



# TrichoderMAX

*Trichoderma harzianum* is a fungus well known for its beneficial effects in the soil. *Trichoderma* species are present in nearly all soils, frequently being the most prevalent [1].

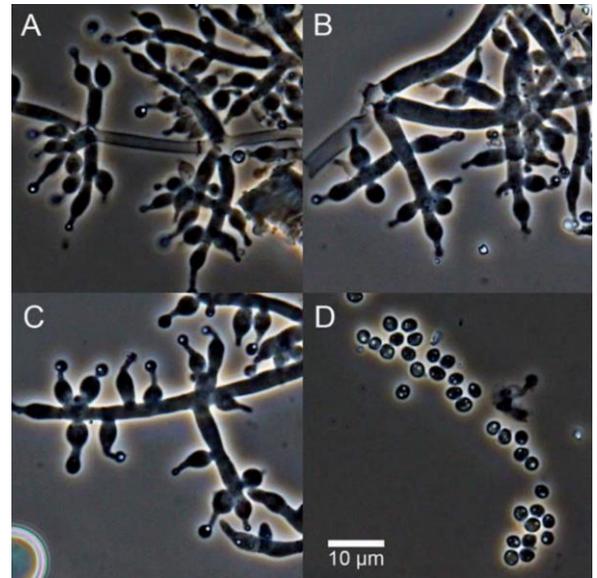
Trichoderma colonizes plant roots and are able to grow on the roots as the root system develops [1]. They have evolved numerous mechanisms for plant enhancement and root growth, allowing plants to develop bigger root systems making the plant more adaptive to abiotic stresses such as drought [2]. In addition, Trichoderma solubilizes nutrients present in the soil, supporting the plant in nutrient uptake, while receiving energy in return.

In general, Trichoderma is known for its following traits:

- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improves plant resilience
- Self-sustaining for up to 16 weeks

Additionally, TrichoderMAX comes with additional benefits:

- Increased survivability
- Improved infectivity



*Trichoderma* under a microscope. A-C. Conidiophore. D. Conidia

*Trichoderma* can be grown using several production techniques such as inoculating solid substrates such as rice or by liquid fermentation of pure spore solutions.

Different cultivation techniques result in different products. Growth on solid substrates generally produces aerial conidia, whereas liquid broths most commonly produce blastospores.

Conidia are much easier to preserve and survive longer storage periods [3]. Where Blastospores generally have faster germination rates.





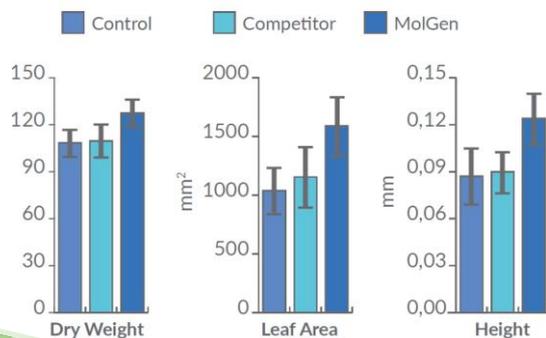
# TrichoderMAX

Beneficial microbes have been studied for over 90 years due to their unique traits and biostimulating effects. This results in countless publications that showcase the opportunities beneficial microbes can provide.

## Improving crop yield

As a result of previous highlighted traits, it has often been reported for Trichoderma to increase crop yields [4]. Increasing the plant root system allows plants to reach minerals that could not be reached previously, but also prevents yield losses due to drought as a result of deeper roots. Additionally Trichoderma allows for more minerals to be available to the plant and the colonisation of the roots prevents yield loss due to infections [5].

Yields can increase ranging from 10% up to 125% depending on the quality of the soil [4].



## Stimulating plant root systems

In contrast to some fungicides that inhibit root growth, Trichoderma enhances root growth [4].

After colonizing the plant root system and having established a hyphal network, Trichoderma will secrete hormones that signals the plant to branch and grow deeper roots.

