



Harnessing the soil-plant microbiome

February 2017



What is Agrinos?

A global leader in biological crop input solutions to improve the productivity & sustainability of agriculture



Founded ■ 2009

Geography ■ Commercial presence in 7 countries

Staff ■ ~ 140 employees worldwide

Patent Portfolio ■ 50+ patents & patent applications
 ■ 10 patent families

Agrinos Innovative and Proprietary Product Portfolio

“Must Have” High Yield Technology Products



- Promotes root biomass function
- Enhances crop quality and fertility under both favorable and stressful conditions
- Proprietary liquid applied to soil



- Provide carbon, nitrogen, true protein, free amino acids & essential micronutrients
- Improves crop tolerance to environmental and physiological stresses
- Unique foliar nutrient solution



- Improves root structure
- Strengthens plant function to increase tolerance to environmental stresses
- Supports soil health
- Nutrient-rich powder applied to soil

Broad Acre Crops



Corn



Potatoes



Soybeans



Sugarcane



Cotton



Wheat

Specialty Crops



Berries



Citrus



Coffee



Tomatoes



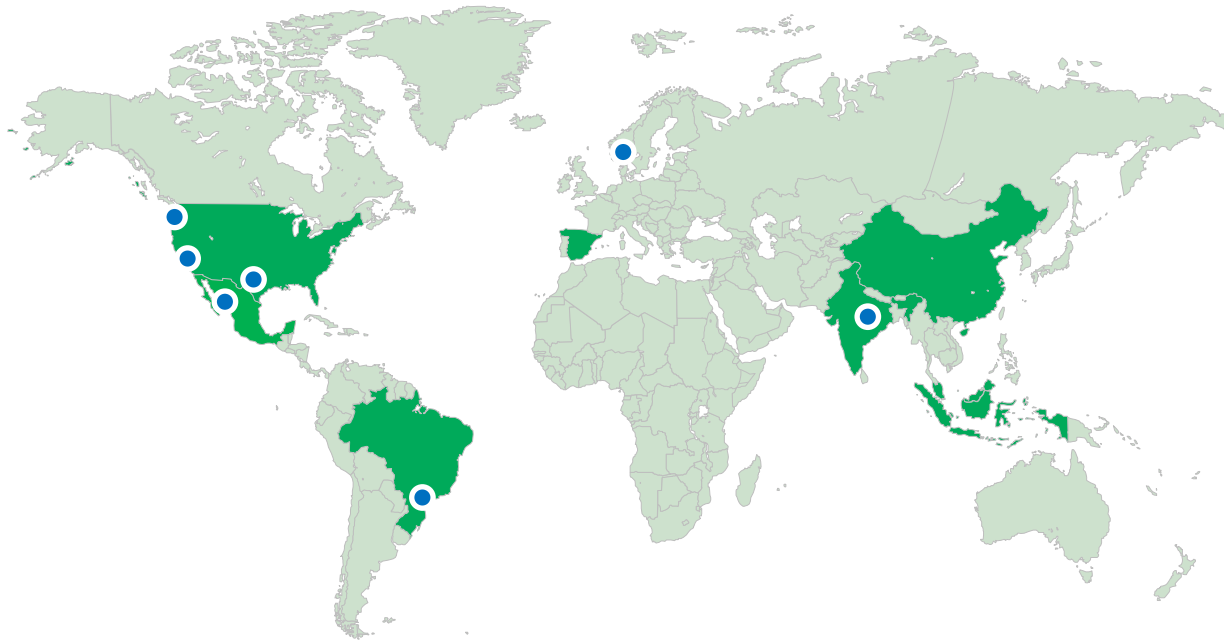
Leafy Greens




Vegetables

Agrinos' Partners with Leading Crop Input Distributors

Agrinos Distribution Network



 **Agrinos**
 Commercial Operations
 Corporate Hubs

Select Distribution Partners

 Butterfly Warehouse Company	 cooxupé
	 DCM SHRIRAM Growing with trust
	
	 NAGARJUNA GROUP
 RALLIS INDIA LIMITED A TATA Enterprise	RALLIS INDIA LIMITED
	 WILBUR-ELLIS® Ideas to Grow With™
ZUARI AGRO CHEMICALS LTD.	

