

# **Commercial microbial inoculants with endophytes – (an overview)**

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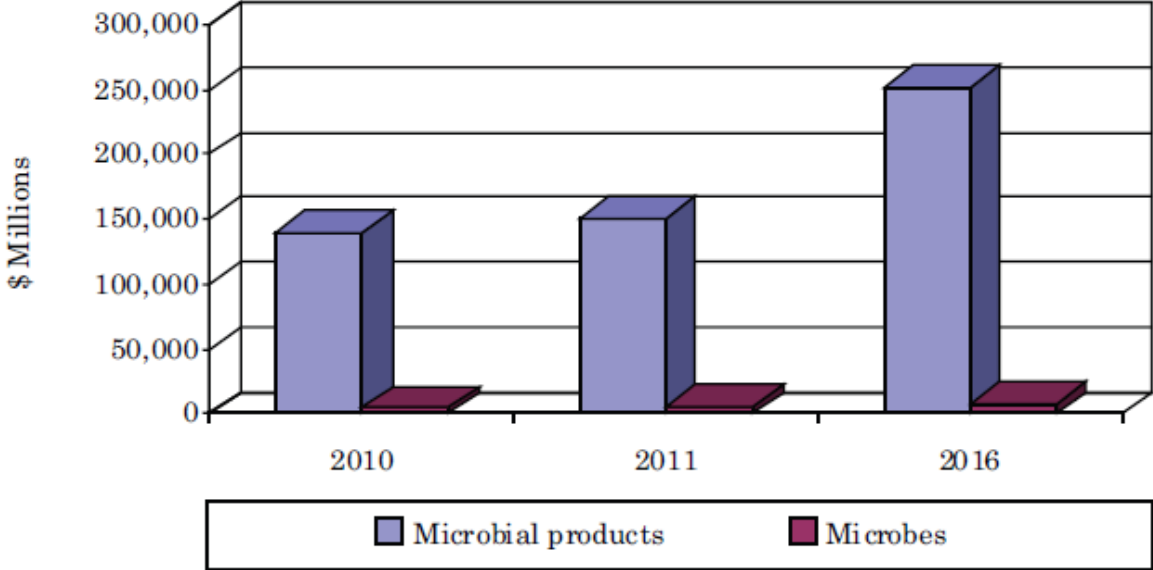
Inquiries about products with ENDOPHYTES by:

- EU commission of agriculture
- German Ministry of agriculture
- International Biocontrol Manufacturers Association
- Food and Agriculture Organization of United Nations
- United States Environmental Protection Agency

# Global market of microbial inocula



SUMMARY FIGURE  
TRENDS IN GLOBAL MARKET FOR MICROBES AND MICROBIAL PRODUCTS,  
2010-2016  
(\$ MILLIONS)



