Quantis is the exciting new biostimulant from Syngenta for field-scale crop production. With the benefit of in-depth R&D applied by Syngenta scientists and researchers, there is a better understanding of how biostimulants work and the benefits they can deliver in the field.

We investigate the science behind Quantis as an essential new tool for growers and agronomists now, along with what the future holds for biostimulant use in sustainable crop production

What are abiotic stresses?

Abiotic stresses are caused by environmental factors, such as heat, drought, cold, shade, nutrient deficiency or physical damage to the plant. Many abiotic stresses are outside the influence of growers' agronomy actions.

Biotic stresses, however, are a result of living organisms or other biological factors impinging on plant health – such as disease or pest damage to the plant.

The effects of abiotic stresses can also be compounded in the field, hence a plant suffering from heat stress, for example, may also be more susceptible to drought or nutrient stress.

Furthermore, there is also good incidental evidence that plants under the effects of abiotic stress are more likely to succumb to the effects of biotic stress, and to suffer more severe damage.

Why can't plants cope with stress?

Plants are constantly adapting to stress from environmental conditions, often with little or no adverse effects. Some plants, or even individual cultivars, have greater natural tolerance to specific biotic and abiotic stress factors.

However, when stress is extreme, or prolonged, plant stress tolerance mechanisms may no longer be able to cope naturally and suffer potentially significant damage.

Furthermore, with changing climatic conditions, the frequency and severity of stress effects are becoming more severe. Periods of heat and drought are generally becoming longer and more intense, and when conditions change the effect is more sudden and intense.

Plants that have taken millennia to evolve natural tolerance to environmental stresses are being subjected to conditions that are changing relatively rapidly. New biostimulant technologies, such as Quantis, can help to enhance plants' resilience to specific abiotic environmental stresses.

Why is heat stress becoming more of an issue?

Climatic conditions are undoubtedly becoming more extreme. The ten hottest years on record in the UK, for example, have all occurred since 2000. Furthermore, as climatic conditions have changed over recent years, prolonged heat periods are becoming more frequent.

Reviewing historic weather has shown the variability in heat events from season to season and location, but at some stage most crops will be subject to some effects.

Independent research has shown the optimum root growth in potatoes occurs at soil temperatures of 15 to 20ºC, with a fall off when temperatures exceed 20ºC. The relatively shallow rooting of potatoes in the top 60 cm of soil profile, compared to cereals rooting to at least twice that depth, makes the crop more susceptible to temperature changes.

Warmer soils have also been shown to limit tuber initiation and the numbers of tubers formed. The UK's highest temperature of 38.7ºC, recorded in the eastern counties in 2019, exemplifies future challenges for potato production.

Of the 32 Quantis field trials in the UK experiencing conditions of greater than 25ºC for more than four hours over the duration of the application programme, yields from the treatment programme were an average 2.2 t/ha greater. The 14 sites that *experienced a heat event in excess of 30ºC recorded an average 1.9 t/ha yield increase.*

What effect does abiotic stress have in potatoes?

Plant physiological studies that indicate where potatoes are under the effects of oxidative stresses, are unable to assimilate photosynthates, including sugars and carbohydrates, from leaves down into tubers. In fact, they may even be drawing on plant reserves to counter the stress factors.

When plants come under stress, cells respond at a molecular level to try and mitigate the effects. Whenever cell function adapts, it requires energy that may otherwise be utilised for growth and carbohydrate storage – in potato roots and tubers, for example. Initially oxidative stress occurs as the plant seeks to mitigate heat stress effects. As a result, plants use the proteins and enzymes that would typically be used for growth and development, to produce different proteins that will better protect cells against heat shock.

If the impact of heat is prolonged, the plant will start to extract proteins, carbohydrates and sugars that are components of cell membrane and cell walls – a process that will slow down growth and development of the plant. If potatoes are developing tubers, the plant will cease translocation of required sugars, carbohydrates and other metabolites to storage in the tuber.

That can cause a yield reduction in both the number and size of tubers, along with the consistency of quality, and where the heat stress relief of Quantis is targeted to minimise the damage.

What's happening at a plants' cell molecular level?

As plant cells adapt under the influence of stress there is an increase in reactive oxygen species (ROS - known as free radicals).

