The Role of Biological Adjuncts in a Sustainable Agricultural System - Chris Alenson April 2016

"Essentially, all life depends upon the soil ... There can be no life without soil and no soil without life; they have evolved together." - *Charles E. Kellogg, USDA Yearbook of Agriculture, 1938*

Introduction

Agriculture in the Western world has become highly mechanised, specialised and dependent on fossil fuels for both energy and the production of fertilisers and pesticides. Studies are indicating that these farms are now reporting declining soil productivity, reduced profitability and ecosystem deterioration (Reganold, 1990).

Pimental et al, 1995 reports that over the last 40 years nearly one third of the world's arable land has been lost to erosion which means that at current erosion rates soils are being depleted faster they are being replaced. This is occurring at a time when the need to increase food production for a world population in excess of 7 billion people puts pressure on environmental resources of soil and water.

The decline in the productive base of our soils means that there is a concomitant decrease in soil minerals and valuable organic matter which fuels the microorganism which assist in mobilising plant nutrients. A number of studies have reported that degraded soils also illustrate a decrease in essential nutrient elements vital for animal and human nutrition (Marler, and Wallin, 2006).

Soils, their fertility and their long-term sustainability require an understanding and management that often seems to contradict the goals of modern 'high tech' farming.

Organic/biodynamic farming has the potential to manage our resources while producing food and fibre of high quality using techniques, which are environmentally benign.

The attainment of optimum soil health/soil quality is the goal of all organic/biodynamic farmers. From a scientific perspective

Those farmers that have a hands-on connection to nurturing the soil will understand Kirschenmans plea "to love soil requires that we see more than dirt. It requires that we become intimately involved with soil – see its life and its beauty, smell its rich aroma, hear its voice."

Although a number of conventional farmers may use, what might be called **alternative biological preparations**, there is an over-riding belief that this does not constitute a scientifically based agriculture.

The practicality of managing the soil sustainably

It is assumed that this soil quality/fertility will be obtained using techniques that maximise soil biological activity improve physical structure and provide for the 16 or more inorganic nutrient elements that may not be available in the soil given its geological and weathering history and its past exploitive cropping patterns. In this active, living soil, microbial activity is sufficient to release many organic acids and compounds that can mobilise nutrients from soil colloids and mineral particles for plant nutrition through the principle of chelation.

This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government's National Landcare Programme

Demonstrating Sustainable FARM PRACTICES

Biological adjuncts in a sustainable system

If the major soil inorganic elements have been supplied through mineral fertilisers, composts, green manure crops and legumes or a combination of these, and that the physical properties of the soils have been attended to, then the use of biological stimulants may be seen as essential adjuncts to further enhancing soil fertility in a sustainable system.

The sustainable agricultural industry has seen a large increase in the number of commercially available plant bio stimulants, or agricultural bio stimulants. The use of these stimulants as agricultural inputs on a range of crops and plants has been supported by a growing amount of scientific evidence (Calvo, Nelson & Kloepper, 2014).

The intention of this article is to draw attention to the range of bio stimulants available and the response that might be seen in crops and plants from their use. It will not detail commercially available products.

The following categories of bio stimulants will be examined.

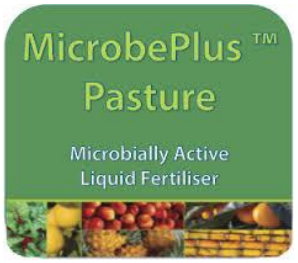
(i) microbial inoculants, (ii) humic acids, (iii) fulvic acids, (iv) protein hydrolysates and amino acids, and (v) seaweed extracts.

The available research appears to indicate commonalities in plant responses to a range of different bio stimulants, such as increased root growth, enhanced nutrient uptake, and stress tolerance (Calvo, Nelson & Kloepper, 2014)..

It should be stressed that bio stimulants operate through totally different mechanisms than fertilisers, and such cannot be seen as substituting for the use of mineral fertilisers to address pH and or nutrient deficiencies.

Bio stimulants are defined as “substances, including microorganisms, that are applied to plant, seed, soil or other growing media that may enhance the plant’s ability to assimilate applied nutrients, or provide benefits to plant development” (Bio stimulant Coalition, 2013). They can be seen as complementing the use of mineral fertilizers.

