USO DE BIOPROTECTORES PARA EL MANEJO DE PLAGAS QUE AFECTAN LA RAÍZ

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FRECUENTES MEXICO/ DIVERSOS CULTIVOS AGRICOLAS

Fusarium spp.

Rhizoctonia solani

Phymatotricopsis omnivora

Botrytis spp.

Sclerotinia spp.

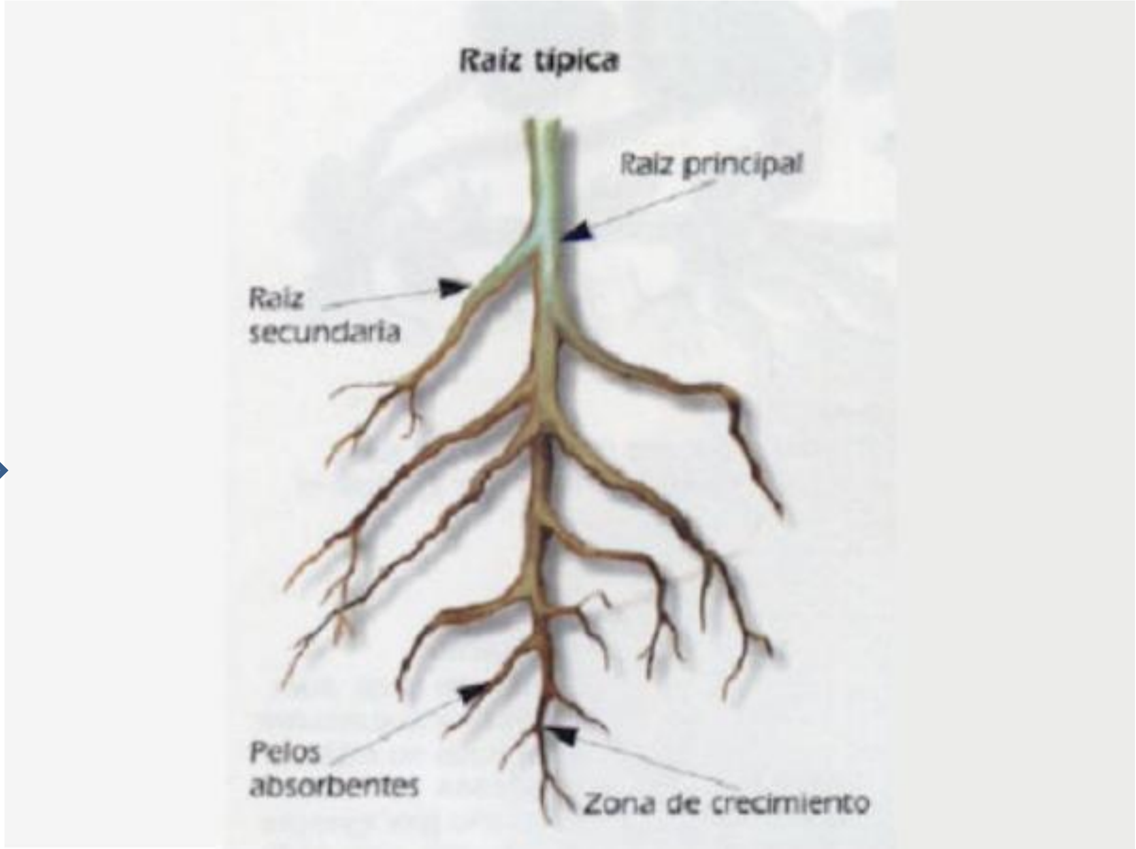
Sclerotium (*S. cepivorum*, *S. rolfsii*)

Verticillium dahliae (*V. albo-atrum*)

Macrophomina phaeolina

Phytophthora spp.

Pythium spp.



CONOCIMIENTOS PREVIOS

Cracterísticas suelo

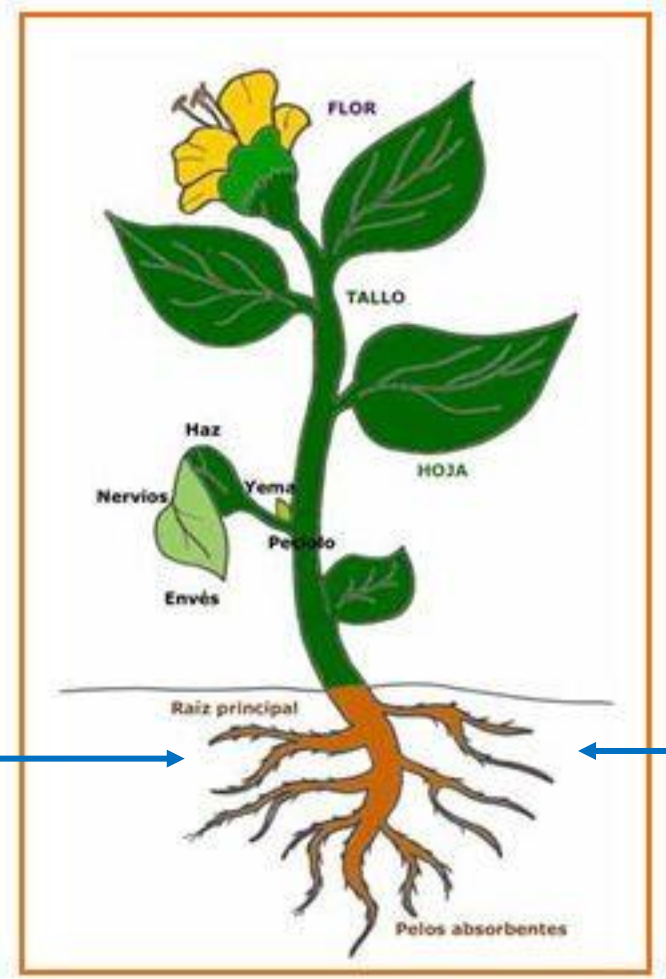
Historial de cultivos y patógenos de raíz

Fenología del cultivo, RAÍZ

Condiciones cultivo: suelo directo o sustratos

Condiciones climasticas región

ORGANISMOS
BIOREGULADORES



BIOESTIMULANTES

Los agentes de biocontrol son conocidos como antagonistas y antagonismo es el mecanismo a través del cual reducen la actividad de vida o enferman a los organismos que afectan los cultivos (insectos o patógenos)

BIOESTIMULANTES

Los bioestimulantes son mezclas de una o más sustancias o materiales, como microorganismos, oligoelementos, enzimas, hormonas vegetales y extractos de algas marinas, en lugar de fertilizantes químicos, que pretenden corregir una deficiencia grave de nutrientes. Se ha demostrado que influye en varios procesos metabólicos como la fotosíntesis, la respiración, la captación de iones y la síntesis de ácidos nucleicos. Los bioestimulantes mejoran la disponibilidad de nutrientes, aumentan los antioxidantes, mejoran la capacidad de retención de agua del metabolismo y aumentan la producción de clorofila. Además de muchas ventajas, el uso de bioestimulantes en prácticas agrícolas se propone como una herramienta segura para mejorar las propiedades nutricionales de los cultivos agrícolas

Shubha *et al*., 2019

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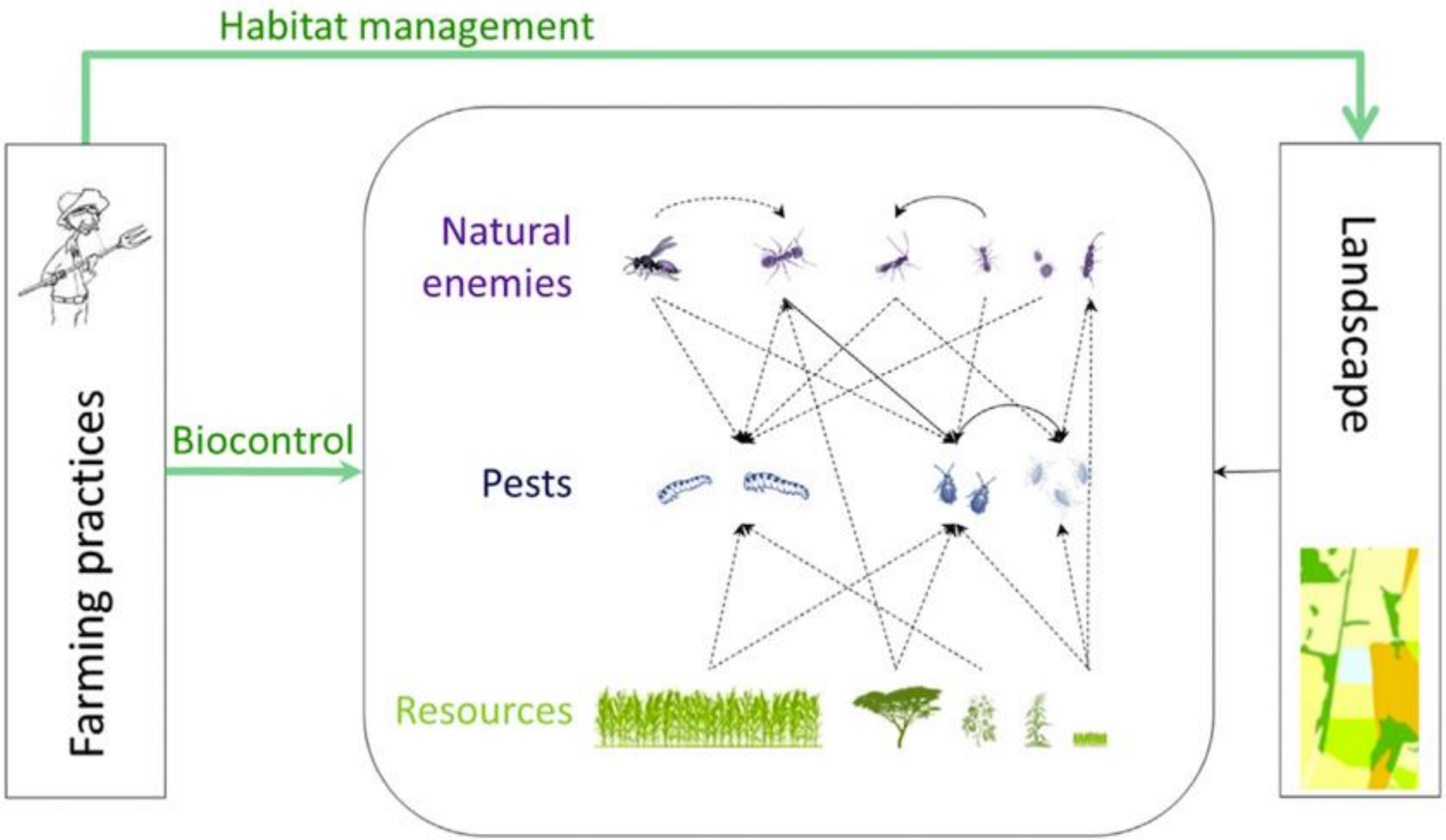

Fig. 1. Ecological control of crop pest populations is one of the ecosystem services (ES) provided by biodiversity. It can be carried out via natural enemies (top-down) or via resources and their availability, according to the landscape composition and structure (bottom-up). Some resources are also used by natural enemies which might find prey or alternative hosts and food there. The approach that we propose for improved management of crop pests consists in reconciling (i) action on the environment through biodiversity-friendly farming practices and technical innovations (e.g., biocontrol), and (ii) action on the landscape to stimulate the ecological processes involved in natural pest regulation (e.g., habitat management).

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Crop Protection 115 (2019) 1–6

Table 1. Types of interspecies antagonisms leading to biological control of plant pathogens.

