Terrestrial plants first appeared approximately 500 million years ago and are some of the oldest living organisms that have evolved on earth. It is hard to imagine that modern crop plants were derived from the humble 'pond scums' eventual landfall. Through multiple planetary extinction events and dramatic climate change, modern plants have been selected by a process of extreme natural selection.

Today's agricultural cropping systems rely almost exclusively on the Angiosperms, a phylum that arose approximately 125 million years ago and more commonly known as flowering plants. They are the most successful land plants and dominate terrestrial habitats.

Land plants have evolved unique survival strategies, particularly as they are sedentary and hence subject to intense biotic stress – such as herbivory and disease – as well as abiotic stresses such as drought, fire and climatic extremes. Part of their evolutionary success has been their ability to detect potential threats and defend themselves against these life-threatening stresses. These defensive responses in modern plants appear to have developed very early in their evolutionary history but in modern plants they are complex and multipronged in effect.

Plant Defence Strategies

The sophisticated defence mechanisms that plants use to ward off and counter biotic attacks can be broadly divided into three main categories:-

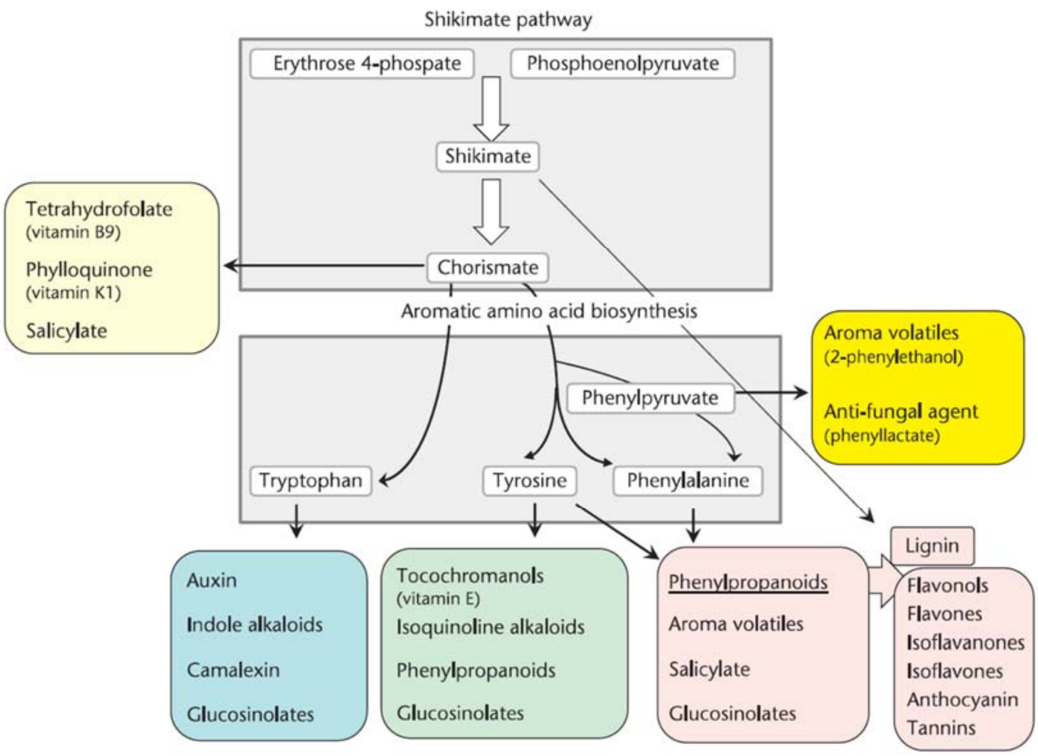
1. Physical – Plants have developed physical features to deter herbivory, such as thick barks, rapid or modified growth to increase height and thorns and sharp leaf edges and compartmentalisation (ie shot hole diseases).
2. Chemical – This is the most complex and diverse strategy used by plants and includes an extensive library of chemical compounds, commonly referred to as phytoalexins such as salicylates, abscisic acid, coumarins, jasmonic acid, pipecolic acid etc. These biochemicals vary in mode of action, transportation dynamics and persistence.
3. Protein/Enzymatic – The "Defensive Proteins "or Pathogenesis Related (PR) Proteins and include Chitinases, Chitosanases and Glucanases; Peroxidases and Proteinases; Systemins and Defensins.

In terms of maximising disease control with agronomic practices; genetic resistance, fungicide choice, timing and dose are all key factors in achieving a healthy crop. One area often overlooked is supporting the plant's ability to maximize its own innate immune/defence system.

