, whilst supporting microbes.



Plant Beneficial Bioactive Compounds Within SeaAction Seaweed

Phytohormones and Phytohormone Analogues	Component	Effect
<p>Phytohormones, also known as plant growth substances, are chemicals produced in plants which;</p> <ul style="list-style-type: none"> Regulate essential cell processes. Perceive and communicate correct cell response to their microenvironment for; repair, immunity and homeostasis (stable optimal function). Determine formation of leaves, stems, roots, fruits and flowers. 	Glycine betaine (Trimethylglycine).	<ul style="list-style-type: none"> Key components for plant development and growth. Governs leaf, shoot and root growth via stimulation of cell elongation and loosening of cell walls. Induces wound response via cell differentiation and regeneration. Promotes branching of roots and shoots via transport mechanisms and signalling.
	Cytokinin's.	<ul style="list-style-type: none"> Regulate all aspects of plant growth including cell growth and division, shoot initiation. Induce resistance to disease pathogens. Facilitates nutrient uptake. Key signal produced by photosynthetic tissues to maintain chloroplasts and prevent senescence. Govern responses to light. Levels must be balanced to produce optimal plant growth response.
	Absciscic acid (ABA).	<ul style="list-style-type: none"> Signals protective responses to abiotic stress such as governing growth response in relation to cold, or regulating stomata guard cell function to prevent water loss. Shown to maintain root growth in times of limited water availability.
	Gibberellic acids.	<ul style="list-style-type: none"> Stimulates cell elongation, leading to growth of leaves and roots in response to light. Required for seed germination and seedling maturity.

Biochemical Defence and Nutrition	Component	Effect
<p>Polysaccharides</p> <p>Seaweed extracts contain high concentrations of long sugar chains referred to as polysaccharides. <i>Ascophyllum nodosum</i> contains a range of soluble polysaccharides only found in brown seaweed extracts.</p> <p>These substances provide energy, chelate nutrients and play a key role in plant defence.</p> <p><i>“The presence of polysaccharides indirectly activate defence signalling pathways within the plant. This leads to the creation of antimicrobial plant proteins and enzymes that can stop pathogens getting a foothold”</i> (Vera et al, 2011).</p>	Alginates.	<ul style="list-style-type: none"> Form microcolloid films on the surface of plants which complex nutrients and plant protection products (PPP's) enhancing absorption. Links of guluronic acid and mannuronic acid which bind to metal ions in the soil making them more plant available. Gelling agents which promote crumb structure of soils, improving water holding capacity and infiltration.
	Fucoidans/ fucans.	<ul style="list-style-type: none"> Sulphur-containing polysaccharides which stimulate the growth of particular beneficial microbes important in sulphur cycling in the soil.
	Laminarin.	<ul style="list-style-type: none"> A source of glucose providing carbon-based energy which underpins the soil ecosystem and plant function. Known to activate plant defence mechanisms.
<p>Other Bioactive Compounds</p> <p>As well as polysaccharides seaweeds contain other compounds which benefit biochemical defence and nutrition.</p>	Amino acids.	<ul style="list-style-type: none"> Used as metabolic short cuts when synthesising proteins and activating phytohormones at critical stages of growth. Fundamental to chlorophyll production leading to increase photosynthesis. Assist in stress tolerance by regulating physiological plant responses.
	Coblamine (Vitamin B12).	<ul style="list-style-type: none"> Natural chelate of cobalt produced by bacteria which plants and animals can only access via supplementation. Seaweed is a host to the bacteria which produce coblamine, thereby providing it with a high concentration. Cobalt is a key component of plant enzymes which play a vital role in growth and healthy metabolic function. Free living bacteria in the soil require cobalt to fix nitrogen.
	Glycine betaine (Trimethylglycine).	<ul style="list-style-type: none"> Fortifies cell membranes against abiotic stress such as salt, heat and frost. An osmolyte regulating water retention thereby, delaying wilting and tolerance to drought.
	Iodine.	<ul style="list-style-type: none"> <i>“Iodine influences the interaction with beneficial microbes and helps with the biofortification of crops”</i> (Medrano-Macias, 2016).
	Kahydrin.	<ul style="list-style-type: none"> A vitamin K1 derivative which induces the release of hydrogen ions out of plant roots into the rhizosphere. This displaces nutrient ions attached to soil aggregates, making them available for uptake by the plant.
	Mannitol.	<ul style="list-style-type: none"> A sugar alcohol which acts as an osmolyte and antioxidant assisting in tolerance to the abiotic stresses; drought, salt and cold. Coenzyme regulator assisting healthy metabolic function. Provides a chelation partner for boron, which is essential for cell wall synthesis and structural integrity.

SeaAction Will...

Up-regulate leaf, stem and root growth, branching and tillering.

Maintain efficient plant metabolism and healthy cell function.

Enhance seed germination and seedling maturity.

Elicit plant defense responses against biotic stresses such as; bacteria, viruses, fungi, and parasites.

Stimulate root based nutrient exchange.

Chelate nutrition and PPP'S via microcolloid leaf films.

Feed beneficial microbes on the leaf and in the soil.

Condition soils, improving crumb structure and water management.

Provide chelated sources of micronutrients and plant beneficial compounds; boron (mannitol), cobalt (vitamin B12), iodine.

Supply a balanced source of amino acids.



SeaAction Why...

- Our exclusive fresh cold-press manufacturing process extracts the maximum quantity of bioactive compounds such as auxin and vitamin B12, without any degradation that results from heat or chemical extraction.
- Naturally low pH promotes easy tank mixing.
- Contains high levels of plant essential compounds such as iodine.
- Zero added NPK, facilitating managers with maximum control of nutritional inputs.
- Sustainably and responsibly sourced.
- Produced without creating additional waste by-products.

SeaAction How...

SeaAction Seaweed can be applied to turf grass and plants every 2-4 weeks throughout the year and particularly during the spring and summer.

SeaAction Seaweed is best applied as a foliar treatment.

Application Rates

Application Type	Applicator	Application Rate	Water Volume (L/ha)	Pack Coverage (m ²)
Remedial Application	Boom Sprayer	20 L/ha	300-400	5000-2500
	Knapsack	2 ml/m ²		
Maintenance Application	Boom Sprayer	10 L/ha		
	Knapsack	1 ml/m ²		

SeaAction When...

Apply SeaAction proactively before a period of high disease pressure to prime plant defence, whilst avoiding application when a pathogen is established to circumvent issues with stimulating disease.

Application Period

J	F	M	A	M	J	J	A	S	O	N	D
•	•	•	•	•	•	•	•	•	•	•	•



Tip: Optimise the uptake of nutrients by applying liquid sprays in the early morning when the leaf stomata are open.



Sustainably sourced from the British Isles





Mike Cartwright, Highcliffe Castle Golf Course has been applying a combination of Green Solutions liquid fertilisers, HumiMax biostimulant and SeaAction Liquid Seaweed to his greens and tees.

“ Together these products perform well, and we are very happy with the results we get; the greens have great sward health and vigour which lasts for longer. In addition to the physical benefits to the turf, there are also a number of other advantages including; less hours spent applying the products as they can be applied all together, a reduction in nutrients applied annually and less room is taken up storing products, all this put together provides considerable cost-savings, and less wear on machinery. ”

Perfect Tank Mix Partners



HumiMax



BULLET



BioMass SUGAR



SolControl



GreenSOLUTIONS

Fully compatible with a broad range of Maxwell liquid nutrition, soluble nutrition and complimentary biostimulants.



Maxwell Amenity Ltd, Allscott Park, Allscott, Telford, TF6 5DY