In a trail with tomato plants, it has been demonstrated that the amount of root branches increased two-fold and the length increased by 50% [6].



*Plant roots on a petri dish to isolate the microflora present on the roots. Left: control, right: Trichoderma treated plants.*

Applying Trichoderma to the plants in the early stages allows for the best colonization and root stimulation. With the biggest chances of succesful colonization when the root is not yet fully occupied by other microbes.





# TrichoderMAX



## Enhancing nutrient uptake

Trichoderma can solubilize minerals via three possible mechanisms: acidification of the soil, production of chelating metabolites and redox activity [5].

Its major mechanism to acidify the microenvironment near the roots can solubilize minerals such as phosphate, manganese and zinc.

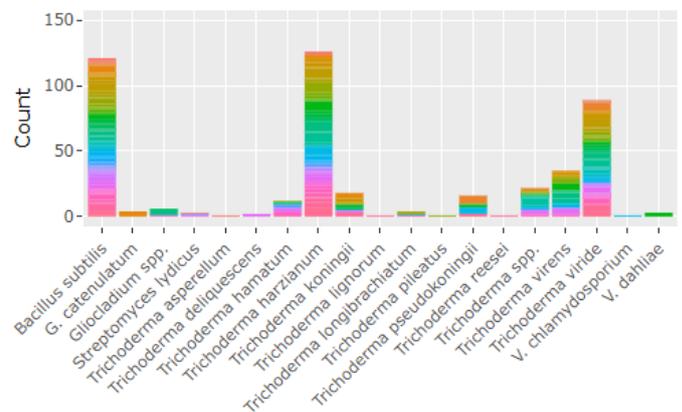
Chelating compounds partly account for the solubilization of iron and copper.

Trichoderma will absorb these minerals and stores them for later use. That way the plant and Trichoderma will benefit most from fertilizing.

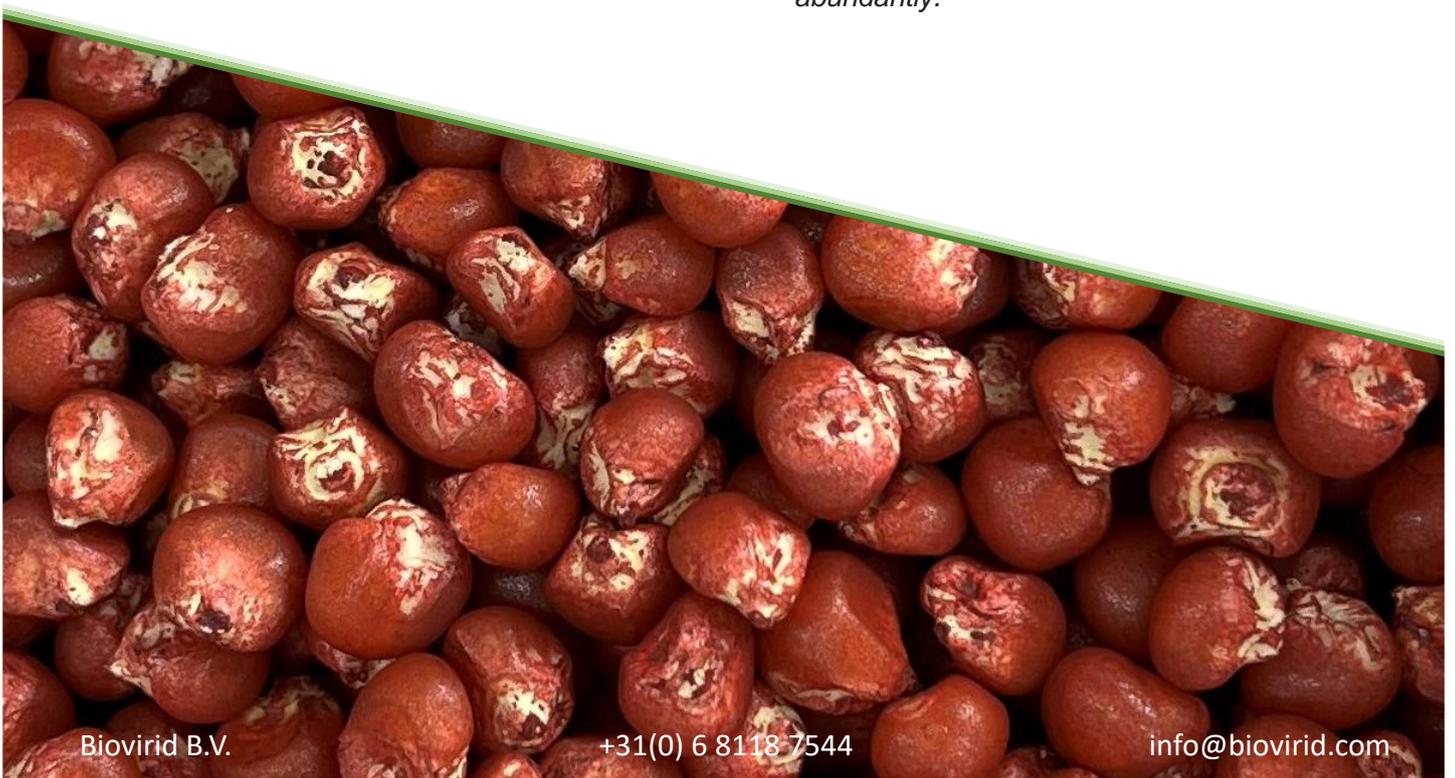
## Compatible with a large variety of crops

