REPORT

Effect of Agro Biosol on Strawberry Cultures, Soil Microorganisms, and GRANMET Active Substance

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Summary

Agro Biosol promotes fungi with mycoparasitic action, as well as nitrogen mineralizers from the group of mucorales (Zygomycetes) in the soil. Due to the detectable accumulation of these beneficial fungi in the soil, the suppression of phytopathogenic fungi can be expected. At the same time, the plant health can be regarded as secured or improved due to improvement of the immune system of the plant.

When fertilizing with Agro Biosol, the number of strawberries per frigo strawberry plant (variety Darselect) was increased on average by 13 per cent. An increase in fruit weight per plant could not be achieved by using Agro Biosol, as the drip-irrigated reference plants did not encounter any nutrient deficiencies in the soil during the entire two-year growing season. At the end of the season of the year of planting 2005, potassium and boron deficiencies were detected in the soils treated with Agro Biosol. These were balanced by selective fertigation in the spring of 2006. In the second year of growing, the soil treated with Agro Biosol had a higher supply rate of mineralized nitrogen (N_{min} supply) so that this could be regarded as a possible long-term effect in the trial areas.

No differences compared to the fertigated variant have been found with regard to plant health (evaluated by means of leaf analyses and after diagnosing possible plant diseases). The frigo plants (variety: Darselect), as well as the conventionally grown plants (variety: Elsanta) were free from symptoms of disease. Organoleptic investigations of the harvest products carried out at regular intervals revealed no differences in taste. The taste of the strawberries was rated excellent.

No adverse effect on the persistence of insecticidal fungi was detected after treatment with Agro Biosol. The simultaneous use of the biological control agent GRANMET (active substance: *Metarhizium anisopliae*) to control *Otiorhynchus sulcatus*, which is increasingly found in strawberry cultures, can be recommended.

Introduction and Purpose

Strawberries of first-class quality have been grown on a large scale in South Tyrol, Italy, since the eighties. The planting areas of the Martell valley, situated at altitudes between 900 and 1,800 metres, are a major cropping area for mountain strawberries in South Tyrol (plants of the variety Elsanta). In lower-level positions in the valley, mainly frigo strawberry cultures (variety: Darselect) are grown on ridges. This type of cultivation allows controlled irrigation, fertilization/fertigation, as well as plant protection measures using a drip irrigation system.
The purpose of this study is to examine the effect of Agro Biosol (i) as a long-term fertilizer on strawberry cultures, (ii) on the active substance GRANMET, an insecticidal fungus preparation used for control of the vine weevil (*Otiorhynchus sulcatus*), and (iii) on selected soil fungi, in cooperation with the Erzeugergenossenschaft Vinschgau/Martelltal (producers cooperative Vinschgau/Martell valley) and the Versuchszentrum (research centre) Laimburg (Auer/Bozner Unterland). In addition to the assessment of strawberry plants with regard to plant health and yield, selected soil fungi were examined with regard to their occurrence in the soil over a period of two years. Conclusions should be drawn from fungus monitoring about the fertilizing effect of Agro Biosol and the persistence and mode of action of the biological control agent GRANMET.

Materials and Methods

Experimental Sites

The field trials were carried out on two experimental sites:

Planting area Laimburg: (140 m^2, 8 ridges, 16 m in length, at an altitude of 250 m above sea level); 48 plants were set out per ridge.

Planting area Dorf Martell in the Martell valley: (1,000 m^2, randomised planting with four replications per trial variant [20 m * 3 m per trial variant and replication]; 24 rows in low mountain ranges at an altitude of 1,400 m); 24 rows were planted in total; planting density (80,000 plants per hectare).

Planting Time and Assessment:

400 frigo plants (variety: Darselect) were planted on Mai 11, 2005, two weeks after fertilizing the strawberry beds with Agro Biosol (application rate according to the manufacturer's instructions, 1,000 kg of granules per hectare) and assessed once per week over the entire growing period. The ridges were covered with strawberry foil (type black-white), and the plants were fertigated by means of a drip irrigation system or supplied with water.
In the test plot Laimburg, there were five harvest dates in the planting year 2005 (July 1, 4, 8, 15, 27, 2005), and eight harvest dates in the subsequent year 2006 (May 17, 20, 24, 27, 30, as well as June 3, 6, and 9, 2006).

On August 10, 2005, more than 6,000 plants (variety: Elsanta) were planted in the test plot Dorf Martell; Agro Biosol and conventional fertilizer were applied immediately after planting.

