ORGANIC AGRICULTURE AS AN IMPROVEMENT TO ECOSYSTEM

Introduction to organic farming

- Biopesticides
- Composting
- Rhizobacteria

The Future of Agriculture

- Increased Production per Acre
- Increased Farmland Area
- New Crops and Hybrids
- Better Irrigation
- Organic Farming
- Eating Lower on the Food Chain

Organic farming

- **Organic farming** is typically considered to have three qualities:
  - It is more like natural ecosystems than monoculture;
  - It minimizes negative environmental impacts;
  - The food that results from it does not contain artificial compounds.

- According to the U.S. Department of Agriculture (USDA),
  - organic farming has been one of the fastest-growing sectors in U.S. agriculture,
  - although it still occupies a small fraction of U.S. farmland and contributes only a small amount of agriculture income.

How to reach this goal????

1. Management of cropping systems and soil fertility, quality of agricultural products and recovery of by-products

- Cultivation of legumes and their green manuring, through crop rotations, recycling organic matter resources through composting

- Scientific research contributes on the management of the farm and industrial organic wastes

How to reach this goal????

2. Biological control and natural biomolecules

- Organic molecules of plant origin have an impact on the environment which is by far lower than for conventional products.
- Search for new products of natural origin extracted from native plants, micro-organisms (yeasts, bacteria, fungi) and biotechnical means.
- Research work for evaluating the efficacy of control means, the development of integrated management so as to improve the quality characteristics of the product, to guarantee food safety through the monitoring of residual levels and the impact on the agroecosystems.
- The global improvement of organic productions, through the validation of methods for pest management; the genetic characterization of beneficial, the setting up of competence centers.

3. Sustainability of agricultural and natural systems

- To investigate and causes and interrelationships between different elements characterizing farm and natural systems, influencing farm and land sustainability in its different aspects as social, economic, environmental and governance dimensions.

- Sustainability is strictly linked to natural resource and land management including landscape with natural and agricultural systems.

4. Economic and market research

- The investigation of issues applicable to farm management;
- The exploration of marketing and market aspects of organic agriculture..

5. Socio-economic impacts and organic support policies

- How the adoption of organic farming affects the livelihoods of rural communities and contributes to the development of local economies
- To monitor and analyze the emergence and evolution of organic regulatory and policy settings.

Organic Farming

ORGANIC FARMING PRINCIPLE

Health

Care

Principles of Organic Farming

Ecology

Fairness

Basic Steps of Organic Farming

Organic farming approach involves following five principles:

1. Conversion of land from conventional management to **organic management**
2. Management of the entire surrounding system to **ensure biodiversity** and sustainability of the system
3. Crop production with the use of **alternative sources of nutrients** such as crop rotation, residue management, organic manures and biological inputs.
4. Management of weeds and pests by better management practices, physical and cultural means and by **biological control system**
5. Maintenance of **live stock in tandem with organic concept** and make them an integral part of the entire system

BIO-PESTICIDES

Microbial pesticides; Biochemicals; Plant-Incorporated protectants; Antagonists and Pathogens;

Biopesticides

- The appeal among consumers for alternatives is growing and the market for “natural” or more environmentally benign pesticides has concomitantly improved over the past few years.
  - These “alternatives” are then called **biorationals**, the agents and organisms that are currently being pursued in laboratory and field to become the pesticides of the future.

- The **microbial insecticides, biorational,** or **bio-insecticides** are also referred to the same thing.
  - The U.S. Environmental Protection Agency's (EPA) uses a similar term, **biopesticides**.

Biopesticides Characteristics

- Characteristics that distinguish biopesticides from conventional ones:
  1. very low orders of toxicity to non-target species,
  2. pest targets are specific,
  3. generally low use rates,
  4. rapid decomposition in the environment,
  5. usually work well in IPM programs
  6. reduce reliance on conventional pesticide products.

Biopesticides

- EPA places biopesticides into three categories:

1. **Microbial pesticides** (*bacteria, fungi, viruses or protozoa and* Nematoda?)
2. **Biochemicals** – natural substances that control pests by non-toxic mechanisms. An example is *insect pheromones.*
3. **Plant-Incorporated Protectants** (PIPs) – (primarily transgenic plants, e.g., (*Bt corn*).

First: Microbial Pesticides

Microbial pesticides consist of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient.

- Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest[s].
  - For example, there are fungi that control certain weeds, and other fungi that kill specific insects.

Microbial Pesticides

- The most widely used microbial pesticides are subspecies and strains of ***Bacillus thuringiensis***, or Bt.
- Each strain of this bacterium produces a different mix of proteins, and specifically kills one or a few related species of insect larvae.
- While some Bt's control moth larvae found on plants, other Bt's are specific for larvae of flies and mosquitoes.
- The target insect species are determined by whether the particular Bt produces a protein that can bind to a larval gut receptor, thereby causing the insect larvae to starve

Second: Biochemical Pesticides

Biochemical pesticides Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms.

- Conventional pesticides, by contrast, are generally synthetic materials that directly kill or inactivate the pest.

- Biochemical pesticides include substances, such as
  - ***insect sex pheromones***, that interfere with mating,
  - various scented **plant extracts** that attract insect pests to traps.