Microbial inoculants



Microbial inoculants are classified as biocontrol agents or bio fertilisers.

They may promote growth by increasing root biomass or density of the root area and by enhancing nutrient uptake. (Vessey 2003, Wu et al. 2005).

Phosphorus availability in agricultural soils is a always a challenge due to its ability to be fixed or absorbed on various soil particles. The production of organic acids and phosphatases by phosphorus solubilising microorganisms can assist in increasing phosphorus availability (Goldstein 1995, Rodriguez et al. 2006)).

Potassium (K) is another essential plant nutrient that through the actions of soil microorganisms and microbial inoculants can be solubilised (Friedrich et al. 1991).

Application of various strains of *Bacillus* resulted in significant increases in available K in the soil and K uptake by eggplant roots and shoots. It is suggested that the uptake was due to the production of a range of organic acids including citric, oxalic, tartaric, succinic and ketogluconic acid, which dissolves rock potassium or chelated silicon ions

Microbial inoculants increased plant growth due to increased production of plant hormones and can also help plants overcome or tolerate extremes of environmental conditions, thereby reducing potential yield losses.

Compost teas and biodynamic preparation 500 are considered microbial bio stimulants and have been demonstrated to be a rich ferment of microorganisms.

Compost teas are considered a viable way to manage plant diseases and crop fertilization.

This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government’s National Landcare Programme

Humic acids

Humic substances are the end products of decay of organic matter and dead biota. Their importance and role has been emphasised through the history of organic agriculture with practitioners such as Steiner, Howard and Balfour advocating their use.

Major soil and plant functions include nutrient exchange through cation exchange, nutrient availability through their chelating roles (P and Fe mobilisation), the stimulation of root growth and the enhancement of soil aggregation (Piccolo and Spiteller 2003). Humic substances also affect the composition and function of rhizosphere microorganisms.

Calvo, Nelson and Kloepper (2014) reported that humic substances enhanced aspects of growth in over 16 species of plants including, soybeans, wheat, rice, and maize. Vegetable crops such as potato, tomato, cucumber, peppers and fruit crops such as citrus and grapes also benefited with increased growth.

Interestingly a viticulturist using a commercial humic acid preparation reported increased quality of wine through the increase of nitrogen content of the grape (Morard et al. 2011).

Humic substances also includes fulvic acids that like humic acids are involved in processes including chelation and mobilisation of metal ions and the enhancement of physiological processes in plants leading to increased growth.

The use of these substance s are becoming routine in agriculture delivering important economic benefits through increased yield, quality and minimisation of abiotic stresses.

Protein hydrolysates and amino acids

These products are made from animal or plant wastes. Many Australian organic producers would have used a fish emulsion of some sort. Aung et al, 1984 reported the promotion of growth of a range of crops using fish emulsion. There are great environment benefits to be had from recycled wastes that are made into useful agricultural products. Research has provided evidence for the ability of these products to stimulate plant growth and enhance resistance to a number of environmental stresses (Schiavon et al. 2008.

Seaweed products

The use of seaweed in agriculture as a soil amendment has almost as long a history as the use of compost. Seaweed products are composed of a number of components that vary according to the type of seaweed sourced and the process that extracts the final product. They have a unique composition of organic and mineral components including polysaccharides not found in terrestrial plants such as laminarin, fucoidan and alginates, and plant hormones (Sivasankari et al. 2006)

Seaweed extracts are reported to behave as chelators, improving the ability of plants to be able to more efficiently utilise plant nutrients. Improvement in soil structure and aeration thereby enhancing root growth are also reported (Milton 1964).