Experimental Design:

Comparison between Agro Biosol and Standard Fertilization

1) *Site Laimburg:* Eight ridges were built, 16 m long and 1,2 m wide, and provided with drip irrigation (4 litre dripper). Two weeks before planting time (May 2005), four ridges were fertilized with Agro Biosol (according to the recommendations of Sandoz GmbH), and the other four ridges were fertigated with standard fertilizer or supplied with foliar nutrient. In the second year of the project, both areas were fertigated in the same manner in order to balance the extremely low potassium and boron contents in the trial area. Composition of the fertilizers according to the fertigation plan (Tab. 1). The strawberry cultures were irrigated with 500 ml of water per plant per day. Strawberry plants that had been damaged by mice in the summer of 2005 with a lasting effect (< 10 per cent) were replaced in autumn 2005 with cuttings that had been propagated during the summer.

Table 1: Fertigation plan for frigo ridge culture, test plot Laimburg. Project years 2005 and 2006. Fertigation rate of standard fertilizer products*: grammes dissolved in 5 litres of water, foliar nutrient rate: grammes dissolved in three litres of water.

Treatment time	Product	Total fertigation rate	Total foliar nutrient
June 24, 2005	FERRILENE	38.4 g	
June 27, 2005, distrib. over 5 days	MASTER	192.0 g	
June 29, 2005	BORO plus	11.5 g	
June 30, 2005	BREXIL Ca		19.2 g
July 1, 2005	BORO plus	11.5 g	
	BREXIL Ca		19.2 g
July 4, 2005, distrib. over 5 days	MASTER	192.0 g	
July 4, 2005	BREXIL Ca		19.2 g
July 5, 2005	BREXIL Ca		19.2 g
July 11, 2005, distr. over 15 days	MASTER	576.0 g	
April 4, 2006	FERRILENE	38.4 g	
May 12, 2006, distrib. over 5 days	MASTER (1)	192.0 g	
May 17, 2006, distrib. over 5 days	MASTER (2)	192.0 g	
on two days	BORO plus	23 g	
May 22, 2006, distr. over 15 days	MASTER (1)	576.0 g	

* Dosage – recommendations according to local custom (fertigation every two days).
Master (1): 15.5.30+2 (N.P.K+Mg), Master (2): 13.40.13 (during blossom); Ferrilene (iron preparation).

2) *Site Dorf Martell*: The plants grown in soil culture were treated with Agro Biosol, and the control rows were treated by spreading a complete fertilizer. In addition, one plot treated with Agro Biosol was supplemented with the biological control agent GRANMET to control *Otiorhynchus sulcatus* [active substance: *Metarhizium anisopliae,* Agrifutur s.r.l.].

Fungus Monitoring of Selected Indicator Organisms

The selected soil fungi represent a specific group of fungi that are frequently isolated from agricultural soils worldwide (Tab. 2). These indicator organisms were used for the study to obtain answers regarding the effect of the fertilizing method on yield and health of the strawberry plants. In addition, data were collected regarding the biodiversity and abundance of fungi. This was done also taking the application of the insecticidal fungus *M. anisopliae* into account, which was deliberately accumulated in the soil of the strawberry cultures on the site Martell.

Three soil samples were taken per site and year (in April, June and August) using a soil sampler (0 to 10 cm). The soil suspensions (n_1=3) were transferred to potato-dextrose-agar (PDA agar; Pronadisa Cat.1261.00), supplemented with dichloran 0.02g l^{-1}, 0.1g l^{-1} streptomycin and 0.05g l^{-1} tetracycline (n_2=4), and evaluated after seven days.

Table 2: Six groups of selected indicator organisms for the mycological evaluation of agricultural areas (Domsch & Gams, 1980).

Group	Selected fungi – indicator organisms
Entomopathogenic fungi	*Beauveria* spp., *Metarhizium* spp., *Paecilomyces* spp.
Mucorales (Zygomycetes)	*Absidia* spp., *Cunninghamella* spp., *Mucor* spp., *Rhizopus* spp.. (indicator organisms for large fractions of organic matter in the soil; e.g. manure fertilization, N indicator MOs)
Mycoparasites	*Gliocladium* spp., *Trichoderma* spp.
Phytopathogenic fungi	*Cylindrocarpon* spp., *Fusarium* spp.
Saprophages	*Acremonium* spp., *Aspergillus* spp., *Mortierella* spp., *Penicillium* spp.
Scattered colonies	*Alternaria* spp., *Cladosporium* spp, *Stachybotrys* spp., *Phoma* spp., *Ulocladium* spp.

The fungi were divided into six groups:

1) Entomopathogenic fungi
Fungi of the genera *Metarhizium, Beauveria* and *Paecilomyces* were classified as entomopathogenic. Dominating species were ***M. anisopliae*** (this fungus is the active substance of GRANMET), ***Beauveria bassiana***, as well as the pink-spored *Paecilomyces* species ***P. farinosus*** and ***P. fumosoroseus***.