Strategically, plants that detect biotic stresses earlier tend to fend off potential injury more effectively. Hence, in addition to physical/chemical barriers, plants actively monitor the presence of pathogens (pathogenic and non-pathogenic) and subsequently activate defence signalling networks, which in turn restrict the further growth and spread of pathogens. This can also operate for pest attacks as well. What is fascinating about this type of response is that it not only operates over long distances in the plant, it can operate between plants through root anastomosis and (where no physical contact exists) remotely by atmospheric chemical release.

As soon as a plant is wounded (abiotic or biotic), there is an elicitation of increased local respiratory rates to support increased upregulated metabolic pathways that specifically generate compounds to abate further tissue damage and isolate the specific incitant. In the case of a disease, this usually means the appearance of fungitoxic biomolecules and a localized compartmentalisation response.

Secondary metabolism is the major route for the host defence mechanisms, often via the Shikimic acid pathway. This pathway is responsible for producing aromatic amino acids and, coincidentally, is the major pathway effected by glyphosate. Aromatic amino acids are energetically costly to produce, but they are precursors to many defensive molecules and PGR's. Critical metabolites are synthesised from this pathway, such as courmarins and other phytoalexins (e.g. salicylates, ethylene, abscisic acid, jasmonic acid, flavonoids and coumarins) as responses to the pathogenic attack.



From: Tzin, et al, 2012

The complexity of these interactions is poorly understood and, as more of these chemical warfare molecules are discovered, the complexity increases. What is encouraging, is that through advances in molecular biology we are able to identify gene clusters germane to these responses and follow their upregulation in response to events, such as fungal infection. The epigenetic regulation of plant metabolism as a response to biotic stress, such as a disease, is a crucial survival tool for plants. The interaction and complexity of these defence networks reveals much as to the plant's ability to integrate detection mechanisms, genetic regulation and metabolic upregulation rapidly and effect an energetically costly, rapid mitigation disease response.

Scyon specifically upregulates plant's biotic/abiotic stress detection systems whilst ensuring the plant is in balance nutritionally so that it's able to devote energy to this process.

Scyon not only upregulates nitrogen uptake and assimilation but is designed to help the plant maintain nutritional stoichiometry which is essential to maintain physiological balance. Critically in plants, photosynthetic upregulation provides carbon flow to support these host defence systems. **Scyon** upregulates photosynthesis to mitigate any negative affect on growth.

As we all know with humans, the correct nutritional input and balance is critical to optimise health. Each element plays its role like an instrument in the orchestra, no one is more important than the other, they all need to be in harmony for a perfect performance. Over expression of certain nutrients e.g. nitrogen can induce diseases such as mildew and under-expression e.g. phosphorus can also do the same intake-all.

It is clear that as plants become nutritionally unbalanced, their ability to coordinate a rapid defensive response is impaired. As such, plants that are nutritionally limited tend to be more susceptible to biotic and abiotic stress; disease levels increase, water stress increases, stem strength weakens, attraction to pests increases etc. Nutritional stoichiometry is critical in plant health. It is easy to increase biomass but if that is not nutritionally balanced, you may be increasing other problems further down the line.

