Biostimulants: When Is It Right to Apply a Biostimulant?

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- This article introduces the concept of using the stress interruption framework for decision-making on-farm
- Think of biostimulants as stress-interrupters, not yield boosters
- Effectiveness depends on environment and timing and can help to close the gap between potential and actual yield

There has been an explosion in the volume and variety of biostimulants available on the market in the last 15 years. The annual market growth rate for biostimulants is ~15%, while the annual growth rate for standard fertilisers is ~1-2% per year.

There is a lot of information to absorb in the biostimulant category (SEE PAGE 49 for an overview of what a biostimulant is, and PAGE 52 for an overview of things to keep in mind when navigating the biostimulant marketplace).

The scientific understanding of and research on biostimulants have not kept pace with market developments, so our understanding of how they work lags behind the availability of biostimulants as a product category. Despite a sharp increase in scientific studies over the last decade, our understanding of the basic functions of biostimulants still needs further study to definitively determine their modes of action. Due to the category's size and diversity, biostimulants have multiple modes of action, most of which are not yet fully understood.

This is a large category, with complex processes underpinning it. In order to make decisions on-farm, two frameworks may be helpful to growers deciding if they want to incorporate biostimulant applications:

1. Biostimulants work best within the category of **mitigating plant stress**. They are most often stress-interrupters
2. Biostimulant effectiveness is **heavily influenced by environmental interactions**

Basics of plant stress and yield potential

Every crop has a yield and quality potential set by genetics, environment, and available resources. In any given growing period, stress events occur that prevent the crop from reaching its full yield potential, taking bites out of it and causing actual yields to fall below the potential.

Growers rarely achieve their peak production every year. Throughout the year, small stressors chip away at yields, creating a gap between actual and potential yield.

Plants respond to stress very conservatively. Whenever a stress is perceived their first response is to cease new reproductive processes (decreasing productivity and yield) so that the remaining fruit can survive to maturity. Plant stress leads directly to declines in yield and quality.

The stress interruption framework posits that biostimulants mitigate plant stress, preventing small stressors from causing a loss of productivity. Biostimulants, in theory, enable plants to tolerate stress.

How does a plant know it's under stress, and how do biostimulants help with that?

Plants perceive their environment through sensors in the outermost layer of the root and leaf epidermises, which detect heat, salinity, nutrients, and other factors. Changes in environmental conditions can trigger a signalling process. The plant uses these signals to change its behaviour, creating a cascade of genetic conversions.

Many biostimulants function at that point of signalling for genetic conversion, where a plant converts a signal into a response. Many biostimulants seem to work by targeting how a plant perceives its environment.

Biostimulants can be tools that help crops hold performance under stress and use resources more efficiently. As a consequence of growing better, plants utilise water and nutrients more effectively, maintaining productivity. Biostimulants may either directly interact with plant signalling or stimulate bacteria, yeast, and fungi in the microbiome to produce molecules beneficial to the plant. The benefit of the biostimulant is primarily in preventing the plant from diverting energy into stress response mechanisms, which would cause drops in yield and quality.

The importance of stress interactions

Always, when you're dealing with crop stressors, you're dealing with interactions between the crop and its environment, but also different vectors of the environment interacting with each other. Common interactions include temperature, water, soil moisture content, soil structure, salinity, nutrition, duration & intensity of stress, chill factors, etc. These are all environmental factors that interact with the plant and with each other. When an imbalance in one of these environmental factors causes a negative reaction in the plant, we call it abiotic stress.

Do biostimulants work without environmental stress?

The short and unsatisfying answer: science isn't sure, and more research is needed. It may be that the plant has been exposed to a stressor not perceived by the grower, which a biostimulant application has alleviated.

An imbalance in any one vector would create stress on the plant, but an imbalance between them, or an imbalance in several can create a factorial vector of different stressors and conditions. Abiotic stress occurs in all cropping systems but can be most severe when several stressors interact.

Effectiveness of biostimulants varies with environment

Biostimulant effectiveness is highly variable. Although some of this can naturally be attributed to the wild west style marketing of the sector (biostimulants have the unfortunate reputation of being the modern-day agricultural equivalent of snake oil), it is also because biostimulants are so dependent on interactions that they're not entirely predictable.

They rely on a series of complex interactions with other environmental factors, both to work and to show an effect. Targeting a specific stress and a specific stress window gives growers the best chance of seeing an effect from biostimulants.

Every grower has had the experience of trying a product that worked well one year, only to see no difference the next.

The specific combination of stress events may have been present one year but not the next. In order to make an effective decision when purchasing a biostimulant, it's important for growers to scrutinise the stress they're trying to mitigate, assess whether they're likely to encounter it, and factor in other interactions that could exacerbate or mitigate that stress before turning to biostimulants.