Type	Mechanism	Examples
Direct antagonism	Hyperparasitism/predation	Lytic/some nonlytic mycoviruses *Ampelomyces quisqualis* *Lysobacter enzymogenes* *Pasteuria penetrans* *Trichoderma virens*
Mixed-path antagonism	Antibiotics	2,4-diacetylphloroglucinol Phenazines Cyclic lipopeptides
	Lytic enzymes	Chitinases Glucanases Proteases
	Unregulated waste products	Ammonia Carbon dioxide Hydrogen cyanide
	Physical/chemical interference	Blockage of soil pores Germination signals consumption Molecular cross-talk confused
Indirect antagonism	Competition	Exudates/leachates consumption Siderophore scavenging Physical niche occupation
	Induction of host resistance	Contact with fungal cell walls Detection of pathogen-associated, molecular patterns Phytohormone-mediated induction

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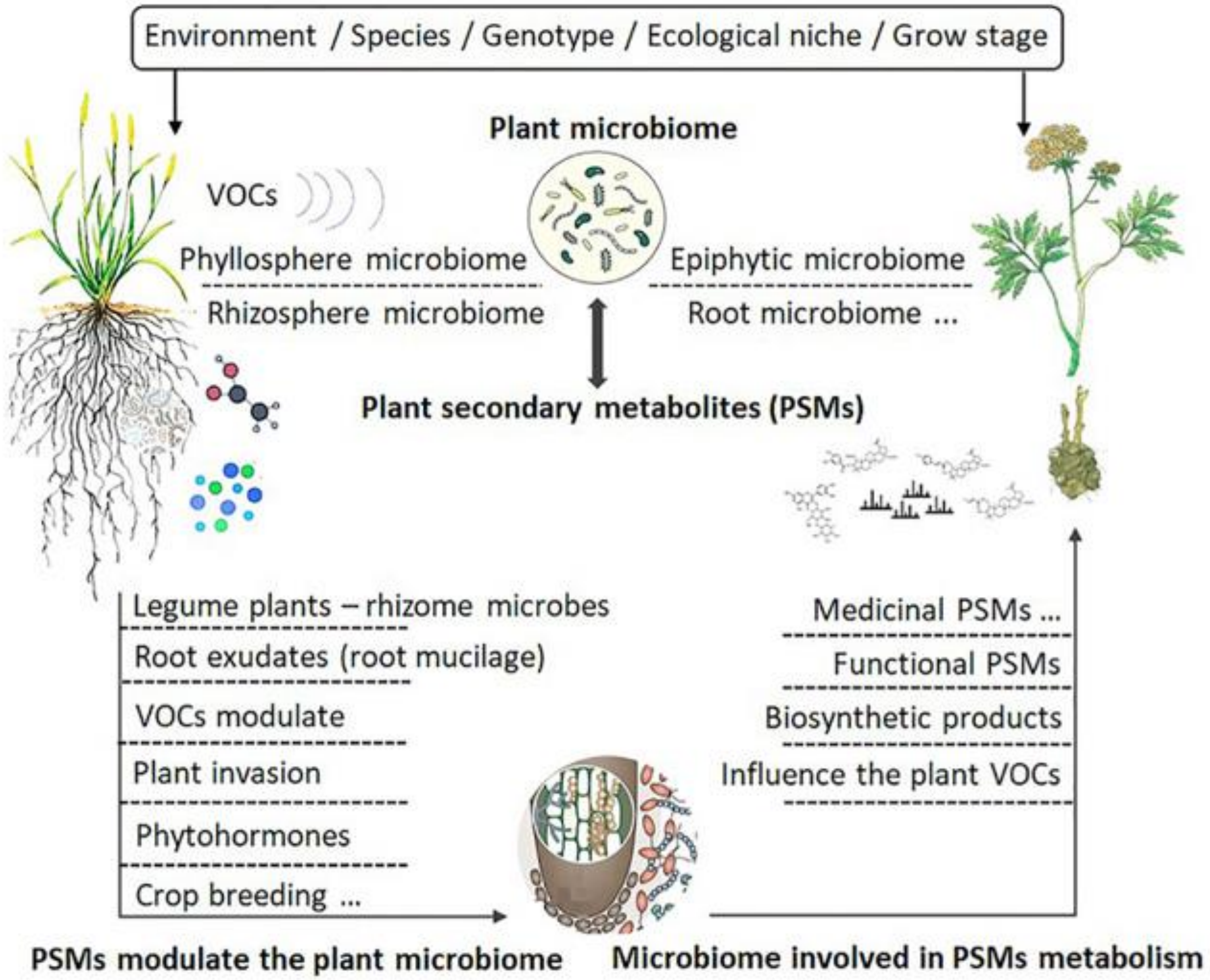

FIGURE 2 | Factors influencing the interactions between plant secondary metabolites and plant microbiomes.

Trichoderma spp.

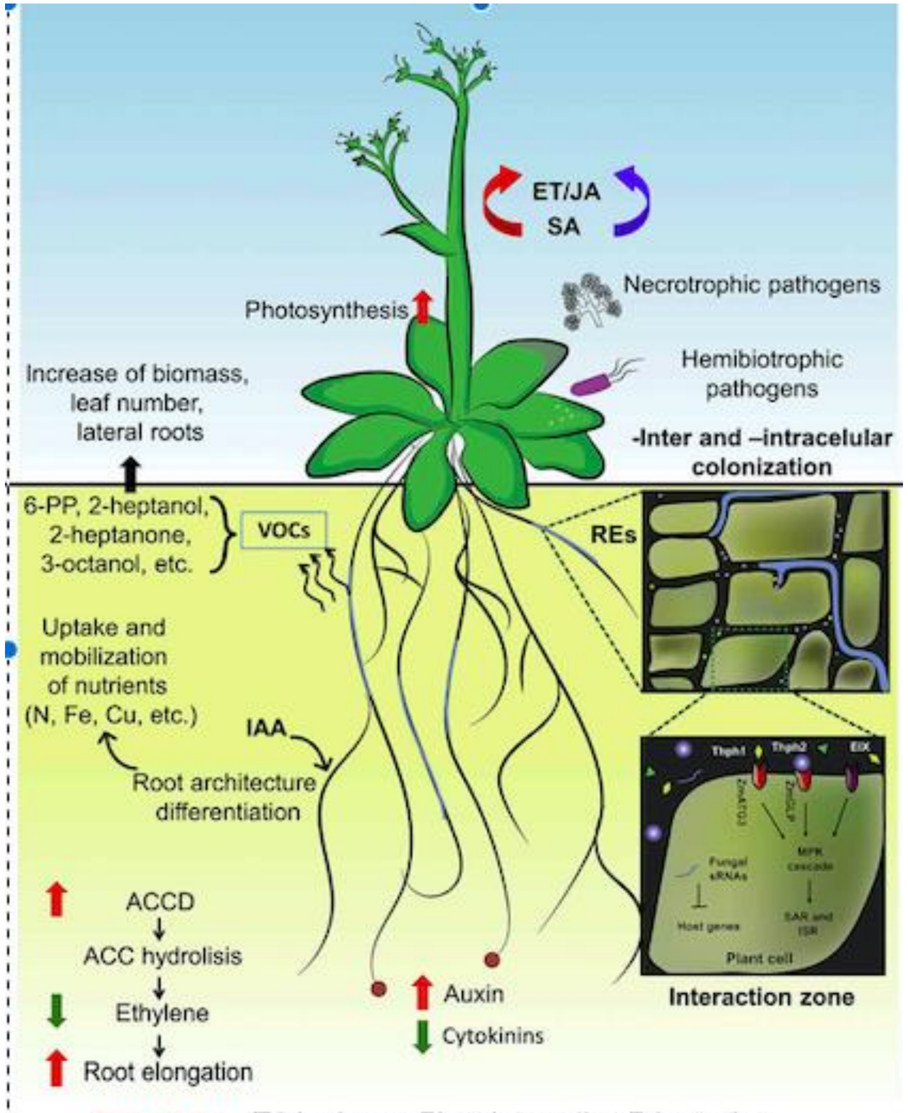

FIGURE 1.1 *Trichoderma*–Plant Interaction.Prior to the physical interaction of *Trichoderma* with the plant, the root exudates (REs), including peroxidases and oxylipins, act as chemical signals in the soil to stimulate the growth of the

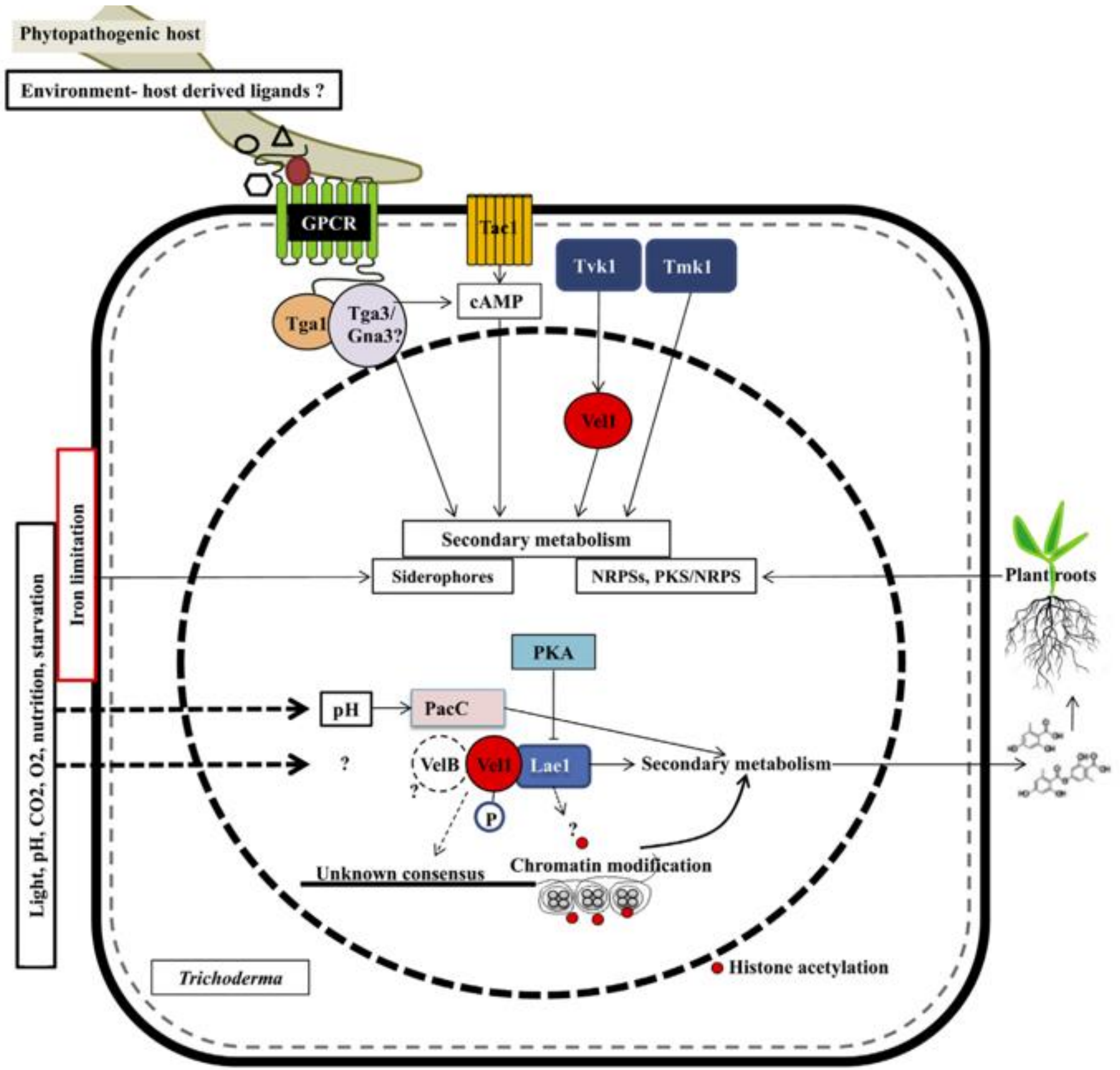

Fig. 7 – Model representing the regulators of secondary metabolite biosynthesis in *Trichoderma*. For details, see text.

Auto-regulators	Mycoparasitism/ Competition/ antimicrobials	Plant defense stimuation
• 1-octen-3-ol • 3-octanone • emodin • pachybasin	• 6-PP • viridin • trichothecenes (trichodermin, harzianum A) • gliotoxin • peptaibols • harzianic acid • siderophores	• harzianolide • 6-PP • peptaibols • trichokonins • harzianic acid

Fig. 8 – Examples of *Trichoderma*-derived secondary metabolites with roles in auto-regulatory processes, in mycoparasitism/competition and interaction with the plant.