2) Mucorales
Most types of mucorales are rapidly growing fungi which mainly use readily available nutrients. Ammonium salts, amino acids, proteins, and less important, nitrates, nitrites or urea are utilized as nitrogen sources. Various sugars are used as the main carbon source. Some species are also able to use fats as a carbon source. Many species are considered coprophilous (growing in dung) or are typical soil fungi. In this trial, mucorales were discussed as indicator organisms for large fractions of organic matter (e.g. due to manure fertilization).
Dominating species were ***Mucor hiemalis*** and ***Cunninghamella elegans.*** Both species are frequent soil fungi in a large number of different soils in a wide pH range. These fungi can mostly be isolated from the upper soil layers, but also down to a depth of one metre. Due to their rapid growth, fresh substrates can be colonized very quickly.

3) Mycoparasites
Trichoderma and *Gliocladium* (*Clonostachys*) were classified as mycoparasites. The ***T. harzianum*** species complex and ***T. viride*** were recognized as the dominating taxa. The genus *Gliocladium* was mainly represented by ***G. roseum*** and ***G. catenulatum*** .

4) Phytpathogenic fungi
Fungi of the genera *Fusarium* and *Cylindrocarpon* were classified as phytopathogenic. Pink colonies and slimy, crescent-shaped conidia were used as generic characteristics of fusaria. Colonies with reverse yellow-brown and slimy, straight and septate conidia were classified as *Cylindrocarpon*. Dominating species cannot be specified, as the species of this genus are very difficult to identify by means of morphologic characteristics.

5) Saprophages
This group summarizes typical soil fungi that do not place special demands on the substrate. ***Aspergillus ochraceus, Penicillium chrysogenum, Mortierella alpina*** were the dominating species.

6) Scattered colonies
This group summarises fungi which, despite being typical soil fungi, prefer rotting organic substrates: The dominating species of this group were ***Alternaria alternata, Cladosporium herbarum*** and ***C. cladosporoides***, ***Stachybotrys chartarum, Ulocladium chartarum***.

GRANMET – Active Substance Used for Control of the Vine Weevil

In the spring of 2005, a natural calamity of the pest *Otiorhynchus sulcatus* (vine weevil; 4 to 6 larvae per strawberry plant) was found on the site Dorf Martell (Martelltal, 1,400 m).
The biological control agents GRANMET and Ma500, both active substances based on the insecticidal fungus *Metarhizium anisopliae* grown on sterile barley, were distributed according to the manufacturer's recommendations, with a concentration of 50 kg per hectare, manually and uniformly on the soil treated with Agro Biosol, as well as on the soil treated with standard fertilizer, and immediately incorporated using a rotary harrow. The purpose of this trial was to test the effectiveness of the active substance against *Otiorhynchus*. A standard commercial chlorpyrifos preparation (DB) was used as reference insecticide.

Evaluation

The selected sites were classified and soil analyses were carried out regarding the nutritional status (i) before planting the strawberry cultures in spring 2005, (ii) after the harvest in summer 2005, (iii) as well as in spring and (iv) summer 2006 (sampling dates on the site Laimburg; May 13, 2005, August 2, 2005, April 19, 2006, June 1, 2006 and August 2, 2006; Dorf Martell: June 6, 2005; October 20, 2005; May 12, 2006, June 13, 2006, July 21, 2006). Leaf analyses were carried out only in the first project year.

Evaluations of yield and number of strawberries per plant were carried out using the statistics programme SPSS version 14.0 for Windows XP (SPSS Inc., Chicago, Illinois, USA): The mean value and the standard deviation of the individual variables were calculated as statistical parameters.

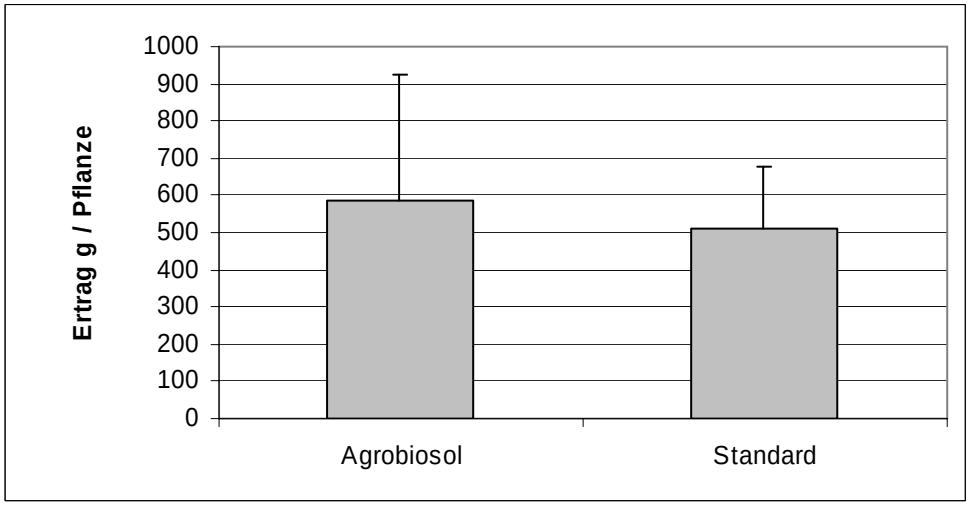
The effect of the treatment on the abundance of selected indicator organisms (only fungi) in the strawberry cultures was examined with the Canonical Correspondence Analysis (CCA; Canoco for Windows, version 4.5, Plant Research International, Wageningen, NL). This programme was created to show gradual relationships between the individual species and the trial areas by means of abundance surveys in different trial areas. For this purpose, combinations of environmental parameters are calculated and used to draw coordinate axes.