Third: Plant-Incorporated Protectants

PIP-pesticides: are pesticidal substances that plants produce from genetic material that has been added to the plant.

- For example, scientists can take the gene for the Bt pesticidal protein, and introduce the gene into the plants own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest.

Remember this is not organic farming!!!!!!!

Microbial Controls Resulted in:

1. Destruction of the propagative units or biomass of the pathogen
2. Prevention of inoculum formation
3. Weakening or displacement of the pathogen in infested residue
4. Reduction of vigor or virulence of the pathogen by agents such as mycoviruses or hypovirulence determinants

Sometimes do nothing

Examples

- *Agrobacterium radiobacter*: Galltrol-A, Nogall, Diegall, Norbac 84C
- *Bacillus subtilis*: Epic, Kodiak , Rhizo Plus , Serenade , System_3
- *Burkholderia cepacia*: Intercept
- *Pseudomonas fluorescens*: BlightBan A506, Conquer, Victus
- *Pseudomonas syringae*: Bio-save100, Bio-save110
- *Streptomyces griseoviridis*: Mycostop
- *Ampelomyces quisqualis*: AQ10
- *Candida oleophila*: Aspire
- *Coniothyrium minitans*: Contans , KONI
- *Fusarium oxysporum*: Biofox C, Fusaclean
- *Gliocladium virens*: SoilGard
- *Gliocladium catenulatum*: PreStop, Primastop
- *Phlebia gigantea*: Rotstop, P.g. Suspension
- *Pythium oligandrum*: Polygandron
- ***Trichoderma harzianum*** and other spp.: Bio_Fungus, Binab_T, RootShield, T-22G, T-22 Planter Box, Bio-Trek), Supresivit, Trichodex, Trichopel, Trichoject, Trichodowels, Trichoseal , Trichoderma 2000

Reasons why biological control is not very popular!!!!!!!!!!!!!!!

1. Wait until something is wrong
2. Chemicals are faster and less complicated
3. Active grower engagement.
4. Marketing
5. Extension pathology
6. Decline in interest in ecology
7. Poor biological control products (haste)

Biological control of inoculums

- Biological control methods have first been used against insects.
  - The Australian scale, *Icerya purchasi*, may be controlled by a release of ***Novius cardinalis*** ladybird beetles
  - Citrus scale (*Aonidiella aurantii*) are controlled by ***Aphytis melinus*** and *Chilocorus* sp.
- Biological control is presently used to **control inoculums** on plants before or after planting (planting material, pruning injuries and plant organs).

Pathogens as natural controls

- Diseases can be **important natural controls** of some insect pests.
- Some pathogens have been mass-produced and are available in commercial formulations for use in standard spray equipment.
- These products are frequently referred to as **microbial insecticides**, **biorational,** or **bio-insecticides**.
- Some of these microbial insecticides are still experimental; others have been available for many years.
- **Formulations of the bacterium, *Bacillus thuringiensis* or Bt, for example, are widely used by gardeners and commercial growers.**

Pathogens as natural controls - Specifications

- To be effective, most microbial insecticides must be applied to the correct life stage of the pest, and some understanding of the target pest's life cycle is required.

- Some microbial insecticides, to be effective, must be eaten by the insect. Good spray coverage is therefore important.

Major characteristics of insect pathogens

1. They kill, reduce reproduction, slow growth, or shorten the life of pests
2. They usually are specific to target species or to specific life stages
3. Their effectiveness may depend on environmental conditions or host abundance
4. The degree of control by naturally occurring pathogens may be unpredictable
5. They are relatively slow acting; they may take several days or longer to provide adequate control
6. They may cause epizootics

Antagonists- effectiveness

- Antagonists have been successfully used to suppress tomato mosaic, foot and butt rot of conifers, citrus tristeza disease, and crown gall of several crops.
- Seeds have been coated with antagonists that reduce infection by pathogens and also enhance plant growth.
- Brown rot of peaches in storage was controlled under simulated commercial conditions by incorporating the antagonist *Bacillus subtilis* into wax used in the packing process.
- Inoculation of hosts with antagonists has been used with good results against a common fungal pathogen of conifers and chestnut blight.

Antagonists

- **The aboveground environment is the least stable for antagonists** because
  - the extreme variability in moisture and nutrients.

- In contrast, greenhouse-planting mixes can be managed more effectively to promote antagonist colonization.

- It is practical to treat seeds to favor microbial antagonists.

Major characteristics of antagonists of plant disease and food

1. genetically stable
2. effective at low concentrations
3. easy to culture and amenable to growth on an inexpensive medium
4. effective against a wide range of pathogens in a variety of systems
5. prepared in an easily distributable form
6. non-toxic to humans
7. resistant to pesticides
8. compatible with other treatments (physical and chemical)
9. non-pathogenic against the host plant

Biological control of inoculums- Antagonists

- *Sclerotinia* spp is a common pest on fruit trees. It survives in the subsoil in the form of microsclerotia.
  - Various species of *Trichoderma* have largely been experimented upon as antagonists of this pest.