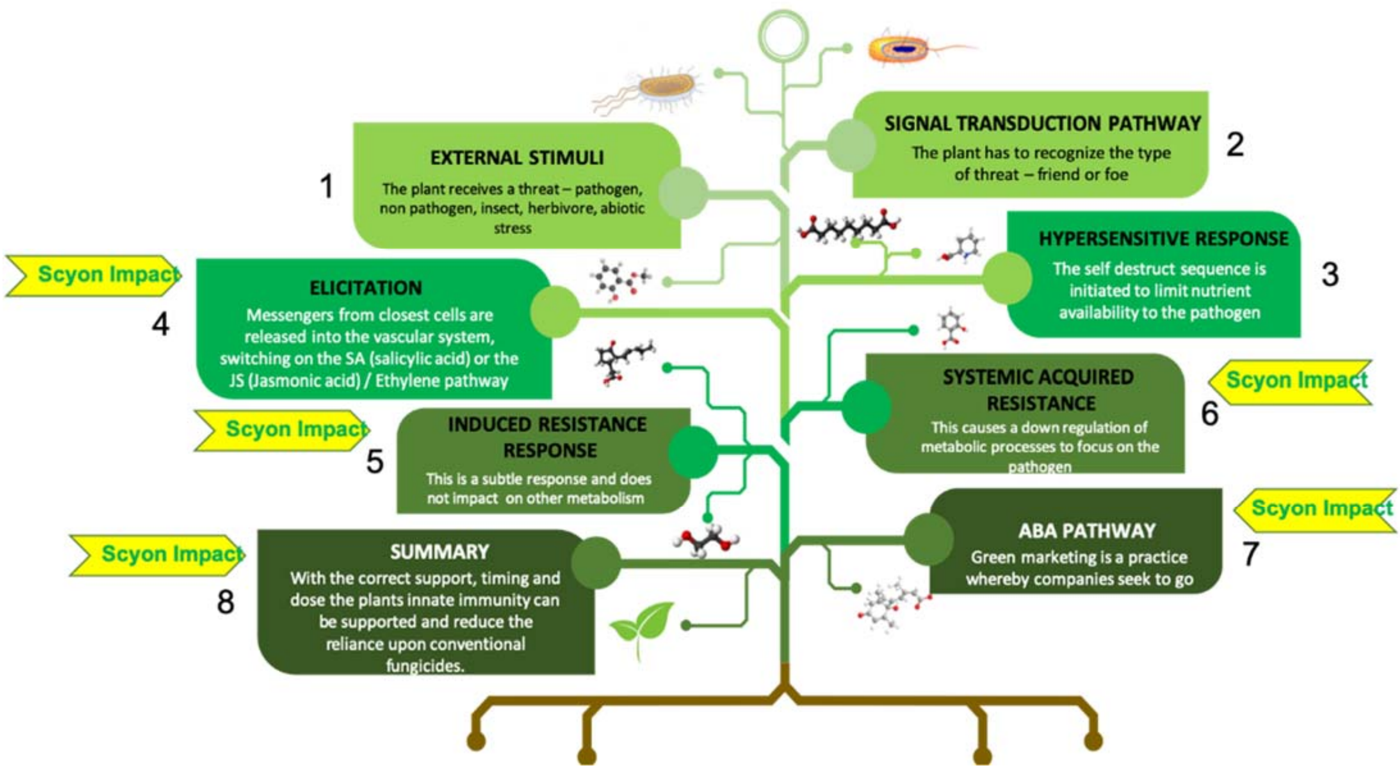
When a plant cell recognizes particles from damaged cells or particles from the pathogen, the plant launches a two-pronged resistance. Plants have two main resistance mechanisms to helps them defend against pests and diseases: a general short-term response, Induced Systemic Resistance (ISR), and a delayed long-term specific response, Systemic Acquired Resistance (SAR).

The plant's defence cascade (as part of the induced resistance response) commences with deployment of reactive oxygen species such as superoxide and hydrogen peroxide to kill invading cells. In pathogen interactions, the common short-term response is the hypersensitive response in which cells surrounding the site of infection are signalled to undergo apoptosis, or programmed senescence, in order to prevent the spread of the pathogen to the rest of the plant.

Long-term resistance, or systemic acquired resistance (SAR), involves communication from the damaged tissue with the rest of the plant using plant hormones such as jasmonic acid, ethylene, abscisic acid or salicylic acid. The reception of the signal leads to global changes within the plant, which induce genes that protect it from further pathogen intrusion, including enzymes involved in the production of phytoalexins.

Often if jasmonates or ethylene (both gaseous hormones) are released from the wounded tissue, neighbouring plants also manufacture plant defence molecules (phytoalexins) in response. For herbivores, common vectors for disease and for other wound responses, aromatics (plant defence molecules) seem to act as a warning that the plant is no longer edible. Also, in accordance with the old adage, "an enemy of my enemy is my friend," the aromatics may alert natural enemies of the plant invaders to the presence of the pest, encouraging a natural biocontrol process.

Plant Response Signaling Pathway
Scyon – Multi Support for your Crop



Potassium Stress

- Low leaf potassium levels induce the movement of sugars from interstitial fluid to the leaf surface.
- Pathogenic microbes use this sugar secretion to trigger germination, promote multiplication rates and locate potential infection sites.

