



# Using GrowGreen Biofertilisers in Cotton Crops

Grown in over 100 countries cotton is one of the most globally important commercial crops, it is both a food and fibre crop, producing cotton fibre, cottonseed and cottonseed oil. Cottonseed is utilised in the animal feed industry and refined into vegetable oil for use in various food and products. However, the production of cotton crop is faced with major challengers, such as pest control, and maintaining profitability with the extensive farming and labour requirements. In 2015 the world cotton market was estimated at AUD\$108 billion (USD\$77 billion), since then, however, global cotton exports have witnessed a small decline. In the 2017-2018 period, Australia was the sixth largest producer of cotton. Most of the cotton produced in Australia is exported. The Australian cotton industry must maintain product quality in order to remain globally competitive.

## Agricultural Challenges of Cotton Production

The compound annual growth rate of the global cotton market is estimated to be 2% during the forecasted 2019 to 2024 period (*Mogdor Intelligence 2019*). With the expected worldwide population increase the demand on land and agricultural produce will increase, with the farmers needing to produce more in less space.

In the 1950's average cotton yields were 230 kg of lint per hectare; today cotton lint yields regularly reach levels of 780 kgs of lint per hectare, the crop producers around 62% more weight of cotton seed than the fibre (*Bremen Cotton Exchange 2014*). Through the years cotton yields have steadily risen, however, they have undergone several plateau periods where yields have remained static.



The average annual planted area of cotton is 33 million hectares, which produces around 26 million tonnes of lint each year.

## Cotton yields in Australia

**Figure 1**. shows the average yield (combination of cotton seed and lint) in Australia from 1989 to 2016. Surpassing these plateaus is attributed to improvements to crop management and nutrition, better insect control, and the introduction of new varieties. Improvements to crop management are made possible by the development and advancements of high-quality products, such as GrowGreen's comprehensive range of biofertiliser, biostimulant, and organically certified products. Which are microbially active and marine based, packed with growth hormones (*Microbe Plus™ Kelp*, available in an organic formulation) and vital amino acids (*AminoKelp™* and *AminoElite™*, available in organic formulations), which encourage crop growth, improve access to nutrients, and enable a higher stress tolerance of the plant. These products provide greater yields in both quality and quantity, beyond that of a conventional fertiliser.



### Average Cotton yields (lint & cottonseed) in Australia

Figure 1. The yearly average of Australia's cotton lint yield. The data was collected through Cotton Australia (2019)

#### Insecticide Dependence

For conventional cotton farming there is a heavy reliance on chemical fertilisers and pesticides, specifically insecticides, as cotton is susceptible to a wide range of insect pests. In 2006 (Oerke) it was estimated that up to 80% of cotton yield can be lost to pests. Insect pest management is the highest variable cost associated with production of the cotton crop. Although it is only grown on 2.5% of the world's agricultural land, it consumes 16% of all the insecticides. A key aspect to reducing the dependence of cotton production on insecticides is targeting the crop nutrition. Nutrient deficient plants are weak and vulnerable to incidences of plant disease and insect pest attack (Marschner, 1995; Huber and Thompson, 2007). A crop which has a high tolerance to biotic stress, can maintain a high performance in the presence of disease and insect herbivory (Ney et al 2013). The application of nutrients affects the insect crop relationship (Abro et al., 2004). A crop with a good nutrient supply will be able to tolerate the biotic stress of disease and insect herbivory, better than a crop in nutrient deficiency (Marschner, 1995; Huber and Thompson, 2007). GrowGreen's products increase a plant's tolerance to a pest by reducing the amount of energy a crop needs to spend on growth and translocation of nutrients, alleviating the negative effects of abiotic plant stress (Colla et al 2017). GrowGreen provides the crop with a full range of "plant available" macro and micronutrients. Additionally, AminoElite™ and AminoKelp<sup>™</sup> products incorporate silica, which is a natural insecticide, helping to further reduce the cotton crops dependence on chemical insecticides.

The decimation of the bee population from insecticides has brought the negative effects of insecticides on the environment to the attention of the general public.

## Sustainability

The higher yields obtained in agriculture are mostly through the addition of chemical fertilisers and pesticides, which is an unsustainable approach. A challenge exists to ensure increases in cotton yield take place sustainably. Improving efficiency through optimisation of product application is a method suggested to increase yield sustainably. GrowGreen's biologically based fertiliser solutions offer a unique scientifically backed way to achieve this challenge. Packed full of plant beneficial microbes, plant essential nutrients, seaweed derived phytohormones (**Microbe Plus™ Kelp** product), and fish derived amino acids (**AminoElite™** and **AminoOrganic Premium™**), GrowGreen products will encourage nutrient uptake, crop growth and tolerance beyond that of a conventional fertiliser. In farming systems, nutrients are usually added in the form of conventional soil applications. Alternatively, applying suitable fertilisers through a foliar spray is shown to improve nutrient efficiency in cotton crop, thus reducing environmental pollution, whilst increasing the yield (Radhika et al 2013). GrowGreen offers a range of products, promoting healthy crop growth which are suitable for both soil and foliar applications. The world needs to begin to greatly increase agricultural productivity, and to do so in a sustainable and environmentally friendly manner.