- Its biological effectiveness has been reported, but its practical use is made difficult by the fact that chemical and cropping control techniques are much easier to implement and more cost-effective for the farmer.
  - The fungus *Athelia bombacina* inhibits the conservation of *V. inaequalis* in dead leaves that have dropped. The main source of inoculums of this pest is then eliminated.

Biological control of inoculums- Suppressive soils

- In suppressive soils, even if the inoculum arrives, the disease is not expressed.
- It has been shown that a **fungistasis** inactivates the inoculum. It has a biological origin, as disinfection modes suppress it.
- This resistance may be successfully transmitted to many sensitive soils.
- According to several authors, soil resistance to **vascular fusarium wilts** is due to *Fusarium saprophytes* and in particular to *F. solani* and *F. oxysporum*.
  - These fungi, with a similar ecology, are responsible for the fungistasis as they inhibit the germination of chlamydospores of parasitic forms.

Biological control of inoculums-Cross protection

- **Cross protection** is the use of a given strain, avirulent or with low virulence and of the same genus or species as the pest, that is able, thanks to a similar ecology, to occupy the same infection sites or to trigger in the host protection reactions that occur before pathogenesis.

- Cross protection is a state of resistance induced in the host plant by an infection with a weak strain of the pathogenic virus.

- Cross protection has been successfully applied to citrus (Tristeza) and tomato (TMV).

Biological control of inoculums-Cross protection

- Mechanism of Cross-Protection Unknown…

- Main theories:
  - **Coat Protein of mild strain re-encapsidates** and captures incoming viral RNA?
  - **Hybridization** ‘Capture’ of incoming viral RNA by complementary RNA made by mild strain?
  - **Competition for ‘sites’ in host** e.g. plasmodesmal proteins or sites on membrane needed for replication?
  - **RNA Silencing**? This is currently the most popular (and probably most likely explanation).

The Biological Control by Cross Protection

- Problems of Cross-Protection:
  - 'Mild' strain reduces yield (5-10%)
  - 'Mild' strain-infected plants can act as reservoir for infection of sensitive crops
  - Mutation of protecting strain from mild to severe
  - Mixed infections (mild strain of virus A with a new virus B) may produce a severe disease complex (same problem for use of sat RNAs).
  - Labor-intensive

COMPOSTING

Objectives :

- What is Composting ?
- Why to compost ?
- What to compost ?
- Composting requirements
- Factors affecting the compost process
- Types of composting
- Compost production systems
- When is compost finished?
- Benefits of compost

What is composting?

Using the natural process of decay to change organic wastes into a valuable humus-like material called **compost**

Why to compost ?

- Environmentally responsible
- Keeps biodegradable waste out of landfills and sewage plants
  - Alternative to burning
  - Gives you a vibrant garden without chemical fertilizers
- Saves money :
  - Garbage handling is the 4th largest expense for many cities. Composting can reduce those costs.

Composting requirements

- Composting requires the following:
  - Organic waste - newspaper, leaves, grass, kitchen waste (fruits, vegetables), woody materials
  - Decomposers (microorganisms)
  - Water
  - Air - source of oxygen

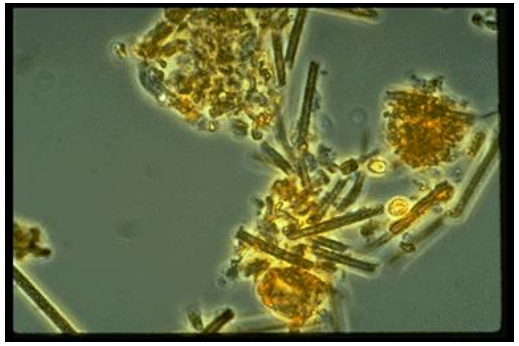
Source of Decomposers

One teaspoon of good garden soil to which compost has been added contains

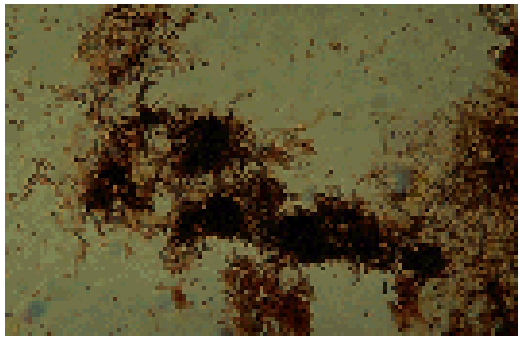
- **100 million bacteria**
- **240 meter of fungal threads**

Soil, Food scraps & Manure each of these will also add microorganisms to the compost

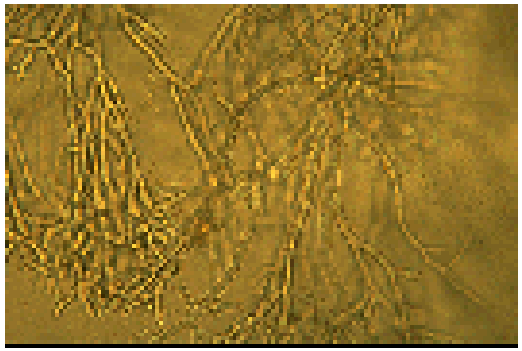
The main players



1. <u>Bacteria:</u>
   major decomposers, breakdown simpler forms of organic material.