Results

Comparison between Agro Biosol and Standard Fertilization

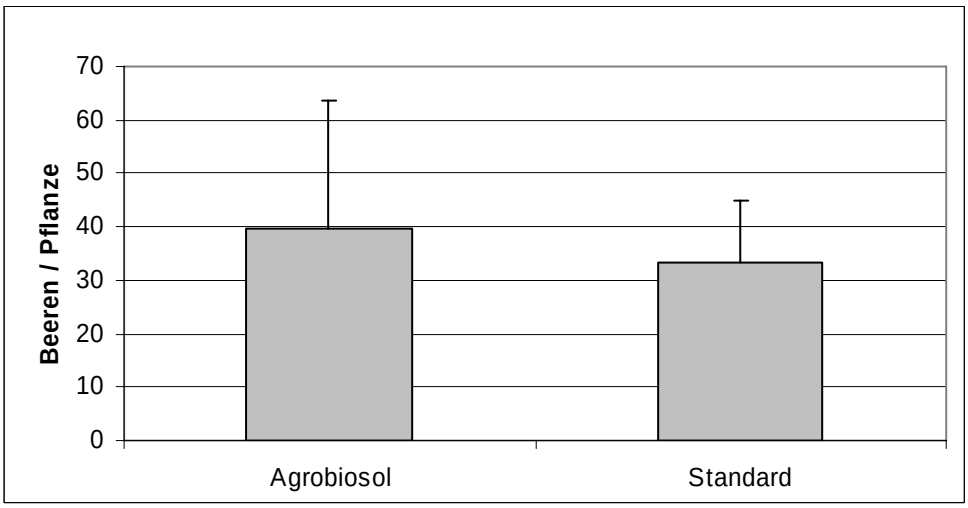
In the year of planting 2005 and in the harvest year 2006, no differences were found in the test plot Laimburg between plants treated conventionally and with Agro Biosol regarding yield, plant growth, and plant health, which were evaluated by means of the total fruit weight, leaf analyses and after diagnosis of possible plant diseases (Fig. 1).

However, a significant difference was found in the number of berries per frigo plant. In the season 2006, on average 39.05 strawberries ± 24.16 were harvested from the Frigo plants on the site Laimburg. For the cultures fertigated with standard fertilizer, 33.50 ± 11.32 strawberries per plant were calculated (Fig. 2).



Ertrag / Pflanze = yield/plant

Figure 1: Fruit weight$_{total}$ per plant (grammes of fresh weight; n= 20) and fertilization (Agro Biosol and standard fertigated rows) after eight harvest dates in the harvest season 2006. Frigo strawberry plants - variety: Darselect - in the test plot Laimburg.



Beeren / Pflanze = berries/plant

Figure 2: Number of strawberries per plant and treatment (AGRO-BIOSOL® and standard fertigated rows, n_1=4) after eight harvest dates in the harvest season 2006. Frigo strawberry plants - variety: Darselect - in the test plot Laimburg (n_2= 20).

Soil Analyses:

For both sites, the macronutrients phosphate, potassium, magnesium and boron, as well as the trace elements manganese, copper and zinc have been evaluated. In addition, the determination of N mineralized was carried out in the spring of 2006 (see Attachments II and III).

General Evaluation:

Site Laimburg

The soil can be described as follows:

type of soil: loamy sand
humus: 2.3%
pH: 7.3
calcium carbonate: topsoil: low to medium carbonate content
subsoil: high carbonate content

The soil nutrient provision at the beginning of cultivation (year of planting 2005) was rated as sufficient with the exception of boron. The treatment with Agro Biosol did not correct the supply situation of boron. The content remained unchanged during the season 2005. Furthermore, a reduction of the potassium concentration was detected in the area treated with Agro Biosol, starting from a medium to low nutrient provision (Attachment II).
In the second project year, both areas were equally fertigated to balance the potassium and boron deficiencies in the trial area that was treated with AGRO-BIOSOL. This measure secured an excellent supply situation of the frigo strawberry cultures during the entire season (Attachment III).