Secondary metabolism in *Trichoderma* – Chemistry meets genomics

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[b]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400085, India

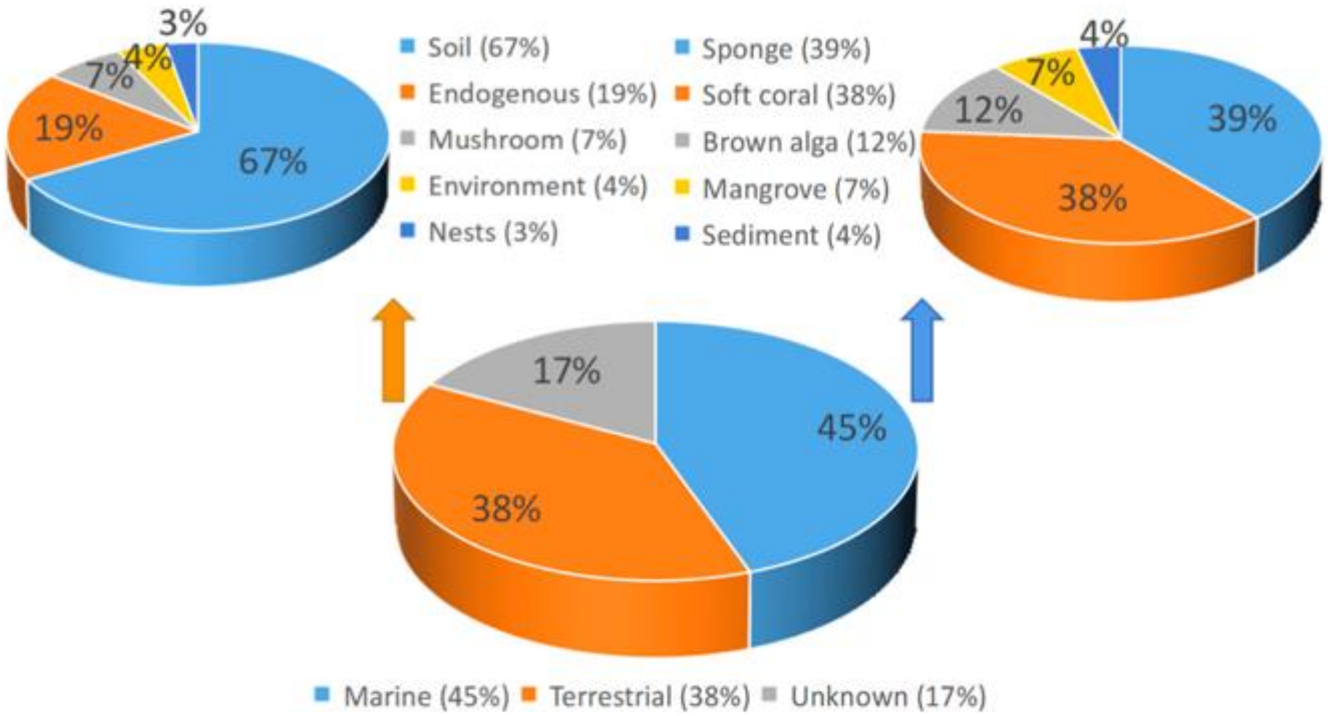

Figure 7. The SMs of *T. harzianum* from marine and terrestrial sources, and its distribution.

Review

Structures and Biological Activities of Secondary Metabolites from *Trichoderma harzianum*

Rui Guo [1], Gang Li [1], Zhao Zhang [2] and Xiaoping Peng [1,*]

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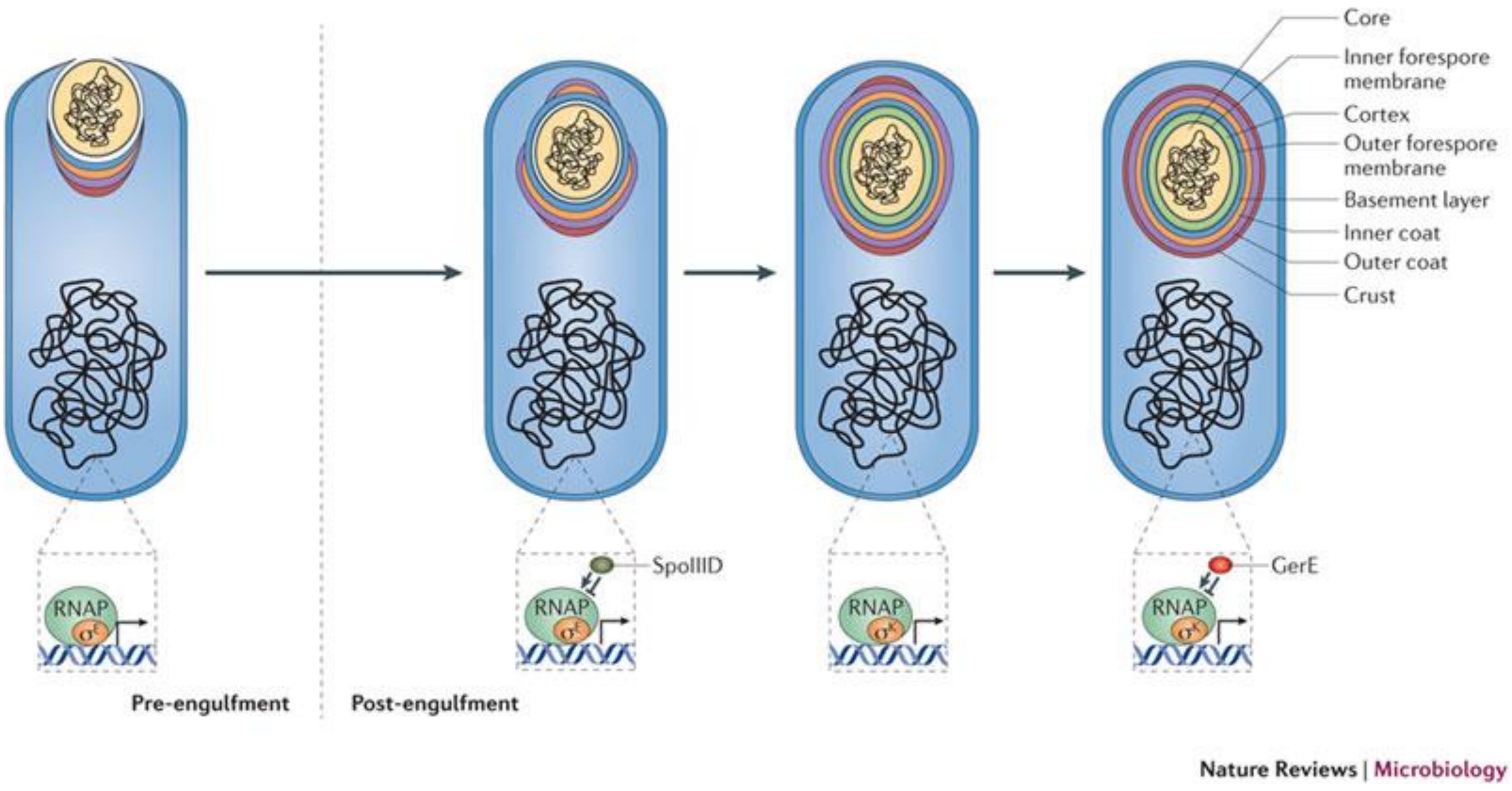
Bacillus subtilis, B. amycoliquefaciens



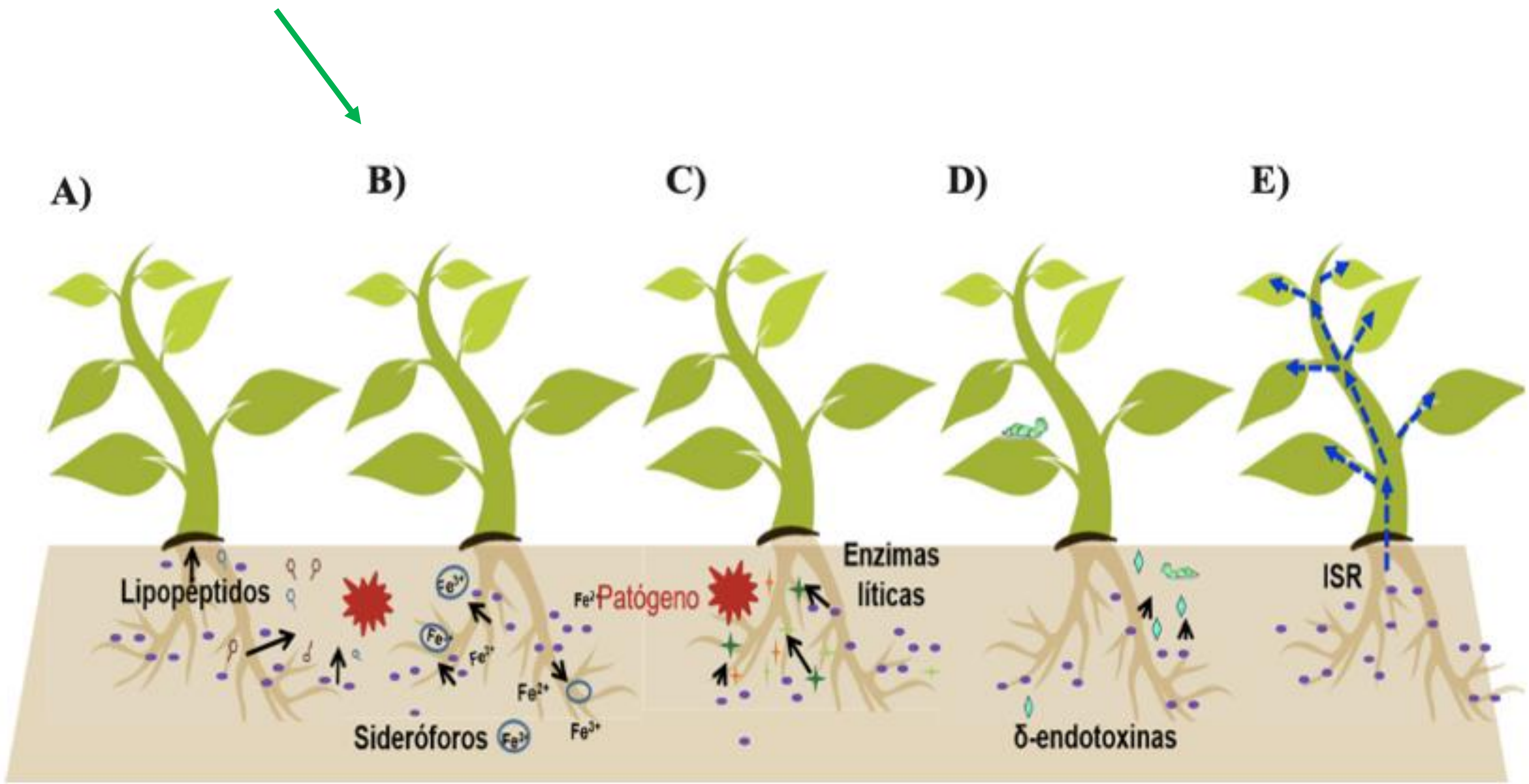


Figura 3. Principales mecanismos de control biológico del género *Bacillus*. Producción de A) lipopéptidos, B) sideróforos, C) enzimas líticas, D) δ-endotoxinas, E) inducción a la respuesta sistémica.

Figure 3. Main biological control mechanisms of the genus *Bacillus*. Production of A) lipopeptides, B) siderophores, C) lytic enzymes, D) δ-endotoxins, E) induction to the systemic response.

