TrichoderMAX

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

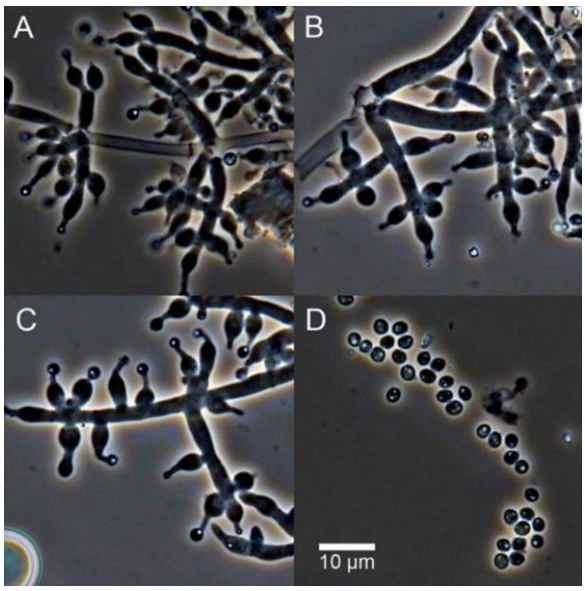
Trichoderma colonizes plant roots and are able to grow on the roots as the root system develops [1]. They have evolved numerous mechanisms for plant enhancement and root growth, allowing plants to develop bigger root systems making the plant more adaptive to abiotic stresses such as drought [2]. In addition, 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
- Improve resistance to soil-borne diseases
- 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.

Using different techniques also results in different stadia of the fungus on a molecular level. Growth on solid substrates generally produces aerial conidia, whereas liquid broths most commonly produce blastospores.
It is however more favorable to produce conidia as they are much easier to preseve and survive longer storage periods [3].

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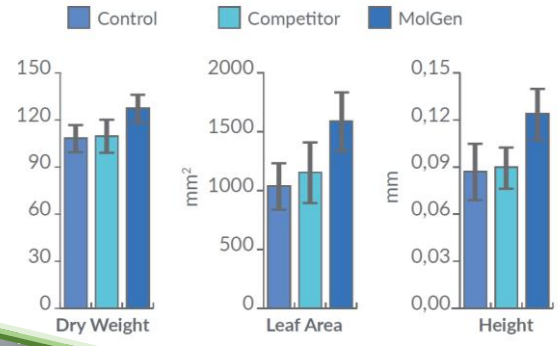
Beneficial microbes have been studied for over 90 years due to their unique traits and biostimulating effects. This results in countless publications that showcase the opportunities beneficial microbes can provide.

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. Additionaly 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 petridish 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.

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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.

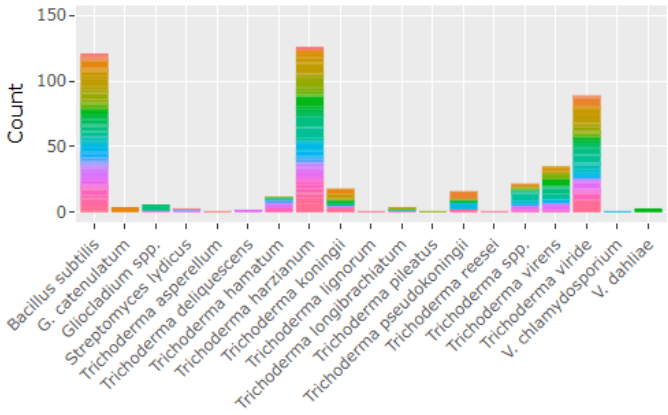
Chelating compounds partly account for the solubilization of iron and copper.

Trichoderma will absorb these minerals to prevent harmful microorganisms such as *Pythium* and *Rhizoctonia* to solubilize these minerals.