Source: BCC Research

# Global market of pesticides (incl. Biopesticides)

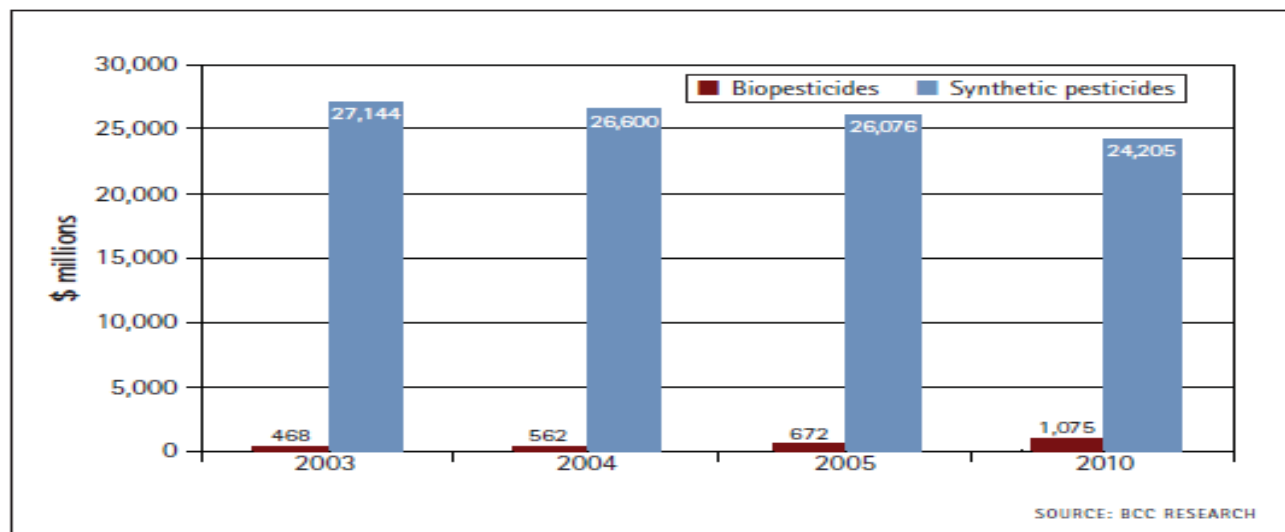


Figure 1. Global biopesticides and synthetic pesticides market, 2003–2010

BIOPESTICIDE FORMULATION	2003	2004	2005
Liquid-based formulation	280.8	337.2	403.2
Water dispersible granules	70.2	84.3	100.8
Wettable powder	70.2	84.3	100.8
Pellets	46.8	56.2	67.2
Total	468.0	562.0	672.0

SOURCE: BCC RESEARCH

# Types of microbial inoculants

- **Biofertilizers**
- Biostimulators
- Bioenhancer
- Plant strengtheners
- Phytostimulators
  
- **Biopesticides**



## Biofertilizers (Biological fertilizers)

...be defined as a substance which contains **living microorganisms** which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.... Vessey (2003)

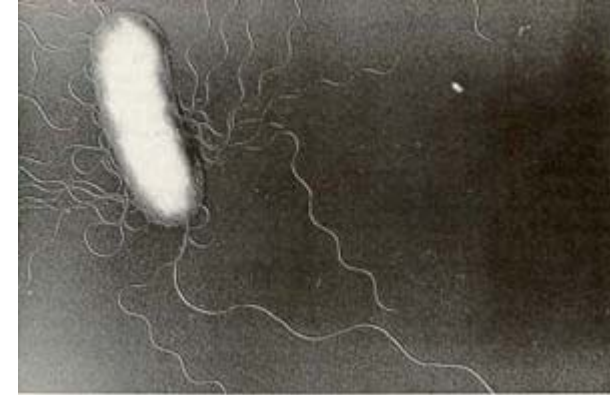
- Nitrogen fixers
- Phosphate solubilizers → Rhizosphere microorganisms!

- **Symbiotic N-Fixers:**
- *Rhizobia* (Most exploited), infect legumes, Rhizobia host compatibility important
- *Frankia* (Actinomycete) forms nodules (Actinorrhizae) with wood species of *Alnus* and *Casuarina*



## N-fixers

- **Non-symbiotic N-Fixers:**
- ***Azospirillum*** Wide host range, Tolerance of high soil temperature, produce Plant growth promoting substance, form Cyst under stress, great promise as a growth promoting N<sub>2</sub> fixing biofertilizer



*Azospirillum brasilense*

### ***Acetobacter diazotrophicus***

Is non symbiotic associated with sugarcane crop, difficult to isolate, grow artificially



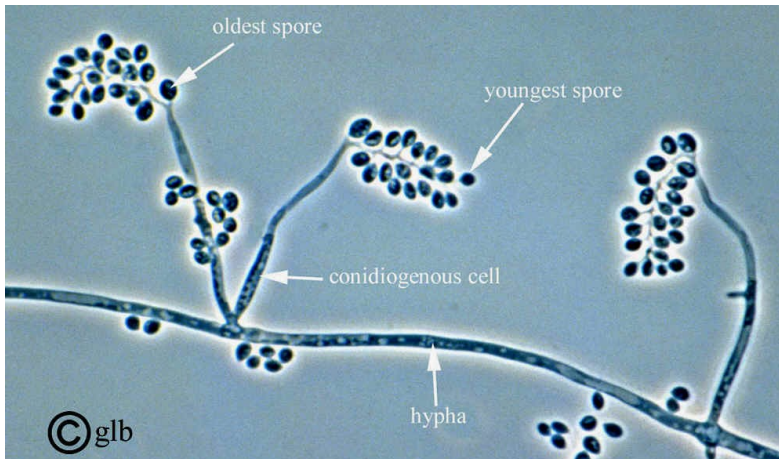
# Biopesticides

- **Microbial Biopesticides** consist of a microorganism (bacterium, fungus,...) as the active ingredient → fungicides, bactericides, herbicides, nematocides, insecticides
- Plant-Incorporated protectants (PIPs)
- Biochemical pesticides