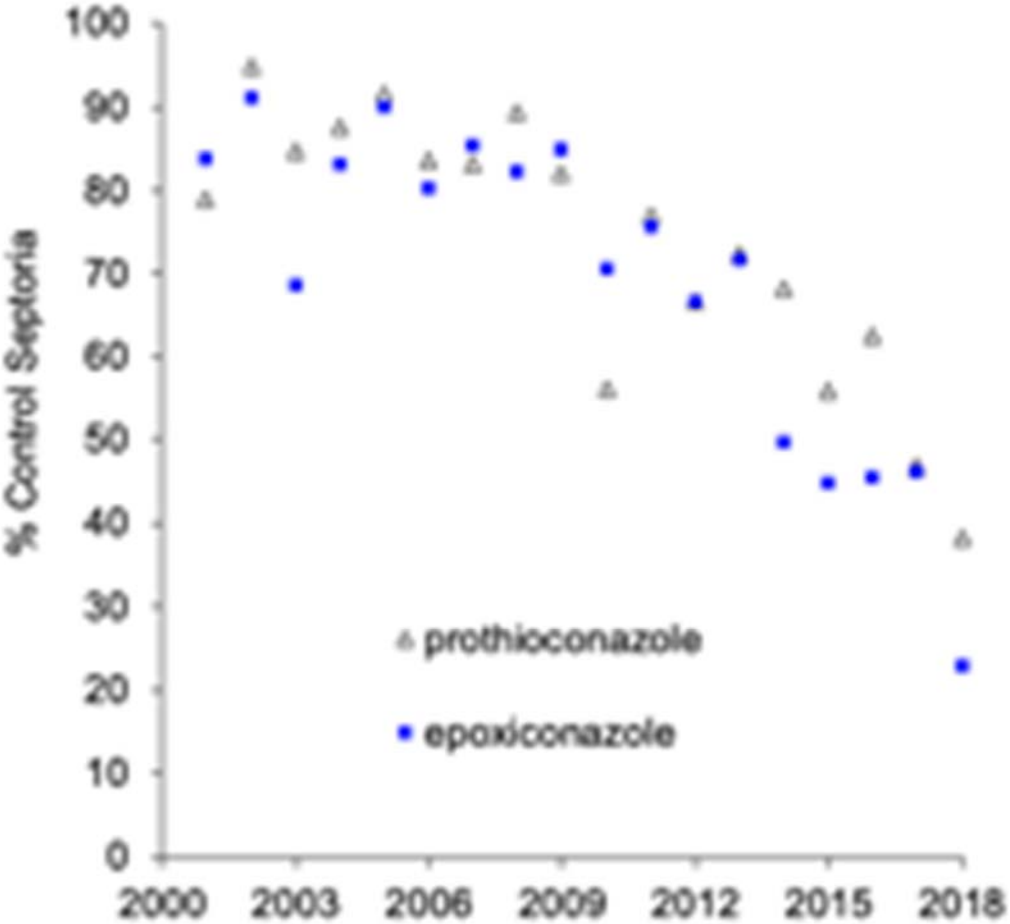
Therefore, for the healthiest crop we have to work with nature not against it for effective disease control.

With increasing regulatory challenges limiting the fungicide armoury, ever increasing resistant strains to chemistry and the newer technologies being limited to single-site modes of actions, this makes creating a healthy plant even more critical.

This means a holistic approach to crop health rather than reliance upon a can of product to protect the plant. Trash disposal, volunteer removal, drilling date, varietal choice, seed rate, weather monitoring and disease forecasting, along with nutritional status are all examples of this more integrated approach to crop management. We can see with Septoria, for example, how quickly nature can mutate, creating resistance to fungicide groups and putting increased pressure on remaining actives.

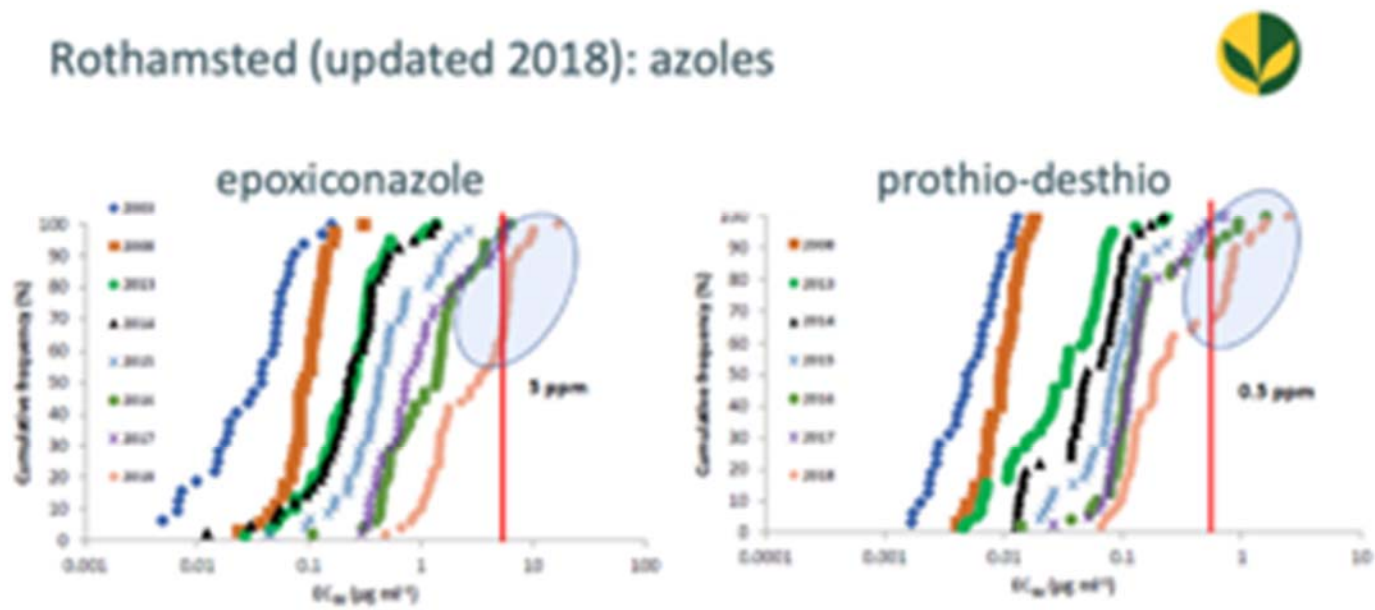
Product performance has halved in the last 10 years (AHDB) for the triazoles and SDHI's should be deployed in protectant situations only (which is hard as there is always a background infection level).

