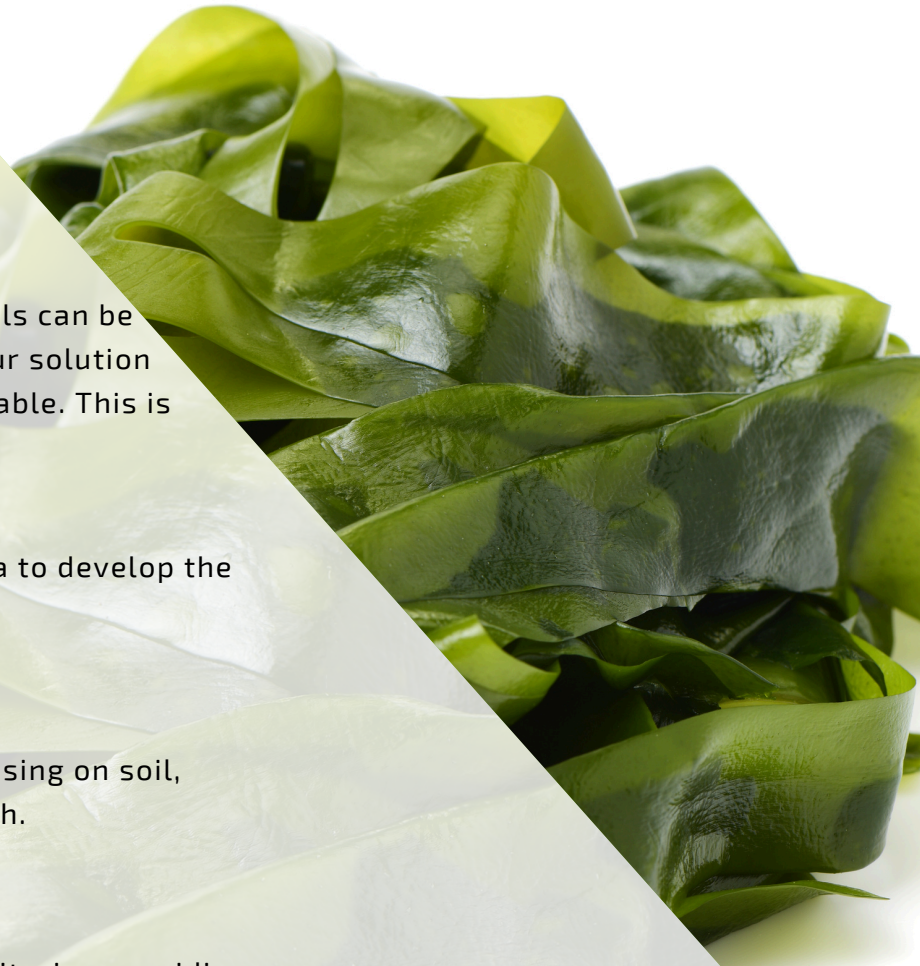

BIOHUB
SOLUTIONS
Solutions for today.
Benefits for generations.
BioTech Series
Kelps
Where science meets sustainability, and your farm's potential meets our passion.

How We Help



We know that understanding biologicals can be both confusing and overwhelming. Your solution should simple, measurable, and profitable. This is why we developed the **BioPlan**.

Focus on testing and data to develop the best solution.

Integrated solutions focusing on soil, nutrition, and plant health.

Simple crop and soil monitoring providing solution accountability.

Simple solutions providing agronomic, environmental, and economic returns.

The BioTech Series has been designed to answer some of the more technical questions you may have about our solutions. Or provide some extra information for inquisitive minds wanting to know a little more about biological strategies. When digesting the information in this booklet and others in our series, remember there is no silver bullet. No solution is the same. No challenge is the same. What is the same are the processes that BioHub team members and trained business partners follow under the BioPlan to try to formulate an integrated solution. This integrated solution can involve nutrition, plant health, biologicals, or soil ameliorants.

At BioHub Solutions, we fuse cutting-edge science and data with the wisdom of nature to deliver pioneering biological solutions to the agricultural sector. Our Australian heritage drives us to innovate for the unique challenges faced by local and global farmers, ensuring our products not only boost your bottom line but also safeguard the environment.

Take the guesswork out of biologicals by contacting one of our team or authorised business partners.

www.biohubsolutions.com.au

What Are Kelps?