So, growers can ask themselves: Using what we know about the processes plants undergo when they experience stress, are there places where we can intervene with the right product at the right time to prevent that stress from compromising yield or quality?

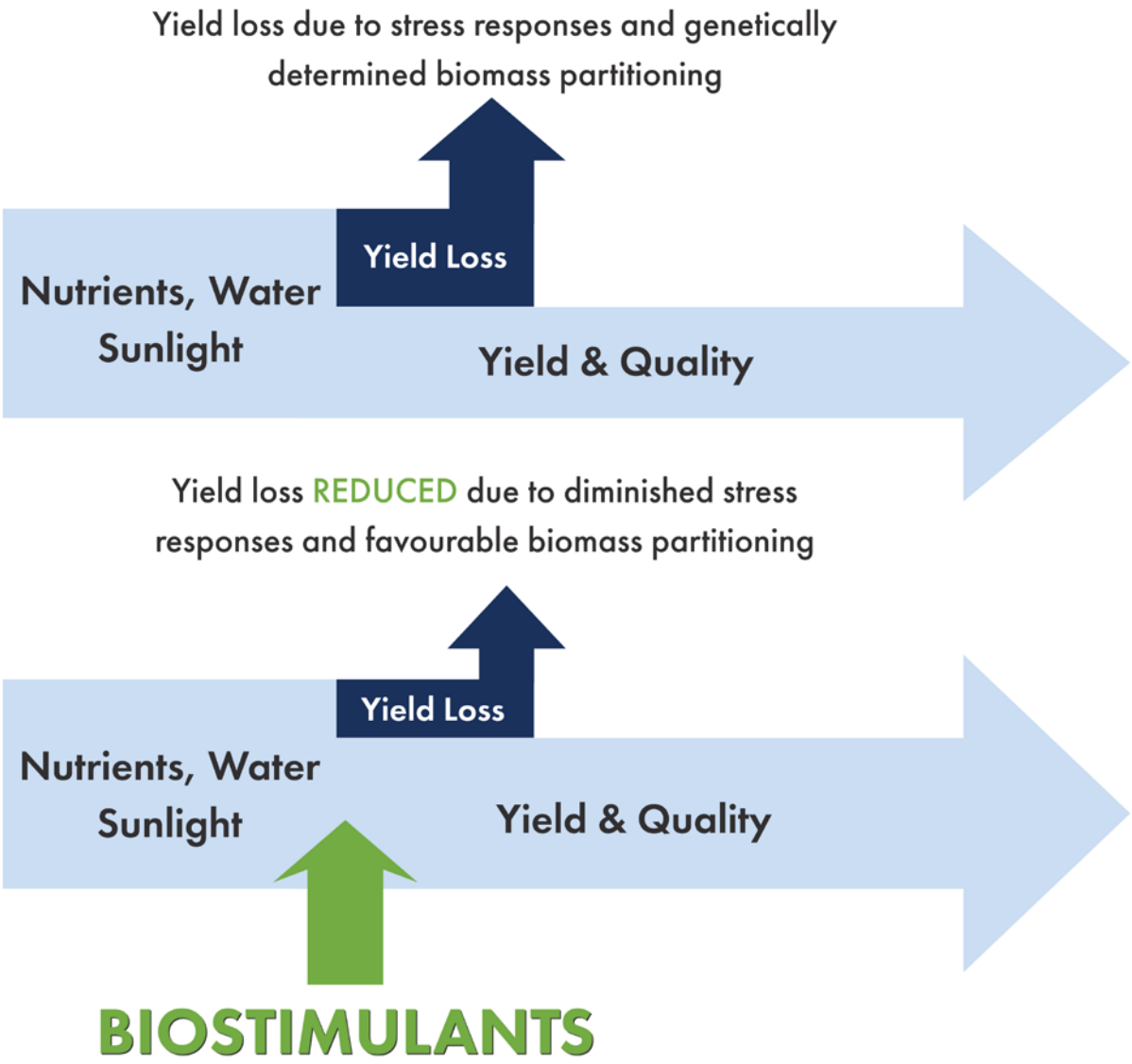

Figure 1. Yield loss throughout the season is a result of accumulated stressors, which divert plant energy to stress responses and mitigation. Many biostimulants interact with the plant at the point of signalling a stress, interfering with the plant's perception and response to stress and reducing negative consequences from the stress response. Figure adopted with permission of one of the authors from 'Biostimulants in agriculture'. *Frontiers in Plant Science*

References:

Brown, P. (2025). *Biostimulants:Their Function and Effective Use in Modern Agriculture.*

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