Septoria: azole performance over time (protectant, full label dose)



By increasing- the diversity of control methods into programmes, growers can maximise control today, but will also minimise/slow resistance build up, protecting the actives for the future.

Septoria: early season sensitivity monitoring



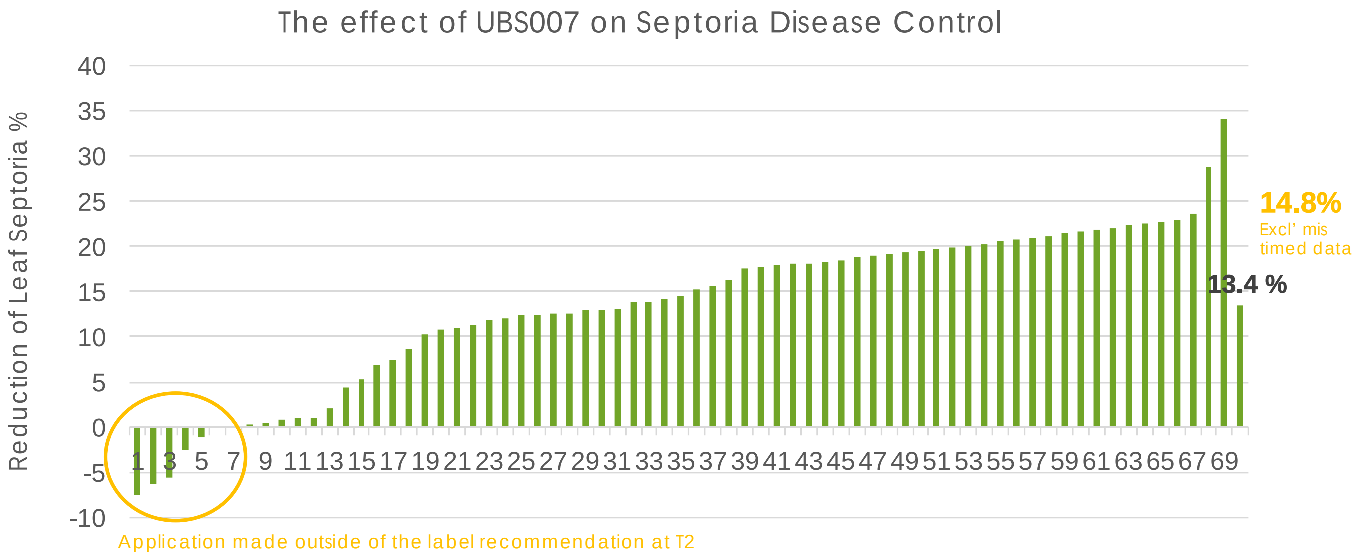
Nutritional stoichiometry – or maintaining balance is critical as part of this approach.

Scyon, a technology developed by Unium Bioscience, is a complex of metabolites specifically targeted to maintain nutritional balance within the plant, at a time of rapid growth, for optimal crop health. It creates a strong robust plant structure (primary metabolism) with increased efficient secondary metabolism (plant defence chemicals) for maintaining health.

It is not the total solution, but it is an important component of plant health in the increasingly complex situation we face.

The following data shows conclusive evidence that Scyon will enhance disease control.

UBS007 Performance against Septoria
69 different comparisons over a range of trial conditions 2018-2019

