biostimulants

Activate the full potential **of plant biostimulants**

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Biostimulants have been for a few years a category of crop inputs recognized for its positive impact on crop yield and quality. Researchers agree that biostimulants are, by definition, "a substance or microorganism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield" (du Jardin, 2015).

Categories of biostimulants

Biostimulants are grouped in nine categories, defined by the type of technology they contain *(**see table 1**)* and by their physiological effect. For many years, farmers and researchers questioned the efficacy of these technologies; however, a great number of recent scientific publications have demonstrated the beneficial effects of these technologies on crop yield and quality, and also on water use efficiency, root growth and the triggering of defensive mechanisms in plants that reduce the effect of abiotic stresses on crops.

Table 1. **Categories of biostimulants**

Type of biostimulant	Mode of action	Utilization
Amino acids and peptides	Source of amino acids and nitrogen. These products improve photosynthesis and increase enzymatic activity. They are effective chelating agents.	Foliage
Seaweed and plant extracts	Improve production of auxin, cytokinin, gibberellin and anti-stress molecules (mannitol, alginic acid). They favour greater absorption of nutrients and water and improve photosynthesis.	Roots and foliage
Chitosan	Protection against viruses and bacteria. It activates plants' natural defense mechanisms. Promotes the production of metabolites and photosynthesis.	Foliage
Metabolic signals	Activate plants' defense mechanisms against abiotic stresses. They increase the chelation of cations and photosynthesis.	Foliage
Fulvic acids	Improve absorption of nutrients and production of some hormones (auxin). They enhance transport of nutrients in the plant and increase photosynthesis.	Foliage
Humic acids	Improve absorption and transport of nutrients. They improve the cation exchange capacity in soils.	Roots
Beneficial bacteria	Improve nitrogen fixation and solubilization of nutrients. Activity similar to an auxin and a gibberellic acid. Production of ACC deaminase.	Roots and foliage
Mycorrhizae	Fungi that improve exploration of soil profile around the roots thus increasing the absorption of nutrients. They stimulate production of amino acids.	Roots
Inorganic compounds	Beneficial mineral elements (silicon, selenium, cobalt, etc.). These minerals increase resistance to abiotic stresses, diseases and insects and facilitate nitrogen fixation in legumes.	Roots and foliage

Source: Calvo et al., 2014 and Ma et al., 2022.

Activate the full potential of plant biostimulants *continued*

Agro 100 cultivating innovation

The Market Worldwide

The worldwide market of biostimulants is valued at $4.2 billion US in 2023. The biostimulants offered by European and North American companies are mainly based on seaweed extracts (23%) and on bacteria (21%), followed by amino acids (18%) and humic substances (7%). In Canada, the proportion of bacterial products is at 43%, followed by mycorrhizae (11%) and humic substances (9%). Only 10% of the products offered worldwide contain more than one biostimulant technology; in Canada, this proportion is below 1%.

When 1 + 1 = 3

However, it has been demonstrated that it is possible to obtain interactions between these biostimulant technologies. There are three types of interaction between technologies. They can be antagonistic, additive or synergistic. Technologies are antagonistic or additive when the effects of the technologies used together are smaller or equal to the sum of the technologies used individually. For example, certain fungi can have a negative effect on the growth of mycorrhizae (De Jaeger et al., 2010). A synergy appears when the effects of the technologies used together are larger than the sum of the products applied individually. Similarly, the negative effects of abiotic or nutritive stresses are sometimes undervalued because they are analyzed individually. Recently, it has been shown that the negative and synergistic effect of five stresses (salinity, heat, herbicides, phosphorus deficiency, heavy metals), that if taken individually would not have had an impact on crop yield, have significantly reduced yield (Sinha et al., 2023). It is therefore possible to use more than one category of biostimulants to reduce the negative impact of abiotic stresses on yields.