Based on previously performed data studies, we found that *Trichoderma harzianum* has been reported to have beneficial effects on over 125 different types of crops. Other well known microbes are *Bacillus subtilis* and *Trichoderma viride*.

More detailed information on crop compatibility is available upon request.



Reports of beneficial microbes in literature versus unique crop types. Where *Bacillus subtilis*, *Trichoderma harzianum* and *Trichoderma viride* have been reported abundantly.





# TrichoderMAX

## Improves plant resilience

*Trichoderma harzianum*, plays a vital role in plant resilience by triggering the plant's immune response.

### Induced Systemic Resistance (ISR)

*Trichoderma harzianum* has a unique ability to trigger Induced Systemic Resistance (ISR) in plants. ISR is a mechanism where the plant's innate immune system is activated without directly harming the environment. When the plant detects the presence of *Trichoderma harzianum*, it perceives it as a non-threatening presence.

### Hormonal Signaling

*Trichoderma harzianum* establishes a symbiotic relationship with the plant, often through root colonization. This interaction triggers the plant to release specific signaling molecules, such as salicylic acid and jasmonic acid. These molecules act as messengers that activate various pathways within the plant.

## Self-sustaining for up to 16 weeks

*Trichoderma harzianum* has several mechanisms to store excess energy for more difficult times. Like in humans, *Trichoderma harzianum* stores excess energy in the form of glycogen.

However, *Trichoderma harzianum* can also differentiate into fruiting bodies called spores. These tiny structures can adapt to harsh conditions that can overcome salinity stresses and prolonged periods of starvation. As soon as the spore finds a suitable new host, the spores can germinate and grow a new network of mycelial hyphae.



