

**Primera Reunión Técnica 2026
Centro de Pomáceas**



Biodiversidad funcional y su aporte a la productividad y resiliencia climática en frutales

Dr. Pablo Cornejo Rivas



100 μm



Compromisos globales: UNA SOLA SALUD y ODS



One Health y producción sustentable

la salud de las personas, la flora y la fauna están estrechamente conectadas a través de un único entorno compartido.

Credit: Delaware Valley University



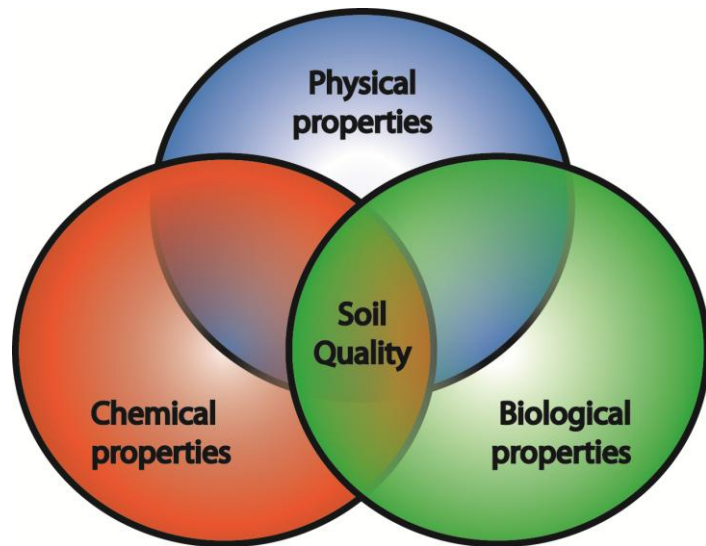
17 objetivos para transformar nuestro mundo



Calidad de suelo y propiedades biológicas

Calidad/Salud del suelo →

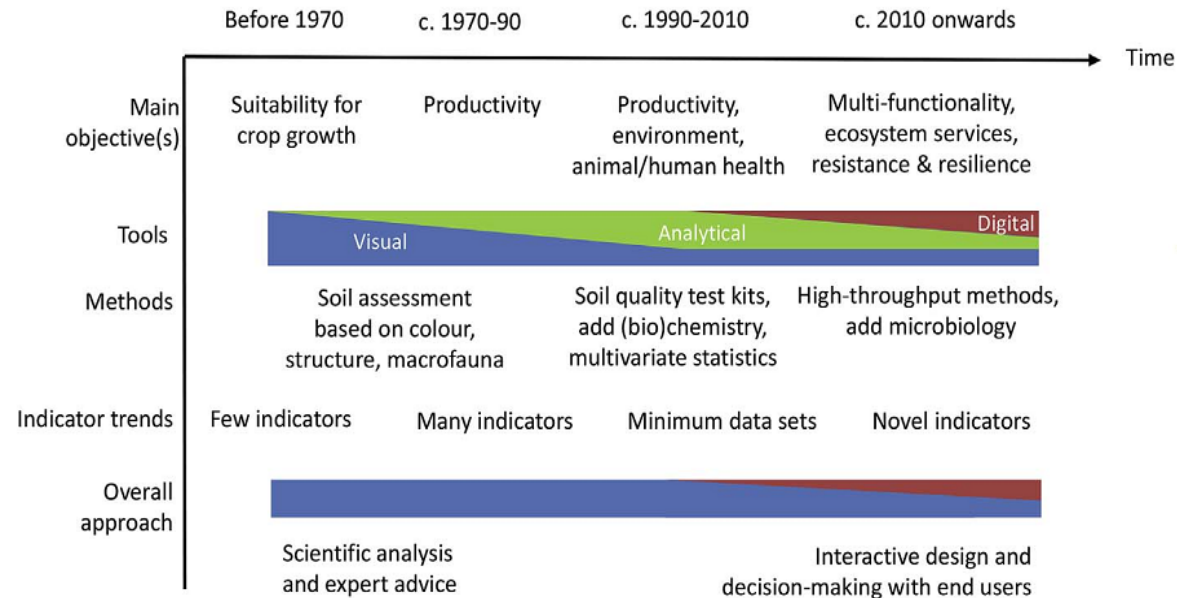
“La capacidad continua del suelo para funcionar como un ecosistema vivo que sostiene plantas, animales y humanos”

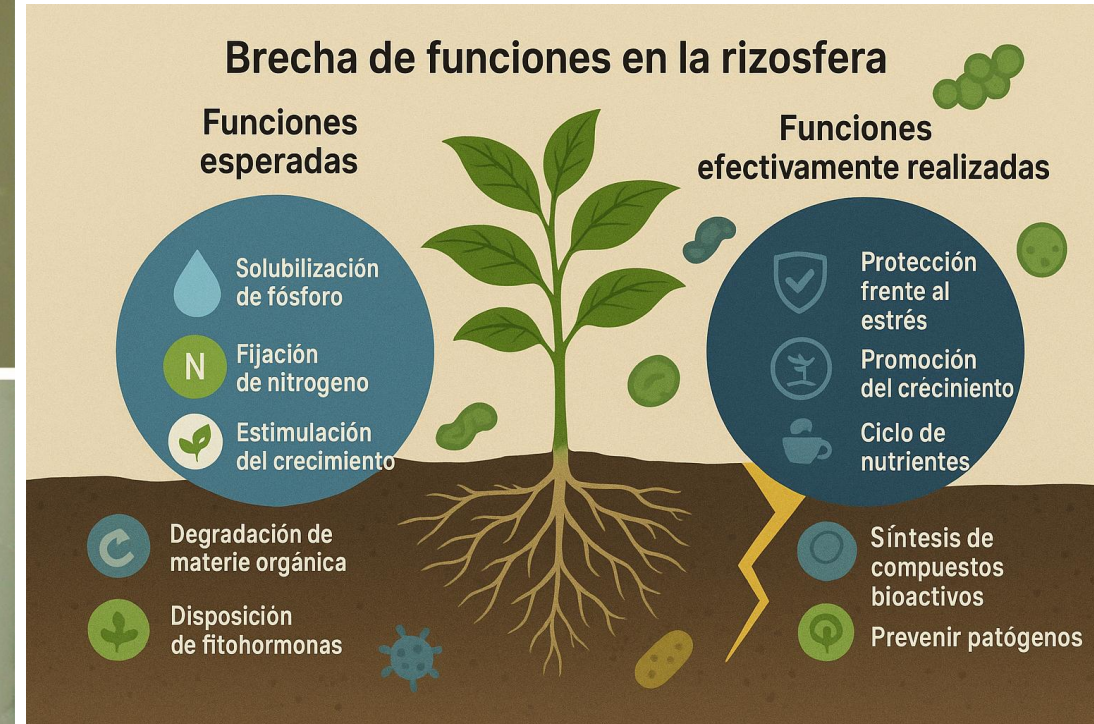
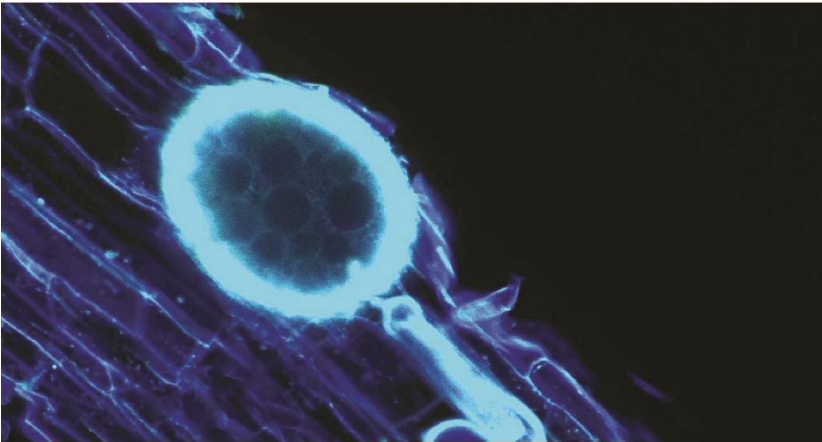
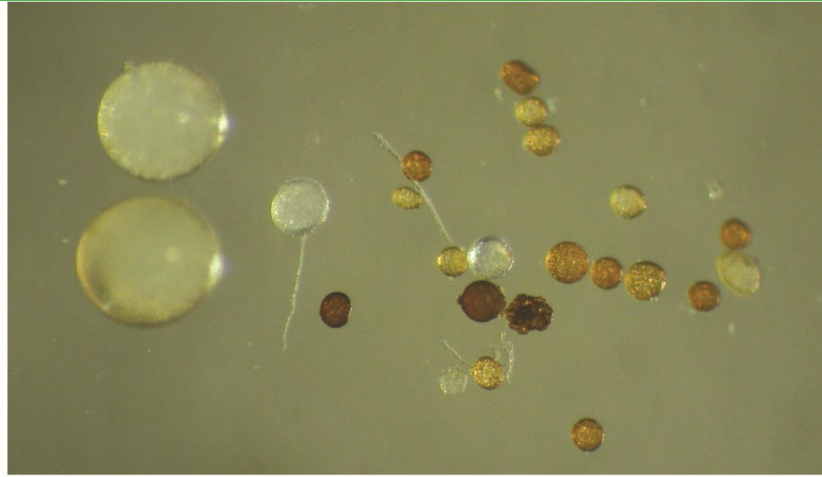


Los indicadores de calidad/salud de suelo deben ser:

- Sensibles
- Rápidos
- Económicos
- Exactos

} **Propiedades biológicas**





“lo esencial es invisible a los ojos”.

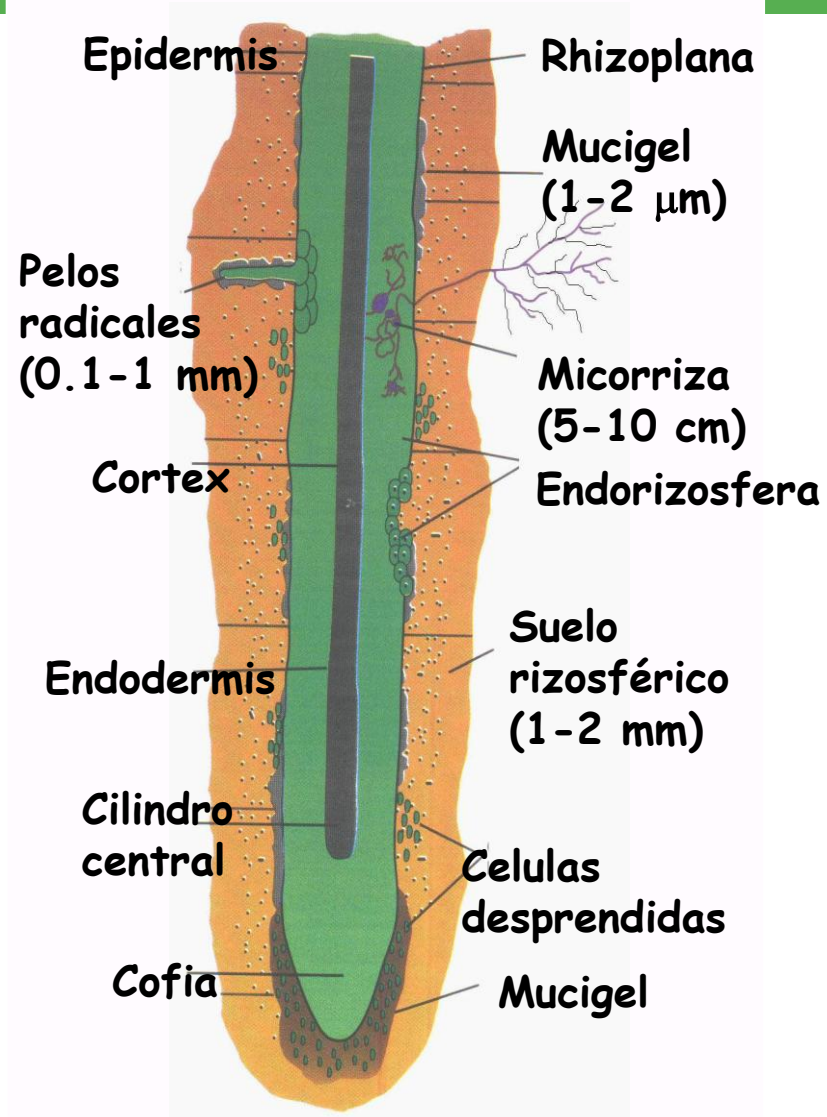


EL SECRETO MUNDO BAJO NUESTROS PIES

¡Las plantas no tienen raíces! Curiosamente, la casi totalidad de plantas terrestres se encuentran asociadas con hongos, formando estructuras llamadas micorrizas (mico=hongo + riza=raíz), que le permiten a las plantas tomar nutrientes y agua desde el suelo. Dentro de las micorrizas más extendidas destacan las llamadas arbusculares, que colonizan la misma célula de las raíces, y que forman estructuras de resistencia o “esporas”