As a result, plants affected by heat or drought can go into a stress induced decline curve:

- *Reduced respiration and energy production limits N uptake and slows the plants amino acid production*
- *Photosynthetic activity is reduced and carbohydrate reserves are depleted*
- *Plants break down existing carbohydrates and proteins from cell membranes and walls, to re-assimilate them to produce a source of nitrogen for cell function.*
- *This can lead to cell decay and, ultimately, cell death. It can be seen as early senescence of leaves – which further impacts on photosynthetic activity and reduced yield.*

A strength of Quantis lies in its relatively high proportion of short chain carbon molecules, which are particularly effective at helping the plant to prevent the creation of ROS during periods of stress. Furthermore, it helps with the scavenging of accumulated ROS, to minimise their adverse effects.

By filling the organic carbon gap when a plant comes under heat stress, it can activate and enhance the plant's natural capability to adapt to heat stress, to prevent damage and minimise its effects.

How does Quantis relieve abiotic stress?

The major component of Quantis is organic carbon, which includes sugars and organic acids with anti-oxidant properties.

These anti-oxidant effects are crucial to minimise the toxicity caused by ROS in cells in plants under abiotic stress. The function is to bring the plant's cell back to a stable physiological state.

As a result, plants no longer need to use reserved proteins to produce specific Heat Shock Proteins to protect cells – enabling the plant to continue generation of sugars and carbohydrates used for growth and development of tubers.

Organic carbons and amino acids in Quantis will also supply energy and protein building blocks. These are both necessary for active photosynthesis and more efficient nutrient uptake that may be reduced under stressed conditions.

The multi-function approach to stress relief in potato plants gives the potential for higher yield and better tuber size under heat conditions.

Quantis further acts as an osmoprotectant. What does that mean?

Osmoprotection with Quantis helps to achieve continuous active cell function against the effects of heat stress, through a combination of its anti-oxidant properties and enabling the cell to maintain its optimum water balance – the process of osmotic adjustment.

As soon as cells are deprived of water, they become less efficient – and further less able to cope with stress effects. Osmotic stress and leaf damage is typically associated with heat, drought and ice formation.

The effect of osmotic stress creates an imbalance in water potential inside and outside the cell. As a result, water is drawn out from the cell, leading to reduced turgor pressure within the cell and, if not rectified, cell collapse.

The osmoprotectant function of Quantis can strengthen the plasma membrane around the cell to better maintain turgor pressure that holds water in the cell, which enables it to continue to function effectively.

Osmoprotection can also help to slow the adverse effects of heat and drought for longer, which could give plants more time to adapt to the prevailing climatic conditions, or for the conditions to alter – through rainfall or irrigation, for example.

Why do biostimulants have such an exciting future role?

Biostimulants offer huge potential for enhancing plant growth that will make more efficient use of available input resources.

Fertiliser use, for example, is under ever greater scrutiny for environmental and economic impacts, along with carbon footprinting and soil health. Where biostimulants can help develop root structures and plant physiological effects to get nutrients into the plant and better utilised, that can improve yields from reduced inputs, as well as cut risk of environmental loss.

Furthermore, with legislative pressure restricting the crop protection arsenal for agronomists, along with societal desire for reduced pesticide use, biostimulants offer the potential to achieve the best possible results of what is available, as well as opening opportunities in new product development.

Although, biostimulants do not have any direct effect on disease pathogens, where plants are under abiotic stress, they are more sensitive to infection by disease and the effects can be more severe. Alleviating plants' natural health may increase the opportunity for crop protection to work most effectively.

Biostimulants are a key element for future sustainable agriculture and food production.

Where does Syngenta see the future role of biostimulants?

Recognising the huge potential of biostimulants as a complementary agronomy tool to crop protection, in 2019 Syngenta bought Valagro, a global market-leader in biostimulants and speciality nutrients in the biologicals market.

The acquisition was seen as fully in-line with Syngenta's strategy to provide growers with additional complementary choices of products and technologies.

The integration of biostimulants with crop protection was cited to enable growers to effectively and sustainably care for crops by managing resistance, enhancing soil health and reducing residues in crops, as well as addressing consumer demands.

The investment also formed part of a $2 billion commitment from Syngenta to help farmers address the effects of climate change and improve agricultural sustainability as part of the company's Good Growth Plan.

Together, Valagro and Syngenta plan to collaborate, share knowledge and build on each other's capabilities.

The more that is understood about the science behind the biostimulants, the better growers and agronomists can make use of the benefits in different situations.

www.syngenta.co.uk/quantis