



TECHNICAL NOTES FOR T34 BIOCONTROL®

SUMMARY

- T34 BIOCONTROL is an approved registered biofungicide** for growing media treatment with preventative activity against a range of root zone plant diseases such as *Fusarium oxysporum* and *Pythium* and some activity on foliar disease.
- Applied by pre-planting mixing into the growing media, plant root dipping (*Dianthus* only) and drench or irrigation treatment. The standard rate of use is 10 grams per cubic metre although two applications at half this rate may be recommended as an irrigation treatment depending on the crop.
- T34 BIOCONTROL is mixed into water for compost application and may be applied through a dosing pump when irrigated.
- T34 BIOCONTROL may be used on crops grown under permanent protection. The approved crops are tomato, pepper, chilli, aubergine and *Dianthus*. EAMUs* allow use on strawberry, cane fruit, bush/small fruit, brassicas in propagation, leaf vegetables (includes lettuce), fresh herbs, forest nursery and container grown ornamental plant production.
- T34 BIOCONTROL contains a strain of a naturally occurring fungus and is supplied as conidia / spores. The fungus has the capacity to colonise growing media and plant roots. It works by forming a physical barrier to pathogens, competing with pathogens for space and nutrients, parasitizing fungal hyphae and by inducing plant disease resistance mechanisms. A few days after inoculation the fungus colonises the growing media and will then resist leaching.
- T34 BIOCONTROL is most effective at temperatures between 15 and 35°C.
- T34 BIOCONTROL is a natural product and should be usable in organic production systems.

These notes include details of compatibility with other products used in plant protection, shelf life, storage and activity in the absence of disease.

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USE PLANT PROTECTION PRODUCTS SAFELY.

ALWAYS READ THE LABEL AND PRODUCT INFORMATION BEFORE USE

Further product information including warning phrases and symbols is included in the main product manual.

TECHNICAL NOTES FOR T34 BIOCONTROL®

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INTRODUCTION

DESCRIPTION

T34 BIOCONTROL is a registered biofungicide** and has approval for growing media treatment on tomato, pepper, chilli, aubertine and carnation (*Dianthus* spp.) with extensions of authorisation (EAMUs)* allowing use on protected ornamental plant production, forest nursery, brassicas in propagation, leafy vegetables, fresh herbs, cucurbits and melon, strawberry, cane fruit and bush/small fruit.

T34 BIOCONTROL has approval for control of *Fusarium oxysporum* f.sp *dianthi* on carnations (*Dianthus* spp.) and *Pythium aphanidermatum* on tomato, pepper, chilli and aubergine. It has activity on a range of other soil born diseases.

T34 BIOCONTROL is formulated as a wettable powder and contains living spores of a specific fungus strain 'T34' of the naturally occurring fungus *Trichoderma asperellum* at 1×10^{12} colony forming units (cfu) per kg

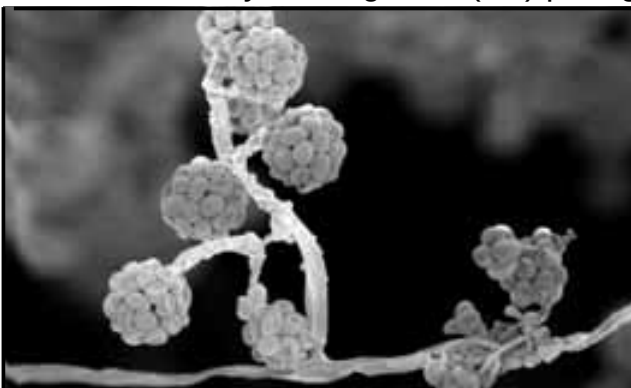


Figure 1: scanning electron micrographs of *Trichoderma asperellum*, strain T34, phialides bearing conidia.