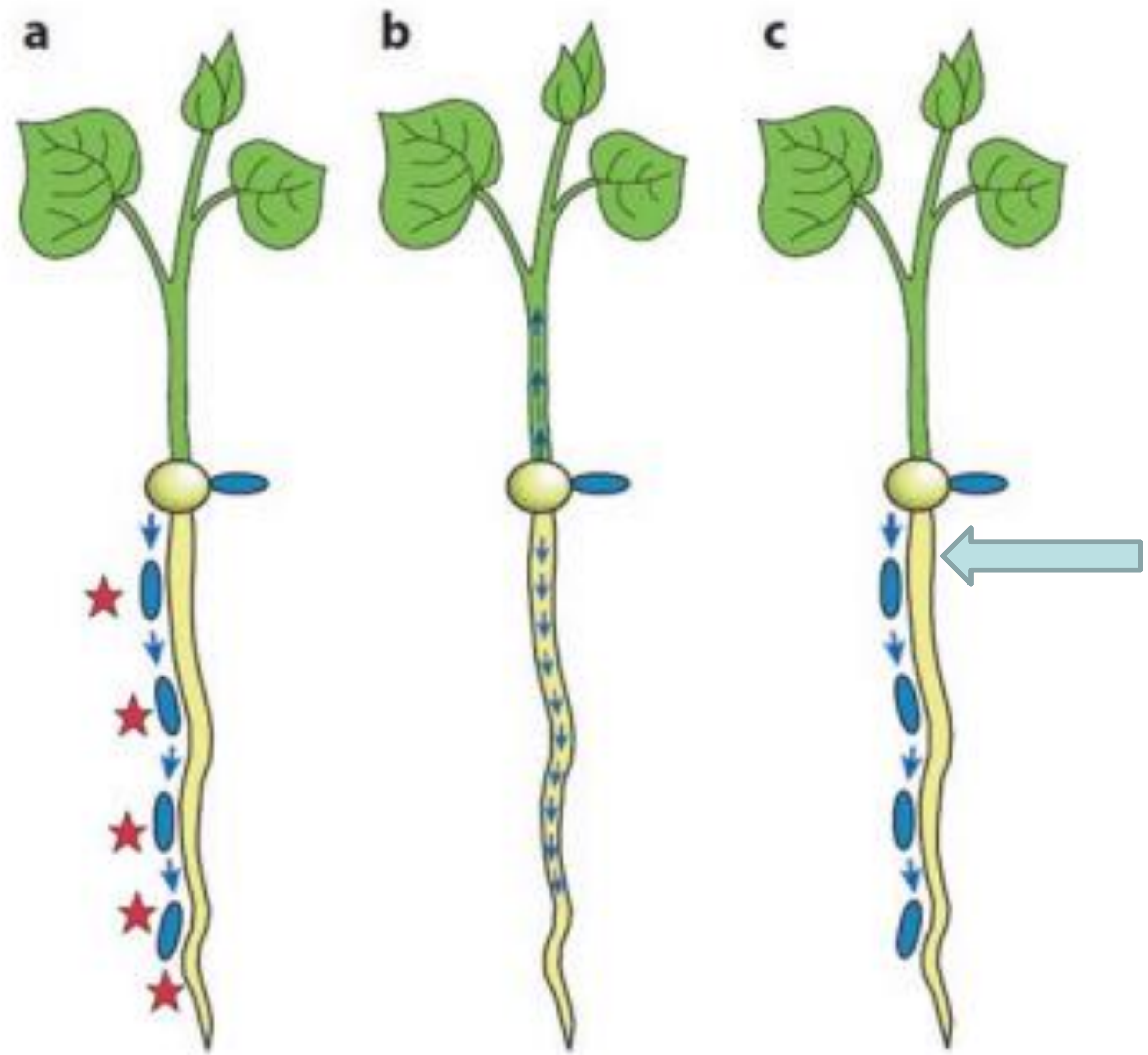


Fig. 9.2 Illustration of the most important mechanisms of biological control of plant diseases by bacteria (Lugtenberg and Kamilova 2009). (**a**) Antibiosis. The bacterium colonizes the growing root system and delivers antibiotic molecules around the root, thereby harming pathogens that approach the root (**b**) Induced systemic resistance (ISR). (**c**) Competition for nutrients and niches

Streptomyces spp.

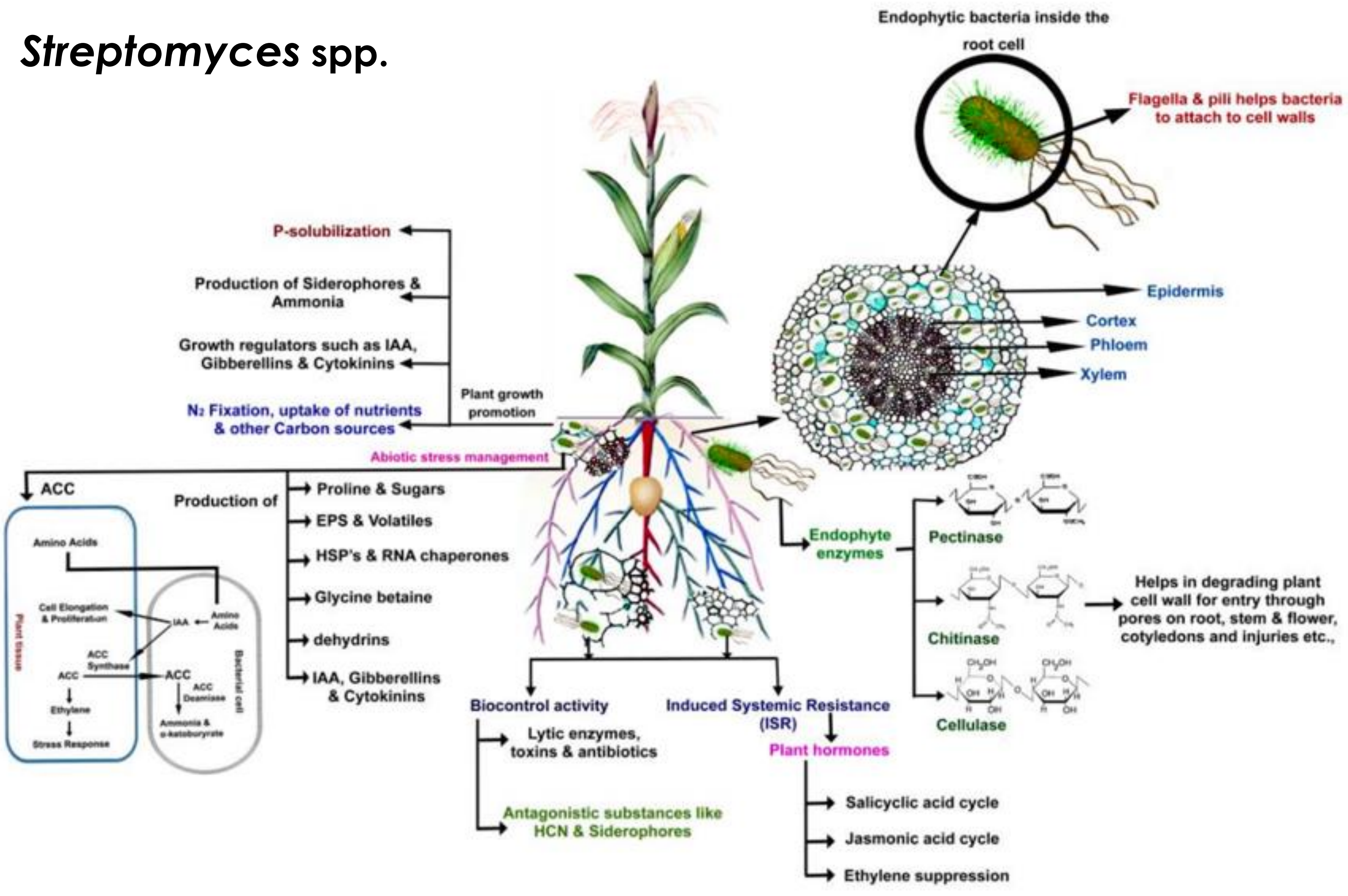


Figure 1. Representation of possible plant–microbe interactions favouring plant growth and/or biocontrol of phytopathogens by streptomycetes as rhizosphere competent microorganisms and/or endophytes (adapted from [57]).

Int. J. Mol. Sci. **2018**, *19*, 952; doi:10.3390/ijms19040952

Streptomyces sp.

Table 1 Concentrations of *Botrytis cinerea* DNA in tomato leaves

Treatment	DNA concertration of *B. cinerea* (ng μl^{-1})					
	3 dpi	5 dpi	7 dpi	9 dpi	12 dpi	15 dpi
Control	0·5271 ± 0·015 aA	0·6134 ± 0·015 aA	0·9417 ± 0·014 aB	1·4825 ± 0·027 aC	2·0739 ± 0·023 aD	2·0842 ± 0·015 aD
Wuyiencin	0·4867 ± 0·011 aA	0·2837 ± 0·009 bB	0·0246 ± 0·003 bC	0·0189 ± 0·002 bD	0·0112 ± 0·001 bDE	0·0376 ± 0·002 bE

Values followed by different letters in each column are significantly different based on Duncan's new multiple-range test at $P \leq 0·05$.