*Fun fact: a mushroom the fruiting body from a fungus and its umbrella releases spores into the environment to spread to different locations. Below the surface there is a large network of mycelium you can compare to plant roots.*

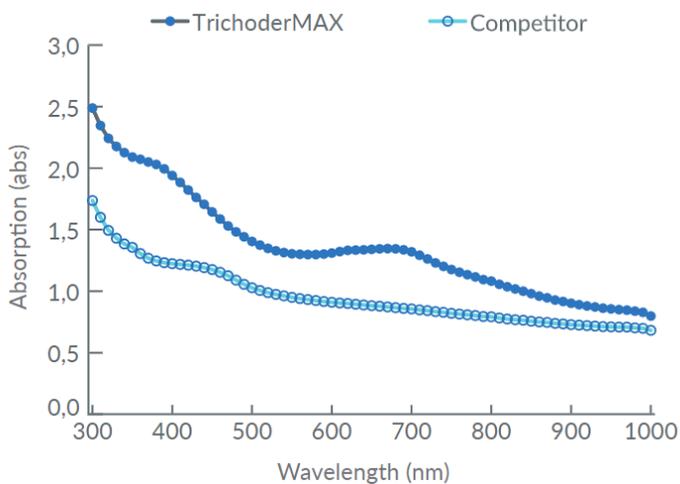




# TrichoderMAX

## Improved survivability

One unique characteristic of TrichoderMAX over competitor product is its distinct dark green color. This green colour is caused by a polyketide synthase gene *pks4*, which is involved in antagonism and defense against other fungi and the mechanical stability of conidium [7].



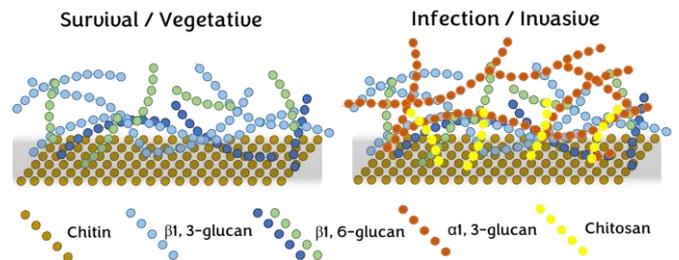
*Absorption spectrum of TrichoderMAX and a competitor product. TrichoderMAX is proven to be more capable of absorbing UV light.*

## Improved infectivity

After carefully studying the effects of TrichoderMAX on plants, significant differences in root colonization were visible between TrichoderMAX and competitor products.

It was noticed that the composition of the fungal cell walls differ between the products. In fact, TrichoderMAX contains a 4-fold increased levels of  $\alpha$ -1-3 glucan in the membrane.

Studies show that fungi with increased  $\alpha$ -1-3 glucan content in their membranes are likely to be in their infection stage, increasing surface adhesion and infectivity [8].



*Fungal cell wall composition. Left: vegetative stage mainly composed of  $\beta$  glucans. Right: infective stage with increased  $\alpha$ -1-3 glucan content.*





# TrichoderMAX

## About Biovirid

We are all becoming more and more aware of our impact on the global climate. We can no longer afford to use (harmful) chemicals without having an impact on our environment. Biovirid's Biological department develops sustainable alternatives to replace the amount of chemicals used in agriculture. Additionally, it is Biovirid's focus on greatly reduce the amount of animal tests by developing tools that support model organisms such as *C.elegans*.

Biovirid provides services beyond traditional ways, partnering and going the extra mile to ensure our customers' success. Biovirid's systems and consumables are versatile, efficient and universally applicable making Biovirid the perfect provider when scaling-up, professionalizing or handling a crisis.

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## Sources

- [1] Wikipedia: [https://en.wikipedia.org/wiki/Trichoderma\\_harzianum](https://en.wikipedia.org/wiki/Trichoderma_harzianum)
- [2] S. Alwhibi Monaa, Abeer Hashem, 2017. Increased resistance of drought by *Trichoderma harzianum* fungal treatment correlates with increased secondary metabolites and proline content. Elsevier
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- [8] Zlotko, K., Wiater, A, 2019. A Report on Fungal (1→3)-α-d-glucans: Properties, Functions and Application. *Molecules*





# TrichoderMAX

Article number	Product	Quantity	Intended use *
BV0000466	Liquid	1.0 liter	Spray, drench
BV0000467	Liquid	5.0 liter	Spray, drench
BV0000468	Liquid	20 liter	Spray, drench
BV0000463	Paste	100 ml	Seed coating
BV0000424	Powder	0.5 kg	Spray, drench, extended shelf life
BV0000430	Powder	1.5 kg	Spray, drench, extended shelf life
BV0000431	Powder	15 kg	Spray, drench, extended shelf life
BV0001004	Dummy	100.000	Sowing application

\* Other quantities and applications upon request.