de gran belleza en el suelo, con las cuales pueden reproducirse. En esta imagen se observa una espora generando una micorriza (arriba/izquierda), varios tipos distintos de esporas (arriba/derecha), una espora fluorescente por el aluminio presente en su pared (abajo/izquierda) y varias esporas azules cargadas con sales de cobre formando el “Meli Wiran Mapu”, que según la cosmovisión mapuche representa la tierra y sus puntos cardinales.

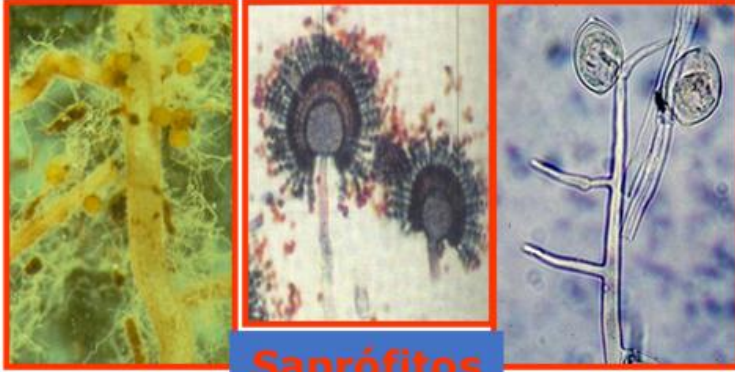
Raíz secundaria



La rizosfera: zona del suelo afectada por la presencia de raíces, donde prosperan y trabajan los microorganismos



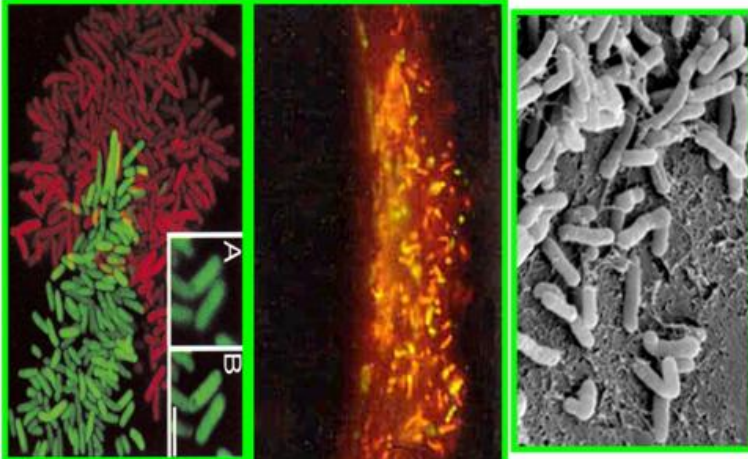
Hongos



Saprófitos

Simbiontes

Patógenos



Bacterias

Microorganismos

Funciones

Saprotitos

Rizobacterias & hongos

Bacterias específicas

Simbiontes mutualistas

Rhizobium y otros

Hongos micorrícicos

Establecimiento de plántulas (**fitoestimuladores**)
Protección planta (**agentes control biológico**)
Ciclado de nutrientes (**biofertilizantes**)

Descontaminación (**agentes de biorremediación**)

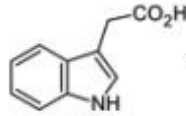
Fijación de N₂ (**biofertilizantes**)

Establecimiento de plántulas (**fitoestimuladores**)
Protección planta (**agentes control biológico**)
Ciclado de nutrientes (**biofertilizantes**)
Descontaminación (**agentes de biorremediación**)
Conservación de suelo (**mejoradores ecosistémicos**)
Sucesión vegetal (**mejoradores de la revegetación**)

BACTERIAS

- Hormones important for:**
- Xylem and phloem differentiation
 - Primary and secondary root development and elongation
 - Seed germination
 - Stem elongation
 - Cell division

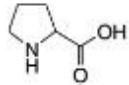
Indole acetic acid (IAA)



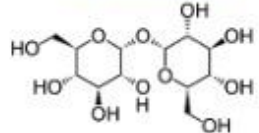
- Other growth regulating substances:**
- Gibberellins
 - Cytokinins

- Osmolytes important for:**
- Hydration capacity
 - ROS detoxification
 - Maintenance of cell turgor
 - Stem elongation
 - Cell division

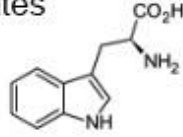
Proline



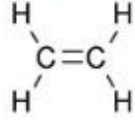
Trehalose



Tryptophan released by roots exudates



Ethylene



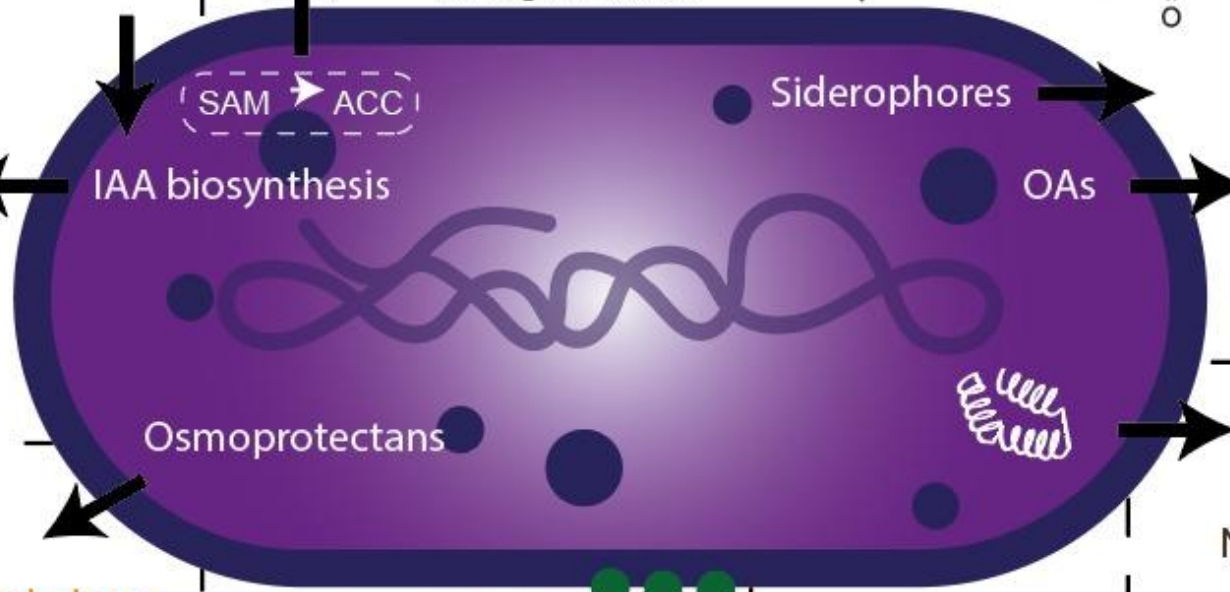
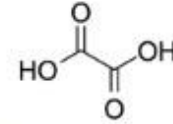
Gaseous hormone

- important for:**
- Promote, inhibit or induce senescence
 - Development of fruits, leaves and flowers
 - Seed germination

- Important for:**
- Nutrient solubilization and mineralization

Organic acids (OAs):

- Gluconic acid
- Oxalic acid
- Malonic acid
- Succinic acid
- Citric acid
- Propionic acid
- Acetic acid
- Isovaleric acid
- Lactic acid
- Aspartic acid
- Tartaric acid
- Glyoxalic acid



Exopolysaccharides

- Important for:**
- Water uptake
 - Protection against desiccation
 - Rhizosphere formation

Extracellular production

Volatile compounds

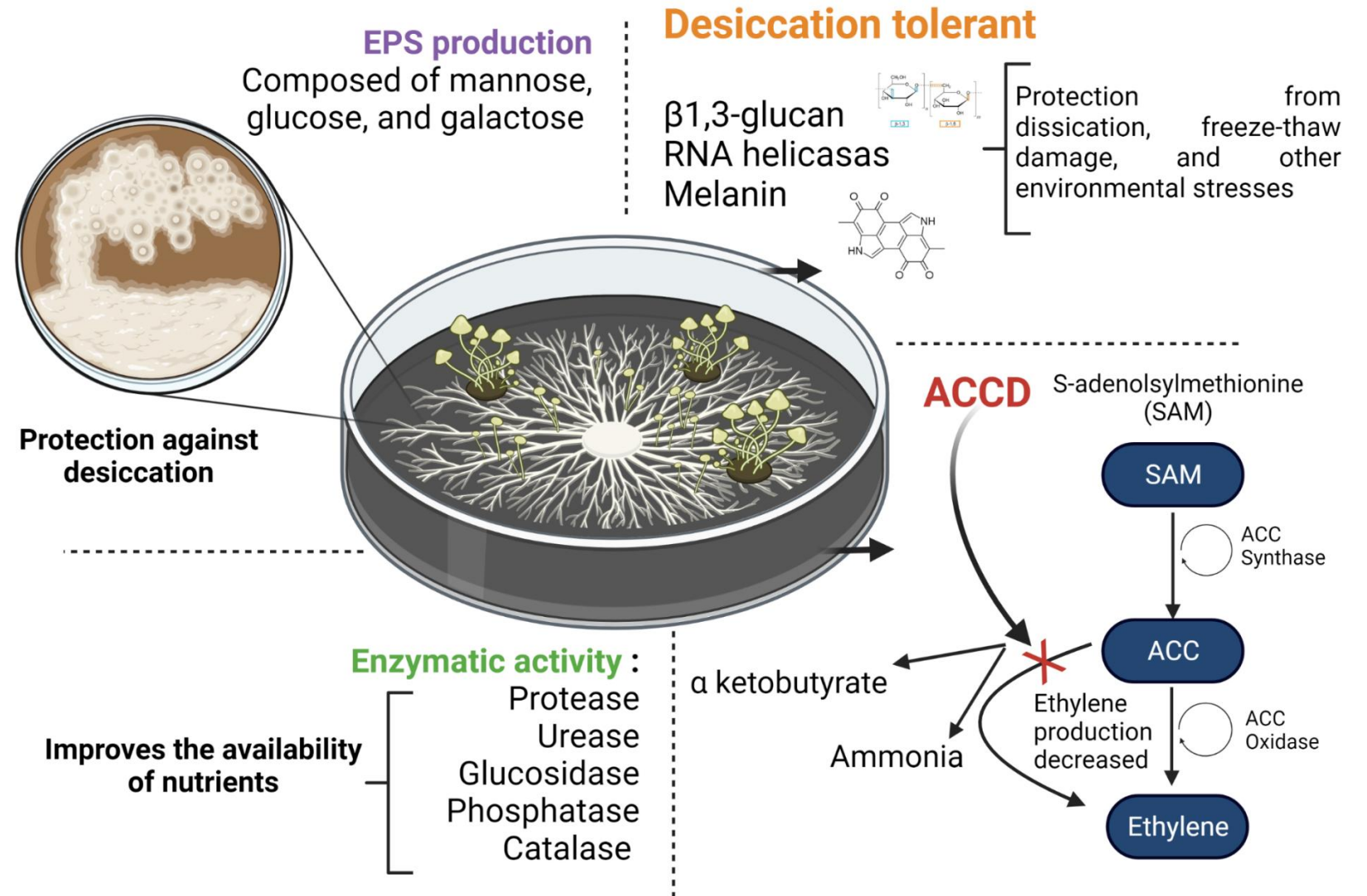
- Important for:**
- Root development
 - Reduction of water losses