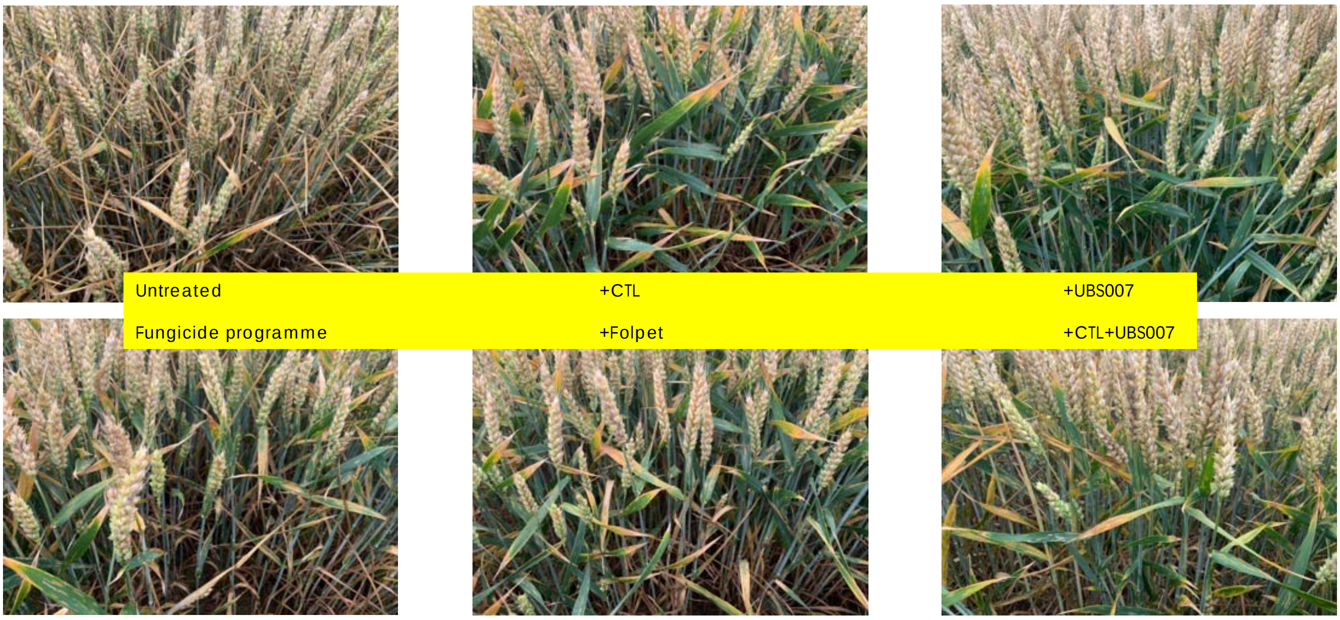


And visually the affect is very apparent

Leaf Health GS37

Standard Farm Practice

SFP + UBS007



From an agronomist's assessment, you can see the cleaner crop

Farm Standard   Farm Standard + UBS007

The enhanced nutritional status of the crop and, in general, an elevation in all nutrients to maintain balance

Analysis	Guideline	Farm Standard	Farm Standard +UBS007	Difference	
Nitrogen (%)	3	3.46	4.16	0.7	20%
Phosphorus (%)	0.3	0.34	0.41	0.07	21%
Potassium (%)	3.5	2.96	3.07	0.11	4%
Calcium (%)	0.4	0.31	0.41	0.1	32%
Magnesium (%)	0.12	0.09	0.1	0.01	11%
Sulphur (%)	0.25	0.12	0.15	0.03	25%
Boron (ppm)	6	2.5	2.8	0.3	12%
Copper (ppm)	7	8.2	9.7	1.5	18%
Iron (ppm)	50	87	109	22	25%
Manganese (ppm)	35	21	29.1	8.1	39%
Molybdenum (ppm)	0.10	0.27	0.26	-0.01	-4%
Zinc (ppm)	25	18.6	26.8	8.2	44%