The living soil

- Soil is a natural body comprised of **solids, liquids, and gases** that occurs on the land surface
- Soil consists of **layers**. The first 2 meters can be **altered by** the **climate, human activities, and living organisms** over time.
- Healthy soils are **full of living organisms**. Some are visible to the naked eye, like earthworms, ants, beetles and mites, but the majority of soil-dwellers are **very small (called microbes)**. They're also very **important to soil fertility** and form **ecological communities or microbiomes**.



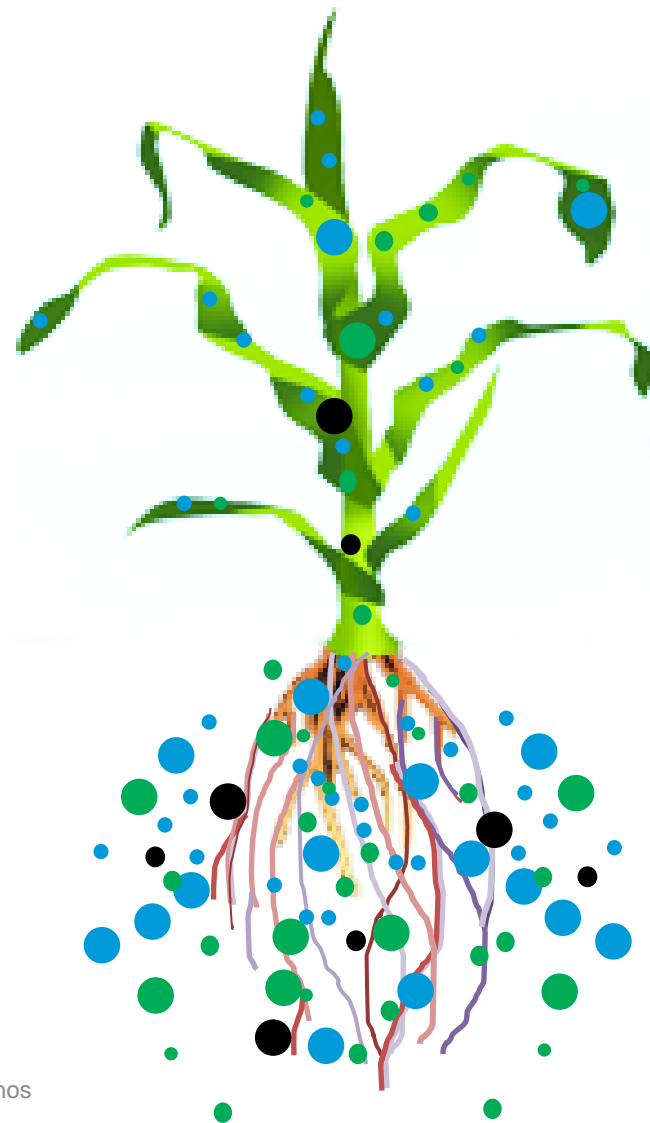
“There can be 10,000 to 50,000 species in less than a teaspoon of soil. In that same teaspoon of soil, there are more microbes than there are people on the earth. In a handful of healthy soil, there is more biodiversity in just the bacterial community than you will find in all the animals of the Amazon basin.”¹

¹ [“Healthy Soil Microbes, Healthy People – The microbial community in the ground is as important as the one in our guts”, The Atlantic, June 11, 2013](#)

Diversity of the plant microbiome provides vast opportunities for agricultural productivity improvements