Enzymes:

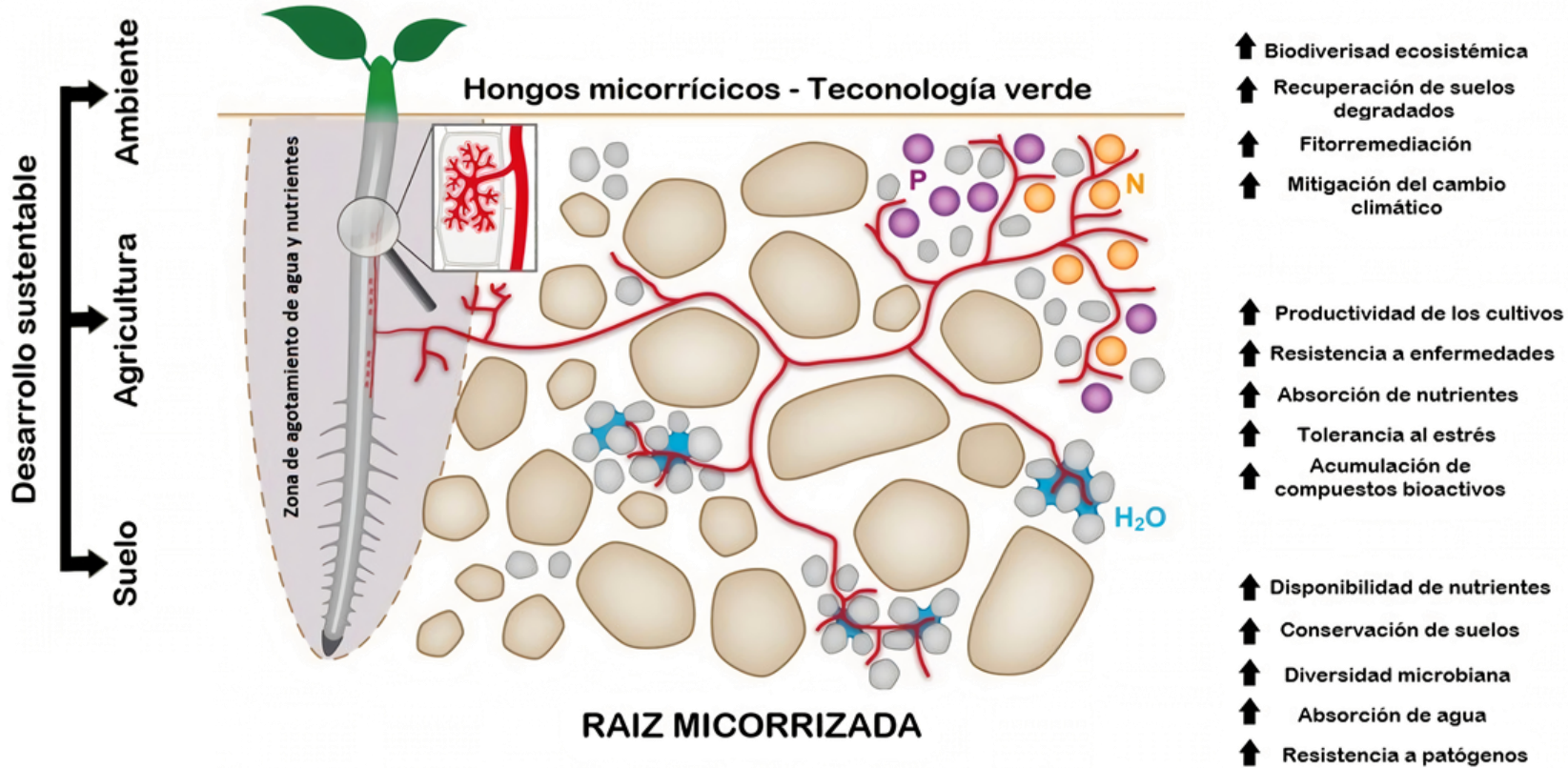
- Phytases
 - C-P lyases
 - Nitrate reductase
- Important for:**
- Nutrient assimilation



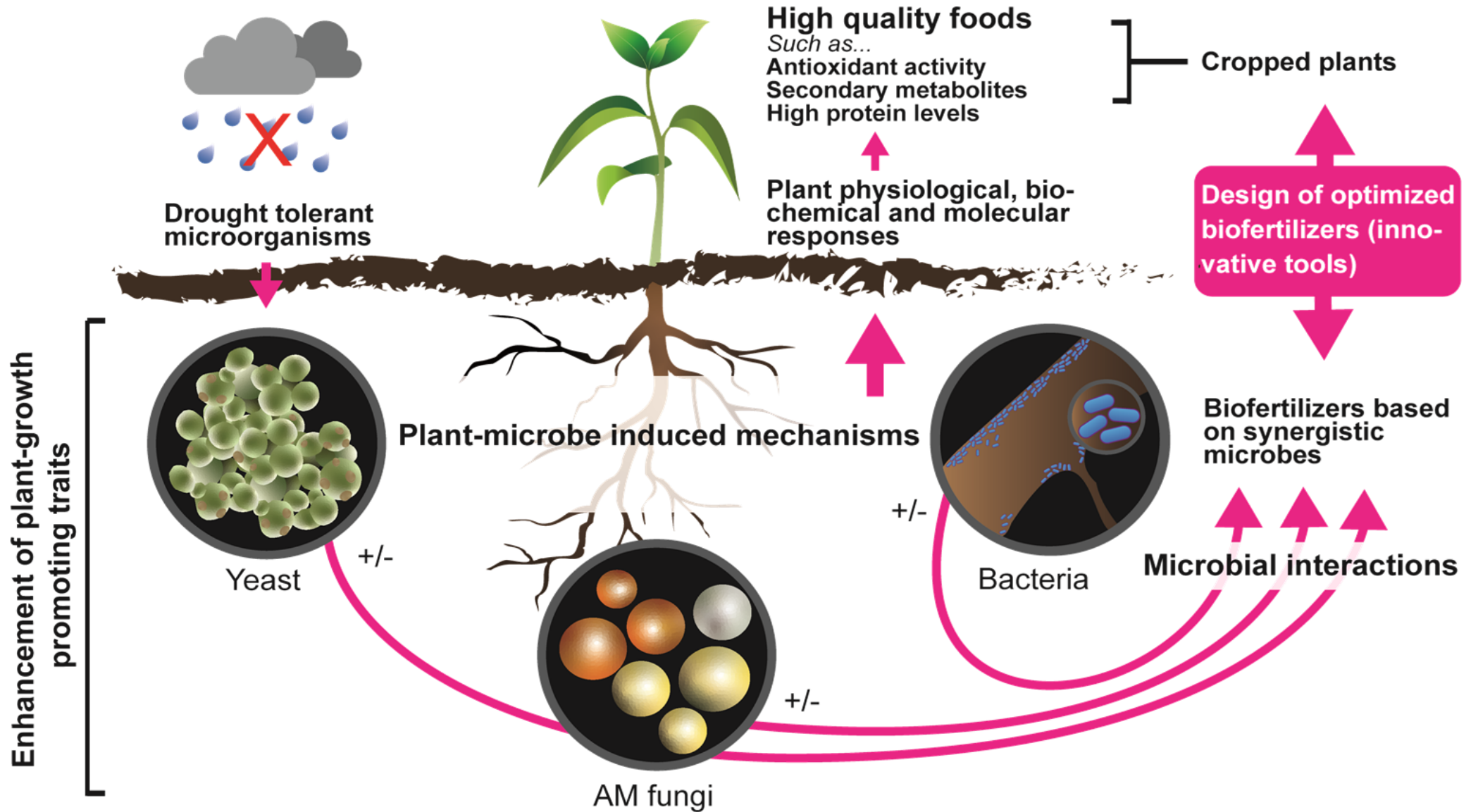
Hongos/levaduras de vida libre



MICORRIZA ARBUSCULAR: Funcionamiento y beneficios en un escenario de cambio climático



COMUNIDADES SINTÉTICAS A LA CARTA



Ambientes Extremos





Arbuscular mycorrhizal fungal abundance in elevation belts of the hyperarid Atacama Desert

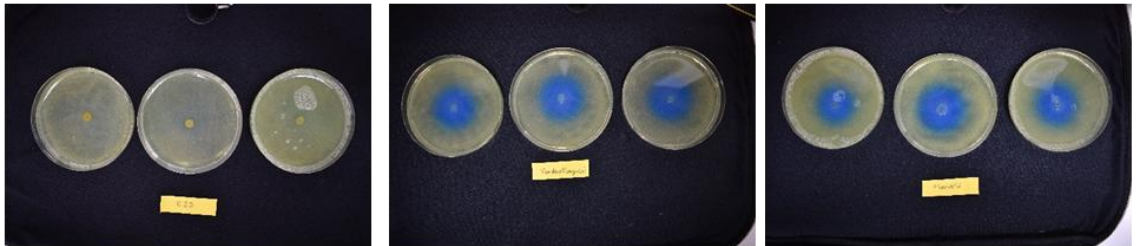
Christian Santander ^{a, b}, Susana García ^a, Jorge Moreira ^a, Humberto Aponte ^{a, c}, Paola Araneda ^d, Jorge Olave ^b, Gladys Vidal ^e, Pablo Cornejo ^{a, *}