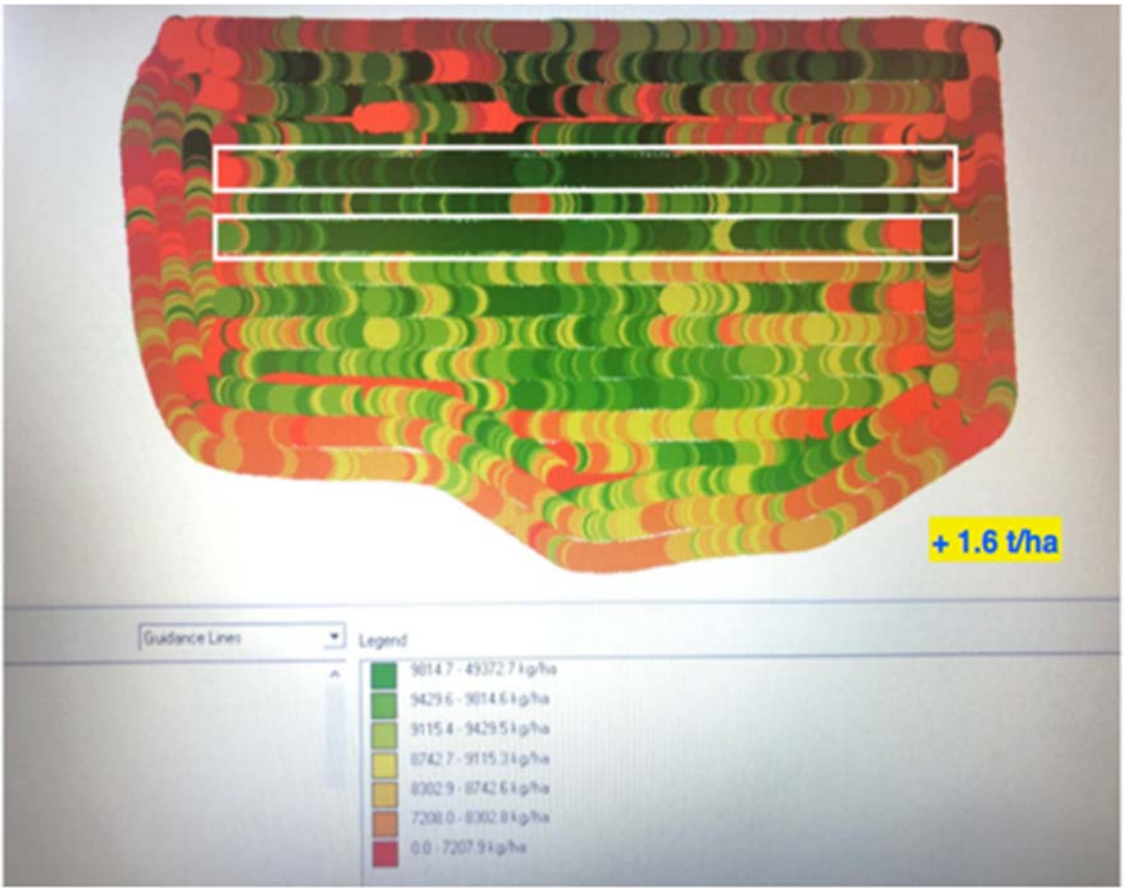
The Brix readings where assessed during the season and although still being evaluated as an agronomist tool it expresses plant health. The higher the reading the healthier the plant with readings between 20 – 35% greater in the Scyon block.

Further Brix tests were carried out through the season, however due to the nature of the weather that occurred in June and July where no significant precipitation fell until after harvest on 28th July 2018, it was decided that disease pressure was extremely low and further tissue analysis and plant disease analysis would not show much in terms of increased disease control.

Brix scores	15/05/2018	31/05/2018	12/06/2018	25/06/2018
Farm standard	9.4	9.7	10.1	9.3
Farm standard +UBS007	11.3	11.5	12.6	12.4

Yield

Harvest was carried out using a New Holland CR9.80 combine with a 10.5 meter header, for the essence of time the treated blocks were not cut individually knowing that at least 1 run would cover the totally treated crop.



Treated combine runs highlighted within white boxes, shows a far higher and more consistent yield. In a field that averaged 8.2T per Ha, the treated plots averaged 9.81T per Ha. In the absence of disease a 1.61T yield response!

Plant Tissue Analysis Comparison

Scyon

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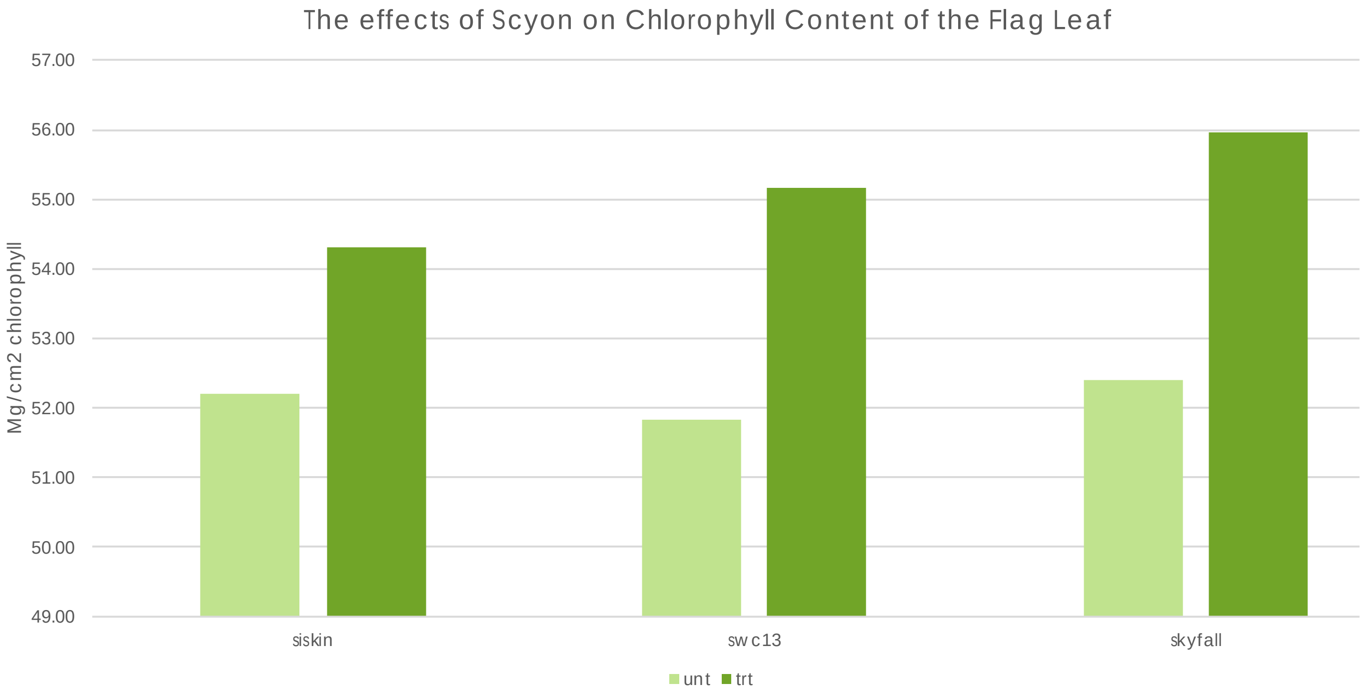
Zinc (ppm)	25	18.6	26.8	8.2	44%