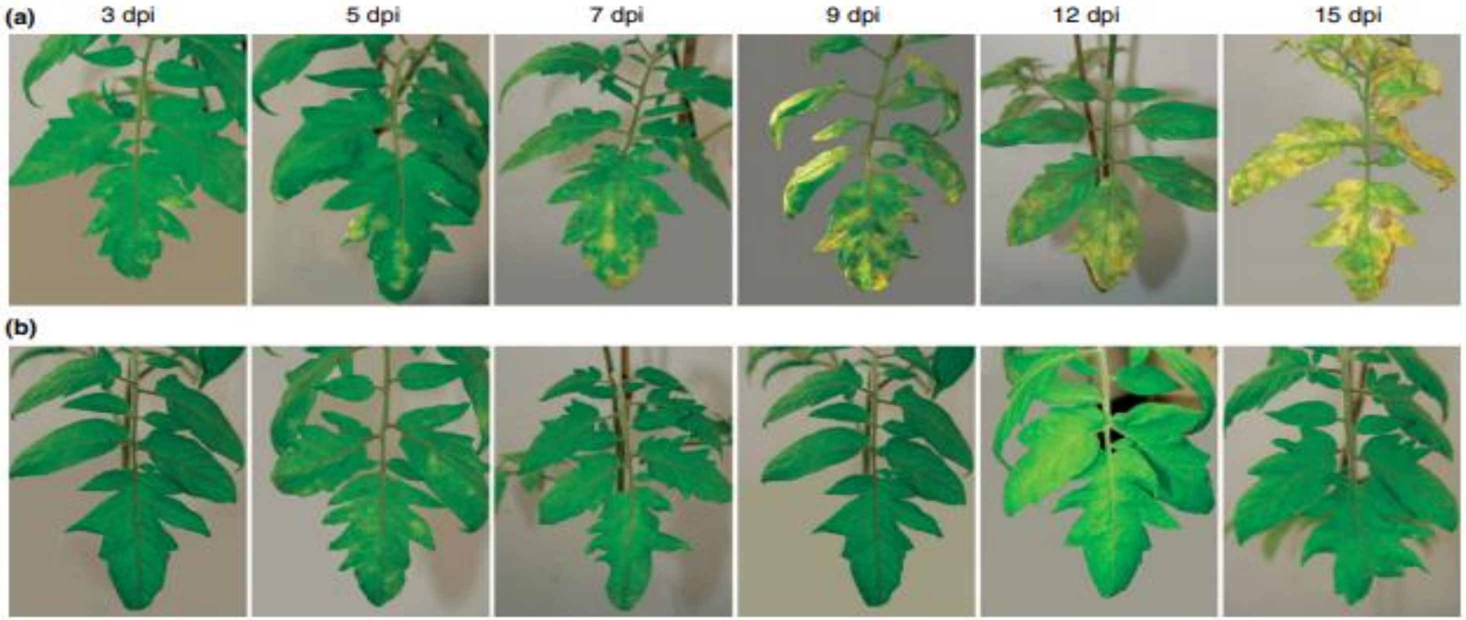
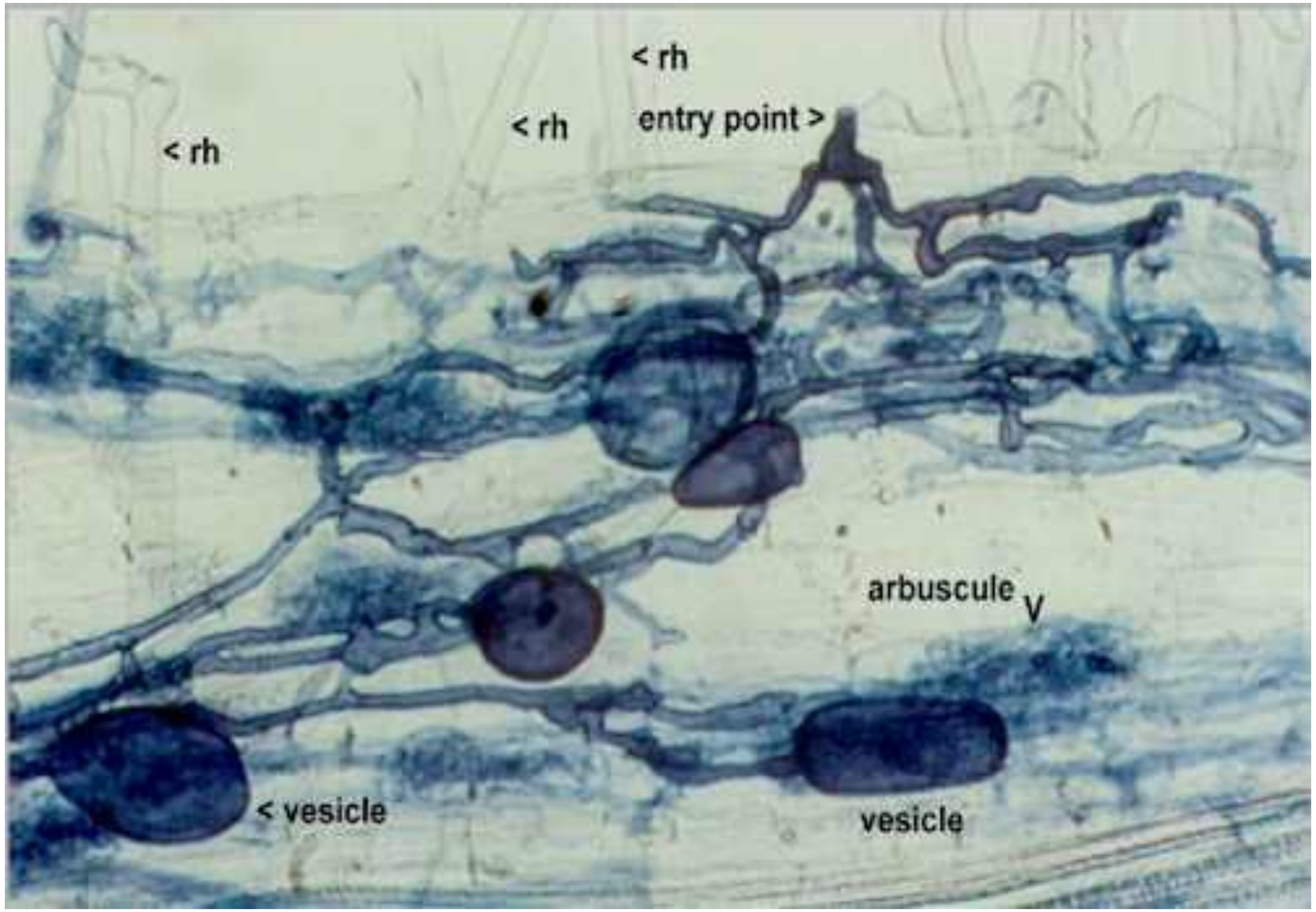
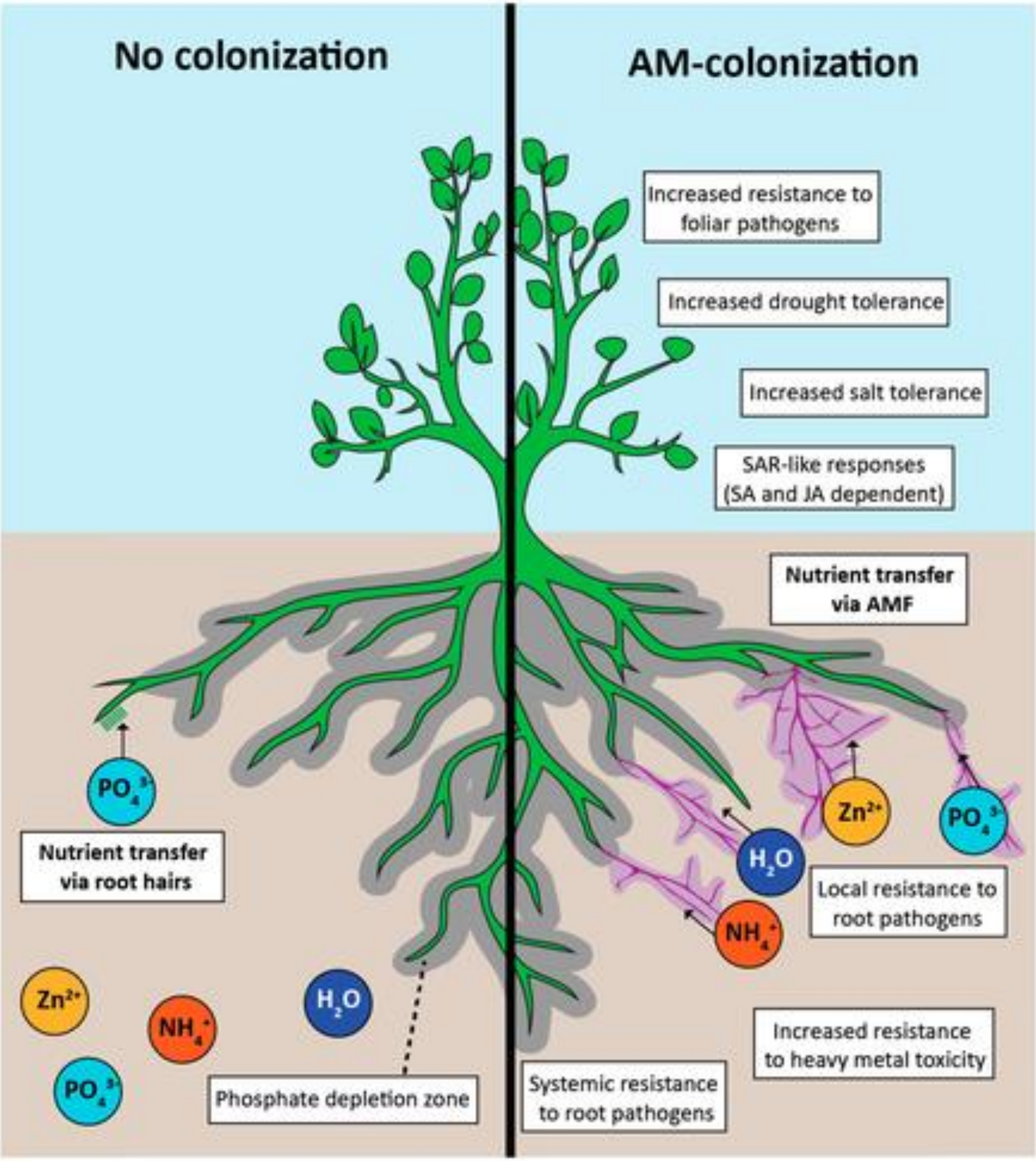
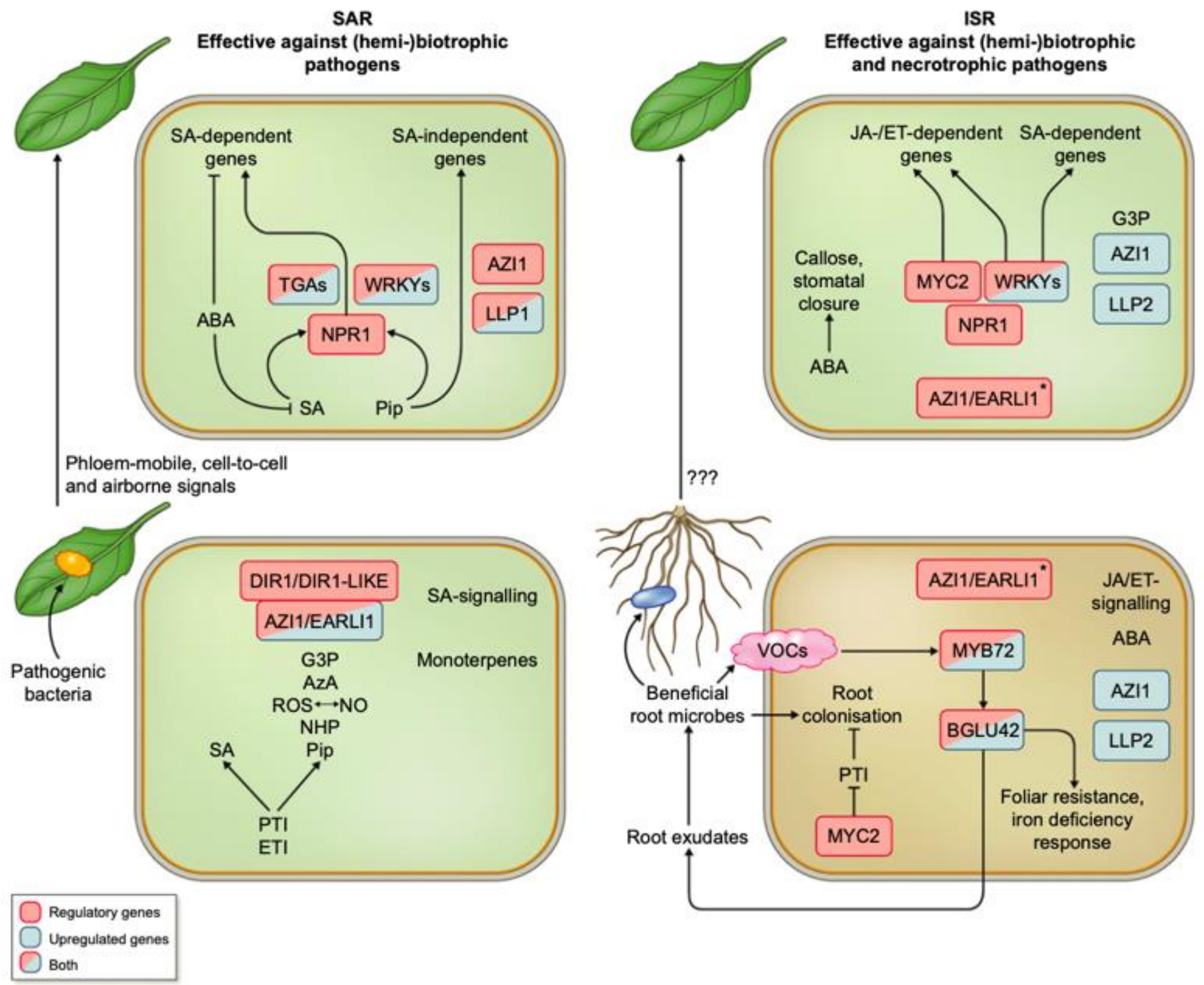


Figure 3 Symptoms in tomato leaves at 3, 5, 7, 9, 12 and 15 days post inoculation under preventive (wuyiencin) and non-preventive treatment. (a) Tomato leaves sprayed with a conidial suspension of *Botrytis cinerea* without preventive treatment by wuyiencin. (b) Tomato leaves sprayed with a conidial suspension of *B. cinerea* with preventive treatment by wuyiencin (100 $\mu g\ ml^{-1}$).