# Promoting Crop Growth with Beneficial Microbes

Topsoil is home to a diverse community of microbes responsible for nutrient cycling, providing available forms of key macro nutrients; nitrogen, phosphorus, potassium for crop uptake. The biological activity of microbes is a key aspect of nutrient cycling making crop nutrients available. There is evidence from a large selection of scientific studies showing that various microbes can enhance plant productivity and reduce susceptibility to pathogens. Organic matter which has been shown to have significant improvements to cotton yield, has a known benefit to the quantity and diversity of microorganisms in the soil (*Blaise et al 2005*).

Plant growth promoting (PGP) bacteria are found in the rhizosphere of soil, and as their name suggests they help promote plant growth, and sustainably increase agricultural yields. GrowGreen's products contain PGP Bacteria, along with essential nutrients to provide a boost to nutrient availability, crop growth, and stress tolerance. The plant and the PGP Bacteria form a mutually beneficial relationship and produce antibiotics and antifungal metabolites which aid in the plant's pathogen defence. They are also responsible for the conversion of nutrients to plant available forms, and the production of certain hormones, such as auxin which stimulates crop growth (Pereg and McMillan 2015).



GrowGreen offers a biofertiliser range called Microbe Plus; which includes the benefits of the PGP bacteria along with the essential nutrients

#### Biostimulants can often overlap with biofertilisers by what they can provide to the crop.

- **Biostimulants** are metabolic enhancers which promote better quality and higher yields and are a complimentary input to conventional fertilisers.
- **Biofertilisers** contain PGP bacteria which inoculate the soil and improve plant nutrition which enhance nutrient availability to the crop, facilitating nutrient uptake.

Biofertilisers are made of living microbes, either by enriching the soil or by improving the availability of some nutrients whilst, biostimulants stimulate plant growth by mechanisms other than (or as well as) improvement of nutrient uptake. Combining biostimulants with specific microbes that are well known for their potential to help plants acquire nutrients and withstand biotic and abiotic stress has been demonstrated to further enhance plant benefits (*Colla et al 2017*).

GrowGreen product range of Microbe Plus provides the benefits of the biofertiliser (essential nutrients and PGP bacteria) and additional mechanisms of encouraging crop growth associated to phytohormones (**Microbe Plus™** Kelp) and amino acids (**AminoElite™** and **AminoKelp™**) which also includes the amino organic products. GrowGreen's biostimulant crop booting growth mechanisms of phytohormones and amino acids are described in more detail below;

## **Benefits of Phytohormones**

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Phytohormones are produced naturally in higher plants, controlling growth and physiological functions. Significant beneficial impacts on cotton yields have been observed from the applications of phytohormones (*Abro et al 2004*). The five primary phytohormones (auxins, cytokinins, gibberellins, abscisic acid, and ethylene) are incorporated into GrowGreen's products. Phytohormones have been shown to have a significant contribution to root activity, root area and volume (*Onanuga et al 2012*). Root area directly affects drought resistance, and nutrient uptake. Promoting a healthy root system and a healthy more resistant crop. Abscisic acid (**ABA**) which is a heavily studied phytohormone is widely recognised as a stress hormone involved in mediating responses to soil compaction and water stress, maintaining seed dormancy and root growth; the addition of which will save the plant the cost of production (*Hussain et al 2000*).

Auxins increase shoot and root biomass, stimulating cell elongation, and is found in actively growing areas of the plant including leaves and root tissue. Plant auxin stimulates root growth and shapes architecture (Aloni et al., 2006). Working in conjunction with auxins, cytokinins stimulate cell division and control root development by inhibiting primary root elongation and lateral root formation and promoting root hair formation (Werner et al., 2003, Riefler et al., 2006). The plant growth promoting (PGP) bacteria can increase the availability of phosphorus (Richardson and Simpson, 2011). Root hair can constitute up to 70% of root volume and may absorb up to 80% of phosphorus (Fohse et al., 1991). Root mass and elongation is critical to access water and nutrients (Clark et al 2003). Gibberellins functions similarly to auxins, however it is most important in promote the development of stem tissue, root elongation and lateral root extension, and breaking the dormancy in seeds and buds (Barlow et al., 1991, Yaxley et al., 2001). Gibberellins are additionally produced by species of PGP bacteria found in a range of GrowGreen's products. The phytohormone Ethylene is essential for crop growth and development; it is slightly different to the other hormones in that it is formed within almost all parts of the plant as a gas. Certain **PGP** bacteria found in GrowGreen's products, can produce small amounts of ethylene, which when in the soil at low concentrations can promote growth of root hairs (*Ribaudo et al., 2006*). At higher concentrations, ethylene is associated with the crops defence in response to pathogen infection (Broekaert et al., 2006)