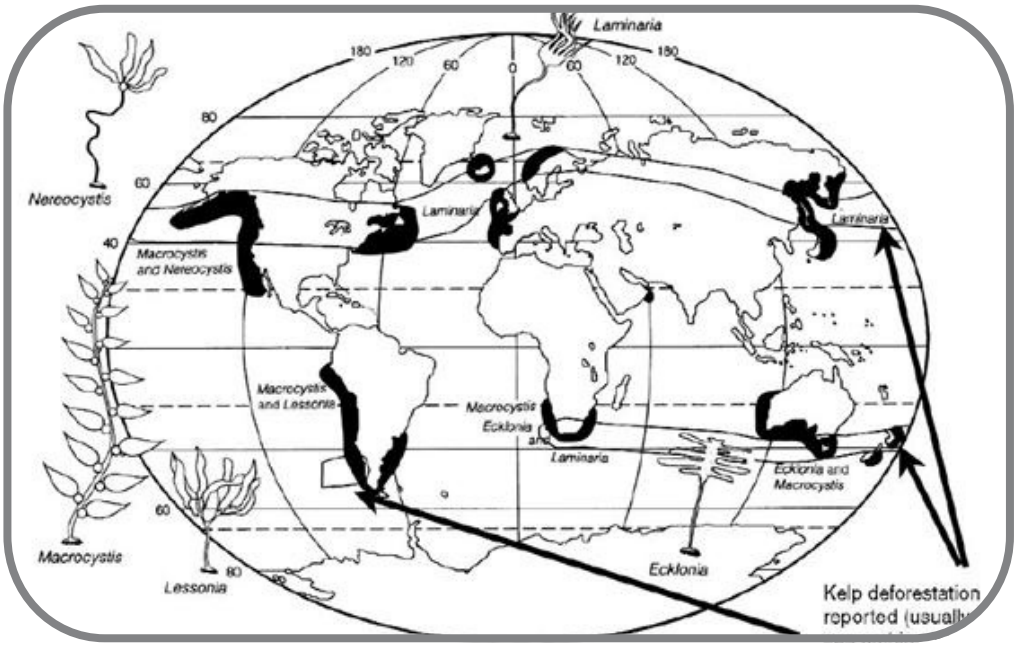
Use of liquid seaweed extracts in Australia began in the 1970's. The first Australian company to manufacture liquid seaweed extract (Durvillaea potatorum) was registered in 1970. Since that time seaweeds continue to be manufactured locally and also imported (Ascophyllum nodosum and Ecklonia maxima) with numerous extraction methods.

Kelps are multicellular, macroscopic marine algae that grown in many coastal ecosystems globally. Approximately 10,000 kelp species exist, and they can be classified into three phyla.

- Green (Chlorophyta)
- Brown (Phaeophyta/Ochrophyta)
- Red (Rhodophyta).

The brown kelp is the second most available of the group, with an estimated 2,000 species, however they are the most utilised group in agriculture. Annually about 15 million metric tonnes of kelp extracts (liquid and powder) are manufactured each year and most of these are used as biostimulants in agriculture.

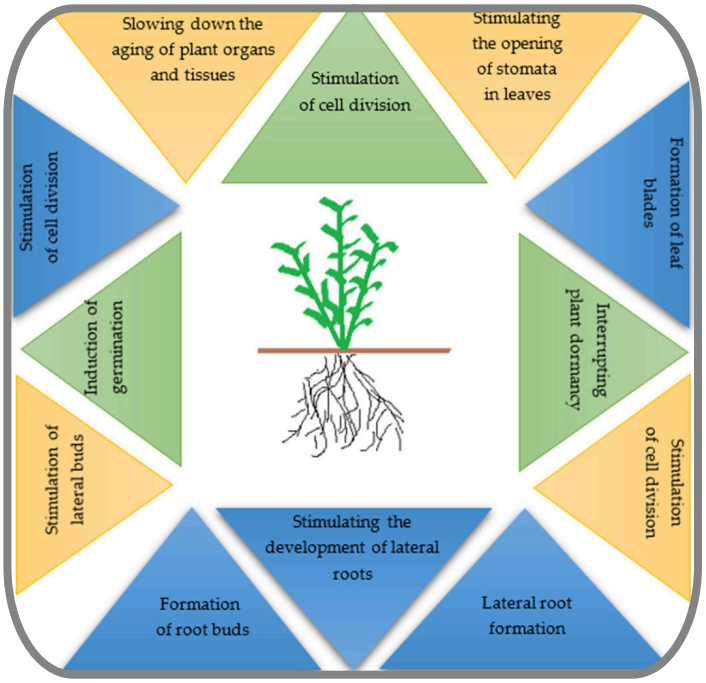
The diagram below shows the global distribution of kelp forests and the dominant genera (Raffaelli & Hawkins 1996)