MICORRIZAS VESICULO-ARBUSCULARES




No colonization
AM-colonization
Increased resistance to foliar pathogens
Increased drought tolerance
Increased salt tolerance
SAR-like responses (SA and JA dependent)
Nutrient transfer via AMF
Nutrient transfer via root hairs
Local resistance to root pathogens
Increased resistance to heavy metal toxicity
Systemic resistance to root pathogens
Phosphate depletion zone
PO_4^{3-}
Zn^{2+}
NH_4^+
H_2O



Systemic propagation of immunity in plants

A. Corina Vlot, Jennifer H. Sales, Miriam Lenk, Kornelia Bauer, Alessandro Brambilla, Anna Sommer, Yuanyuan Chen, Marion Wenig and Shahran Nayem

Department of Environmental Science, Institute of Biochemical Plant Pathology, Helmholtz Zentrum Muenchen, Ingolstaedter Landstr. 1, Neuherberg 85764, Germany

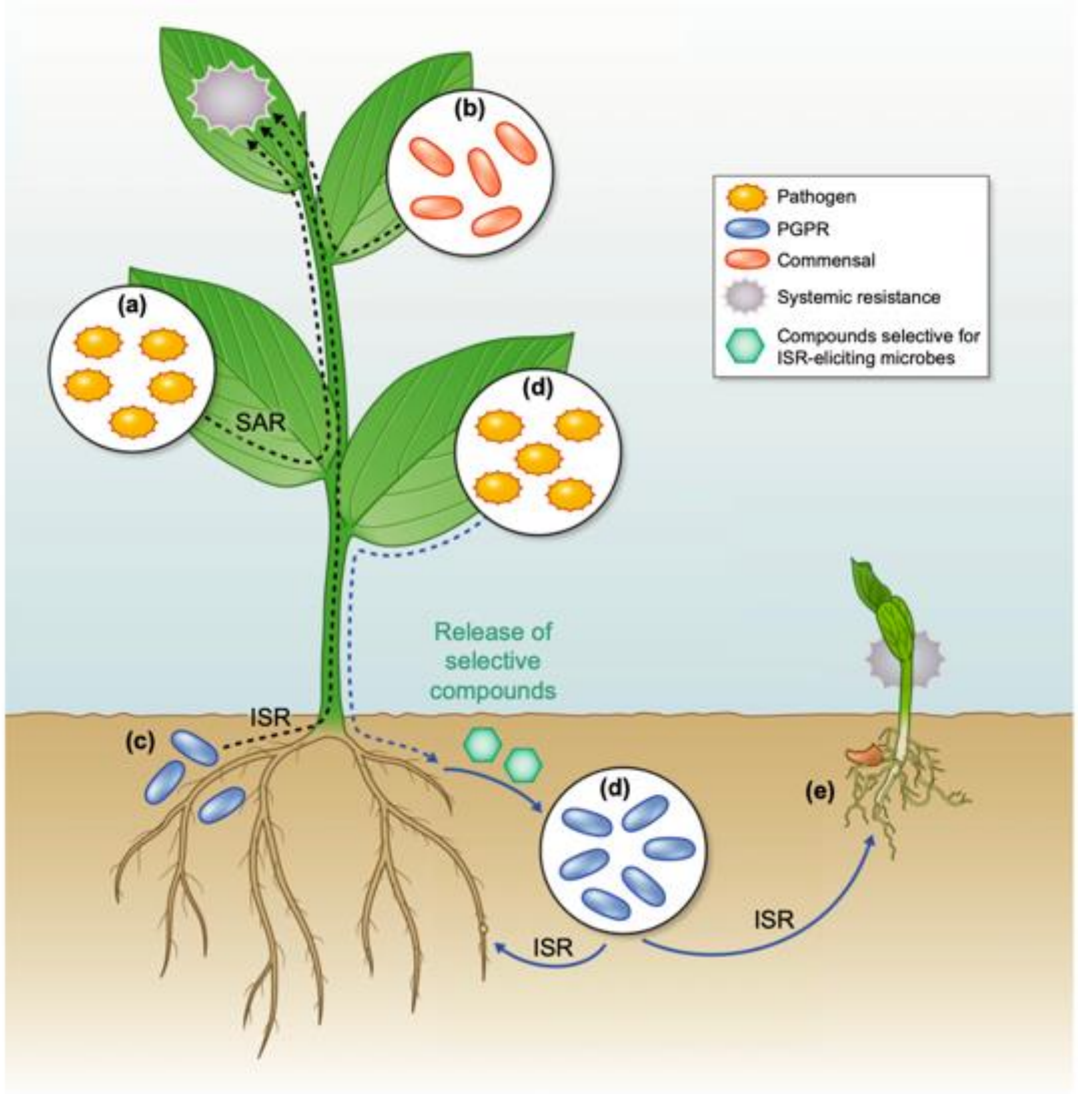


Fig. 6 Reciprocal interactions between systemic immunity and the plant microbiome. Pathogens on leaves can induce systemic acquired resistance (SAR) (a), while commensal microbes on leaves have also been shown to trigger (systemic) immunity (b). While plant growth-promoting rhizobacteria (PGPR) can elicit induced systemic resistance (ISR) (c), certain pathogenic bacteria on leaves can induce the release of compounds from plant roots into the rhizosphere (d). Some of these compounds selectively attract ISR-inducing microbes, which can protect successive plant generations growing on the same soil from disease (e).

Trichoderma sp.

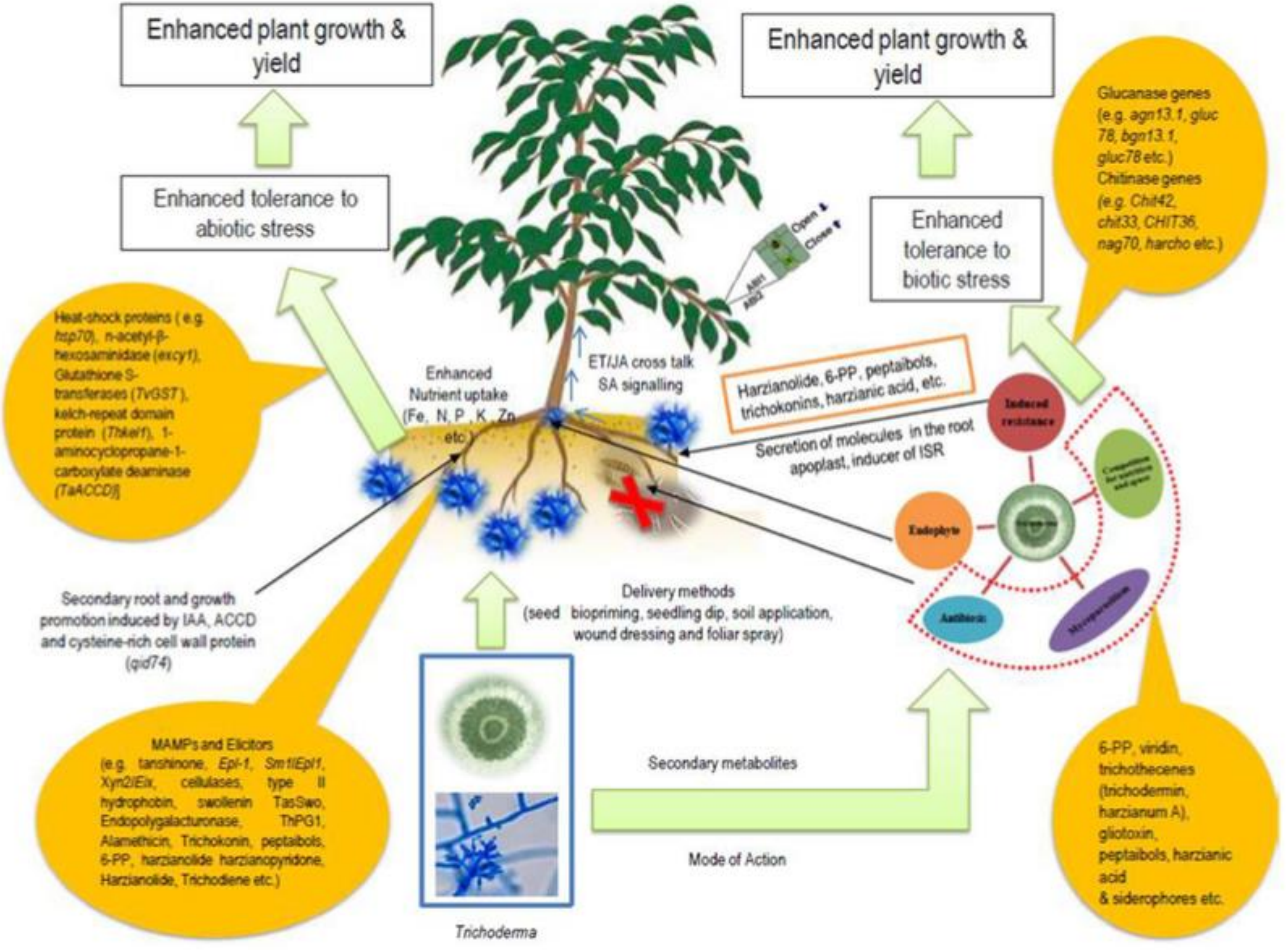


Fig. 1 Mechanism employed by *Trichoderma* species to enhance plant growth and yield by improving nutrient uptake, abiotic/biotic stress resistance and photosynthetic efficiency under changing climatic scenario

PRODUCCIÓN COMERCIAL 2020, PLANTULA

Glomus spp.

SUSTRATO: PEAT MOSS

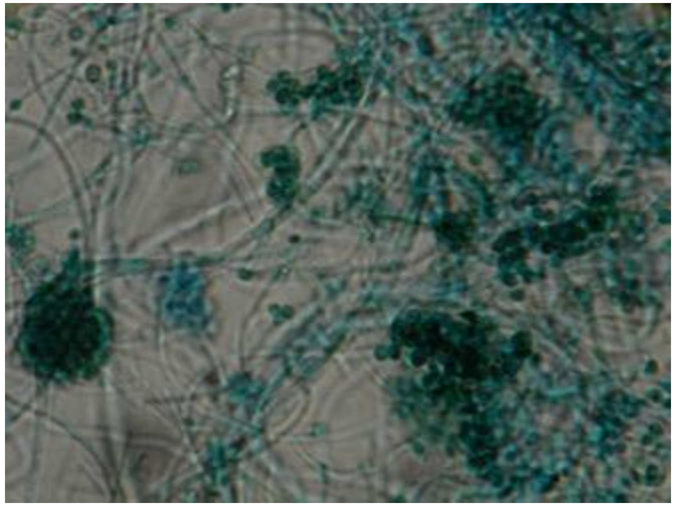
Bacillus subtilis

Trichoderma harzianum

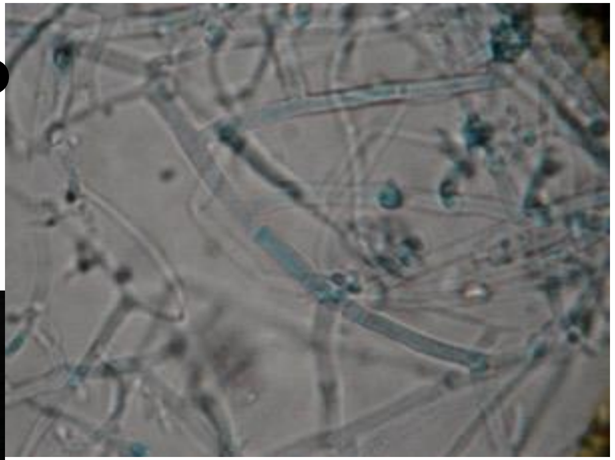
HIBRIDO QUETZAL, SERRANO

APLICACIONES AEREAS DE BIOESTIMULANTE (Algas cafés + ac. Húmicos)