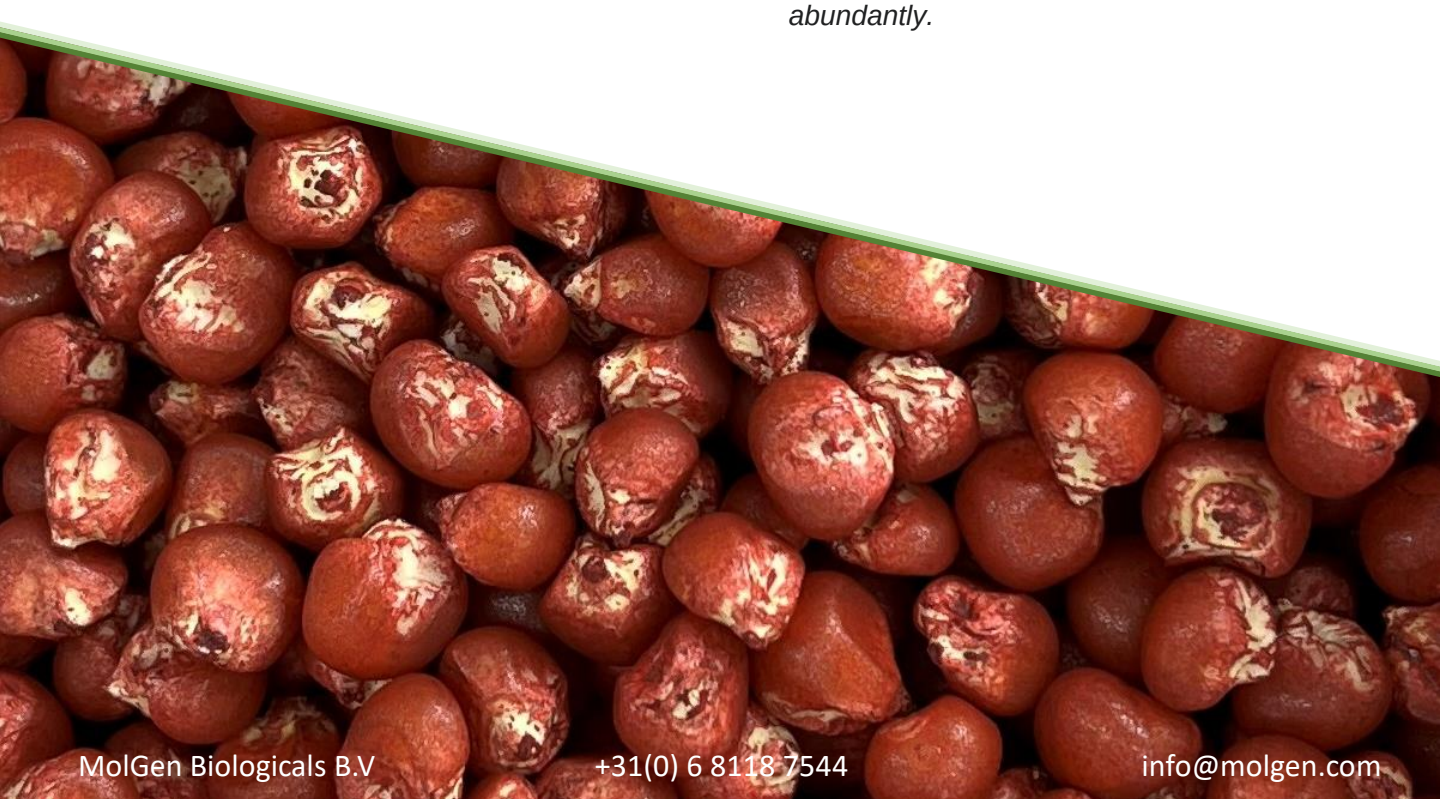
Compatible with a large variety of crops

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.



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Improve resistance to soil-borne diseases
Application of Trichoderma to the plant provides protection to a wide range of pathogens. These pathogens include, but are not limited to:

- *Botrytis cinerea*
- *Colletotrichum capsici*
- *Fusarium oxysporum*
- *Macrophomina phaseolina*
- *Neovossia indica*
- *Phytophthora spp.*
- *Pythium spp.*
- *Rhizoctonia solani*
- *Sclerotinia sclerotiorum*

With chemical pesticides lost to regulatory actions and the lack of adequate chemical replacements biocontrol is a highly attractive alternative.
Additionally for organic application, biocontrol blends in perfectly in this field.

It is good to note that Trichoderma should be applied preventative and has no effect on already prevalent diseases.

Self-sustaining for up to 16 weeks
Fungi have several mechanisms to store excess energy for more difficult times. Like humans, fungi store their excess energy in the form of glycogen.
However, fungi 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 hyphaes.