2. <u>Actinomycetes:</u>
   degrade complex organics such as cellulose, lignin and chitin.



3. <u>Fungi:</u>
   Break down tough debris, too dry, too acidic or too low in nitrogen for bacteria to eat.

Food for decomposers

- Composting will be most rapid if the decomposers are fed a mix of carbon rich and nitrogen rich materials.
  - Carbon rich organic wastes are known as "browns"
  - Nitrogen rich organic wastes are known as "greens"

Browns

High carbon materials such as

- Leaves (30-80:1)
- Straw (40-100:1)
- Paper (150-200:1)
- Sawdust (100-500:1)
- Animal bedding mixed with manure (30-80:1)

Greens

High nitrogen materials such as

- Vegetable scraps (12-20:1)
- Coffee grounds (20:1)
- Grass clippings (12-25:1)
- Manure
  - Cow (20:1)
  - Horse (25:1)
  - Poultry (10:1), with litter (13-18:1)
  - Hog (5-7:1)

Brown vs Green

Browns

- Decay very slowly
- Coarse browns can keep pile aerated
- Tend to accumulate in the fall
- Tie up nitrogen in soil if not fully composted
- May need to stockpile until can mix with greens

Greens

- Decay rapidly
- Poor aeration – may have foul odors if composted alone
- Tend to accumulate in spring and summer
- Supply nitrogen for composting
- Best composting if mixed with browns

Why mixing them

- Because of their characteristics, browns and greens each have some problems if composted on their own.

- **They make excellent compost when mixed together**.
  - If compost made only from browns is not fully mature
    - it could still be high in carbon and tie up nitrogen in the soil.
  - Because greens decompose so rapidly and are high moisture they tend to mat when composted alone.
    - This prevents air from getting into the pile and creates foul odors.

- Browns tend to accumulate in the fall, while greens tend to accumulate in the spring. A good system is to stockpile browns, then gradually mix them with greens the following year.

Factors affecting the compost process

- Aeration : oxygen > 10%
- Moisture: 45-60%
- Carbon to nitrogen (C:N) ratio (30:1)
- pH: 6.5-8.0
- Temperature : 54-60 ^{o}C

Types of composting

- **<u>Active (hot) composting</u>**
  - ~55°C
  - Higher temperature kill most pathogens
  - Regularly stirring ensure aeration
  - Keep moist (H_2O 40-60% of weight)
  - Faster (2-6 weeks, depending on ingredients)

- **<u>Passive (cold) composting</u>**
  - ~30°C
  - Much slower (may take months)
  - May develop anaerobic condition, releasing odor and greenhouse gas (e.g. methane)

Compost production systems

- Small scale
- Large scale (Commercial)

Small scale

Manufactured bins

Small scale


food waste
garden waste
3 BIN PROCESS
gravity does the hard work!!
PULL-OUT PANEL
PUSH-PULL TOOL
STAGE ONE
- mixing
STAGE TWO
- digesting
STAGE THREE
- maturing
AEROBIC/AERATED

Large scale (Commercial)