García-Gutierrez, D. y
Alarcon-Peña, D.
2018



Agave tequilero



Tlapal-Bolaños, 2013


PRECAUCION

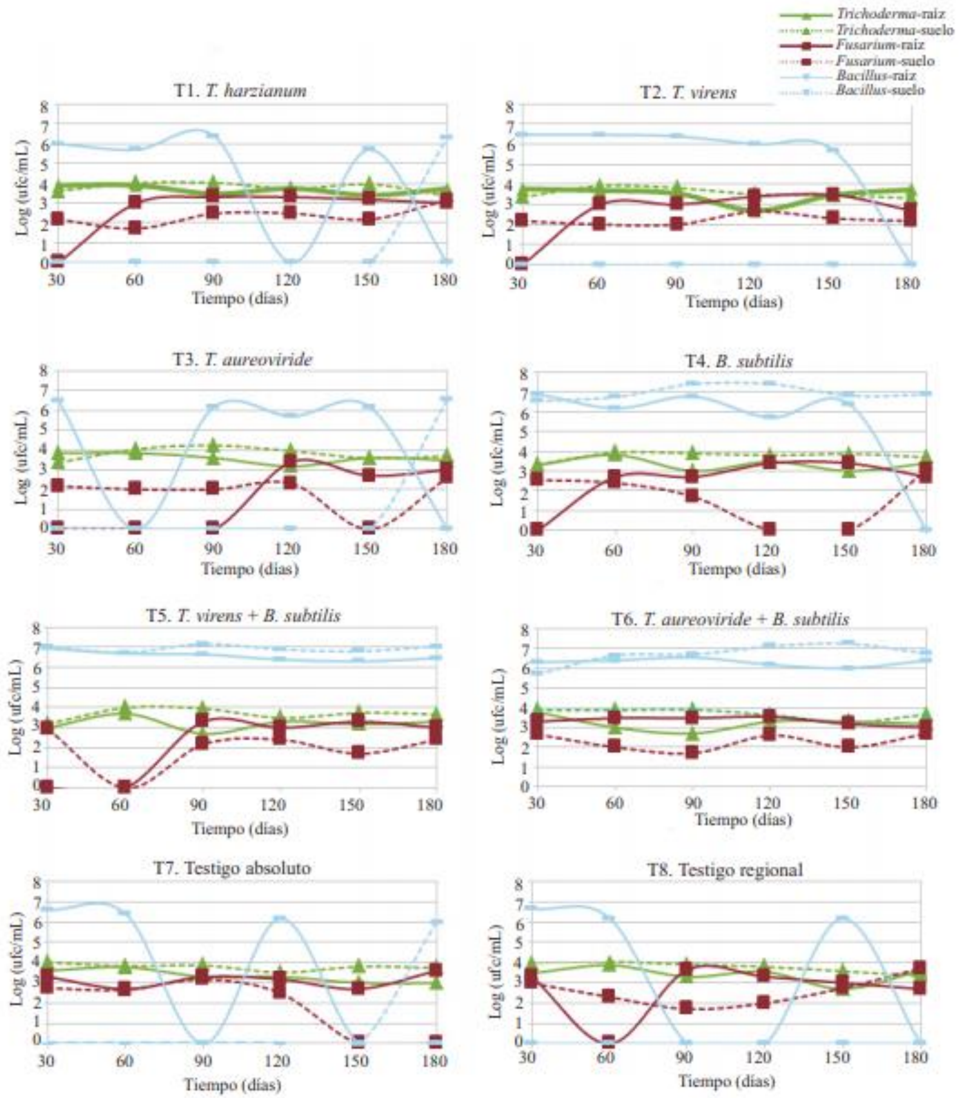


Figura 2 Comportamiento de los tratamientos T1 *T. harzianum* (Th), T2 *T. virens* (Tv), T3 *T. aureviride* (Ta), T4 *B. subtilis* (Bs), T5 *T. virens* + *B. subtilis* (Tv + Bs), T6 *T. aureoviride* + *B. subtilis* (Ta + Bs), T7 Testigo absoluto (Tabs) y T8 Testigo regional (Treg), durante seis meses de diciembre 2008 a mayo de 2009, inoculados al sustrato durante la etapa de adaptación de vivero del agave (*Agave tequilana* weber var. Azul) en el "Rancho el Indio", Tequila, Jalisco.

Figure 2. Behavior of treatments T1 *T. harianum* (Th), T2 *T. virens* (Tv), T3 *T. aureoviride* (Ta), T4 *B. subtilis* (Bs), T5 *T. virens* + *B. subtilis* (Tv + Bs), T6 *T. aureoviride* + *B. subtilis* (Ta + Bs), T7 Absolute control (Tabs) and T8 (Regional control), during six months from December of 2008 to May of 2009, inoculated to the substrate during the nursery adaptation stage of the agave (*Agave tequilana* weber var. Azul) in "Rancho el Indio", Tequila, Jalisco.

Tlapal-Bolaños, 2013

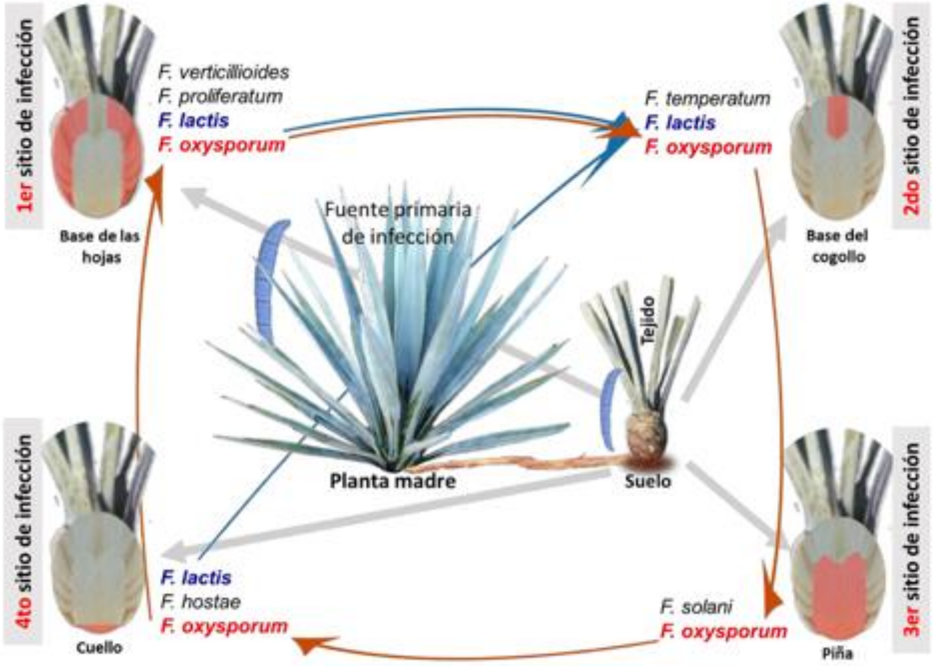


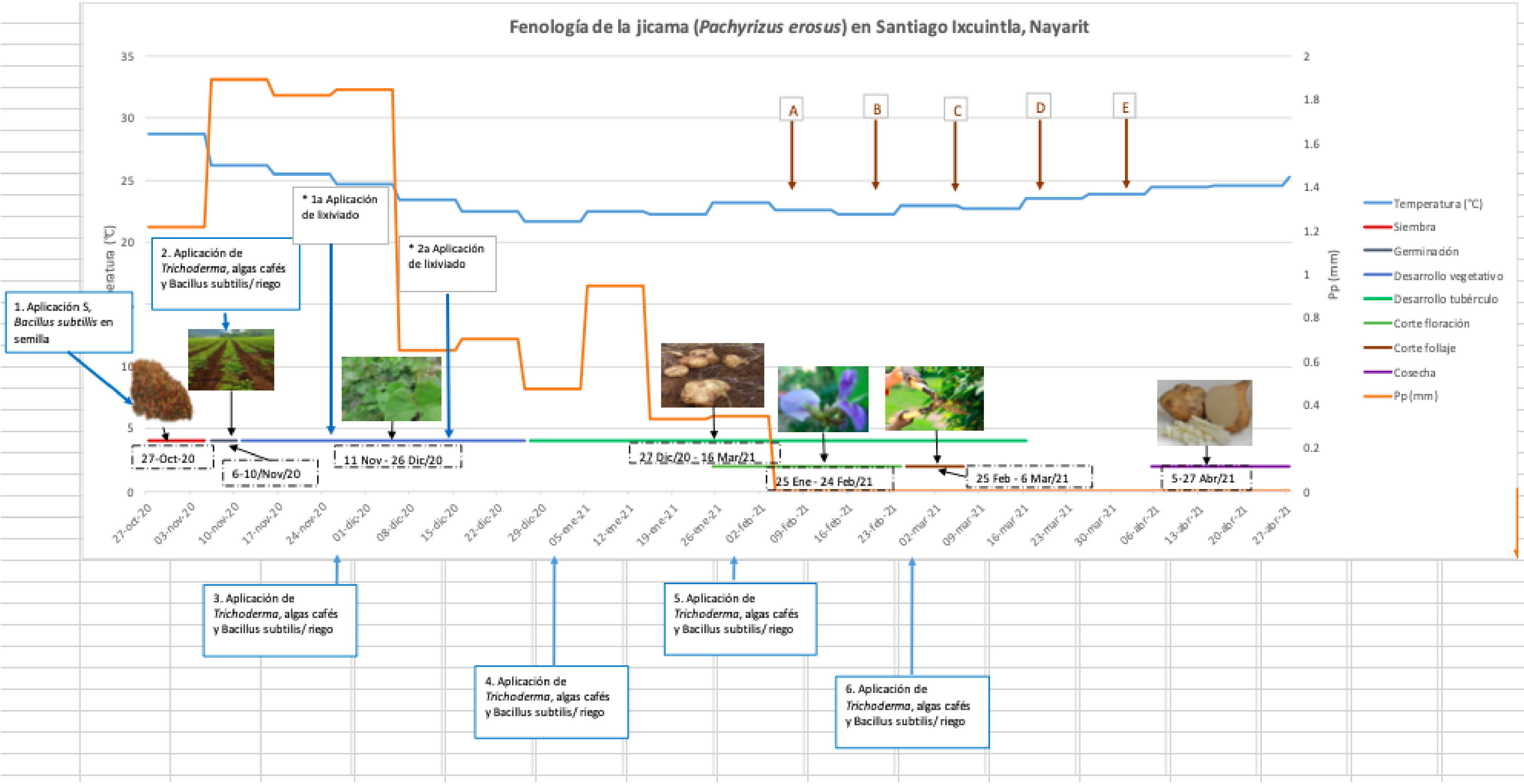
Figura 4.15. Propuesta de ciclo de infección de *Fusarium* en tejido interno del hijuelo, por crecimientos de unidades formadoras de colonias (UFC). *F. oxysporum* se encuentra en todos los tejidos internos del hijuelo.

Mendoza-Ramos, 2020

JICAMA/ Santiago Itxcuintla, Nayarit

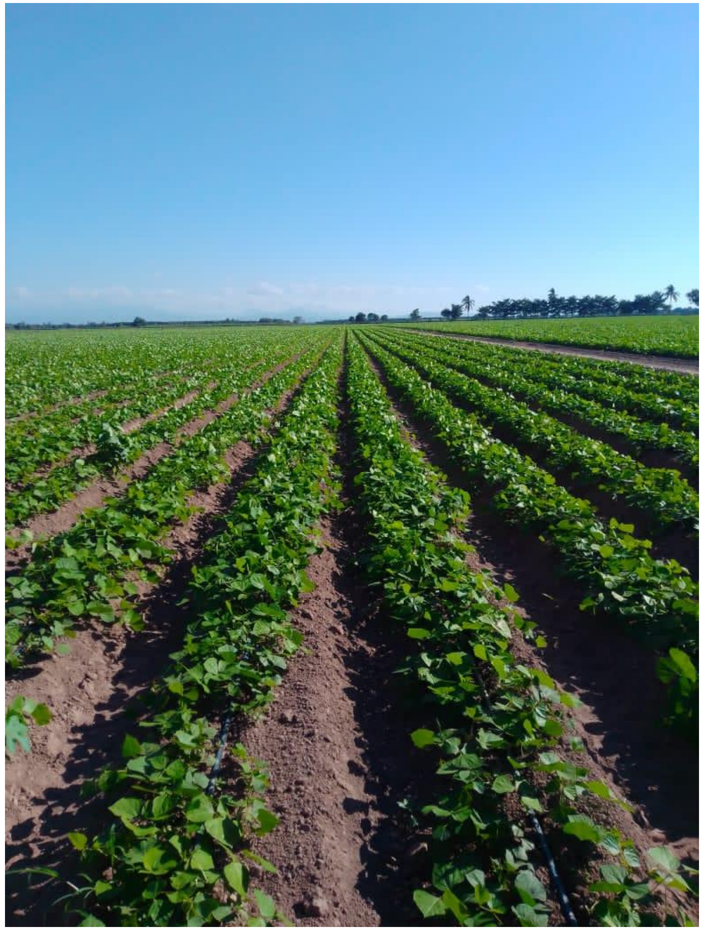
Adición de *Bacillus subtilis* y *Trichoderma harzianum* a la semilla/ con adición del adherente INEX :1Kg/200g/30kg de semilla