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.

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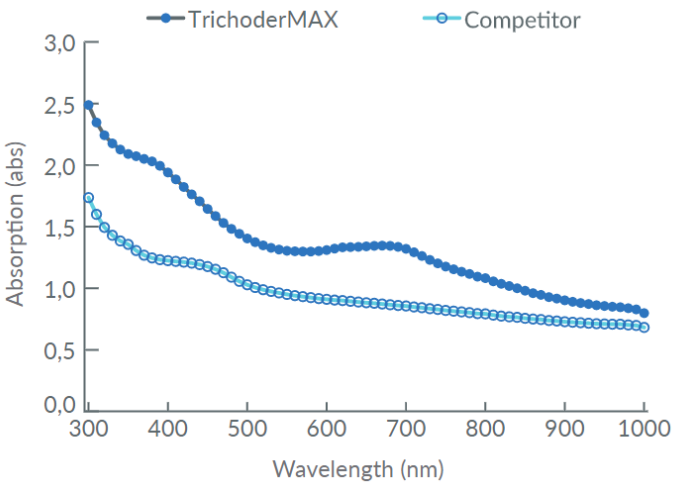
Improved survivability

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].



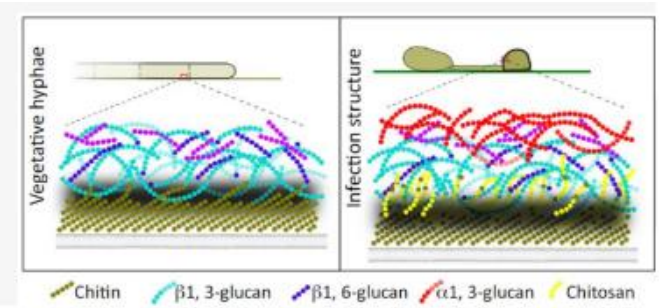
Absorbion spectrum of TrichoderMAX and a competitor product. TrichoderMAX is proven to be more capable of absorbing UV light.

Improved infectivity

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

It was noticed that the composition of the fungal cell walls where different between the products. In fact, TrichoderMAX contains a 4-fold increased levels of α1-3 glucan in the membrane.

Studies show that fungi with increased α1-3 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 β glucans. Right: infective stage with increased α1-3 glucan content.

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TrichoderMAX

About MolGen

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. MolGen's Biological department develops sustainable alternatives to replace the amount of chemicals used in agriculture. Additionally, it is MolGen's focus on greatly reduce the amount of animal tests by developing tools that support model organisms such as *C.elegans*.

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

Reach out to your specialist
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Sources

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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
- Improve resistance to soil-borne diseases
- 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	0.5
Phosphorus	1.0
Potassium	0.8

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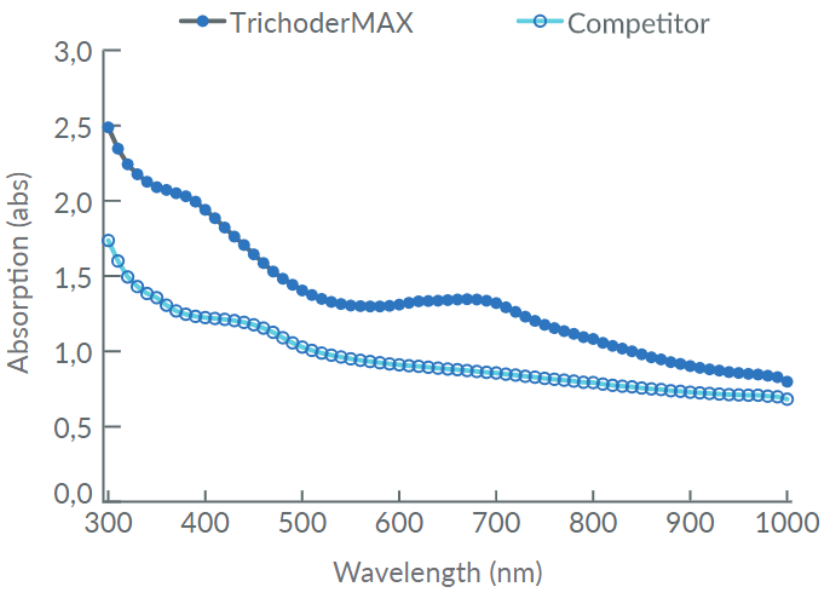
TrichoderMAX Liquid