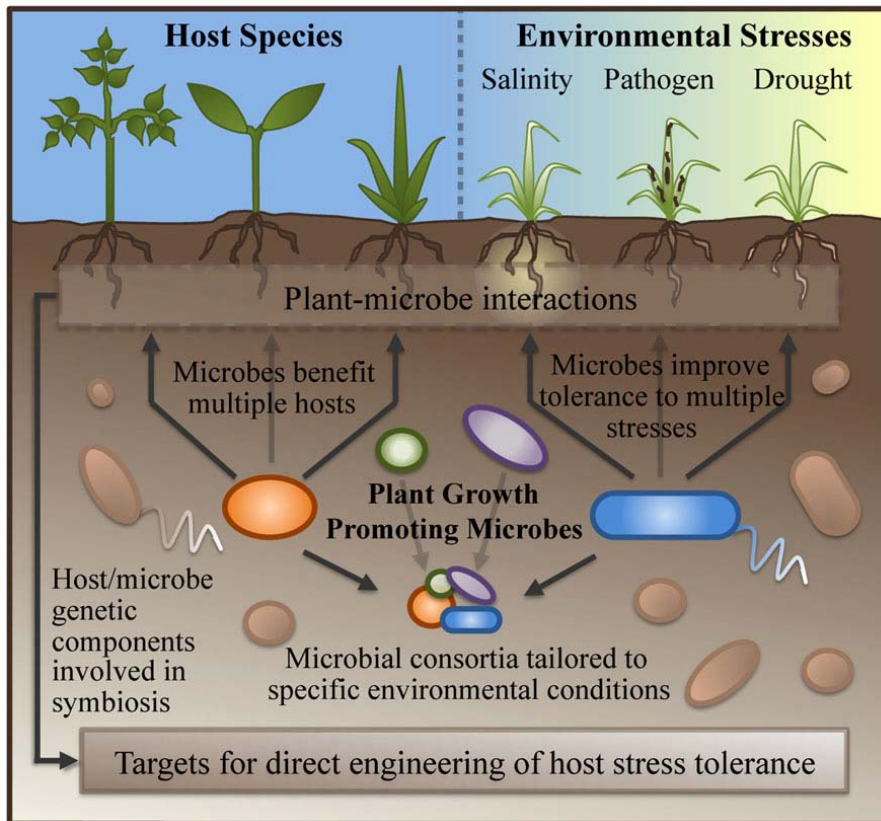
Complex interactions within and with the consortium of microbes that coexist with a plant directly and indirectly affect plant growth and development

- **Beneficial** – microbes which directly benefit a plant through the innate biological functions
- **Commensal** – microbes that benefit the soil microbial community (i.e., are good neighbors to have)
- **Harmful** – microbes that have a negative impact on the plant and/or soil microbial community



- Commensal microbes
- Beneficial microbes
- Harmful microbes

Plant Growth Promoting Microbes Play Different Roles in Soils



- Microbes capture and digest the soil nutrient reserves from inorganic and organic fertilizers and release them in a **plant-usable form, especially P and K**.
- Microbes capture and fix nitrogen gas for use by plants.
- Microbes **create soil organic matter** that improves soil water management.
- Microbes **increase available nutrients** in the soil to help improve efficiency of fertilizer usage.

HYT® A is produced by a fermentation process utilizing a consortium of microbes that promotes a highly productive microbial system in the soil.

In conjunction with fertilizer, **HYT® A** promotes the absorption of nitrogen and critical minerals to increase the level of bioavailable nutrients to the crop root system.