Trichoderma is cultivated using patented technology, stimulating cellular glycan and glycoprotein content on the membrane increasing attachment to surfaces. Additionally, the increased cellular pigment content increases protection from environmental stressors such as sunlight and has been linked to higher mechanical stability and antagonistic abilities against other fungi.

# TrichoderMAX Paste

Highly concentrated for seed coats

## Advantages

- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improves plant resilience
- Self-sustaining for up to 16 weeks

## Suitable for

- Seed applications

## Unique features

- Increased survivability
- Improved infectivity



## Liquid organic fertilizer

### Mineral contents (%)

Nitrogen	1.0
Phosphorus	2.0
Potassium	1.5



# TrichoderMAX Paste

Highly concentrated for seed coats

Specifications	
Quantity	100 ml (other sizes upon request)
Dosage	Sufficient for 5 kilogram seeds
Concentration	$>5 \cdot 10^9$ spores per mL
Storage temperature	4-8°C / 39 - 46°F
Storage conditions	Keep away from direct sunlight
Shelf life	> 30 days

## Unique features

- Higher pigment<sup>1</sup> content improves survivability in soil
- Unique cell wall technology<sup>1</sup> enhances biofilm formation

## Developed for seed applications

- TrichoderMAX concentrated paste is specially designed for easy seed application.
- Combine 4 parts of TrichoderMAX with 1 part of biofriendly binder.

<sup>1</sup> Trichoderma is cultivated using patented technology, stimulating cellular glycan and glycoprotein content on the membrane increasing attachment to surfaces. Additionally, the increased cellular pigment content increases protection from environmental stressors such as sunlight and has been linked to higher mechanical stability and antagonistic abilities against other fungi.

# TrichoderMAX Powder

High quality fertilizer in powdered form

## Advantages

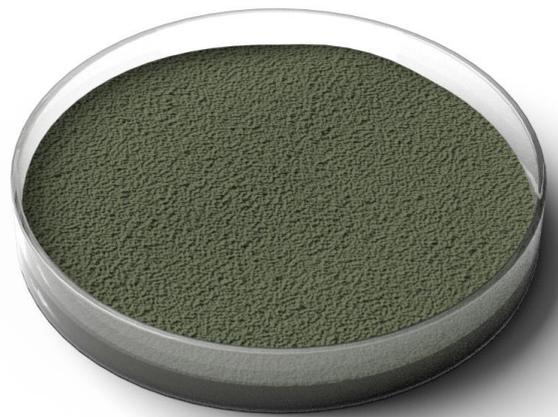
- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improves plant resilience
- Self-sustaining for up to 16 weeks