Appalachian STATE UNIVERSITY

ASU RECYCLES

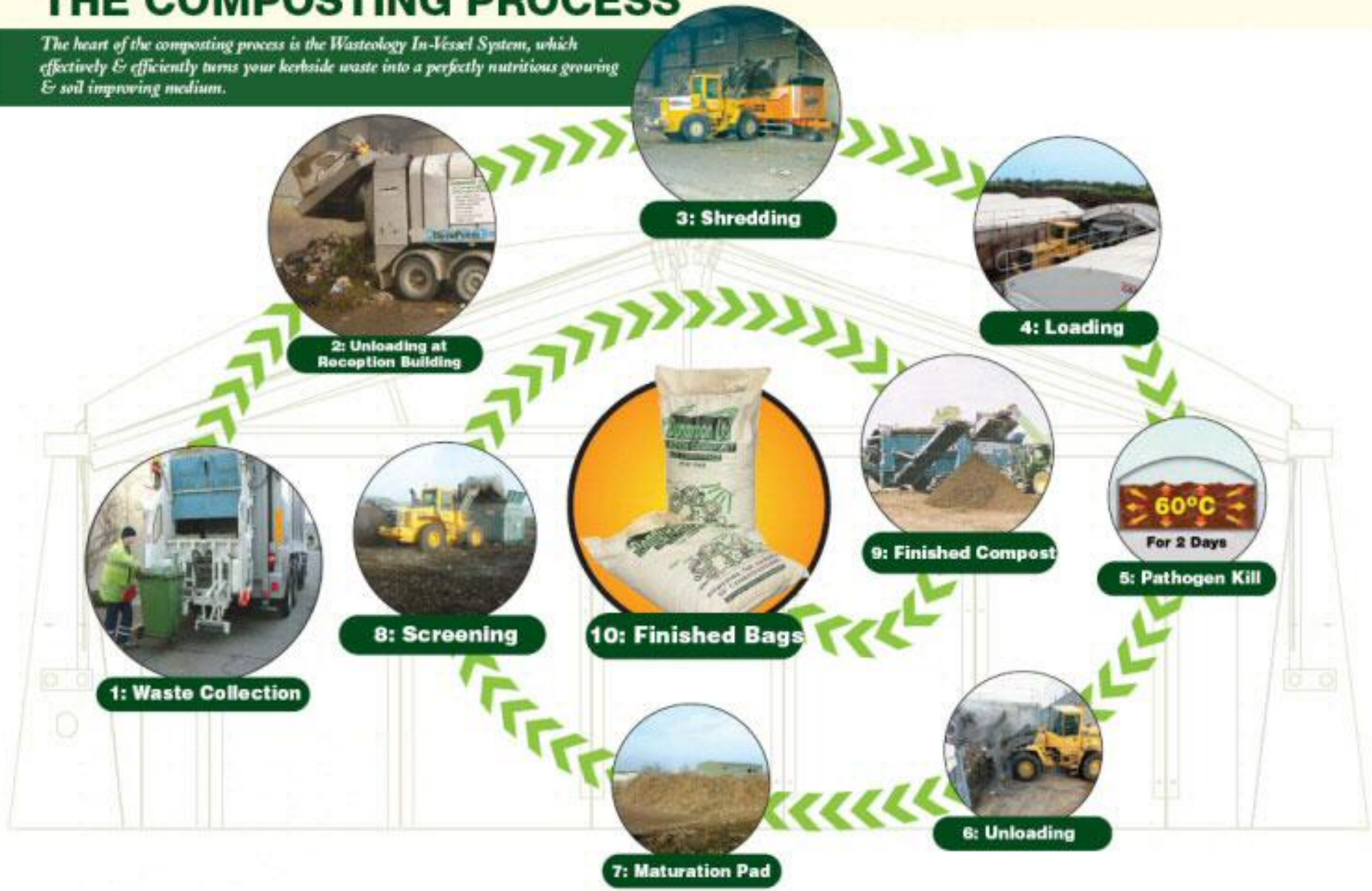
Advanced Composting TECHNOLOGIES

Appalachian State University's commitment to composting began as a student driven initiative in 1999. Over the years, the program has grown into a successful and effective way to sustainably recycle campus food waste into a compost soil amendment for use in the campus flower beds. In September 2011, the university completed this state-of-the-art composting facility that expands our annual composting capacity from 100 to 275 tons. The increased capacity will allow the university to expand food waste composting opportunities and further our commitment to sustainability.

Our Advanced Composting Technologies, Inc. facility creates the perfect environment for the naturally occurring biological process where microbes do all the work. The key is to give them what they need (air, water and food), when they need it, in the right proportions and let them do the work.

THE COMPOSTING PROCESS

The heart of the composting process is the Wasteology In-Vessel System, which effectively & efficiently turns your kerbside waste into a perfectly nutritious growing & soil improving medium.



The composting process

1 – Waste collection :

- waste is collected by the Council or Waste Management company, lorries bring waste to the composting site

2 - Unloading reception building:

- Unloading waste on floor of reception building.

3 – Shredding:

- A slow speed **shredder** fitted with a 150mm to 200mm screen is used for the shredding the green waste and food waste, this allows good blended of material and aids the composting process.
- **Water** is added here to moisten the material to be treated which is essential for effective composting.
- After the waste is shredded and blended the material is transported to one of the **in-vessel buildings in Barrier 1.**
- Each vessel holds approximately 175 tones depending on the bulk density of the material

4 – Loading :

- Loading inside building with Retractable roof fully open.
- The retractable roof allows loading with no height restrictions for the loader.
- After loading the building the roof is electrically closed.

5 - Pathogen Kill & Re-circulatory Air System:

- It is important for **air to be introduced** into the material to encourage aerobic activity.
  - **The air** is forced through the mass by patented ground-level; air ducts.
  - The roof once closed, creates a small void above the material creating good air circulation, temperature profiles, odor barrier and prevents scavenger activity.
- Another factor that is essential for composting is **heat**.
  - The temperature data and time are recorded then stored .
  - Here temperature profiles are created.
  - To ensure that all bacteria activity ceases the material must maintain a minimum temperature of 60˚C for 2 days.
- The material stays in this building (**Barrier 1) for one week**.
- To ensure that no cold spots occur the partly composted material is **transferred to another in-vessel building (Barrier 2)** for a further week,
  - again, 60˚C must be reached and maintained for a minimum of 2 days.

6 - 7 Unloading & Maturation:

- After this final week the building is unloaded and the compost is transported to an **outside concrete pad** where the material, devoid of all pathogens, is matured for a **further 6 to 8 weeks**.
- During the maturation period the compost is **moved approximately once a week.**

8 - Screening the matured material:

- The composted material is screened to remove any unsuitable material that may have escaped earlier separation.
- Firstly the material can be screened at 10 to 15mm to create a fine compost, then if required the material can be screened again at 45 to 50mm to create a mulch like material.

9 – 10 Finished Compost:

- Finished compost can be **transported in bags or in bulk**.
- The composted material is a sanitized product which **can be used in horticulture or agriculture** as a growing medium and soil improver.

When is compost finished?