**48 especies de plantas de diversas familias
100% presentó colonización MA!!!**



Fijación de nitrógeno



Solubilización de fosfatos

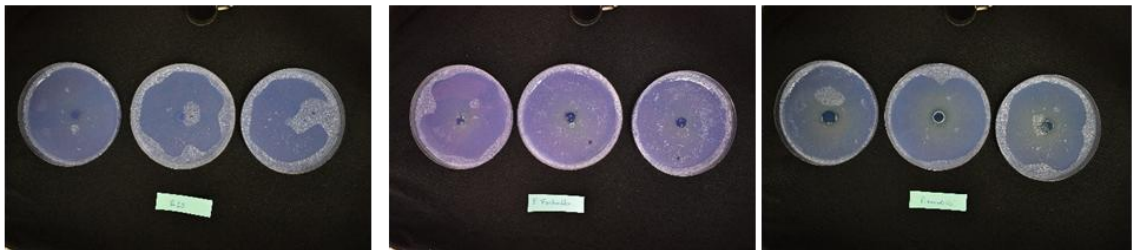
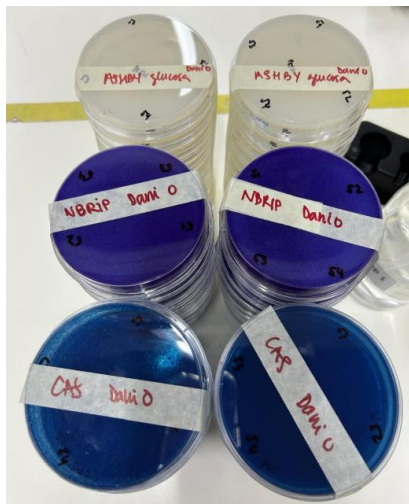
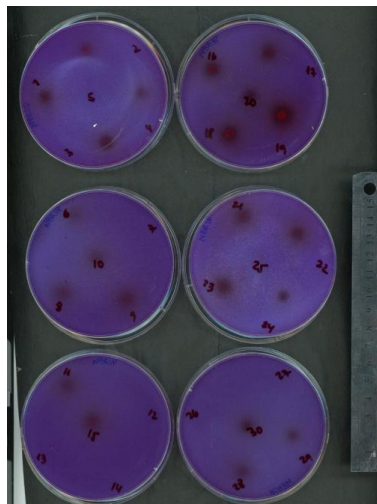


Table 1. Plant growth-promoting traits of the four selected isolated strains obtained from rhizosphere soil of *Sicyos baderoa* in coastal semi-arid areas from central and north-central Chile. Values are expressed as the mean \pm S.E. of three independent samples (n =3).

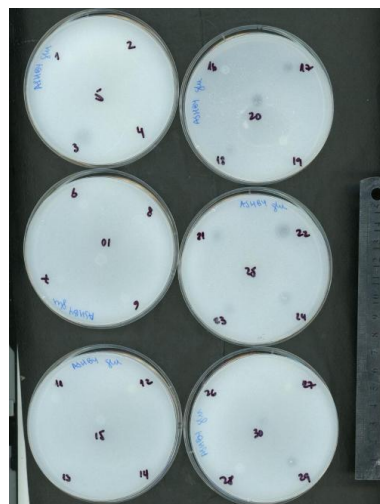
Strain and GenBank accession	Phosphate solubilization (mg P L ⁻¹)	IAA production (μ g mL ⁻¹)	Siderophore production	N Fixation (NFB)
<i>Streptomyces endophyticus</i> (SE) PV363898	386.8 \pm 11.0 ^b	14.38 \pm 0.04 ^b	+	+
<i>Streptomyces kanamyceticus</i> (SK) PV364133	467.5 \pm 20.0 ^a	13.08 \pm 0.11 ^c	+	+
<i>Staphylococcus succinus</i> (SS) PV364282	467.5 \pm 20.0 ^a	14.67 \pm 0.04 ^b	+	+
<i>Peribacillus frigoritolerans</i> (PF) PV363623	470.0 \pm 7.4 ^a	15.36 \pm 0.04 ^a	-	+



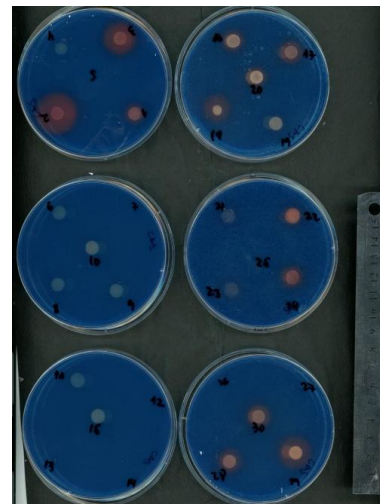
Diversas PGP



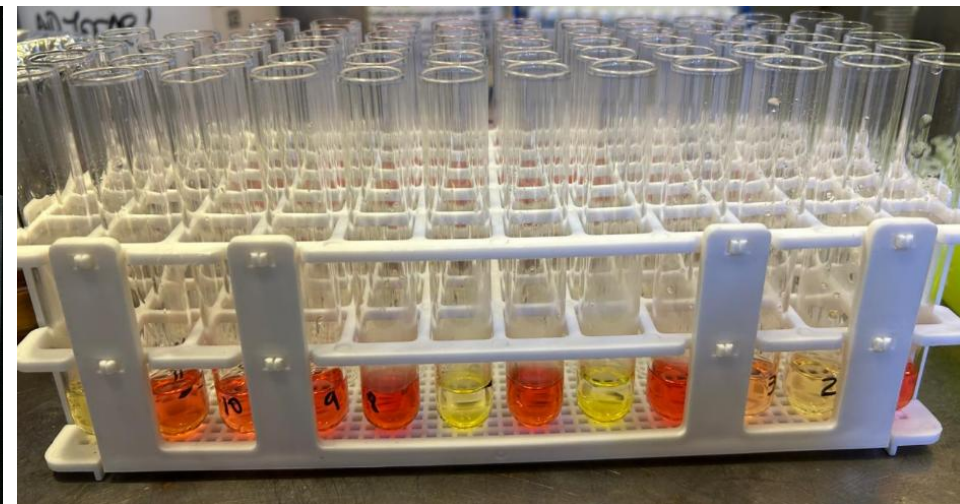
Solubilizadores de fosfatos



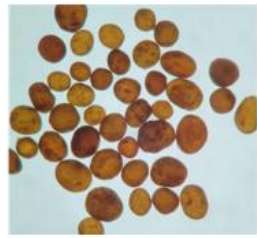
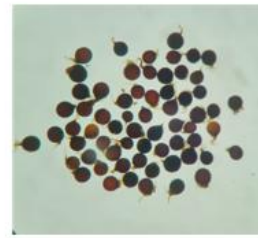
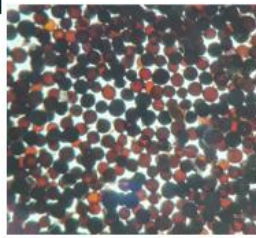
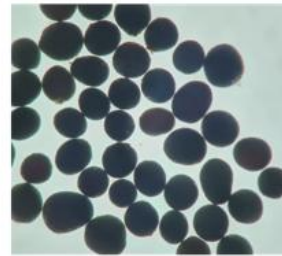
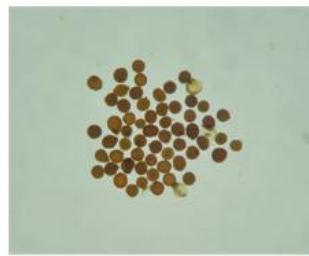
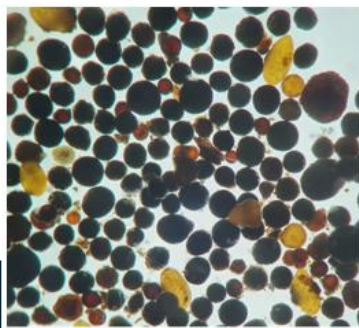
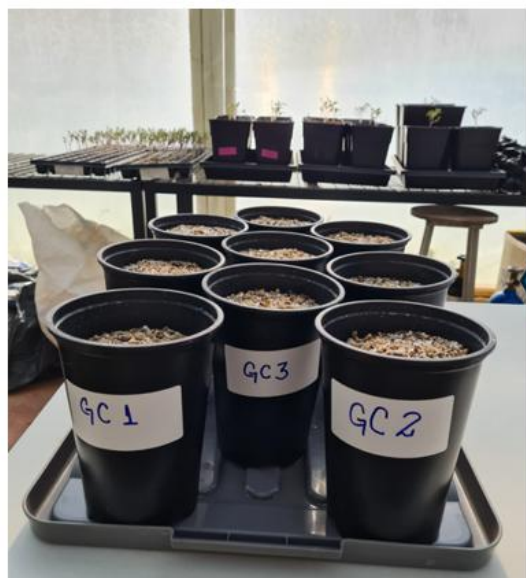
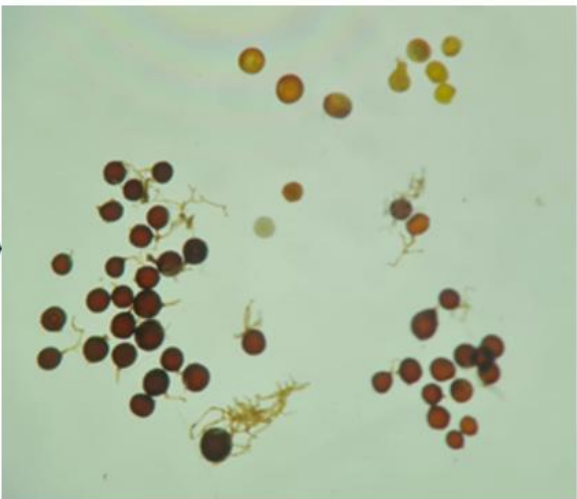
Fijadores de N₂



