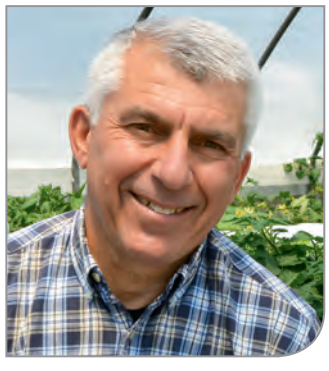
duets

BY PETER KONJOIAN AND MICHELLE JONES

Biostimulants in Crop Production:
Performance Optimization



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Michelle: I got my first introduction to horticulture during a summer internship with Gail Nonnecke and Richard Gladon in the Horticulture Department at Iowa State University. I was hooked! I completed my Ph.D. with Randy Woodson at Purdue University working on cut carnation flowers and spent three years on the faculty at Colorado State University. I have been at The Ohio State University since 2001, doing research and Extension related to greenhouse production and postproduction issues. In 2014, I started doing research on biostimulants and beneficial bacteria-plant interactions, investigating how they might be used to improve greenhouse crop quality and resilience.

Peter: Michelle, thanks for sharing your time with us. Please start today's conversation by defining the different biostimulant product categories and your experiences with them.

Michelle: Biological products, which provide alternatives to some of the traditional chemistries, include biopesticides, biofertilizers or biostimulants. We will not discuss biopesticides today, products that contain naturally occurring substances or microbes that control pests or pathogens, to allow us to focus on biofertilizers and biostimulants.

The most widely accepted definition of a plant biostimulant is a product that contains substances or micro-organisms (microbes) that stimulate natural processes in plants to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield. Biofertilizers are products that contain microbes that colonize roots or inside plants and promote growth by increasing the supply or availability of nutrients.

Peter: Michelle, every one of the natural processes you list that biostimulants enhance can be leveraged into profit. Regardless of crop category — ornamental or edible — learning to incorporate nature's microbes into our daily greenhouse, field and indoor production systems can reduce inputs, increase outputs, or both to help growers achieve necessary margins. To me, this is analogous to human health research in the arena of pro-biotics. We understand enough to know their value but need to learn a whole lot more to maximize performance. Next, help us understand the difference between a biofertilizer and biostimulant.

Michelle: The line between a biofertilizer and a biostimulant can seem a little fuzzy. Overall, biostimulants are a broader class of products that contain other active ingredients besides microorganisms. In addition to beneficial microorganisms, the efficacy of biostimulants can come from a wide range of "substances" that include but are not limited to humic acids, protein hydrolysates, biopolymers, and various botanic extracts (like sea weed extract). The 2018 Farm Bill provides the first statutory language regarding biostimulants in any law in the United States, and I think that we will hear more about how these products will be defined and regulated in the very near future.

Peter: So stay tuned as researchers, legislators and growers scale their learning curves to become more familiar with these categories. Definitions will be tweaked and products will evolve. Tell us more about your research focus shift from post production issues to this product category.

Michelle: I began conducting research on biostimulants about six years ago. With the growing interest from both growers and consumers to increase the sustainability of the greenhouse industry, I saw biostimulants as a valuable tool for growers to have available in their tool boxes. I do not propose that biological products will replace all chemical inputs, but that biostimulants provide additional options for continuing to improve plant health and resilience. While we have evaluated biostimulants that contain multiple categories of active ingredients, our primary focus has been on products that contain beneficial microorganisms, fungi and/or bacteria.

We are conducting product trials in collaboration with companies, and we have a research project that is isolating and identifying beneficial bacteria from the rhizosphere (the narrow interface between the root and the growing media) of various greenhouse ornamentals. Little is known about the beneficial microbial communities that exist within containerized growing systems, or how to use these beneficial bacteria-plant interactions to improve crop quality.

Peter: Let's move on to several practical aspects of biostimulant use. Growers have been experiencing inconsistent results with these products. Can you explain our current knowledge level regarding product performance? Why do some products work for some growers and not others?

Michelle: Well, Peter, I wish that I could provide you with an SOP or a guide to successful use of biostimulants in the

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greenhouse, but there is a lot that we do not know. There are many challenges to the successful use of biostimulants because the products are numerous and diverse, with many different active ingredients. This means that the different products are working to improve plant growth and stress tolerance via many different mechanisms.

In general, the labeling and efficacy documentation for biostimulants is minimal compared to biopesticides. Some labels often lack complete or accurate descriptions of the ingredients and do not provide detailed instructions for application. These products may come to market without adequate testing, and many may not have any third-party testing on greenhouse crops or in greenhouse production environments. Please do not get me wrong, this is not the case for all biostimulant products.

Peter: I hear you, Michelle. When walking cannabis trade shows, I see many companies focused on this product category. All kinds of claims are made, and I notice a few companies promote "backed by science" in their message. That gives me pause, as you state, that others may not have adequate research and testing behind their products.