# Microbial Biopesticides



## Fungal Biopesticides in micropropagated plants



*Beauveria bassiana*



# Microbial biopesticides



Bactericides	Characteristics
<i>Pseudomonas fluorescens</i> A506	Interact with epiphytic pathogenic bacteria (fire blight) on plant surfaces
<i>Agrobacterium radiobacter</i> strain K84	Rhizosphere bacterium; biological control agent for the plant disease crown gall
<i>Agrobacterium radiobacter</i> strain K1026	Genetically engineered strain; rhizosphere bacterium
<i>Bacillus subtilis</i>	Root and leaf endophyte???
<i>Bacillus circulans</i>	Rhizosphere bacterium
<i>Bacillus amyloliquefaciens</i>	Rhizosphere bacterium
Fungicides	
<i>Streptomyces lydicus</i> WYEC 108	Soil bacterium against <i>Sclerotinia sclerotium</i>
<i>Pseudomonas syringae</i> strain ESC-10	Survive in wounds of Citrus against green and blue mold
<i>Pseudomonas chlororaphis</i>	Rhizosphere bacterium
<i>Gliocladium catenulatum</i> strain J1446	Root endophyte against damping-off
<i>Trichoderma</i>	???



# Formulation of microbial inoculants

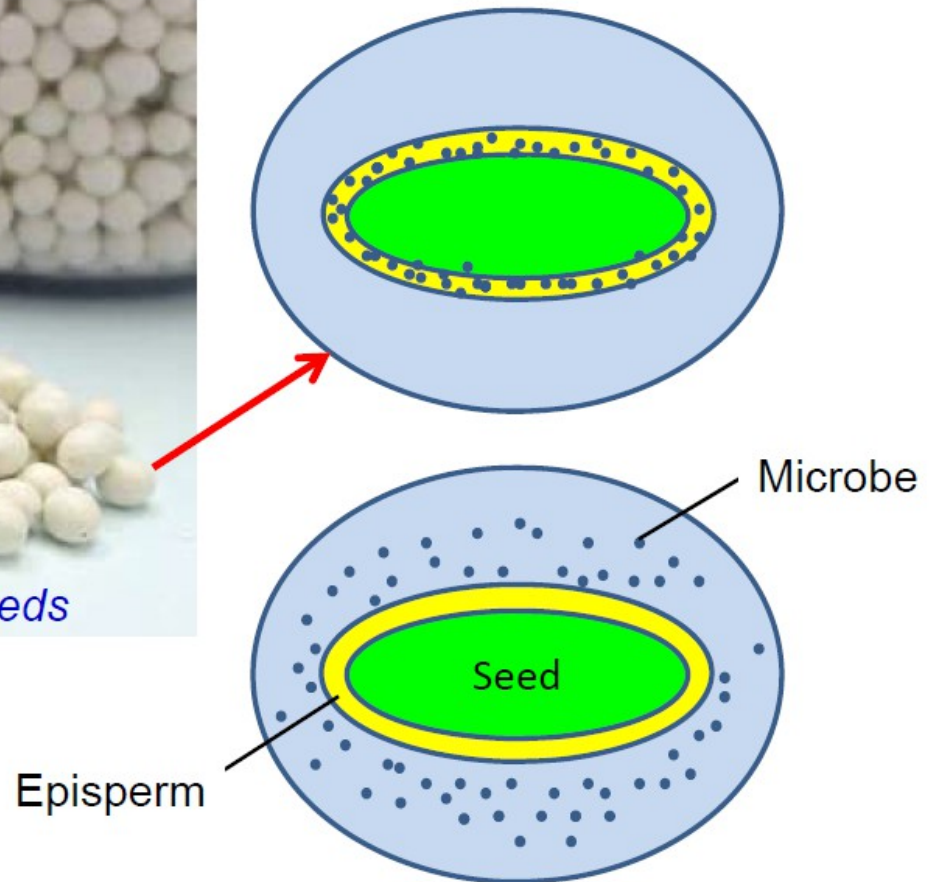
- Powder
- Liquid
- Alginate microbeads
- Seed coating