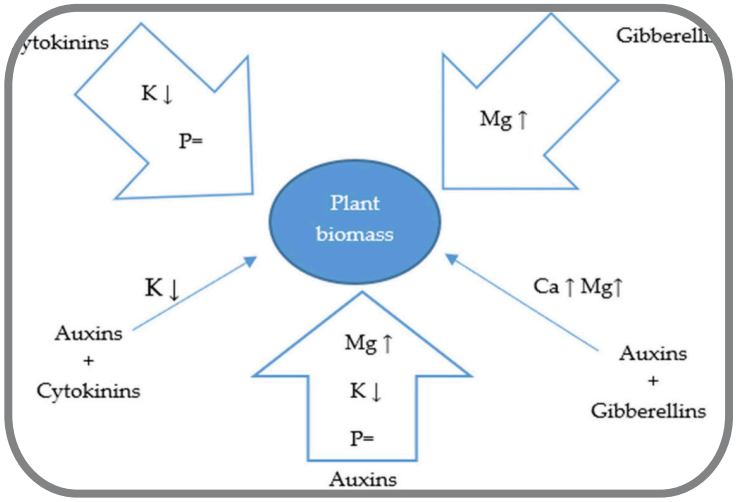
What Are Contained in Kelps?

Plant growth regulators, contained in kelps, are naturally occurring organic molecules which are capable of influencing physiological processes at low concentrations. These processes may include growth, development, and differentiation.

Functions of phytohormones. Auxins (blue); cytokinins (yellow); and gibberellins (green).



The influence of phytohormones on the chemical composition of biomass: increase ↑, decrease ↓, no change =.



Auxins

Auxins are synthesized mainly in young leaves, leaf primordia, and in developing seeds. Auxin transport is from cell to cell and transport to the root system involves phloem.Auxins, originating from young shoots, play an essential role in various aspects of root growth, differentiation, and development. These are summarised below (Davies 2010).

Function	Mode of Action
Cell enlargement	Auxins stimulate cell enlargement and stem growth.
Cell division	Auxins stimulate cell division in the cambion and work inconjunction with cytokinins.
Root initiation	High concentrations of auxins help root growth by stimulating cell enlargement at the root tip.
Root initiation	Auxins stimulate root initiation on stem cuttings, the development of branch roots, and the differentiation of roots.
Vascular tissue differentiation	Auxins stimulate differentiation of xylem and phloem vessels.
Apical dominance	The auxin supply from the apical bud represses the growth of lateral buds.
Tropistic responses	Auxins regulate the movement of roots and shoots towards gravity and light.
Leaf senescence	Auxins delay leaf senescence. Leaf senescence is characterised by the loss of chlorophyll, leaf yellowing, and degradation of proteins.
Assimilate partitioning	Assimilate movement is enhanced towards an auxin source, probably through the effect of the phloem transport.

The role of auxins has been explained. However, what was not elaborated is that there are two forms of auxins.

- Free. This form is available for immediate uptake and action by the targeted host.
- Bound. Which is held in storage and released over an unspecified period of time.

Free auxins have been established as being the biologically active form of auxin. Only certain hydrolysable conjugates have been shown to be active in auxin bioassays (Woodward & Bartel, 2005; Ludwig-Muller, 2011). The level of the free auxins varies tremendously depending on environmental factors. These can include.

- Seasons
- Currents
- Temperature·
- Salinity
- Nutrients
- UV exposure
- Herbivores
- Age of plants
- Density

Based upon internal research by our supplier and external trials a level of 75 mg free auxins per litre has proven to be the optimal amount for consistent results in the field. This is designed to ensure that each application takes immediate action on the targeted plants with a visible and economic difference.

Function (cont.)	Mode of Action (cont.)
Growth of female parts	Stimulated by auxins. Promotes femaleness in dioecious flowers.
Fruit ripening	Auxins delay fruit ripening.
Leaf and fruit abscission	Auxins may inhibit or promote leaf abscission depending on the timing and position of the source.

Cytokinins

Cytokinins are signalling hormones that play a crucial role in regulating cytokinesis, growth, and development in plants. There are adenine derivatives with an ability to induce cell division in plant tissues. They are mainly synthesised in the root tip, particularly in the root cap cells. From here it is transported throughout the plant through the xylem (mainly) to developing organs with high transpiration rates.In roots they are negative regulators of growth and development, whilst in shoots they promote shoot growth and development. Their roles are summarised below (Davies 2010).

Function	Mode of Action
Cell division	Endogenous cytokinins promote cell division in brown gall tumours on plants. Exogenous applications in the presence of auxins promote cell division in tissue culture.
Growth of lateral buds	Exogenous applications or the rise of cytokinins in transgenic plants containing genes for enhanced cytokinin synthesis may lead to release of lateral buds from apical dominance.
Delayed leaf senescence	Cytokinins delay leaf senescence.
Morphogenesis	Cytokinins induce bud formation in moss and promote shoot initiation in crown gall and tissue culture.
Leaf expansion	Cytokinins promote leaf expansion by promoting cell enlargement. Through this mechanism, the total leaf area is modified to compensate for the extent of root growth since the amount of cytokinins reaching the shoot will reflect the extent of the root system.
Chloroplast development	Application of cytokinins promotes conversion of etioplasts into chloroplasts which may lead to an accumulation of chlorophyll.
Shoot initiation	Promote shoot initiation.