Operating from the private sector much of my research is exactly the third-party testing you mention. When research and independent validation is missing growers can find themselves in a 'buyer beware' situation. And regardless of a product's research backing, my advice is to trial a new product on a small section of a crop before jumping in with both feet. As you know, this can be a challenge as well, as there are correct and incorrect ways to set up simple product trials. Growers who understand the requirements of control treatments, uniform trial conditions and objective observation skills will make informed decisions that improve their practices. Continue with your thoughts about how to succeed with biostimulants.

Michelle: Biostimulants, especially those that contain living organisms, rely on plant-microbe interactions that stimulate natural processes in plants. This requires a viable microbe inoculant and a viable environment for that microbe to grow and thrive. Some biostimulants include bacteria or fungi that must colonize the plant root system to provide benefits. Full colonization by mycorrhizal fungi can take six to eight weeks, after which time this symbiotic relationship increases water and nutrient uptake. While this can be beyond the production schedule for many bedding plants, retailers and consumers will see the benefits in improved growth and stress tolerance.

In contrast, some biostimulants contain bacteria that produce

Figure 1. Untreated impatiens plant showing post drought stress recovery symptom of yellowing foliage.

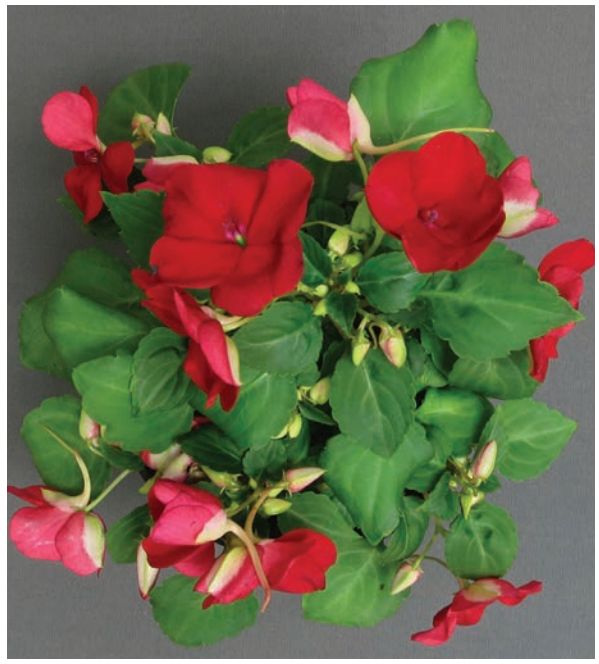

Figure 2. Beneficial bacteria treated impatiens plant showing less post drought stress recovery yellowing.

chemicals that enhance plant growth and stress tolerance without the need to interact with the plants roots and colonize. These products must be regularly applied in order to see a continued effect. These are just a few examples of why it is so important for biostimulant manufacturers to understanding the mechanisms used by all the active ingredients in a product and to translate that into an understandable and detailed application recommendation for growers. Another reason that these biostimulants do not work all the time is that the efficacy of microbe-based products is highly influenced by the growing environment and other cultural inputs. In many instances, the influence of the environment on biostimulant efficacy is complicated and not fully understood.

Peter: You just introduced the production environment as a variable to success. Do we also need to appreciate that environmental factors such as temperature, moisture, fertility and light combine to provide either a conducive or non-conducive setting for the microbial inputs to flourish?

Michelle: That's a maybe, Peter. Perhaps, even more importantly, biostimulants can be thought of like insurance. When plants are being produced with optimal fertility, irrigation and growing environment, the benefit of biostimulants may not be readily observed. It is when plants are produced with lower fertilizer inputs or inadvertently exposed to stress that the benefits can become readily apparent. For example, some biostimulants will make plants more tolerant of drought stress. When biostimulant treated plants wilt due to water stress, irrigated plants tend to recover and are of better quality (i.e., less leaf yellowing, more and quicker flowering) than untreated plants (Figure 1). I think the largest reason that the positive effects of biostimulants are not more consistently observed during production is that plant growth is already optimal and the growth and quality potential of that crop is already realized.

Peter: Based on your research and experience what guidelines, or best practices, do you recommend for consistent success with these products?

Michelle: The best advice I have about biostimulants is to understand what you want to achieve with that product and select a product accordingly. Communicate directly with the manufacturer or your sales reps to get detailed instructions on how and when to apply the products. With all biostimulants, not just those containing microbes, application timing and concentration is very important. Ask to see research-based efficacy data from third parties and talk to other growers who are using the product. Many of the results that we have seen from companies are from field tests of plants growing in soil. Ask if they have done trials with plants growing in soilless mixes. Also ask them what plants they have tested and what responses they saw. It will still be important to do some in house trialing on a small group of plants before you apply a biostimulant product on your whole crop to confirm that there is no phytotoxicity nor negative interactions with other inputs in your production system. Make regular observations of the plants and make sure that you have untreated plants (controls) to compare the treated plants to.

Peter: Thanks, Michelle, for your contribution of helping us understand biostimulants and their value to crop production. gpn