Compost is mature when

1. The color is dark brown
2. It is crumbly, loose, and humus-like
3. It has an earthy smell
4. It contains no readily recognizable feedstock
5. The pile has shrunk to about 1/3 of its original volume

Benefits of compost

Promotes soil health

1. Supplies organic matter to soil
2. Attracts earthworms
3. Stimulates beneficial soil microorganisms
4. Increases soil water holding capacity
5. Increases soil nutrient retention

Plant nutrients

1. Compost is not a fertilizer, but does contain plant nutrients
2. Nitrogen and phosphorus are mostly in organic forms
   - Released slowly to plants
   - Not readily leached from the topsoil
3. Compost contains many trace nutrients that are essential for plant growth

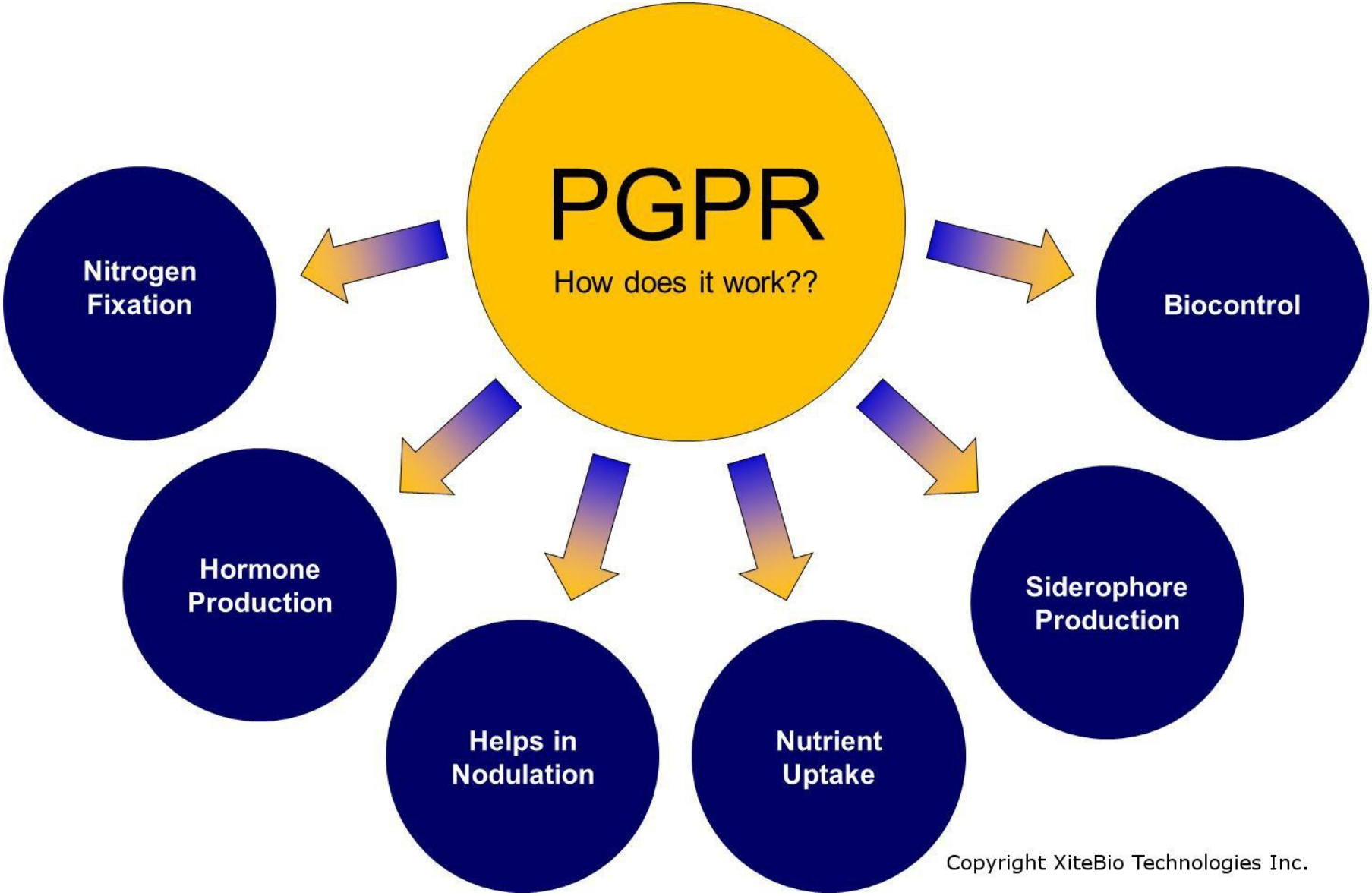
RHIZOBACTERIA

Plant Growth Promoting Rhizobacteria (PGPR)

- Plant growth promoting rhizobacteria is naturally occurring bacteria which is abbreviated to **PGPR** term.

- **Rhizosphere** refers to narrow zone of soil direct surround around the root system of plant.