Gibberellins

Gibberellins have been confirmed in kelp extracts during the 2000's. Gibberellins are different to auxins as they promote stem elongation, germination and flowering. Auxins promote the growth of the shoot system. Gibberellins also play no part in apical dominance in flower development. They aid in the control of many aspects of plant physiology including.

- Shoot elongation
- Seed germination
- Fruit and flower maturity
- Seed dormancy
- Gender expression
- Seedless fruit development
- Delay of senescence in leaves and fruit

Proteins, Amino Acids, and Lipids

All kelp extracts contain proteins, amino acids and lipids. The levels are dependent upon the species and the environmental conditions. Levels are generally lower in summer and higher in winter. Lipids regulate the permeability of cellular membranes and the freezing tolerance of plants. Amino acids are responsible for antimicrobial properties in the plant.

Betaines

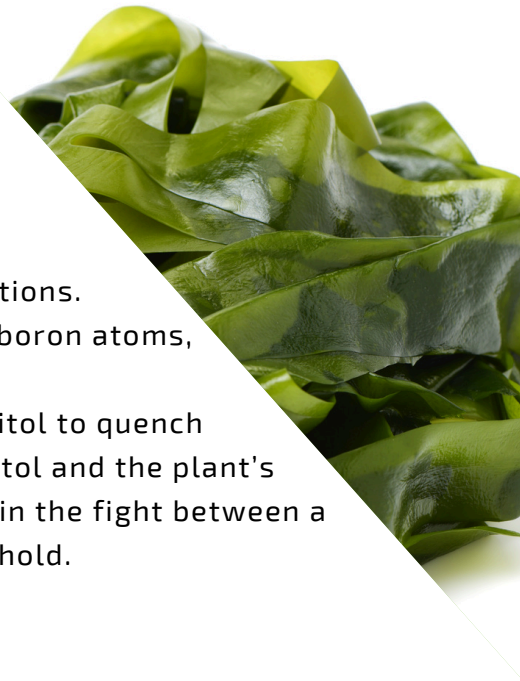
Betaines are known constituents of kelp extracts. They function as a cytoplasmic osmolyte by protecting cells from.

- Osmotic stress
- Drought
- High salinity
- High temperature
- Also slowing down chlorophyll degradation

Mannitol

The sugar alcohol mannitol is found in differing concentrations in kelp extracts. Mannitol is a multifunctional compound and has three main areas of activity.

- Antioxidant. Mannitol is able to 'mop up' reactive oxygen species that create the free radicals that damage plant tissues. The reactive oxygen species are produced in high levels when plants are under abiotic stresses. Therefore, products with higher



mannitol levels are a good choice in stressful growing conditions.

- Boron complexing. Mannitol is able to form a complex with boron atoms, effectively chelating the plant nutrient.
- Signaling in fungal attacks. Pathogenic fungi also use mannitol to quench ROS when attacking the plant. The interplay between mannitol and the plant's enzymes that degrade mannitol is an important interaction in the fight between a crop plant and pathogen that determines if a disease takes hold.

Minerals

Brown and other kelps are rich in macro and micro nutrients, such as calcium, magnesium, potassium, sodium, phosphorus, sulphur, iodine, and iron. It is dependent upon species, growing environment, and timing of harvest as to the levels.

Which Kelp Should I Use?

With so many products available at the moment, choosing which kelp to utilise can be confusing and frustrating. The key is to understand **what the purpose** of the application is and then choose the product best suited to this. Kelps can be utilised for.

- Improving plant performance. Refer to the first section of this document.
- Biostimulant. Helping with improving soil biology numbers.
- Stress mitigation. Helping to reduce the detrimental effects of such events as frost, heat, and waterlogging.
- Nutrition. Kelps contain varying amounts of nutrients that can be utilised by the plant.

	Germination	Root Growth	Growth to Maturity	Stress Mitigation	Fruit Formation
Auxin		✓	✓		✓
Cytokinin			✓	✓	✓
Gibberellin	✓	✓	✓	✓	✓

The table above outlines where auxins, cytokinins, and gibberellins are at their most advantageous in different cropping scenarios. In many of the cases they can be utilised in those boxes not ticked, but they are not the most efficient solution for that challenge.

Always take into account plant health, nutrient strategies and existing soil challenges when utilising any input, including kelps.