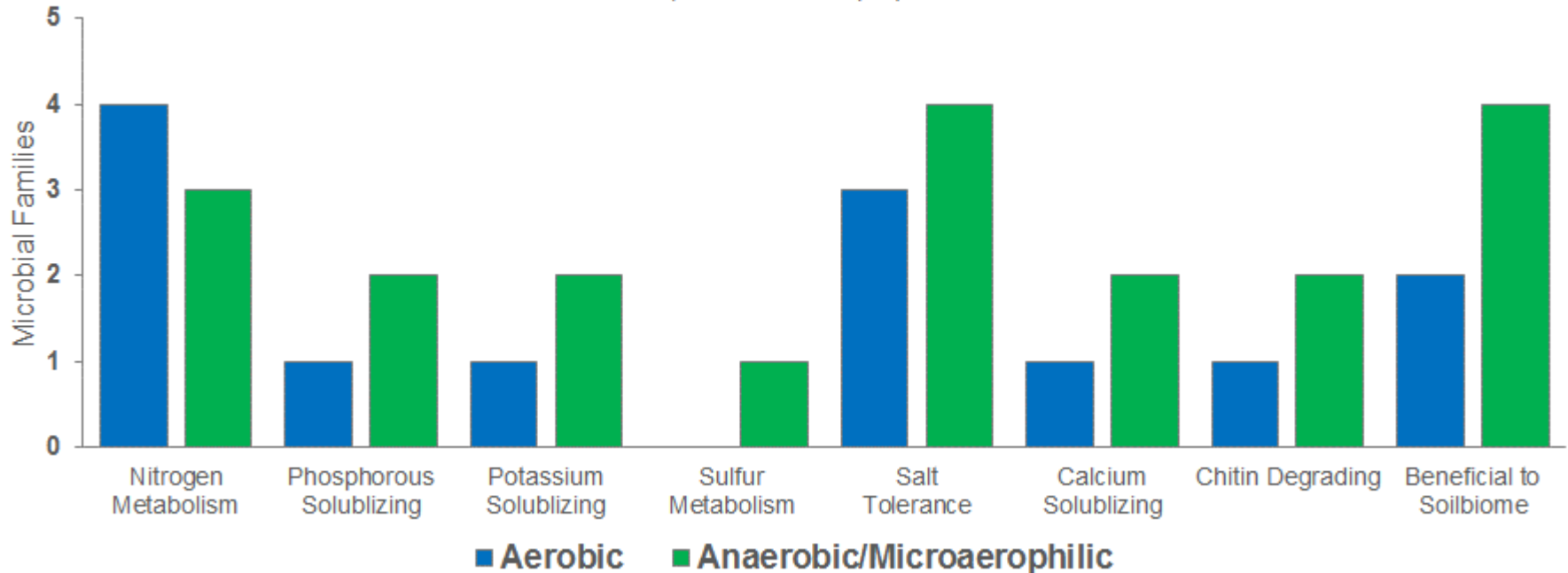
Benefits of HYT® A

- Supports root biomass formation resulting in a more vigorous root system.
- Enhances crop quality and yield under both favorable and stressful growth conditions



HYT A – Benefits Delivered by a Diverse Microbial Consortium

Agrinos Microbial Product Microbial Functionality
(Product Example)



* Ongoing testing may confirm additional families delivering functional attribute.

- Agrinos has isolated and verified the functional benefits delivered by strains of member families in our microbial fermentation collection
- Agrinos' consortium delivers a broad range of benefits, often with redundancy across families, which supports consistent results across a diverse range of environmental conditions and crops

Nitrogen, Phosphate, Potassium and Sulfur Metabolism

N metabolism: the process by which **nitrogen is converted into various chemical forms** including fixation, nitrification, ammonification, & denitrification.

HYT A contains microbes that can **fix atmospheric nitrogen** or **convert nitrates** back into inert nitrogen gas (Denitrification) to provide additional sources of usable nitrogen.

P metabolism: bacteria in HYT A **secrete mild organic acids** that **solubilize mineral phosphate (and calcium)** making it available to plants and other microorganisms.

K metabolism: soil minerals make up more than 90% of soil K; however, most of it is unavailable for plant uptake. HYT A contains potassium solubilizing bacteria that dissolve potassium by excreting organic acids which either directly dissolve rock K or chelated silicon ions to bring K into the solution ⁽¹⁾

1- Priyanka Parmar, S. S. Sindhu. Journal of Microbiology Research 2013, 3(1): 25-31

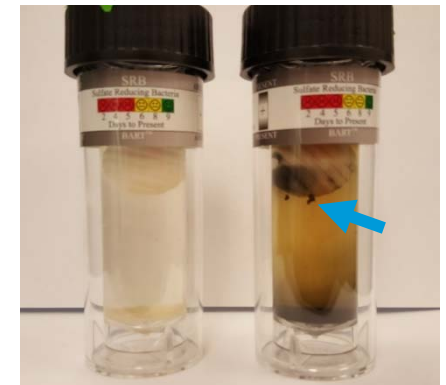
Sulfur metabolism: Sulfur is particularly important to living cells because it is a **component of many proteins and enzymes**. HYT A contains microbes (bacteria & archaea) that can process sulfur compounds.

Nitrogen-free, growth medium



Nitrogen Gas Fixation Test

Negative Positive



Sulfur Metabolism Test

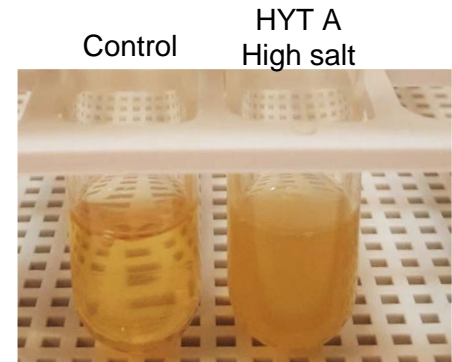
Salt Tolerance and Chitinolytic Activity

Salt tolerance: High concentrations of salts in the soil make it **harder for roots to extract water and nutrients**. Healthy and active salt tolerant microbial populations in the soil convert organic K^+ , Mg^+ and Ca^{++} to the mineral form which makes them more readily available to plants.