Site Martell

The soil can be described as follows:

type of soil: highly humic, silty-loamy sand
humus: 8.3%
pH: 5.8
calcium carbonate: no free carbonate

The nutrient provision at the beginning of cultivation (summer 2005) was rated high for magnesium and phosphate, medium for boron, and low for potassium (Attachment III). All trial areas were sufficiently supplied with nutrients due to a balanced stock fertilization in spring 2006. With regard to the nitrogen supply (nitrate – N content), the required values were exceeded many times due to excessive fertilization.

N_{min} Analysis

N_{min} analyses were carried out in spring 2006. On both sites, a greater supply of mineralized nitrogen in the soil (N_{min} supply) was found in the areas treated with Agro Biosol (Tab. 3).

Table 3: N contents of the soils in Laimburg and Dorf Martell during spring 2006 (first major harvest year).

Site/treatment	**Depth (cm)**	**Strawberry variety**	**DM (%)**	**NO_3-N**	**NH_4-N**	**N-$_{min}$**
				(kg ha^{-1} DM)		
Laimburg/Agro Biosol	0-20	Darselect	81	13	2	15
Laimburg/fertigation	0-20	Darselect	80	8	2	10
Martell/Agro Biosol*	0-20	Elsanta	67	68	2	70
Martell/conventional*	0-20	Elsanta	60	60	2	62

* additionally fertilized with castor-oil meal before sampling

Leaf Analyses:

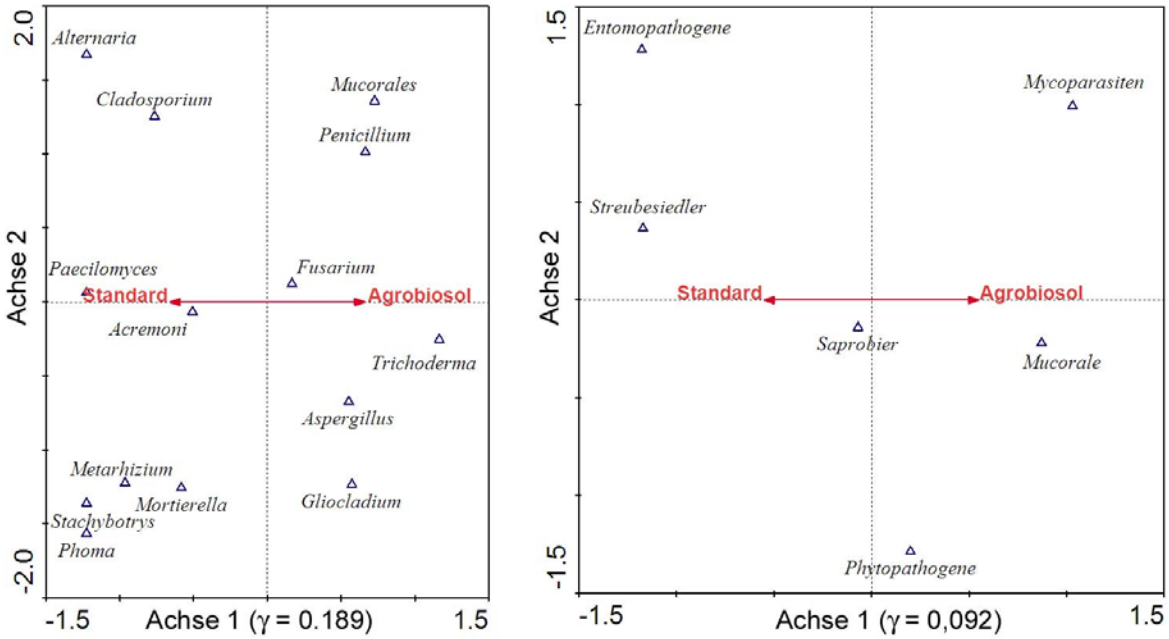
The frigo plants that were treated with Agro Biosol had an improved potassium, calcium, iron and copper supply. Only with regard to boron an undersupply of the cultures was detected already in the first year (> 48 %, Table 4).

Table 4: Evaluation of the nutrient supply (main and trace elements) based on leaf analyses of frigo strawberry cultures during the harvest period (July 14, 2005, n=4).

Fertilization	Specification of the mean values in									
	per cent						mg per kg DM			
	N	P	K	Ca	Mg	B	Fe	Mn	Cu	Zn
Agro Biosol	2.54	0.32	2.06	1.74	0.54	36.7	132.2	43.5	18.6	23.3
fertigated	2.63	0.32	1.76	1.18	0.43	75.5	77.8	41.8	13.4	23.5