# Seed coating

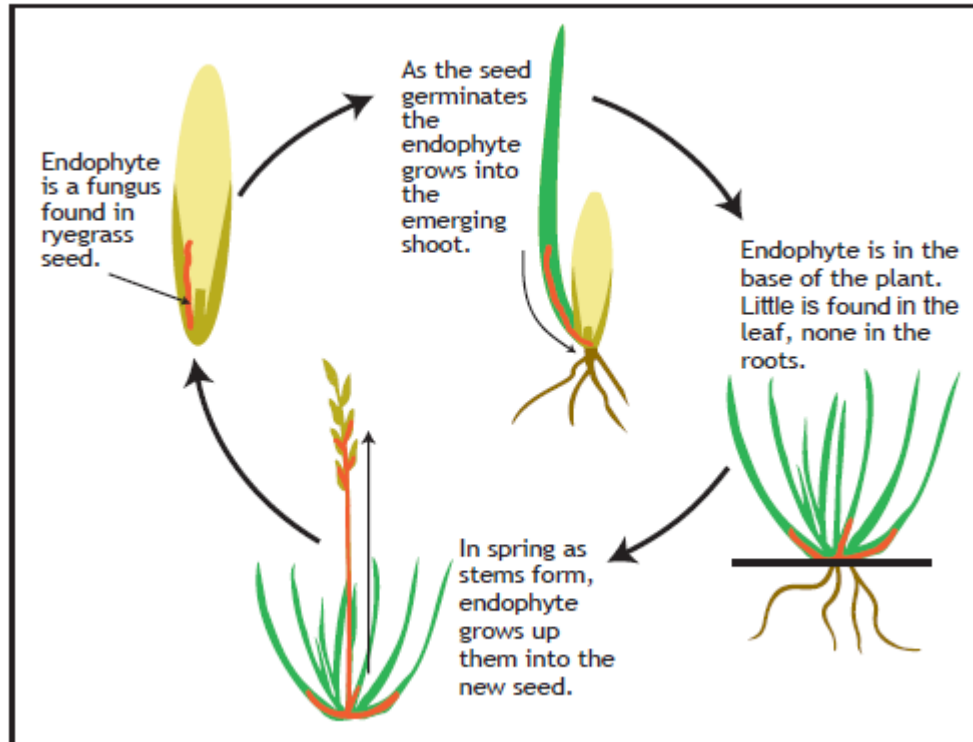


Seeds

Coating Seeds



# Endophytic fungi in Ryegrass



Wild type strains of *Neotyphodium lolii* in Ryegrass cause summer staggers by cattle

New endophytic fungal strains AR1, NEA2, ENDO 5 stop staggers and improve animal performance.

# Endophytes – how characterize?

- Facultative and obligate endophytes
- Competent endophytes
- Opportunistic endophytes
- Passenger endophytes



# Literature about microbial products

- ***“Microbial Products: Technologies, Applications, and Global Markets”***
- ***Price: Ca. 4000 USDollar***
- Understand the broad range of commercial applications of microbes and microbial products in agricultural, healthcare, manufacturing, energy, and environmental applications
- Develop business strategies to negotiate the market drivers and obstacles to successful commercialization of microbial products in each sector
- Identify microbial technologies and applications that have the greatest commercial potential in the 2010-2016 time frame



# Important topics for work about microbial inoculants for practice



Are the endophytes vital, infectious?

Shelf life of product

*In vitro* cultures of microbes on/in „classical „  
Synthetic media can loose their effectivities on  
plants... after many subcultivations....

Formulation of microbes

Application method

Proof of endophytic life style

COST Action 830: Microbial inoculants in  
agriculture and environment

## Summary ....

- Market of microbial products is growing....

We need more efforts to produce inocula with endophytes for practice in

- Phytoremediation
- Salt tolerance
- Thermo tolerance
- .....

Building a bridge in endophyte work between universities/public research associations and biotech companies