HYT A contains microbes which **grow in high salt** conditions:

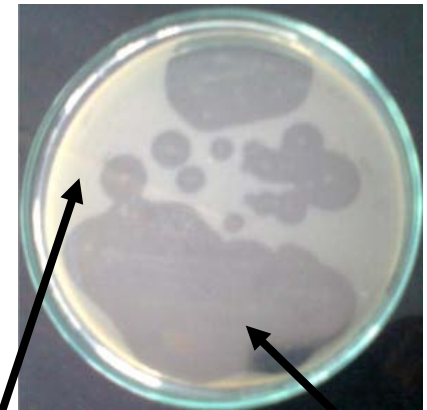
- Produce/secrete **organic acids** as byproducts, which help dissolve mineralized salts.
- **Convert organic K^+ , Mg^+ and Ca^{++} to the mineral form** which makes them more readily available to plants.

Chitinolytic activity: Chitin is a **nitrogen containing complex sugar (polysaccharide)**. Microbes in HYT A are capable of hydrolyzing insoluble chitin to become a nutrient source for other plant beneficial microbes.



Microbial Tolerance Test

Chitin Hydrolyzing Test



“Undigested”
chitin in medium

HYT A microbes
“digesting” chitin

How is HYT A different than other microbial products?

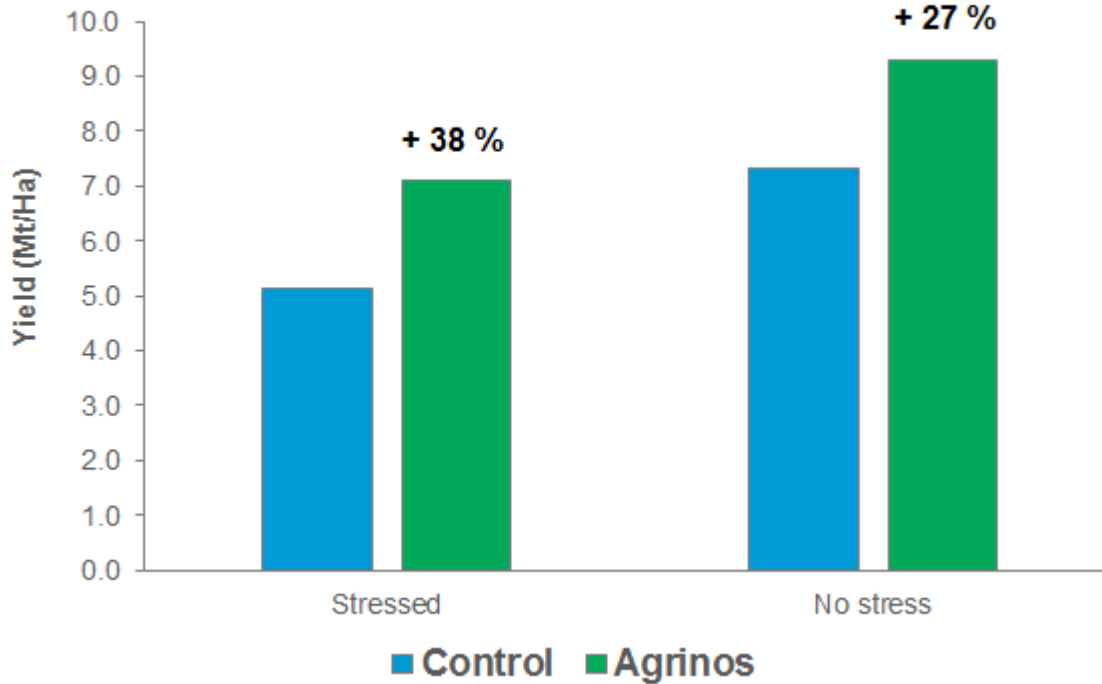
Competitor Products	Agrinos HYT A
<ul style="list-style-type: none">• Contain fewer microbes – majority with 1-6 microbe types• Use “generic” (or commonly used) microbes often from the same family• Microbes are individually fermented and “mixed” together in the final product	<ul style="list-style-type: none">• Microbial consortium results in robust microbe function in soil biome to support plant health and productivity• Unique co-culture process results in leading shelf-life and enhanced microbe viability• HYT A consortium brings a complex and comprehensive microbial “ecosystem” to the soil – to improve efficacy across diverse crops & environments• Ability to mix easily with bulk fertilizers (e.g. UAN) and deliver as value added product

Agrinos, a pioneer in microbial products, has commercialized the **only consortium based microbial product** manufactured through **a co-culture process** on the market.