The Synergy between Biostimulant Technologies

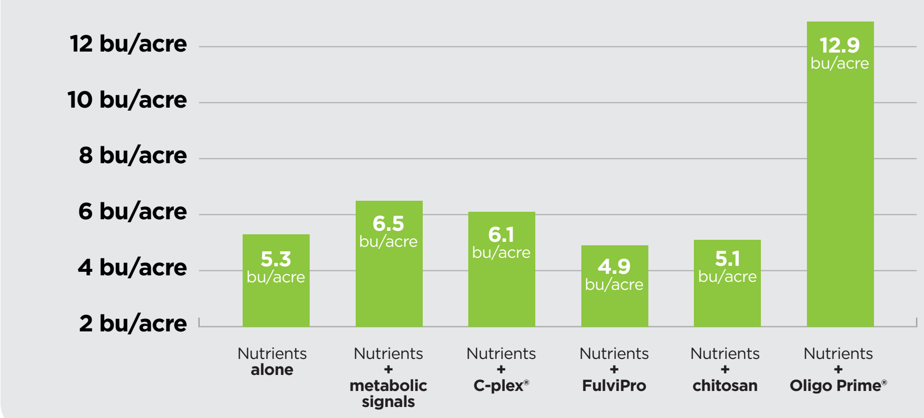
Since the start of its research program, Agro-100 has worked to identify and characterize synergies between its biostimulant technologies. OligoPrime® is the result of more than 8 years of research on the effect of biostimulant technologies on the yield of crops. This research program has enabled us to identify the ingredients, the technologies, the dosages and the manufacturing methods that allow for a dynamic synergy between the four technologies contained in OligoPrime®. The metabolic signals contained in OligoPrime® trigger the natural defense mechanisms against abiotic stresses, a complex of organic acids that chelate cations, fulvic acid, a molecule that increases the production of auxin and the growth of the root hairs, and chitosan, a molecule that triggers defensive mechanisms in plants.

Twenty-two small plot trials conducted in corn between 2017 and 2022 allowed us to measure the interactions obtained when more than one technology was utilized in our biostimulants. Yield increases obtained with OligoPrime® are substantially larger than the yield increase obtained when only one technology is used.

Proven Efficacy

In collaboration with farmers, Agro-100 also runs trials to confirm the efficacy of our technologies in very variable agro-climatic environments. These large scale trials confirmed that the yield increases obtained were at least sufficient to pay for the product in 88% of the cases. The variability in crop conditions and observed stresses explain these results.

Yield increases (bu/acre) obtained by biostimulant technologies in 22 trials between 2017 and 2022



REFERENCES

CALVO, P., NELSON, L., KLOEPPER, J.W. (2014). Agricultural uses of plant biostimulants. *Plant Soil* 383, 3–41. https://doi.org/10.1007/s11104-014-2131-8

DE JAEGER, N., DECLERCK, S., DE LA PROVIDENCIA, I.E. (2010). Mycoparasitism of arbuscular mycorrhizal fungi: a pathway for the entry of saprotrophic fungi into roots. *FEMS Microbiology Ecology* 73, 312–322. https://doi.org/10.1111/j.1574-6941.2010.00903.x

DU JARDIN, P. (2015). Plant biostimulants: Definition, concept, main categories and regulation. *Scientia Horticulturae* 196, 3–14. https://doi.org/10.1016/j.scienta.2015.09.021

MA, Y., FREITAS, H., DIAS, M.C. (2022). Strategies and prospects for biostimulants to alleviate abiotic stress in plants. *Frontiers in Plant Science* 13.

SINHA, R., PELÁEZ-VICO, M.Á., SHOSTAK, B., NGUYEN, T.T., PASCUAL, L.S., OGDEN, A.M., LYU, Z., ZANDALINAS, S.I., JOSHI, T., FRITSCHI, F.B., MITTLER, R. (2023). The effects of multifactorial stress combination on rice and maize. *Plant Physiology kiad557.* https://doi.org/10.1093/plphys/kiad557