Sideróforos



Microorganismos productores de auxinas



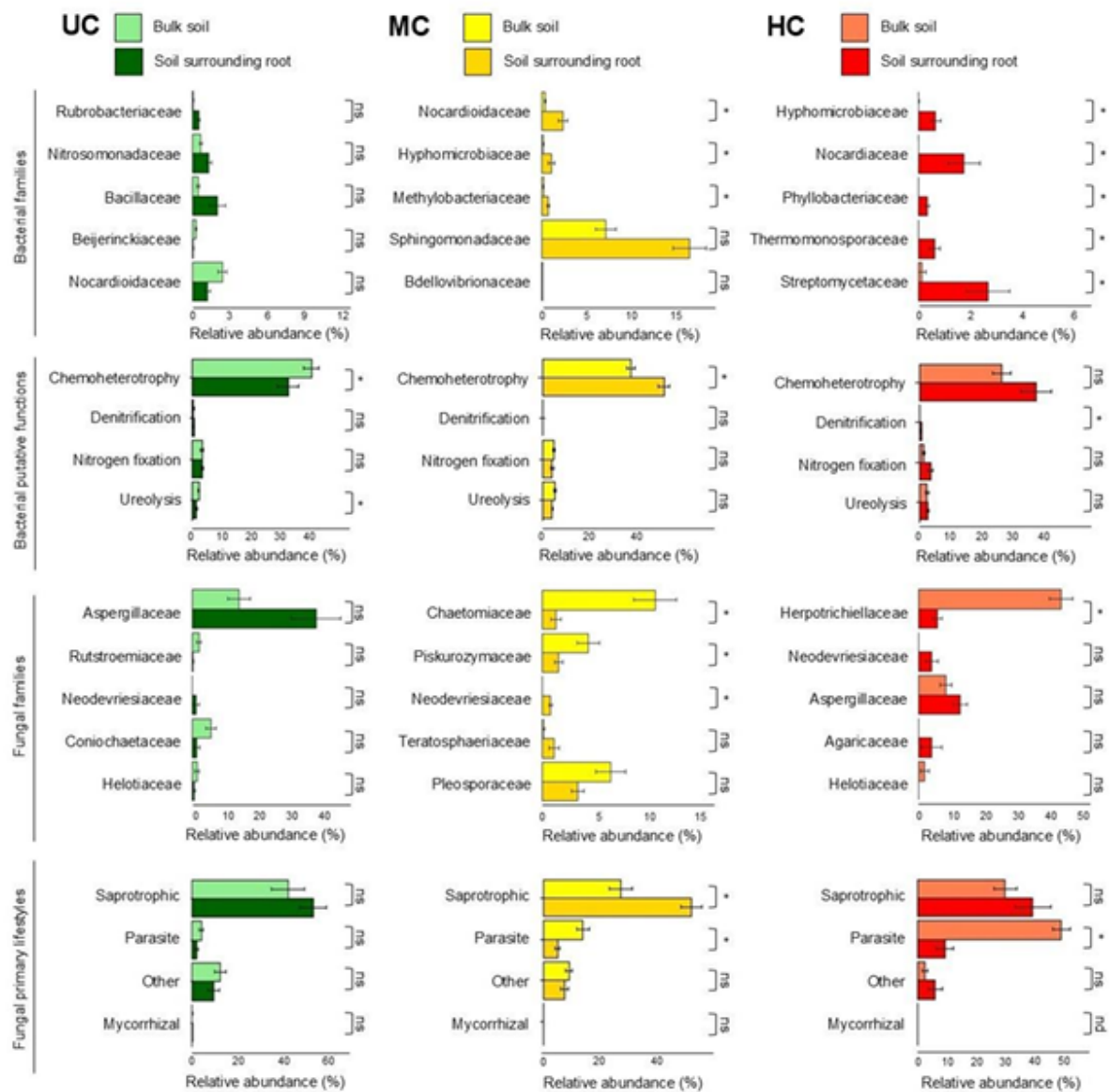


Figure 3. Changes in bacterial and fungal composition and function between soil compartments at each contamination level (UC = uncontaminated; MC = moderately contaminated; HC = highly contaminated). Statistically significant differences ($p < 0.05$) are indicated by asterisks. Additional bacterial families with significant differences between bulk soil and soil surrounding roots are shown in Fig. S3.

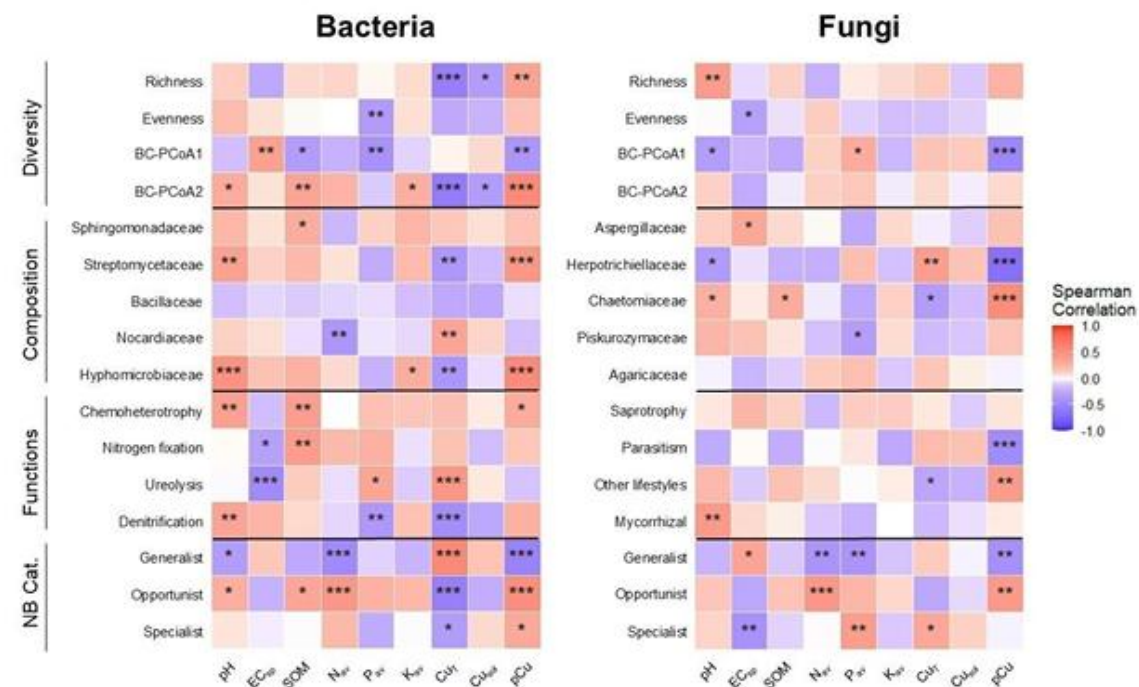


Figure 5. Spearman correlations between soil microbial ecological traits and soil chemical variables. Colour intensity indicates correlation strength (red = positive, blue = negative). NB Cat = niche breadth category. Significance levels: *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$.

Main Categories of Biostimulants Used in Fruit Crops



1. Seaweed Extracts (SWE)

From brown seaweeds like *Ascophyllum nodosum* and *Ecklonia maxima*. Rich in alginates, fucoidans, polyphenols and glycolipids.



2. Protein Hydrolysates (PHs) and Bioactive Peptides

Short peptides (2–20 aa) from plants, animals or microbes. Improve nutrient uptake and stress resistance.



3. Humic and Fulvic Substances (HSs)

Organic compounds from decomposed matter in soil. Enhance nutrient availability and soil structure.



4. Beneficial Microorganism (PGPRs, Mycorrhizae & Yeasts)

Symbiotic microbes that promote plant growth, root health, and nutrient efficiency.



5. Plant-Derived Compounds

Essential oils and extracts from various plant parts and cultures. Natural origin and biodegradable.



6. Nanobiostimulants

Materials <100 nm like carbon nanotubes, chitosan, and nano clays. Enhance uptake and precision delivery.

Table 1. Effects of biostimulants on vegetative and root growth of fruit crops.

Biostimulant	Fruit Crop	Biological Pathways	Effect
<ul style="list-style-type: none"> • 4 or 6% moringa leaf extract (MLE) • 0.3 or 0.4% seaweed extract (SWE; unknown species); • 0.1% or 0.2% fulvic acid (FA) • 4% MLE + 0.3% SWE + 0.1% FA (combination 1) • 6% MLE + 0.4% SWE + 0.2% FA (combination 2) 	Apple (<i>Malus domestica</i> L.) cv. Anna	<ul style="list-style-type: none"> • Photosynthetic efficiency • Plant vigor (shoots and leaves)	<ul style="list-style-type: none"> • MLE, SWE, and FA and their combinations increased shoot length and diameter, leaf area, and relative leaf chlorophyll content • Combined biostimulants increased shoot length, shoot diameter, leaf chlorophyll content, and leaf area
<ul style="list-style-type: none"> • 1.0 g L⁻¹ of humic acids (HA) • 3.0 g L⁻¹ of alfalfa protein hydrolysate (APH) • 4.0 g L⁻¹ of macro seaweed extract (SWE; unknown species) • 4.0 g L⁻¹ of microalga hydrolysate from <i>Spirulina</i> spp. (SPI) • 3.0 g L⁻¹ of mix of amino acids (MAA) • 3.0 g L⁻¹ of MAA combined with pure phenylalanine (1%) (PHE) • 3.0 g L⁻¹ of MAA combined with zinc (2%) (ZIN); • 1.0 g L⁻¹ of B-group vitamins (VIT) • 10 mL L⁻¹ of chitosan (CHI) • 0.3 mL L⁻¹ of siliforce® (SIL) 	Strawberry (<i>Fragaria × ananassa</i> Duch.) cv. Elsanta	<ul style="list-style-type: none"> • Roots development • Plant vigor (shoots and leaves) • Photosynthetic efficiency 	<ul style="list-style-type: none"> • APH, SWE, SPI, VIT, and CHI promoted biomass accumulation in roots • APH, VIT, CHI, and SIL increased leaf area (+15–30%) • HA, ZIN, and SIL increased leaf photosynthetic rate at 57 DAT (days after transplanting) • APH increased chlorophyll content at the end of the experiment (88 DAT)
<ul style="list-style-type: none"> • 3.0 g L⁻¹ and 4.0 g L⁻¹ of fulvic acid (FA) • 3.0 g L⁻¹ and 4.0 g L⁻¹ of seaweed extract (SE; unknown species)—extract composition: alginic acid 15–18%, organic matter 45–55%, potassium K₂O 16%, N 2.5–3%, P₂O₅ 4.5–5% and water solubility 99.1% • FA + SE 	Guava (<i>Psidium guajava</i> L.) cv. Maamoura	<ul style="list-style-type: none"> • Plant vigor (shoots and leaves) • Photosynthetic efficiency 	<ul style="list-style-type: none"> • FA and SE, and their combinations, increased shoot length and diameter, leaf area, and total chlorophyll

Table 1. Effects of biostimulants on vegetative and root growth of fruit crops.

<ul style="list-style-type: none"> • 250 and 500 ppm of Glu, Met, L-Try, and Lys amino acids • 250 ppm Glu + 250 ppm Met + 250 ppm L-Try + 250 ppm Lys (combination 1) • 500 ppm Glu + 500 ppm Met + 500 ppm L-Try + 500 ppm Lys (combination 2). 	<p>Peach (<i>Prunus persica</i> L.) cv. Florida Prince</p>	<ul style="list-style-type: none"> • Plant vigor (shoots and leaves) • Photosynthetic efficiency 	<ul style="list-style-type: none"> • Foliar application of Glu, Try, Met, Lys, and their combinations increased shoot thickness, leaf area, and total chlorophyll content
<ul style="list-style-type: none"> • 25, 50, and 100 mg L⁻¹ of putrescine (Put) • 0.5, 1, and 2 mg L⁻¹ of brassinosteroids (Brs) • 500, 1000, and 1500 mg L⁻¹ of chitosan (CHI) 	<p>Mango (<i>Mangifera indica</i> L.) cv. Keitt</p>	<ul style="list-style-type: none"> • Plant vigor (shoots and leaves) • Photosynthetic efficiency 	<ul style="list-style-type: none"> • Put, Brs, and CHI increased shoots number, length, and thickness • Put, Brs, and CHI improved leaf area, trunk girth, and leaf chlorophyll content
<ul style="list-style-type: none"> • Soil fertilization with 0, 1, and 2 kg per tree of 100% water-soluble HA • Foliar fertilization with 0, 0.2, 0.3, and 0.4% of SWE (unknown species). • Foliar fertilization with 0, 2, 4, and 6% of MLE. 	<p>Navel Orange (<i>Citrus sinensis</i> L.) cv. Osbeck</p>	<ul style="list-style-type: none"> • Plant vigor (shoots and leaves) • Photosynthetic efficiency 	<ul style="list-style-type: none"> • Shoot length and diameter, and total leaf chlorophyll increased as the amount of HA, SWE, and MLE increased • 2 kg HA with 0.4% SWE + 6% MLE sprays resulted in the greatest vegetative growth increases
<ul style="list-style-type: none"> • 1, 5, 10, and 50% solutions of: • <i>Gracilaria edulis</i> (G Sap) • <i>Kappaphycus alvarezii</i> (K Sap) • <i>Ascophyllum nodosum</i> (AN) • <i>Ecklonia maxima</i> (EM) • Humic acid (HA) 	<p>Kiwifruit (<i>Actinidia deliciosa</i>) cv. Monty, Abott, Hayward, Allison, Bruno</p>	<ul style="list-style-type: none"> • Plant vigor (shoots and leaves) • Roots development • Photosynthetic efficiency • Gene expression modulation 	<ul style="list-style-type: none"> • Improvement of shoot and root growth parameters (leaf number, number of roots, number of branches, plant height, shoot diameter, root length, root diameter, and root weight) in all treatments • Higher chlorophyll and secondary metabolites content • Higher expression of root promoting candidate genes (<i>GH3-3</i>, <i>LBD16</i>, <i>LBD29</i> and <i>LRP1</i>)

Table 1. Effects of biostimulants on vegetative and root growth of fruit crops.