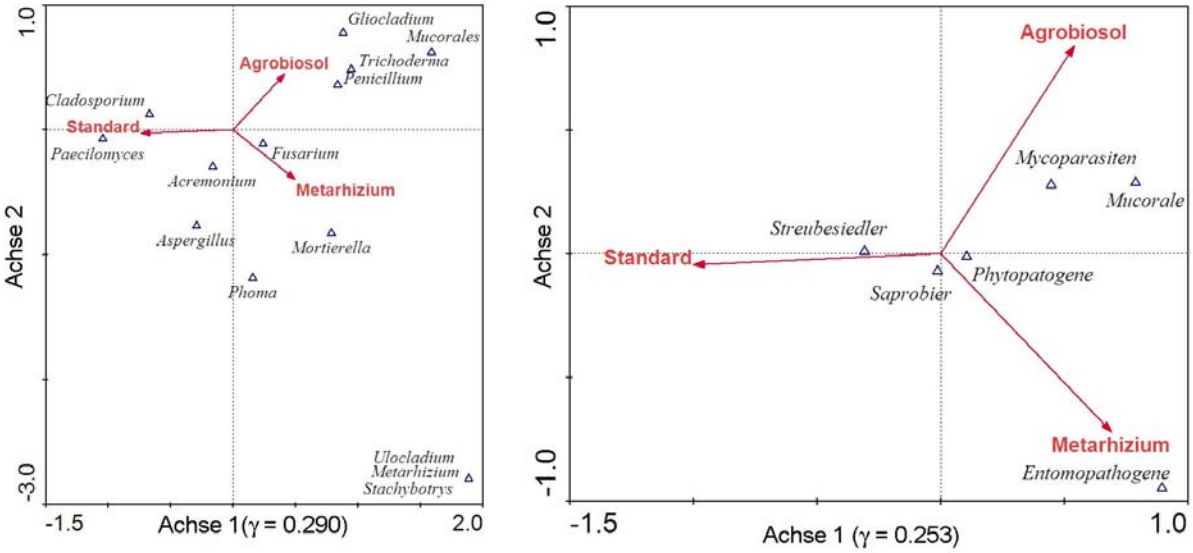
Fungus Monitoring:

Agro Biosol has a significantly positive effect on the abundance of mucorales and of the group of mycoparasitic fungi (e.g. *Trichoderma* and *Gliocladium*). Both groups were detected in increased numbers in the areas treated with Agro Biosol (Fig. 1 a, b). The fertilizing method had no effect on the groups of classical saprophages and phytopathogenic fungi. They were found on both sites with unchanged abundance. Entomopathogenic fungi, which were not explicitly accumulated on the site Laimburg, were found in the areas treated with standard fertilizer only in isolated cases. In the areas where they had been applied to control *Otiorhynchus*, sufficient numbers were detected over the trial period of two years (Fig. 2a). In contrast to the soil culture (Dorf Martell), where scattered colonies were equally detected in all trial areas, such colonies were mainly found on the site Laimburg in the areas fertigated with standard fertilizer (Fig. 2a, b).



(a) **(b)**

Figure 1 a, b: Ordination diagrams of the canonical correspondence analyses of the fungus diversity in the soil of the test plot Laimburg. The Monte Carlo Permutation Procedure indicates a significant difference of the first canonical axis (analysis of the abundance of individual indicator fungi: F = 1.733, p = 0.048; analysis of the abundance of ecological groups: F = 1.968, p =0.049). (a) Evaluation based on individual fungus species; (b) indicator organisms were summarised in six groups.