Corn – Significant stress reduction demonstrated with HYT A *California, US 2015*



2015 California Corn Yield
(Water Stress Study)



Year	2015
Crop / Hybrid	Hybrid Corn
Location	Woodland, CA
Products / Rates	<ul style="list-style-type: none"> • HYTA – injected with UAN at 2.5 L/Ha rate at V6 • Stressed and non-stressed plots were irrigated with a total of 275 mm and 425 mm water, respectively • Stress applied at V8 through initial flowering
Field Size / Replications	Small plot RCBD with 5 replications

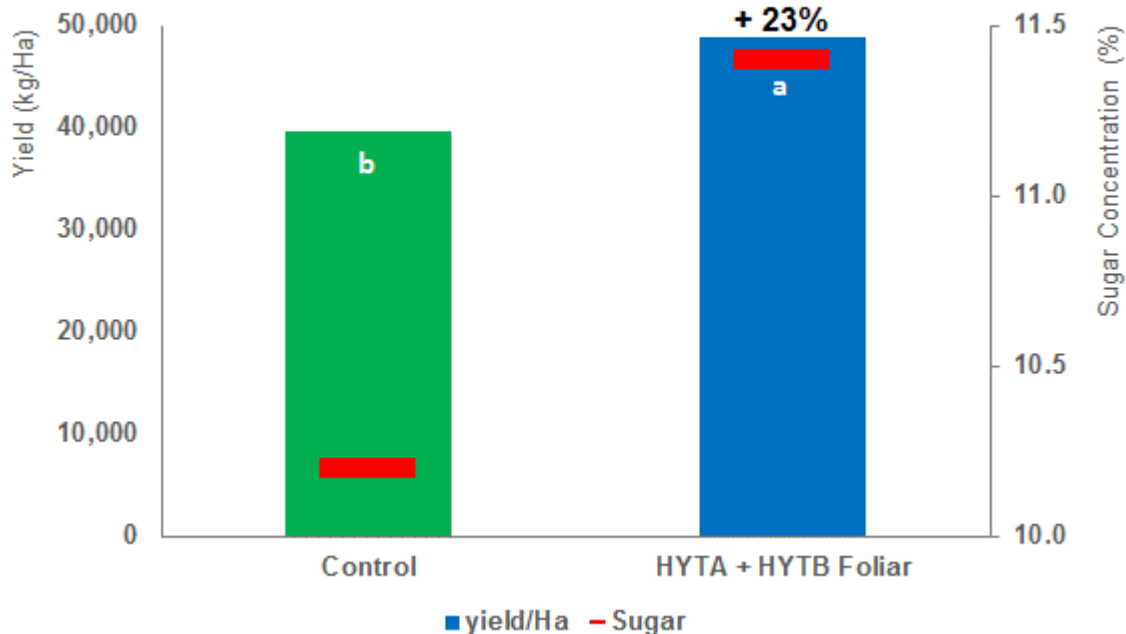
Research Trial
performed by:

Agro-Tech, Woodland

Watermelon – Yield and sugar concentration results

2016 Spain

Watermelon Yield & Sugar Concentration - 2016
(Spain, Kg/Ha and %)



Planting / Harvest	February 2016- 27 April and again 11 May 2016
Crop / Hybrid	Watermelon
Location	Almeria, Spain
Products / Rates	HYT A – 10 L / Ha injected with fertilizer at transplant, week 5 & week 8 HYT B – 2.5 L/Ha foliar applications at 1 st flowering and 1 st cut
Field Size / Replications	3 reps in 100 m2 plots
Trial performed by	<i>Fitotest S.L. Agricultura Ensayos Agrícolas</i>
Comments:	<ul style="list-style-type: none"> • HYTA + HYTB had better watermelon production (P<0.05) than the control • Sugar concentration (Brix) differed (P<0.05) and was higher for the Agrinos treated melons compared to the control. • Individual melon weights did not differ

➔ Increased yield by 23% (or > 9,200 kg/Ha)

Conclusions

- Agrinos' HYT A contains a unique, complex and multifunctional microbial ecosystem to support a healthy soil microbiome
- Application of HYT A to plants tips the rhizosphere microbiome in favor of beneficial microbes
- A rhizosphere with robust beneficial microbes enhances the plants' ability to overcome stresses –"probiotic" (abiotic and/or biological)
- Although a few years behind the science of human microbiomes, understanding and deciphering soil/plant microbiomes is now undergoing the same revolution