<ul style="list-style-type: none"> BC204 (citrus-based plant biostimulant containing extracts from <i>Citrus aurantium</i> and other plant extracts and acids) 	<p>Tomato (<i>S. lycopersicum</i>) cv. Moneymaker</p>	<ul style="list-style-type: none"> Plant vigor (shoots and leaves) Roots development Gene expression modulation 	<ul style="list-style-type: none"> Increased fresh and dry biomass, shoot length, root length, and stem width Increased plant growth as a result of upregulation of genes involved in photosynthesis, various aspects of cell wall biogenesis, remodeling and restructuring, carbohydrate metabolism, signaling, stress response, and secondary metabolism
<ul style="list-style-type: none"> CBL (CropBioLife, Aussan Laboratories Pty Ltd., Campbellfield, VIC, Australia, containing 12% of flavonoids, 3 mL L⁻¹) 	<p>Tomato (<i>S. lycopersicum</i> L.) cv Marmande</p>	<ul style="list-style-type: none"> Plant vigor (shoots and leaves) Photosynthetic efficiency Osmotic regulation Gene expression modulation 	<ul style="list-style-type: none"> Vigorous growth in the aerial or productive part of the plants Larger cell area and leaves Increased photosynthetic rate, CO₂ fixation, stomatal conductance, and number of stomata Increase in water transport, evidenced by the upregulation of most aquaporin isoforms Greater nutrient uptake by the plant Upregulation of several key genes involved in different metabolic pathways related to plant growth

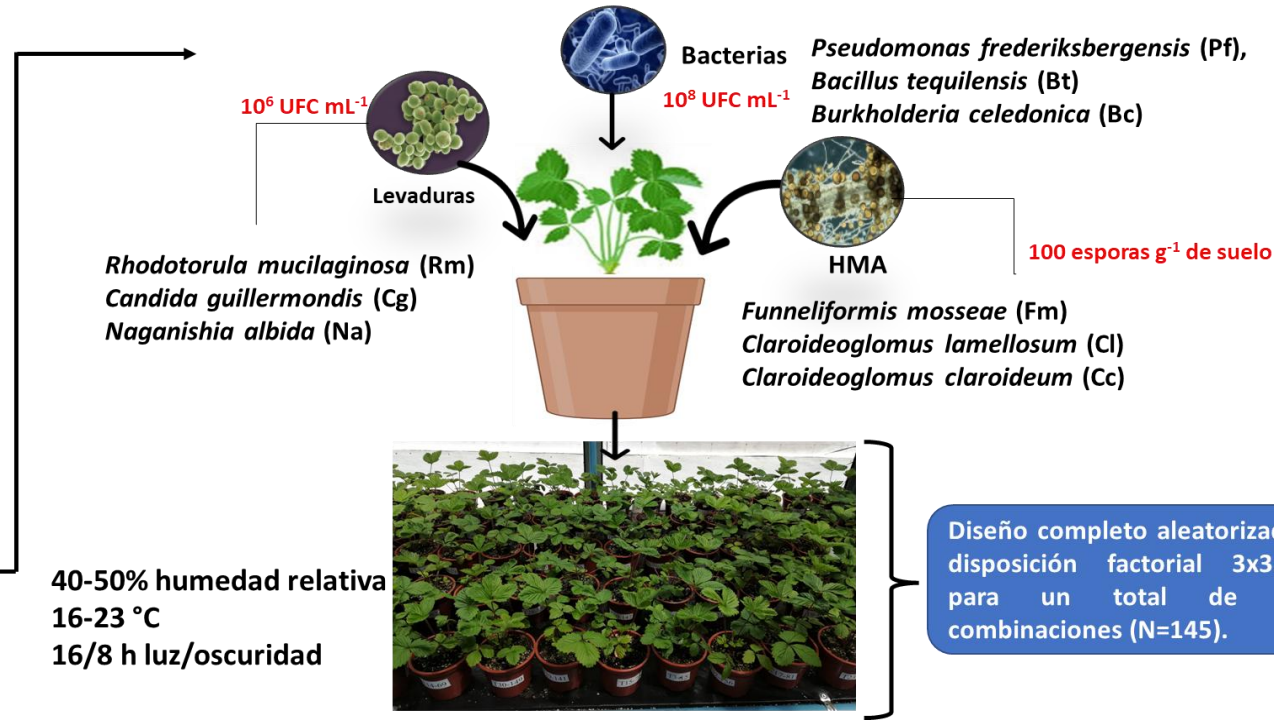
Table 2. Effects of key biostimulants on hormonal regulation in fruit crops.

Biostimulant	Phytohormone Pathway	Effect
<ul style="list-style-type: none"> Seaweed extracts (from Phaeophyceae—brown algae, Chlorophyceae—green algae, and Rhodophyceae—red algae), <i>Ascophyllum nodosum</i>; <i>Ecklonia maxima</i>; <i>Sargassum</i> spp.; <i>Laminaria</i>; <i>Turbinaria</i>; <i>Fucus</i>; <i>Macrocystis pyrifera</i> 	<ul style="list-style-type: none"> Cytokinins Auxins Gibberellins 	<ul style="list-style-type: none"> Stimulate plant growth and overall production Enhance stress tolerance Enhanced nutrient absorption Accelerated seed germination Improved flower and fruit development, leading to higher fruit quality
	<ul style="list-style-type: none"> Auxins Cytokinins Abscisic acid Gibberellins 	<ul style="list-style-type: none"> Improved phytohormone content through <i>E. maxima</i> application, promoting cell growth and division, and increasing fruit weight and size
	<ul style="list-style-type: none"> Auxins Cytokinins Gibberellins 	<ul style="list-style-type: none"> Promote cell division, elongation, and differentiation, leading to enhanced growth of roots and shoots Improve seed germination and development Improve stress tolerance and resistance to pests and diseases
<ul style="list-style-type: none"> Protein hydrolysates 	<ul style="list-style-type: none"> Auxins Gibberellins 	<ul style="list-style-type: none"> Promote crop performances Enhance rooting and shoot length Improve plant nutrition and phytochemical composition
	<ul style="list-style-type: none"> Auxins Gibberellins 	<ul style="list-style-type: none"> Enhance plant growth (root and leaf biomass) Increase yield Mitigate abiotic stresses
	<ul style="list-style-type: none"> Auxins Gibberellins Cytokinins Ethylene 	<ul style="list-style-type: none"> Improvements in root development Increased shoot length Upregulation of <i>GA 3-beta-dioxygenase</i>, and downregulation of <i>GA 2-oxidase</i>, genes related to the activation/ deactivation of GAs Upregulation of <i>cytokinin riboside 5'-monophosphate phosphoribohydrolase</i>, related to cytokinin production, plays a role in modifying root architecture Induces the accumulation of ethylene precursor (1-aminocyclopropane-1-carboxylate), stimulating flowering, plant growth, and cell division

Table 2. Effects of key biostimulants on hormonal regulation in fruit crops.

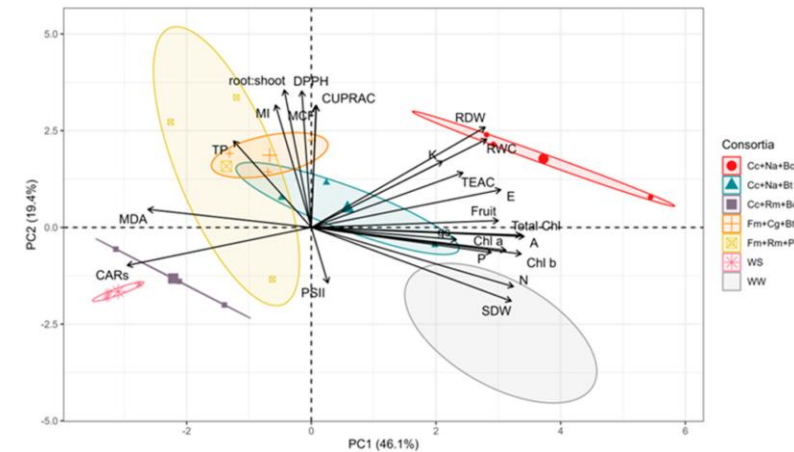
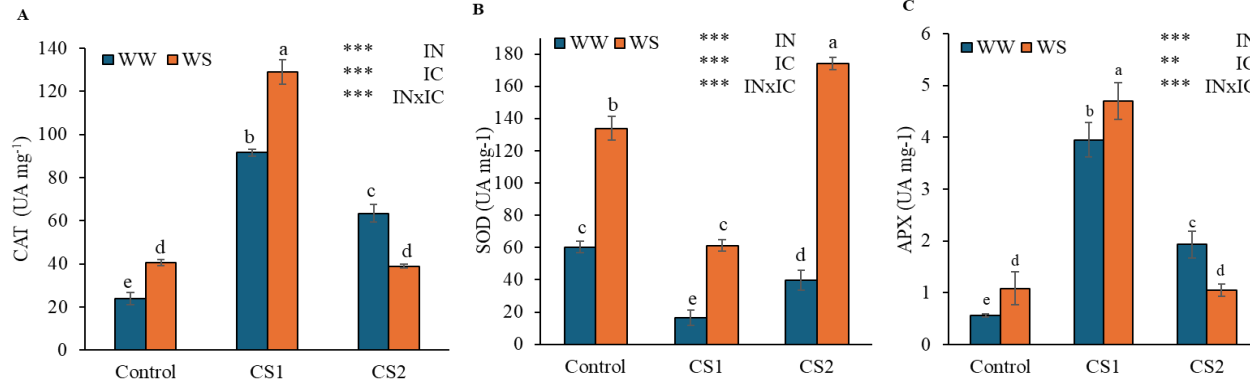
	<ul style="list-style-type: none"> • Auxins • Cytokinins 	<ul style="list-style-type: none"> • Increase crop/plant growth • Stimulate root and shoot growth
<ul style="list-style-type: none"> • Humic and fulvic acids 	<ul style="list-style-type: none"> • Auxins • Gibberellins 	<ul style="list-style-type: none"> • Upregulation of <i>auxin-responsive protein SAUR20</i> and <i>gibberellin 2-beta dioxygenase 2</i> genes • Increase in shoot and root biomass and in the numbers of leaves and fruits
	<ul style="list-style-type: none"> • Auxins 	<ul style="list-style-type: none"> • Induce root development in plants
	<ul style="list-style-type: none"> • Auxins • Gibberellins • Cytokinins 	<ul style="list-style-type: none"> • Enhances vegetative growth in plants by stimulating the production of key phytohormones, including IAA, GA, and cytokinins • Enhancing the biosynthesis of antioxidants and essential vitamins, thereby supporting cellular function and stress resilience
		<ul style="list-style-type: none"> • Cytokinins
<ul style="list-style-type: none"> • Beneficial microorganisms 	<ul style="list-style-type: none"> • Auxins 	<ul style="list-style-type: none"> • PGPR promotes plant growth by inducing the expression of auxin-responsive genes in host-plant roots
	<ul style="list-style-type: none"> • Ethylene 	<ul style="list-style-type: none"> • PGPR can alleviate plant oxidative stress by producing 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase, which modulates ethylene • PGPR has the capacity to regulate ethylene content; however, at higher amounts, it may inhibit root elongation