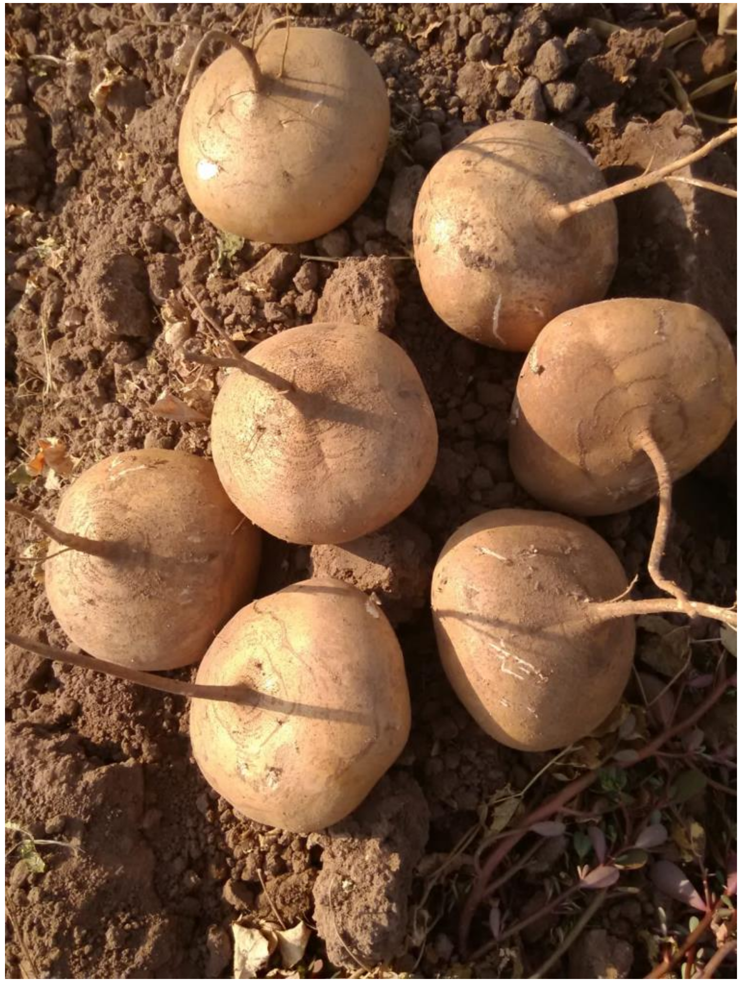
PLANEACIÓN Y PROGRAMACIÓN DE ACTIVIDADES



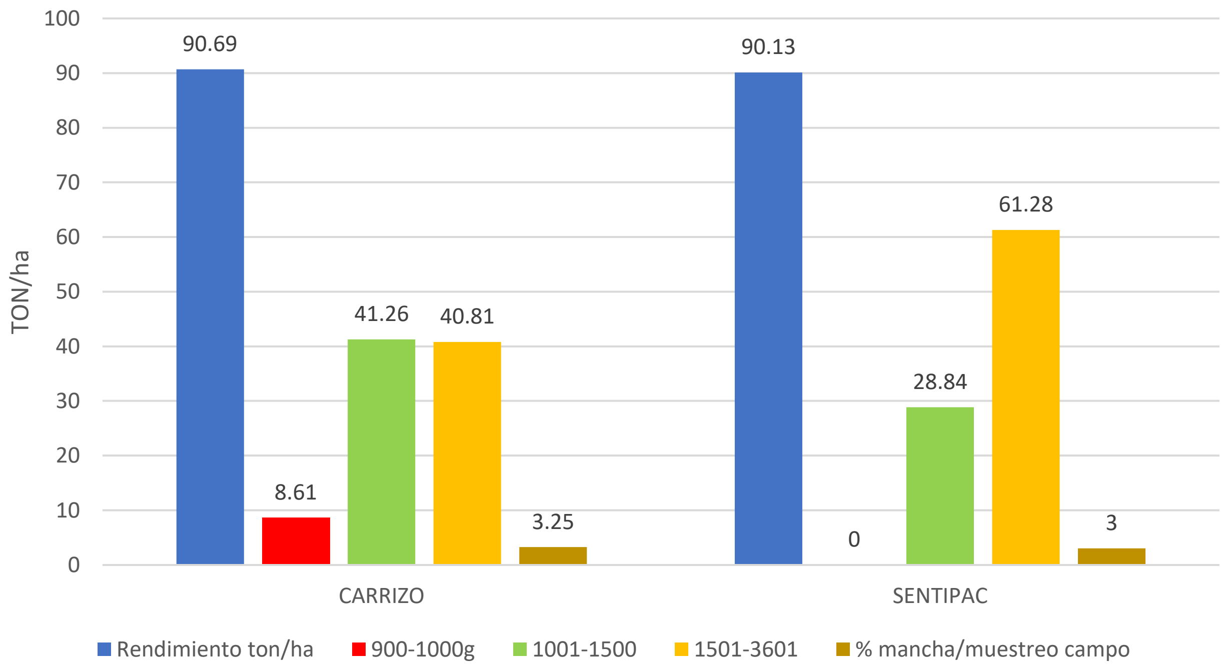
Diciembre 16 del 2020

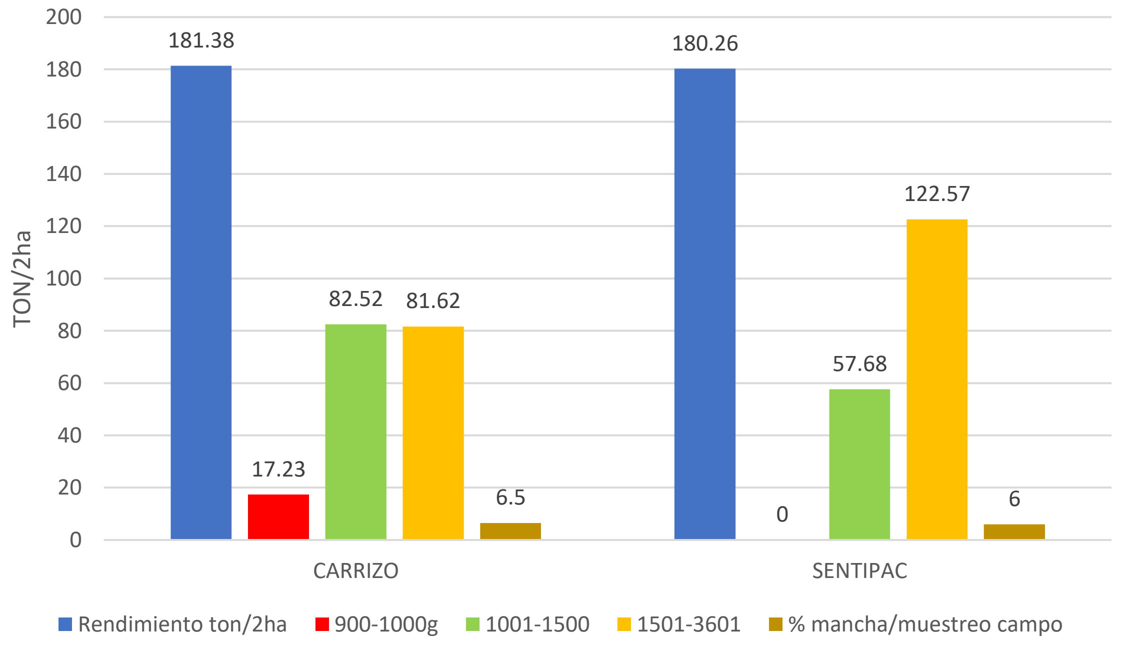
Primera aplicación de lixiviado/25L/ha





RENDIMIENTOS. Rendimiento por hectarea y total, por lote y peso de tubérculos; así como porcentaje de tubérculo manchado encontrado.





Acibenzolar–s-methil

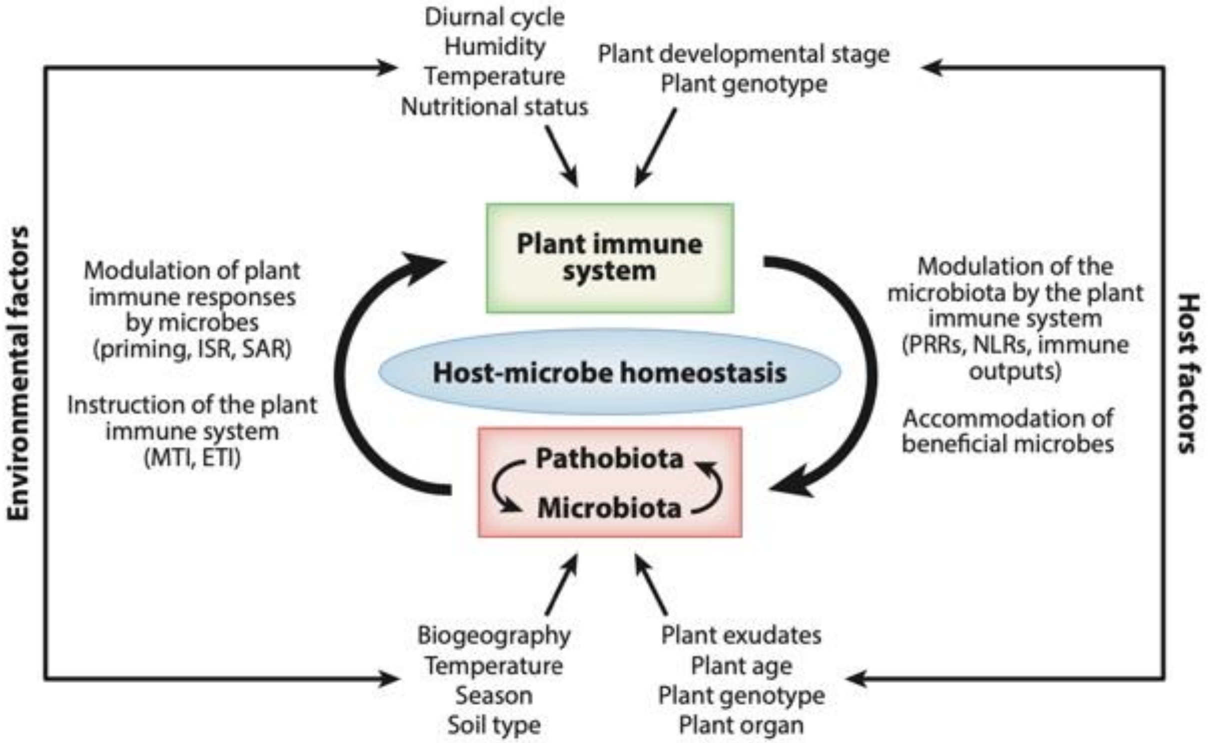


Figure 3

Reciprocal interactions between the immune system and the plant microbiota. The plant immune system, influenced by environmental and host factors, sculpts microbial assemblages in plant endosphere compartments and emerges as a complex microbial management system required for both terminating pathogen growth and accommodating beneficial microbes. In turn, the microbiota, also modulated by environmental and host factors, represents a developmental signal for immune maturation. The underlying functions include immune system priming, induced systemic resistance (ISR), and systemic acquired resistance (SAR) and represent important mechanisms that promote plant health in their natural habitats. This reciprocal interplay defines the immunity-microbial homeostasis and likely serves an important function in shaping beneficial plant-microbiota combinations. Abbreviations: ETI, effector-triggered immunity; MTI, MAMP-triggered immunity; NLRs, nucleotide-binding leucine-rich repeat proteins; PRRs, pattern recognition receptors.

¡GRACIAS POR SU ATENCIÓN!