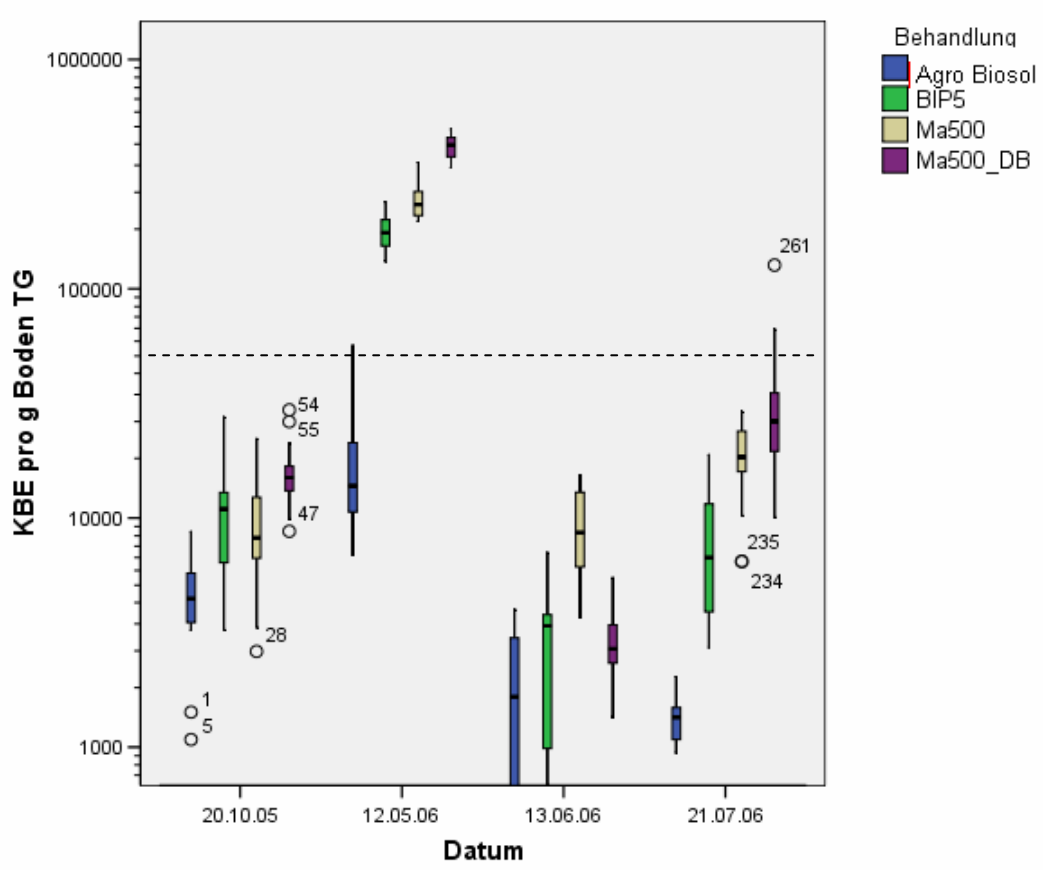


(a) **(b)**

Figure 2 a, b: Ordination diagrams of the canonical correspondence analyses of the fungus diversity in the soil of the test plot Dorf Martell. The Monte Carlo Permutation Procedure indicates a significant difference of the first canonical axis (analysis of the abundance of individual indicator fungi: F = 3.251, p = 0.009; analysis of the abundance of ecological groups: F = 3.680, p =0.010). (a) Evaluation based on individual fungus species; (b) indicator organisms were summarised in six groups.

GRANMET

On the test plot Dorf Martell (Martelltal, 1,400 m), strawberry plants (variety: Elsanta) were planted on August 2, 2005 immediately after the cauliflower harvest in a randomised experimental design. In addition to testing the long-term effect of the fertilizer AGRO BIOSOL, the effect of the fungus preparation GRANMET (*Metarhizium ansiopliae*, active substance used for control of the vine weevil *Otiorhynchus sulcatus*) and of another product (Ma500), were investigated. On the site Dorf Martell, a natural calamity of the pest of 4 to 6 larvae was found per strawberry plant only in the first trial year. In the second year of the project, only isolated cases were detected. Despite the insufficient infestation level, the fungus *M. anisopliae* was accumulated in sufficient concentration in the soil as expected (> 1×10^4 colony-forming units per gramme of soil (dry weight) [CFU per g of soil DW], Fig. 3). No negative effect on the soil biota was detected either in the soil horizons (0 to 10 cm and 10.5 to 30 cm) or in the two fertilized variants (Fig. 2a).



Behandlung = treatment
KBE pro g Boden TG = CFU per g of soil DW
Datum = date

Figure 3: Evaluation of the fungus density of *Metarhizium anisopliae* using a selection medium (n=12) on the site Dorf Martell. Several potential Metarhizium strains were applied, and their persistence was tested (GRANMET = BIPESCO 5; strain Ma 500; MA 500 + DB = chemical soil insecticide). The dotted line defines the minimum fungus density of *M. anisopliae* in the soil required to ensure the control of *Otiorhynchus sulcatus* in crop cultures with a lasting effect (5,000 CFU per gramme of soil, dry weight), provided there is a high infestation level of vine weevil in the area (> 10 larvae per m^2).

Discussion

The classical advantages of drip irrigation of A+ frigo plants was confirmed over the two-year observation period on the site Laimburg. At no time were the standard fertigated strawberry plants undersupplied with nutrients due to selective fertigation. This is also the reason why in the second trial year the Agro Biosol areas that were undersupplied with boron and calcium were fertigated with the drip irrigation system.
In the second project year, the areas treated with Agro Biosol had a greater supply rate of mineralized nitrogen (N_{min} supply) so that this could be regarded as a possible long-term effect in the trial areas. However, this otherwise desirable effect of Agro Biosol has to be qualified for strawberry cultures, as there is no undersupply of the plants due to the

reasons specified above (fertigation). The same applies to strawberry cultures that are sufficiently supplied with nutrients by means of stock fertilization.

It is worth mentioning that the yields on the site Laimburg in the harvest year 2006 did not entirely meet the expectations. The average total fruit weight of 588.40 ± 338.83 g per plant is too low by 20 to 25 per cent compared with A+ frigo plants of the variety Darselect that were grown in similar situations. The lower yields are caused by the harvest already carried out in the year of planting 2005. The blossoms of strawberry ridge cultures are usually removed in the year of planting to achieve good tillering. This leads to increased yields in the following harvest year.