# Benefits of Using GrowGreen Products for Cotton

When using GrowGreen products, the efficiency of cotton nutrient uptake is optimised, this is due to the research and consideration that has gone into the design on each of the products. For specific nutrient requirements GrowGreen's Microbe Plus<sup>™</sup> range is helpful in targeting specific deficiencies within the field. The biostimulant range offers a comprehensive optimisation of cotton production, providing both the essential macro and micronutrients, **PGP B**acteria, and a range of amino acids and phytohormones, which stimulate crop growth beyond providing plant available nutrition. GrowGreen's products have proven to produce higher crop yields than conventional fertilisers.

# Importance of Balance

The key to GrowGreen's success in encouraging crop optimisation, is the ratio of the nutrients, PGP Bacteria, amino acids and phytohormones. Research has proven the phytohormones do not work in discrete pathways, but rather exhibit extensive interactions with each other as well as with the environment. For example, cytokinins cannot work alone, they need auxin present to stimulate cellular division, higher levels of cytokinin induce growth of shoot buds; higher levels of auxin cause root formation (Campbell et al., 2008). Ethylene has different effects on plant growth, depending on its concentrations in plant roots high levels can exacerbate stress, PGP Bacteria can reduce the adsorption of ethylene by the roots and allow the plant to re-establish a healthy root and cope with environmental stress (Pierik et al., 2006; Glick, 2005). Therefore, research has gone into not just the beneficial components included in GrowGreen's biostimulants but with consideration to their interactions and the ideal ratio of the components to maximise efficiency, the phytohormone concentrations can be seen in Figure 2.



<u>Plant Hormone concentration in, Microbe Plus™ Kelp,</u>

Figure 2 Plant Hormone concentration in the GrowGreen Biostimulant products range

GrowGreen products are more efficient, leading to both economic and environmental benefit.

# Efficiency, Economic and Environmental Benefits of GrowGreen Products

Cotton is not cheap to produce. Insecticides are an expensive heavily relied upon input. It is sensible to carefully evaluate where money is being spent on cotton production and evaluate the best way to see a return in expenditure. Volatilisation and leaching of nitrogen from conventional fertilisers can be as high as 50% in commercial fields, meaning half of the applied fertiliser never benefits or even reaches the crop. Nitrogen escapes from the agricultural system into the atmosphere and contaminates water ways with devastating consequences. GrowGreen products are engineered with the concern of environmental consequences in mind, incorporating nutrient compositions which readily attach to soil particles and have thus prevented them from leaching. In an independent test GrowGreen products retain more than 60% of our nutrients in pure sand (clay and organic matter are the components in soil known to hold on to nutrients).

Seaweed contains a number of plant growth stimulating compounds, beneficial microbes, and nutrients. Sourcing biostimulants from seaweed offers an environmentally friendly renewable resource. GrowGreen's **AminoElite™** and **AminoKelp™** and **Microbe Plus™ Kelp** are biostimulants, they are microbially active marinebased fertilisers, packed with vital amino acids and growth hormones, allowing plants greater access to macro and micronutrients. Unlike, chemical fertilisers, extracts derived from seaweeds are biodegradable, nontoxic, non-polluting and nonhazardous to the environment. Offering a sustainable means of improving cotton yield and quality to meet the ever-growing demand. An additional environmental benefit of marine based biofertiliser products is the reduced GHG emissions associated with its production.

Cotton farms are subject to the increasing challenges from soil pollution and labour shortage (*Dai and Dong 2014*). Additionally, using a combination of biostimulants and conventional fertiliser, Yao (*2006*) found an increase in the root system size and capacity as well as the additional availability of phosphorus and an increase in crop yield. It is recommended when using GrowGreen products to reduce their standard application rate by 10-15% in the first year and reduce by 30% in the following year. In doing this, farmers will experience an increase in yields, and GrowGreen products won't represent an extra cost. Furthermore, they are compatible for application with most widely used pesticides. By promoting healthy stress and pest tolerant crops using GrowGreen's biostimulants the reliance on other external inputs is reduced. Reducing the amount of required inputs will save both time and money, and subsequent labour and fuel costs. The reduced environmental impact is a key selling point to the growing community of conscious customers, who want to source cotton products from an environmentally sustainable system (*Maraseni et al 2010*).



GrowGreen's products used in conjunction with reduced conventional fertiliser results in higher yields, achieved by stimulating plants to perform at their maximum genetic potential.

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