Uso de Consorcios Microbianos

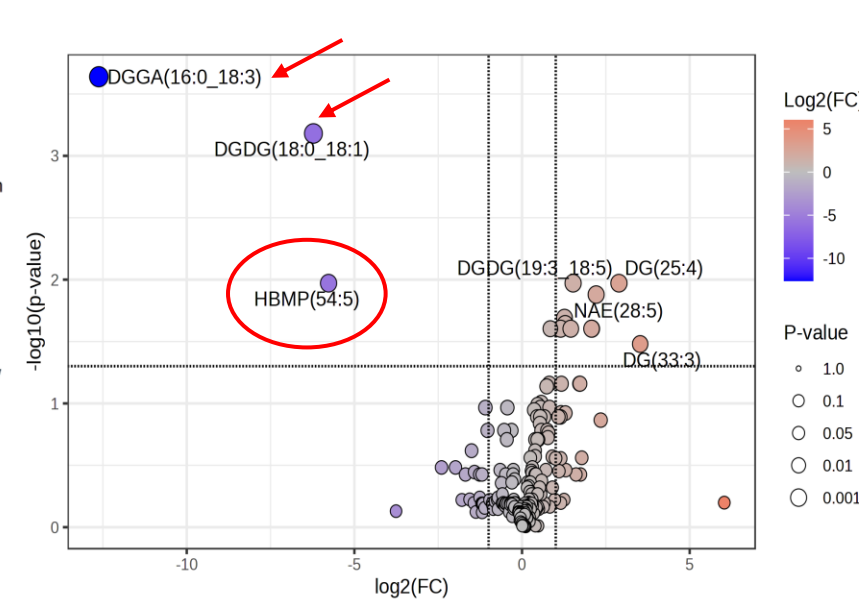
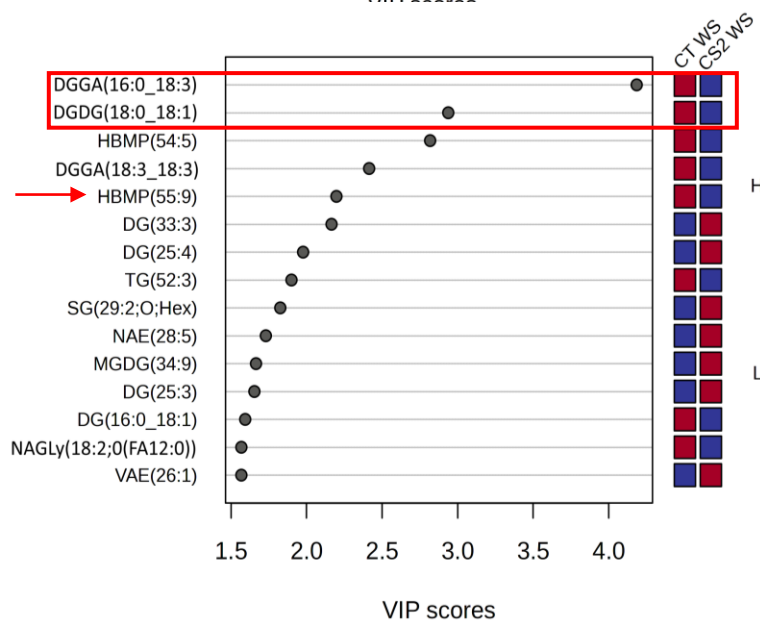
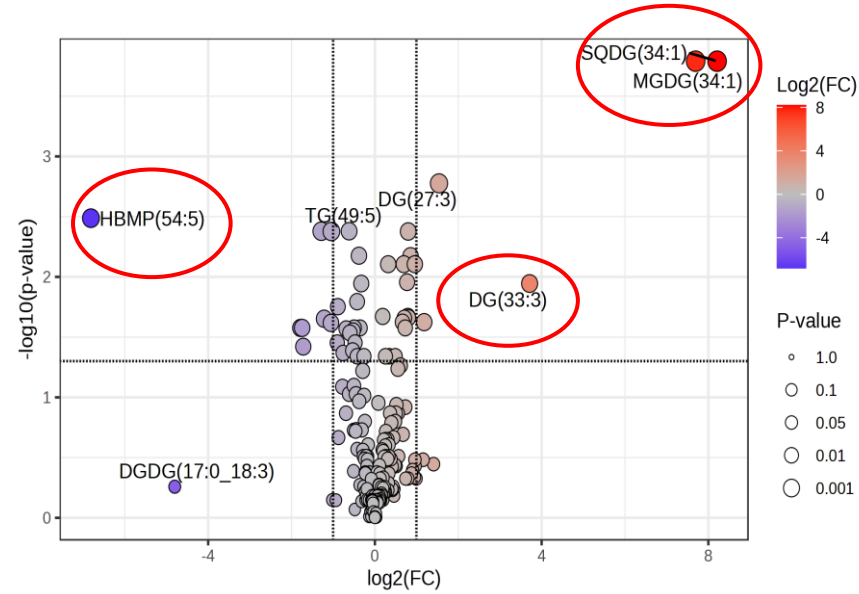
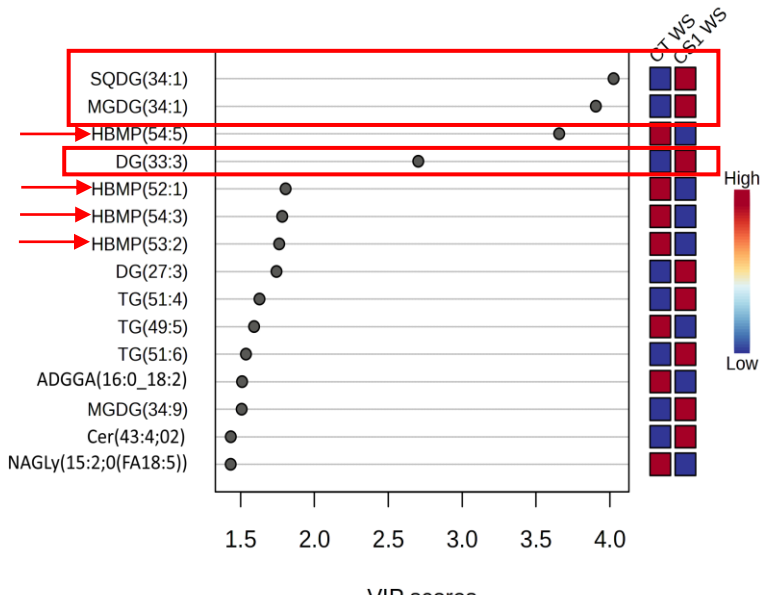


Article Design of Microbial Consortia Based on Arbuscular Mycorrhizal Fungi, Yeasts, and Bacteria to Improve the Biochemical, Nutritional, and Physiological Status of Strawberry Plants Growing under Water Deficits

Urley A. Pérez-Moncada ^{1,2}, Christian Santander ^{2,3}, Antonieta Ruiz ², Catalina Vidal ², Cleidir Santos ^{2,4,*} and Pablo Cornejo ^{4,5,*}

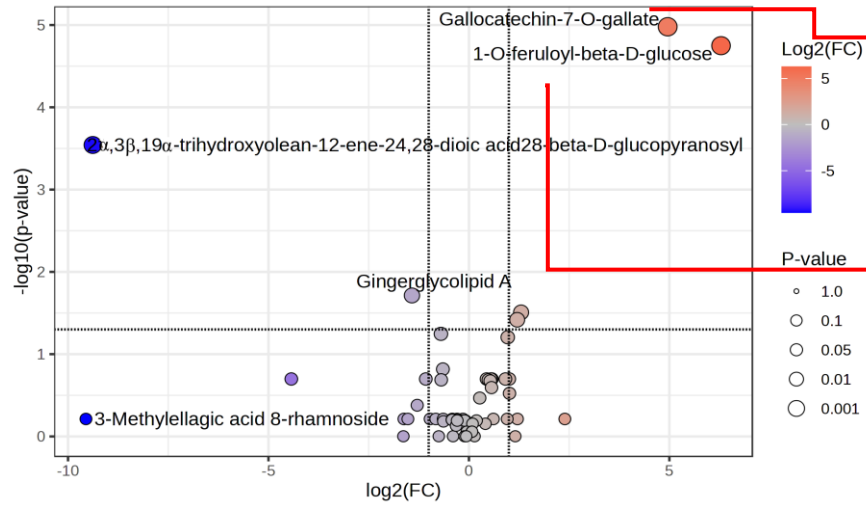


Manuscript Number:	JPGR-D-25-00988R2
Full Title:	Untargeted lipidomics reveals responses of tripartite microbial consortia-dependent in strawberry plants growing under drought conditions



Microbial consortia modulate the metabolic profiles as relevant mechanism of water deficit tolerance in strawberry plants

CS1WS/CTWS



Up-regulated

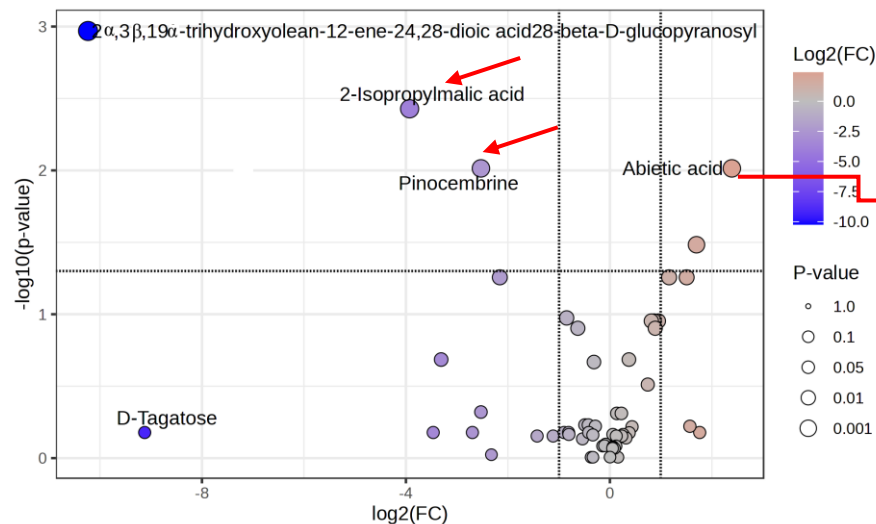
Gallocatechin-7-O-gallate is a type of catechin, synthesized through the flavonoid biosynthesis pathway.

- ✓ Antioxidant properties and promote photosynthesis by inhibiting ABA-induced stomatal closure (Sato et al., 2022; Ahammed et al., 2023)

1-O-feruloyl-beta-D-glucose (ferulic acid), is a phenolic acid.

- ✓ Exhibiting antioxidant properties
- ✓ SOD and CAT and proline
- ✓ Can have pro-oxidant effects (Hussain et al., 2021; Linić et al., 2021; Khan et al., 2024).