- These microbes naturally motivated plant growth promotion through directly and indirectly mechanism



frontiers in
PLANT SCIENCE

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Plant growth-promoting rhizobacteria and root system functioning

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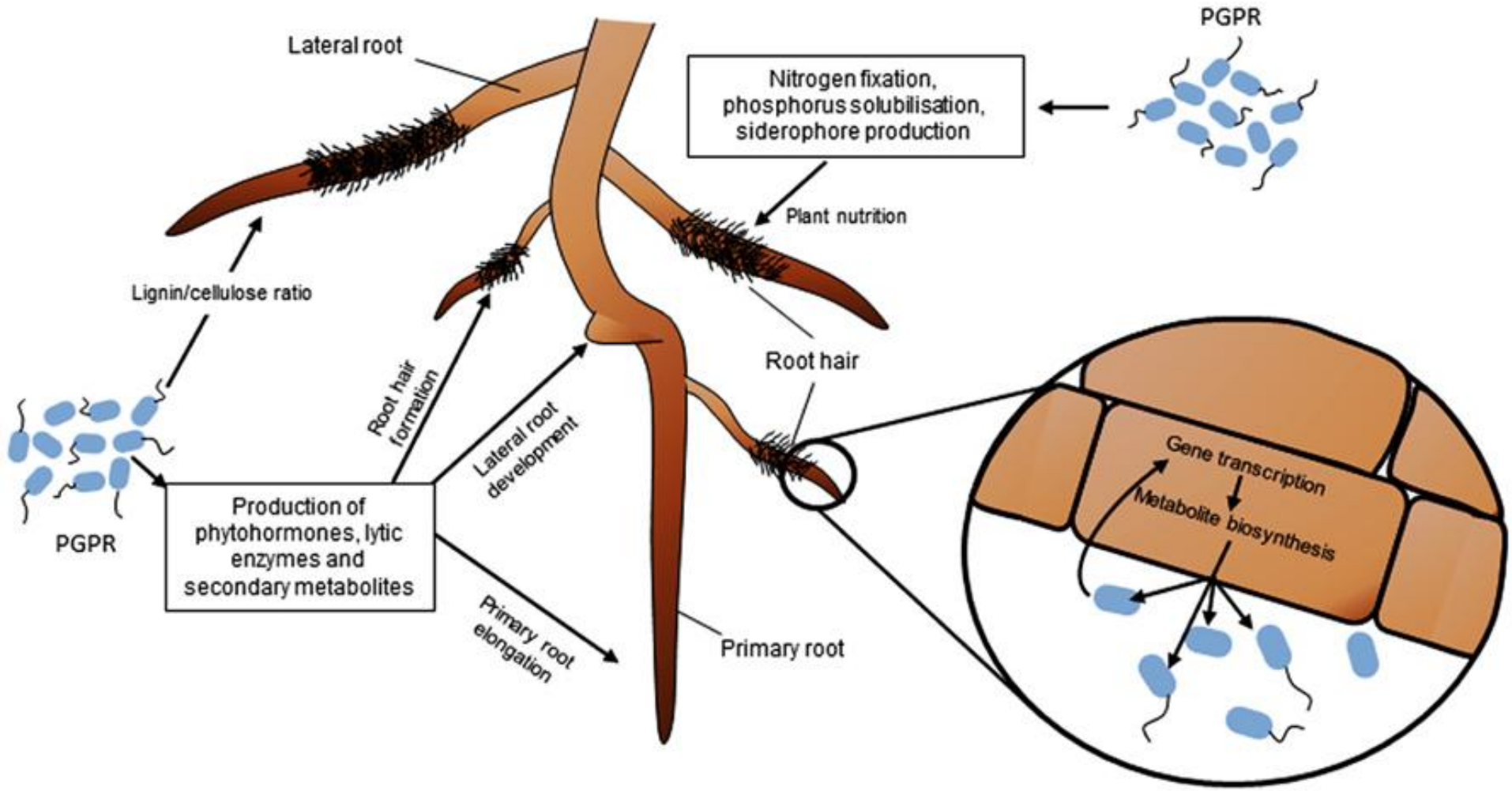
The rhizosphere supports the development and activity of a huge and diversified microbial community, including microorganisms capable to promote plant growth. Among the latter, plant growth-promoting rhizobacteria (PGPR) colonize roots of monocots and dicots, and enhance plant growth by direct and indirect mechanisms. Modification of root system architecture by PGPR implicates the production of phytohormones and other signals that lead, mostly, to enhanced lateral root branching and development of root hairs. PGPR also modify root functioning, improve plant nutrition and influence the physiology of the whole plant. Recent results provided first clues as to how PGPR signals could trigger these plant responses. Whether local and/or systemic, the plant molecular pathways involved remain often unknown. From an ecological point of view, it emerged that PGPR form coherent functional groups, whose rhizosphere ecology is influenced by a myriad of abiotic and biotic factors in natural and agricultural soils, and these factors can in turn modulate PGPR effects on roots. In this paper, we address novel knowledge and gaps on PGPR modes of action and signals, and highlight recent progress on the links between plant morphological and physiological effects induced by PGPR. We also show the importance of taking into account the size, diversity, and gene expression patterns of PGPR assemblages in the rhizosphere to better understand their impact on plant growth and functioning. Integrating mechanistic and ecological knowledge on PGPR populations in soil will be a prerequisite to develop novel management strategies for sustainable agriculture.