## Suitable for

- Direct field application
- Plant drenching

## Unique features

- Increased survivability
- Improved infectivity



## Solid organic fertilizer

### Mineral contents (%)

Nitrogen	2.5
Phosphorus	0.7
Potassium	1.4



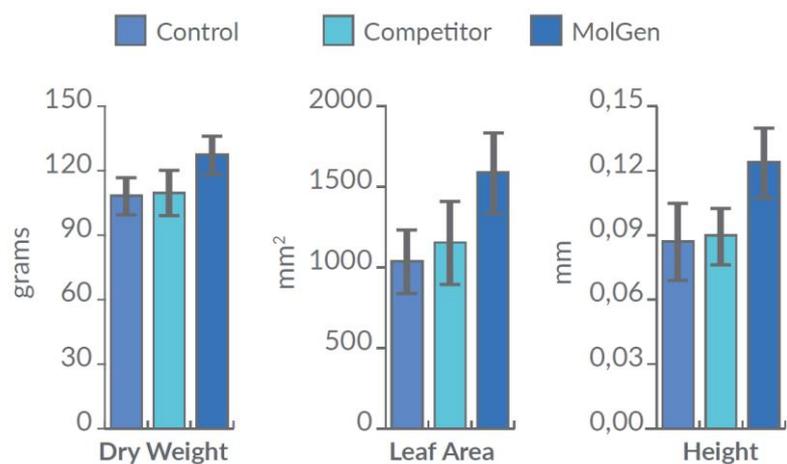
# TrichoderMAX Powder

High quality fertilizer in powdered form

Specifications	
Quantity	0.5, 1.5 and 15.0 kilograms
Dosage	1-5 kilogram per hectare, 20 grams per 1000 plants
Concentration	$1 \cdot 10^9$ spores per gram
Storage temperature	4-8°C / 39 - 46°F
Storage conditions	Keep away from direct sunlight
Shelf life	> 365 days

## Unique features

- Phenotyping studies show increased growth and yield<sup>1</sup>
- Increased shoot weight and fruit yield in greenhouse studies<sup>2</sup>
- For a healthy root microbiome



<sup>1</sup> Phenotyping experiments are performed by PhenoVation B.V. and NLRResearch B.V.

<sup>2</sup> Greenhouse studies are performed by Botany Group, on tomato plants.

# TrichoderMAX Liquid

High quality fertilizer in liquid form

## Advantages

- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improves plant resilience
- Self-sustaining for up to 16 weeks

## Suitable for

- Direct field application
- Plant drenching

## Unique features

- Increased survivability
- Improved infectivity



## Liquid organic fertilizer

### Mineral contents (%)

Nitrogen	0.1
Phosphorus	0.2
Potassium	0.2



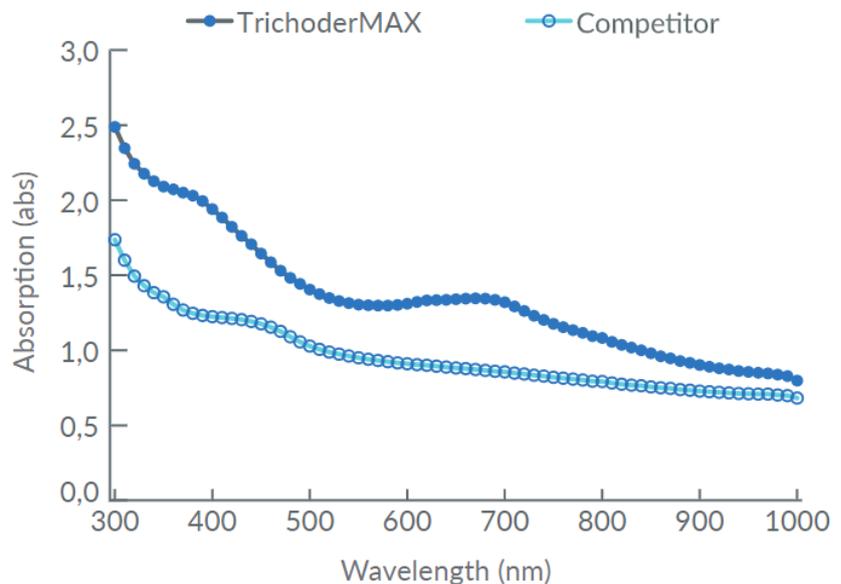
# TrichoderMAX Liquid

High quality fertilizer in liquid form

Specifications	
Quantity	0.5, 1.5 and 15 liter
Dosage	1-5 liter per hectare, 20 ml per 1000 plants
Concentration	$1 \cdot 10^9$ spores per mL
Storage temperature	4-8°C / 39 - 46°F
Storage conditions	Keep away from direct sunlight
Shelf life	> 30 days