No major plant diseases were found either on the site Laimburg or in the trial area Dorf Martell. This is particularly remarkable as no plant protection measures were carried out in the ridge cultures of the site Laimburg over the entire trial period.
Organoleptic investigations of the harvest products carried out at regular intervals revealed no differences in taste. The taste of the strawberries was rated excellent.

Agro Biosol promotes fungi with mycoparasitic action, as well as nitrogen mineralizers from the group of mucorales (Zygomycetes) in the soil. Due to the detectable accumulation of *Trichoderma harzianum* and *Gliocladium catenulatum (Clonostachys rosea* f. *catenulata)* in the soils treated with Agro Biosol, the suppression of phytopathogenic fungi in the soil can be expected, and the plant health can be regarded as secured or improved due to the improvement of the immune defence system of the plants. Products based on *T. harzianum* and G. *catenulatum* that are also sold as plant restoratives have been successfully used for more than twenty years to control phytopathogenic fungi, such as *Armillaria mellea, Botrytis cinerea, Cylindrocladium spp., Fusarium spp., Myrothecium* spp., *Phytium* spp., *Rhizoctonia solan, Sclerotinia homoeocarpa, Sclerotium rolfsii* and *Thielaviopsis* spp. (Freeman et al. 2004, Harman et al., 2004). The effect of *T. harzianum* and *G. catenulatum* is due to the rapid colonization of the plant tissue and therefore the competitive suppression of the growth of harmful fungi. In addition, appressorium-similar structures of the fungus were detected on the mycelium of phytopathogenic fungi, which indicates a parasitic effect. The fungi also release a large number of substances (e.g. secretion of hydrolytic enzymes and production of secondary metabolites, such as antibiotics), which may induce a local, as well as a systemic resistance of the plants.

Agro Biosol is known to stimulate the mineralization of organic fractions in the soil. This is confirmed by the observation that increased numbers of *Mucor hiemalis* and *Cunninghamella elegans* were detected in the strawberry cultures that were treated with Agro Biosol. Both types can be isolated worldwide in a large number of soils. They are typical soil fungi that are able to quickly colonize fresh substrates due to their rapid growth (Ellis & Ellis, 1988).

The effect of GRANMET (*Metarhizium ansiopliae,* active substance used for control of the vine weevil *Otiorhynchus sulcatus*), could not be verified *in situ*, because the infestation level on the site Dorf Martell was too low. Despite the insufficient infestation level, the fungus *M. anisopliae* was accumulated in sufficient concentration in the soil as expected. No negative effect of the active substance of the fungus on the soil biota was detected either in the two fertilized variants or in the soil horizons (0 to 10 cm and 10.5 to 30 cm).

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Attachment I

Test Plots Laimburg and Dorf Martell in South Tyrol, Italy

Picture 1
site – research centre Laimburg
(Pfatten / Auer)
measuring the trial plots
(8 rows; ridge: 1.2 m x 16 m)

Picture 2
ridge culture method for planting frigo strawberry cultures in May 2005

Picture 3
treatment with Agro Biosol – two weeks before the planting date (April 27, 2005)
application rate: 1,000 kg per hectare

Picture 4
application of Agro Biosol – the granules were applied manually directly to the ridges (1,000 kg per hectare)

Picture 5
foil type black/white to cover the ridge culture on the test plot Laimburg

Picture 6
drip irrigation – control device; controlled irrigation of the strawberry cultures and treatment of the control plants with conventional fertilizer

Picture 7
frigo plants on ridge culture – research centre Laimburg

Picture 8
frigo cuttings grown to replace damaged and diseased plants

Picture 9
test plot Dorf Martell, 1,400 m above sea level

Picture 10
test plot Dorf Martell before the cauliflower harvest in August 2005

Picture 11
test plot Dorf Martell after the cauliflower harvest in August 2005; the randomised design of plants grown in soil culture was started immediately afterwards

Picture 12
plants, variety Elsanta, for the test plot Dorf Martell (August 4, 2005)

Picture 13
rotary harrow for incorporating the fungal active substance GRANMET (*Metarhizium anisopliae*) and the chemical insecticide „Dursban-Granulat“ used for control of the vine weevil (*Otiorhynchus sulcatus*)

Picture 14
seed-bed preparation with the rotary harrow

Picture 15
test plot Dorf Martell ten weeks after planting the strawberry plants

Picture 16
marketing of the strawberries by the Genossenschaftsbetrieb (producers cooperative) Vinschgau „Martelltal“

Picture 17
Martelltal – Genossenschaftsbetrieb (producers cooperative), marketing of strawberries from altitudes up to 1,800 m

Picture 18
strawberry plants damaged by the root feeder vine weevil (*Otiorhynchus sulcatus*), average infestation 4 to 6 larvae per plant

Picture 19
Otiorhynchus sulcatus larvae with damaged strawberry rhizome