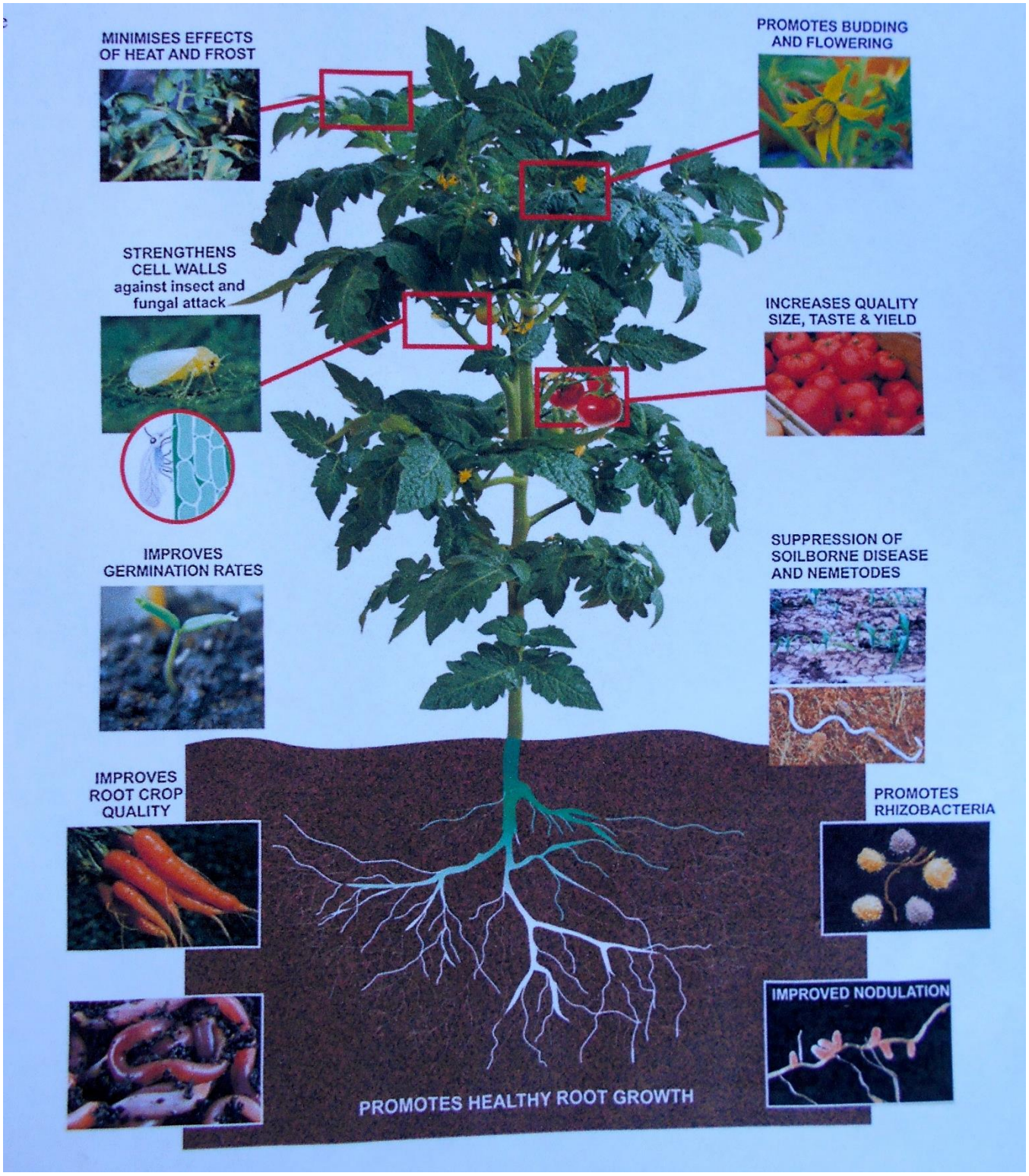
A number of researchers have indicated, “that seaweed extracts also act as bio stimulants, enhancing seed germination and establishment, improving plant growth, yield, flower set and fruit production, increasing resistance to biotic and abiotic stresses, and improving postharvest shelf life” (Mancuso et al. 2006)

Studies have indicated that foliar applications of seaweed enhance growth and root development and increase mineral nutrient uptake.

This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government’s National Landcare Programme

Demonstrating Sustainable FARM PRACTICES

Summary of plant and soil benefits reported upon application of liquid seaweed extracts Source: Seasol Int.



References can be provided by Chris Alenson on request

These notes are freely available as a resource for farmers and may be of assistance to you but the WPCLN does not guarantee that they are without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequences which may arise from you relying on information from these notes.

This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government's National Landcare Programme