Keywords: plant-PGPR cooperation, rhizo-microbiome, rhizosphere, phytohormone, plant nutrition, ISR, functional group


PGPR
Lateral root
Nitrogen fixation, phosphorus solubilisation, siderophore production
Plant nutrition
Lignin/cellulose ratio
Root hair formation
Lateral root development
Root hair
PGPR
Production of phytohormones, lytic enzymes and secondary metabolites
Primary root elongation
Primary root
Gene transcription
Metabolite biosynthesis

- The plant growth-promoting rhizobacteria (PGPR) colonize roots of monocots and dicots, and enhance plant growth by direct and indirect mechanisms:
  1. Modification of root system architecture by PGPR implicates **the production of phytohormones** and other signals that lead, mostly, **to enhanced lateral root branching and development of root hairs**.
  2. PGPR also modify root functioning, **improve plant nutrition** and influence the physiology of the whole plant.

The plant growth-promoting rhizobacteria (PGPR)

- **Directly mechanism** includes:
  1. production enhancement substances,
  2. facilitate acquisition of nitrogen, phosphorous, and any required mineral for growth
  3. motivation plant hormone concentration levels

- **Indirectly mechanism** involves
  - decreasing inhibitory effects of many pathways limit plant growth or effect photosynthesis process.

- [Glick and Penrose ,1998 ;Munees and Mulugeta ,2014].

Plant Growth Promoting Rhizobacteria Mechanisms

PGPR action through directly and indirectly mechanism	Nitrogen Fixation
	Hormone Production
	Helps in Nodulation
	Nutrient Uptake
	Siderphores production bio control

Example of Plant Growth Promoting Rhizobacteria Strains

PGPR	**Plant growth promoting traits**
Pseudomonas putida	IAA, siderophores, HCN, ammonia, exo-polysaccharides, phosphate solubilization, Antifungal activity, siderophore, HCN, phosphate solubilization
Pseudomonas aeruginosa	IAA, siderophores, HCN, ammonia, exo-polysaccharides, phosphate solubilization; Siderophores
Klebsiella sp.	IAA, siderophores, HCN, ammonia, exo-polysaccharides, phosphate solubilization
Enterobacter asburiae	IAA, siderophores, HCN, ammonia, exo-polysaccharides, phosphate solubilization
Pseudomonas sp. A3R3	IAA, siderophores
Psychrobacter sp. SRS8	Heavy metal mobilization
Bradyrhizobium sp.	IAA, siderophores, HCN, ammonia, exo-polysaccharides

Followed pictures represent photos for some trials for comparing between them in visual differences:

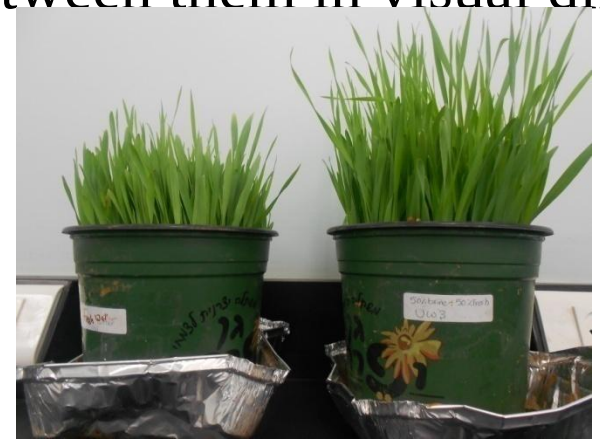


Figure 4.48: Picture where (A) represent trial of control Barley Plant irrigated with fresh water, (B) trials of treatment of Barley Plant with UW3+UW4 irrigated with 6000ppm

Figure 4.51: Picture where (A) represent trial of control Barley Plant irrigated with fresh water, (B) trials of treatment of Barley Plant with UW3+UW4 irrigated with 10000ppm

Figure 4.52: Picture where (A) represent trial of control Barley Plant irrigated with fresh water, (B) trials of treatment of Barley Plant with UW3 irrigated with 10000ppm

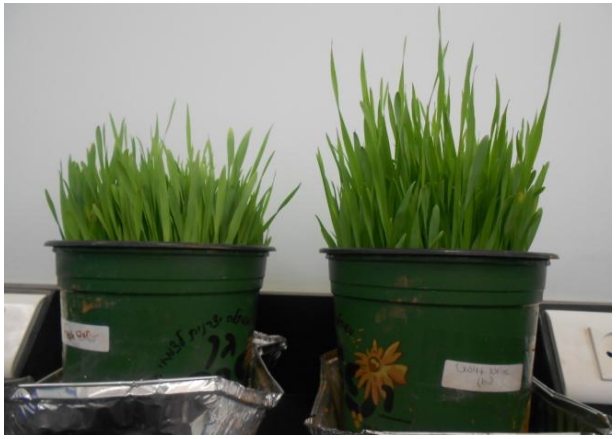


Figure 4.53: Picture where (A) represent trial of control Barley Plant irrigated with fresh water, (B) trials of treatment of Barley Plant with UW4 irrigated with 10000ppm