## Unique features

- Higher pigment<sup>1</sup> content improves survivability in soil
- Unique cell wall technology<sup>1</sup> enhances biofilm formation



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# TrichoderMAX Dummy

Dummy beads to include when sowing

## Advantages

- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improves plant resilience
- Self-sustaining for up to 16 weeks

## Suitable for

- Sowing application

## Unique features

- Increased survivability
- Improved infectivity



## Solid organic fertilizer

### Mineral contents (%)

Nitrogen	2.5
Phosphorus	0.7
Potassium	1.4



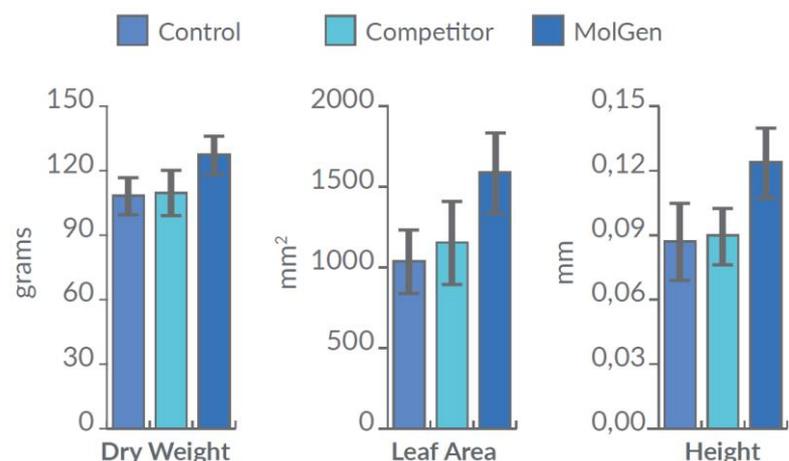
# TrichoderMAX Dummy

Dummy beads to include when sowing

Specifications	
Quantity	100.000, 1.000.000, 10.000.000 beads
Dosage	1 bead per plant
Concentration	20.000 spores per bead
Storage temperature	4-8°C / 39 - 46°F
Storage conditions	Keep away from direct sunlight
Shelf life	> 365 days

## Unique features

- Phenotyping studies show increased growth and yield<sup>1</sup>
- Increased shoot weight and fruit yield in greenhouse studies<sup>2</sup>
- For a healthy root microbiome



<sup>1</sup> Phenotyping experiments are performed by PhenoVation B.V. and NLRResearch B.V.

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# About Biovirid

**It is our everyday mission to produce biological compounds for a healthier planet.**

Biovirid has a focus on delivering biological alternatives for chemical fertilizers and insecticides to the market. We believe that incorporating fungi, bacteria or other microorganisms with known beneficial effects to agriculture will not only allow farmers to work on a more sustainable way, doing less harm to the environment, but also has a beneficent effect on yield and quality of the crop. This can go hand in hand when the right combination of biological alternatives is used and we are confident, we can move the world towards a safer and healthier place with our products.

## **Full control**

We have developed a robust system for manufacturing microorganisms in-house, allowing us to have complete control over the process and ensure the highest quality standards. With our patented fungal sporulation method, we have developed a unique method for inducing and controlling fungal sporulation, which is crucial for the production of spores for various applications. This protocol allows us to optimize the sporulation process, ensuring consistent and high-quality spore yields.

By manufacturing microorganisms in-house and having control over the entire process, from strain selection to final product formulation, we can guarantee the quality, purity, and consistency of our microorganisms. This enables us to provide our customers with reliable and effective solutions tailored to their specific needs.

## **A part of the MolGen group**

Biovirid is part of the MolGen group, a global solutions provider of innovative extraction DNA / RNA isolation technology, systems, products and kits for human diagnostics, animal diagnostics, agricultural research, aquaculture, pharma and the biotech industry.