As a measure of stress reduction, it is clearly seen that Scyon either prevents reduction of chlorophyll during a stress event or increases chlorophyll during the normal growth pattern.

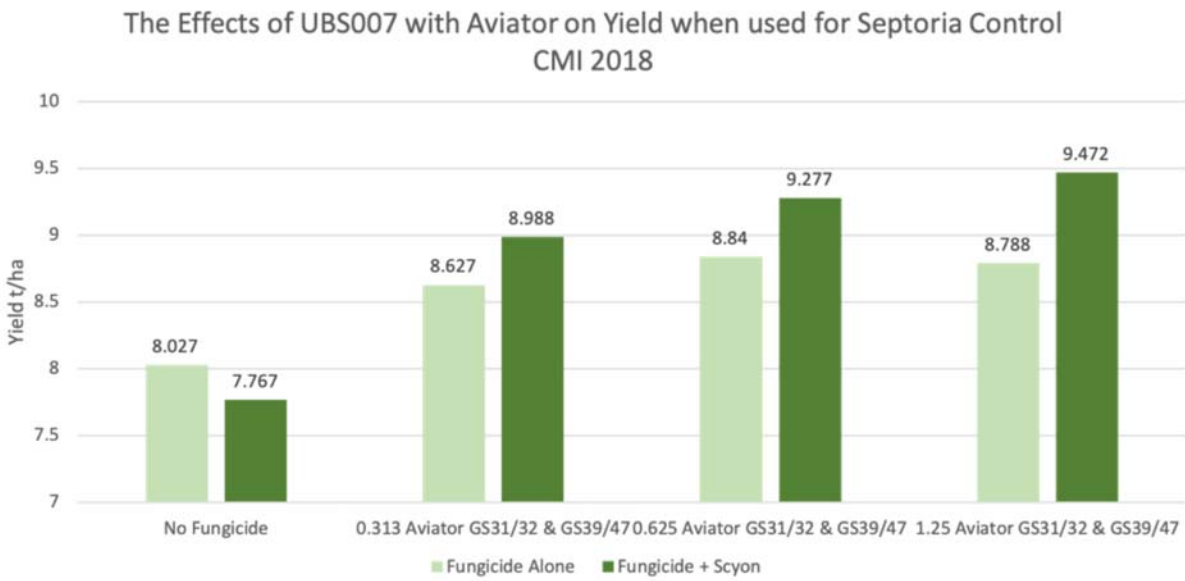
Chlorophyll Content of Flag Leaf June 2019



This demonstrates the anti-stress components of the material ensuring growth and crop health are optimised, not compromised.

So, does that translate into yield. This replicated trial shows the increase in yield, in particular as the fungicide programme gets stronger.

CMI



This has been seen across numerous programmes.

SUMMARY

- Scyon is a unique biostimulant complex (of natural metabolites) with a surfactant designed to enhance plant health by supporting a range of biochemical pathways.

- It optimises the plant's nutritional balance.

- It optimises fungicide performance whilst strengthening the plant's natural defences.

- It reduces crop stress and maximises nutrient availability during times of maximum growth.

- Enhances an anti-resistance strategy to support existing and new chemistry.

Apply at 1 litre per hectare as part of your disease control programme starting at T0 or T1.