CS2WS/CTWS

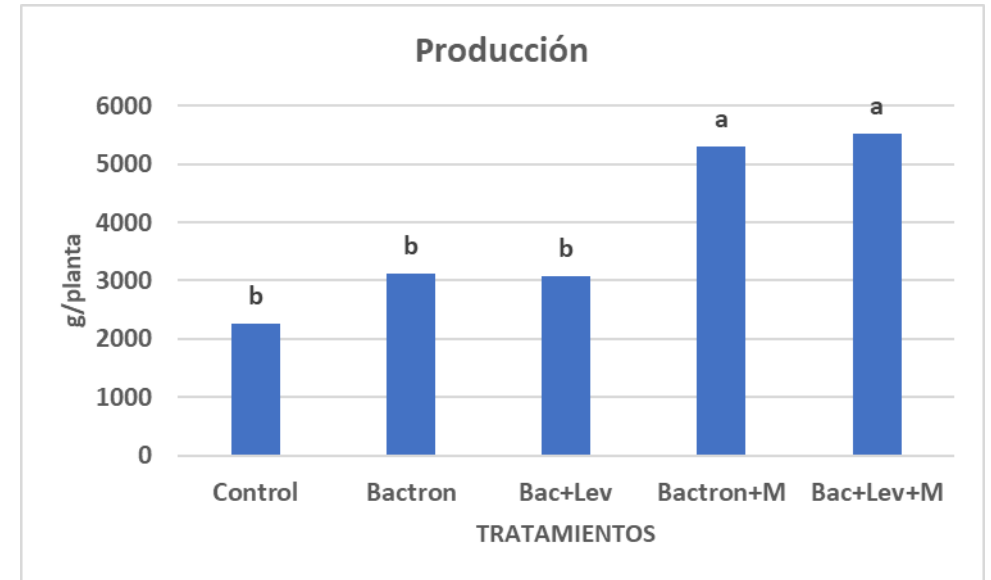


Down-regulated

Flavonone pinocembrin, 2-isopropylmalic acid, and the glycosidic triterpenoid 2 α ,3 β ,19 α -trihydroxyolean-12-en-24,28-dioic acid 28-beta-D-glucopyranosyl

Abietic acid, a diterpene was the only metabolite to be significantly up-regulated

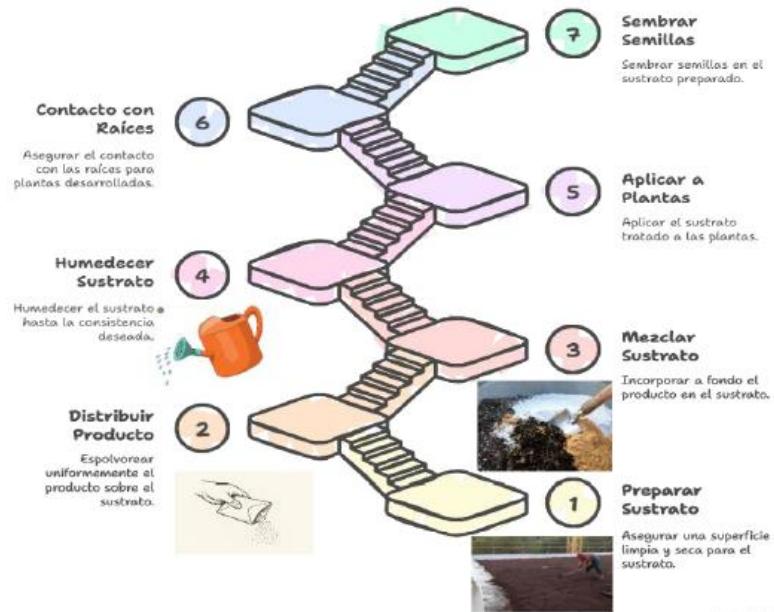
LA VALIDACIÓN BIOTECNOLÓGICA



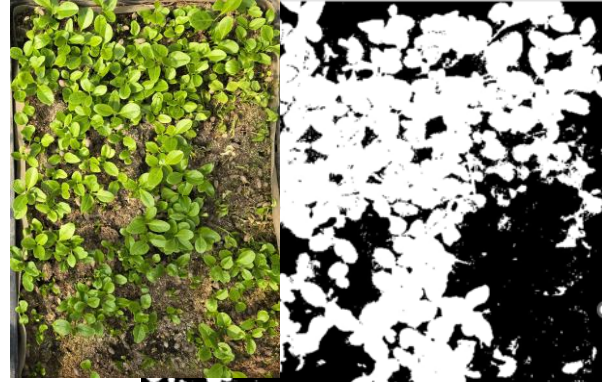
BUSCANDO EL EFECTO WOW!!!...



Aplicación del Producto para el Crecimiento de Plantas



87,73 %



52,18 %

ANID/ATE250015: "HOLOBIONT BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE FACING WATER SCARCITY (HOLODRONE)"

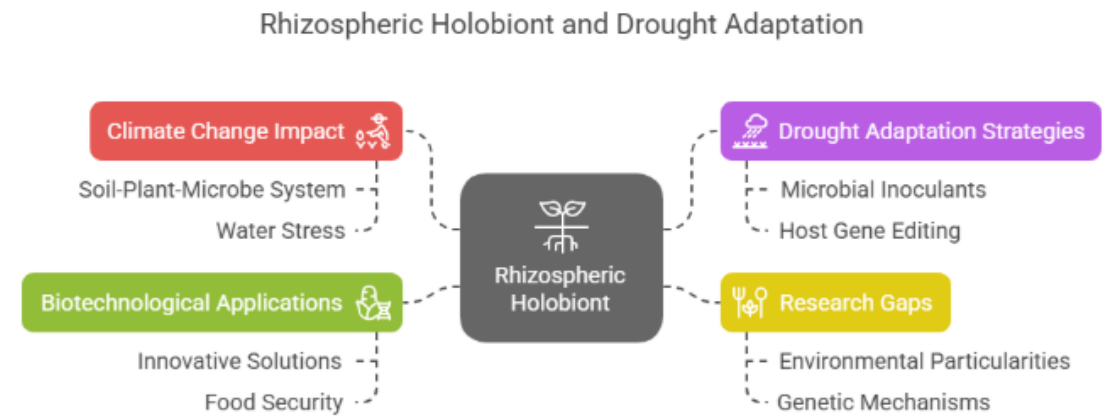
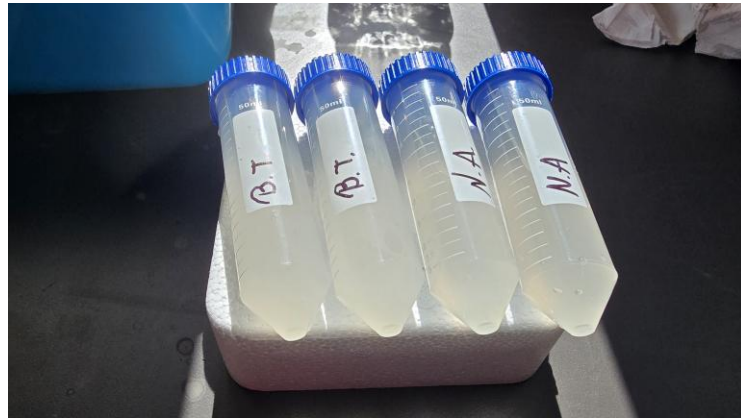
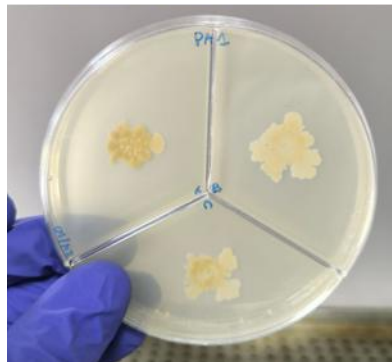
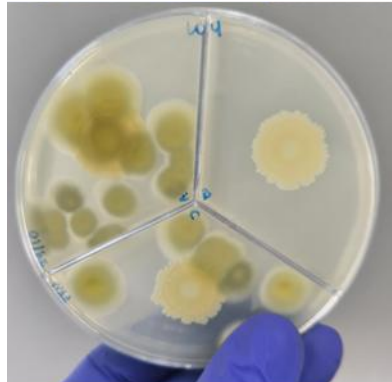
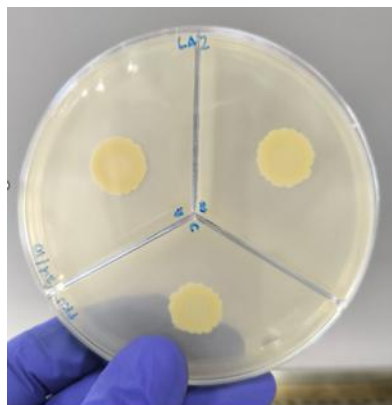


Figure 1. Main factors to be addressed in the present proposal for a deep understanding of the functioning of the rhizospheric holobiont under drought conditions.

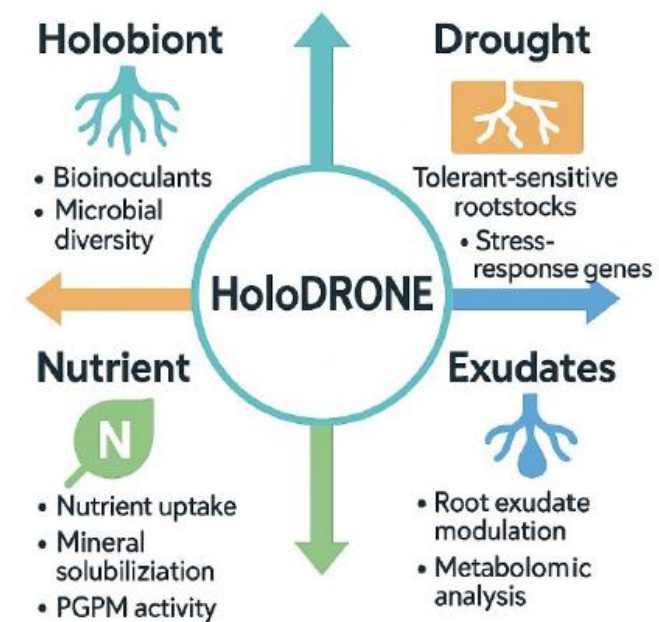
INOCULANTES PARA LA HORTOFRUTICULTURA



Acondicionamiento rizosférico de portainjertos de *Lagenaria siceraria*



Acondicionamiento rizosférico de portainjertos de *Prunus sp.*



ANID/ATE250015: "HOLOBIONT BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE FACING WATER SCARCITY (HOLODRONE)"

EN RESUMEN...

-) Los microorganismos benéficos del suelo son probablemente la alternativa más sustentable para incrementar la producción agrícola y calidad de alimentos en el futuro cercano

-) En el escenario actual de cambio climático, es necesario no sólo hacer uso de los microorganismos con fines nutricionales (biofertilizantes), sino como una herramienta de acondicionamiento para la planta, favoreciendo su tolerancia a estreses como sequía y salinidad

-) La existencia de ambientes extremos permite una amplia presencia de microorganismos con adaptaciones para hacer frente a las condiciones adversas, que resulta promisorio para su uso en producción vegetal.

-) Finalmente, la manipulación dirigida de las poblaciones microbianas del suelo resulta ser un efectivo amortiguador de cambios, por lo que en la actual emergencia climática se debe potenciar su estudio para promover el desarrollo de bioproductos innovadores que permitan una producción vegetal sustentable desde el suelo y hasta el fruto...

Microorganismos del suelo=Seguro de Vida



Muchas Gracias!!

**Listos para la
batalla!!!**



**Primera Reunión Técnica 2026
Centro de Pomáceas**



Biodiversidad funcional y su aporte a la productividad y resiliencia climática en frutales

Dr. Pablo Cornejo Rivas



100 μm