High quality fertilizer in liquid form

Specifications	
Quantity	2.5 liter (other sizes upon request)
Dosage	Sufficient for 1 hectare
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[1] content improves survivability in soil
- Unique cell wall technology[1] enhances biofilm formation



[1] 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
- Improve resistance to soil-borne diseases
- Self-sustaining for up to 16 weeks

Suitable for

- Seed applications

Unique features

- Increased survivability
- Improved infectivity

Liquid organic fertilizer

Mineral contents (%)	
Nitrogen	0.5
Phosphorus	1.0
Potassium	0.8

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TrichoderMAX Paste

Highly concentrated for seed coats

Specifications	
Quantity	100 ml (other sizes upon request)
Dosage	Sufficient for 5 kilogram seeds
Concentration	>5 · 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[1] content improves survivability in soil
- Unique cell wall technology[1] 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.

[1] 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

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Highly quality fertilizer in powdered form

Advantages

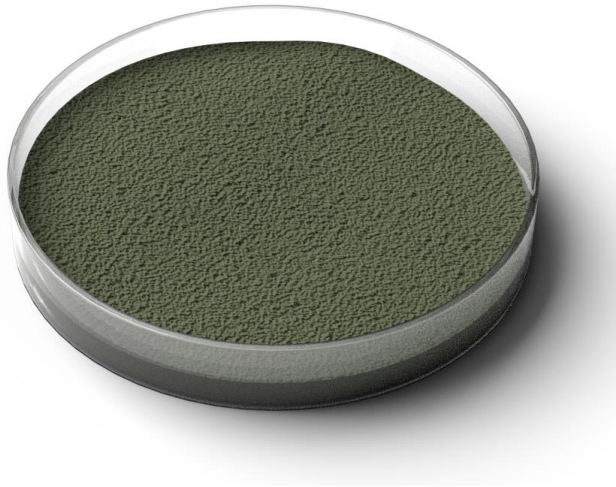
- Improving crop yields
- Stimulating plant root systems
- Enhancing nutrient uptake
- Compatible with large variety of crops
- Improve resistance to soil-borne diseases
- Self-sustaining for up to 16 weeks

Suitable for

- Direct field application
- Plant drenching

Unique features

- Increased survivability
- Improved infectivity



Solid organic fertilizer

Mineral contents (%)	
Nitrogen	1.0
Phosphorus	2.0
Potassium	1.6

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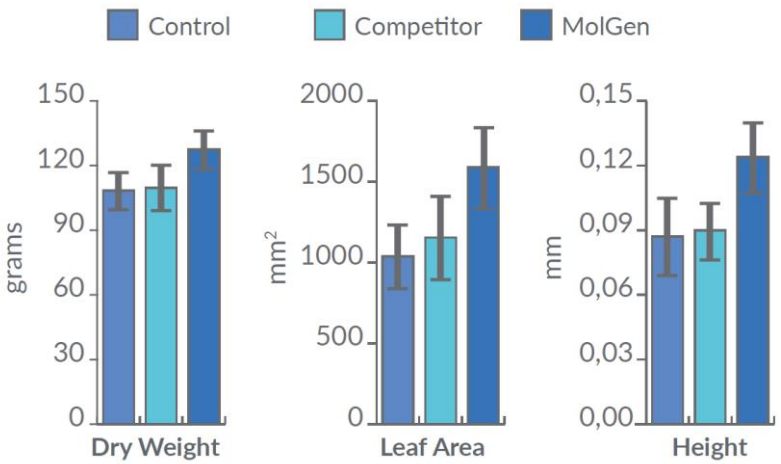
TrichoderMAX Powder

Highly quality fertilizer in powdered form

Specifications	
Quantity	500 grams (other sizes upon request)
Dosage	Sufficient for 0.2 hectares
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[1]
- Increased shoot weight and fruit yield in greenhouse studies[2]
- For a healthy root microbiome



[1] Phenotyping experiments are performed by PhenoVation B.V. and NLResearch B.V.
[2] Greenhouse studies are performed by Botany Group, on tomato plants.