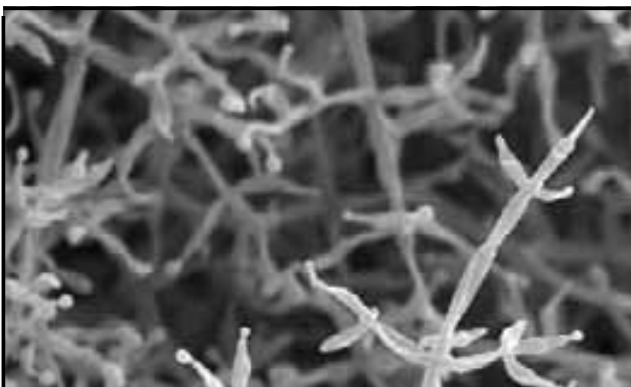


Figure 2: Scanning electron micrographs of mycelia with conidiophores in pyramidal arrangement and phialides in a flask shape and few conidia attached at the tip.

(12 % w/w).

T34 BIOCONTROL does not contain anything that is genetically manipulated.

T34 BIOCONTROL contains pale green conidia (2-5 microns) which germinate producing mycelium which infect and compete with other fungi.

BACKGROUND:

The specific strain of *Trichoderma asperellum*, strain T34 was isolated by the University of Barcelona from composted waste which was found to be naturally suppressive to *Fusarium*. T34 BIOCONTROL is manufactured and approvals held by Biocontrol Technologies, S.L., in association with the University of Barcelona and the University of Seville in Spain.

T34 BIOCONTROL is registered for use in several European countries.

In the UK T34 BIOCONTROL was approved in 2012 for use on ornamentals, in 2016 it was re-registered allowing additional use on edible crops. T34 BIOCONTROL is patented.

Activity on *Fusarium*:

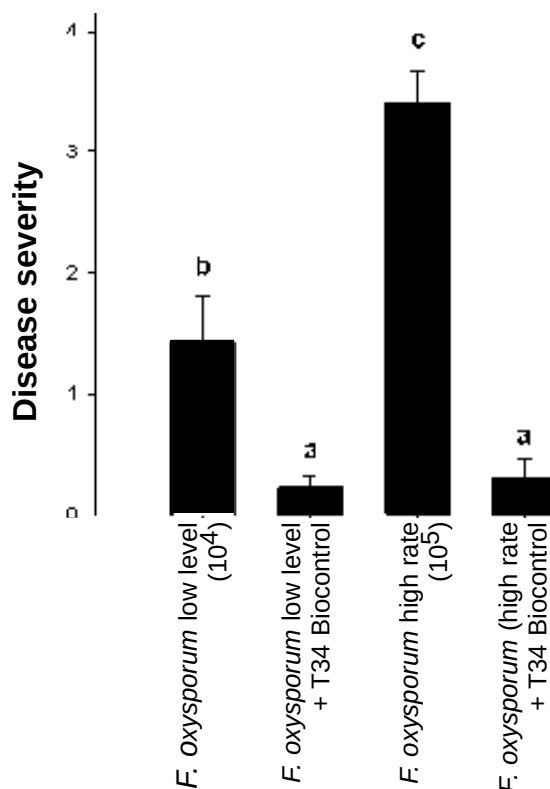


Figure 3: *Fusarium oxysporum* f.sp *dianthi* with and without T34 Biocontrol. Units are cfu/ml.

WHY USE T34 BIOCONTROL?

To Control Disease:

T34 BIOCONTROL has approval for reducing *Fusarium oxysporum* (*Fusarium* wilt), a disease that has not been well controlled with chemical fungicides and for *Pythium aphanidermatum*.

T34 BIOCONTROL also has been found to have good preventative control of a range of other root diseases, see section below but currently there is no approval for the control of these other diseases.

Use of T34 Biocontrol will help to:

- Reduce chemical fungicide use.
- Eliminate or reduce chemical pesticide residues.
- Reduce the risk of fungicide resistance.
- Minimize environmental problems with chemical pesticides.
- Enable disease control where there are no chemical fungicides available.
- Use in IPM programmes.
- Improve plant growth.

Activity on *Pythium*:

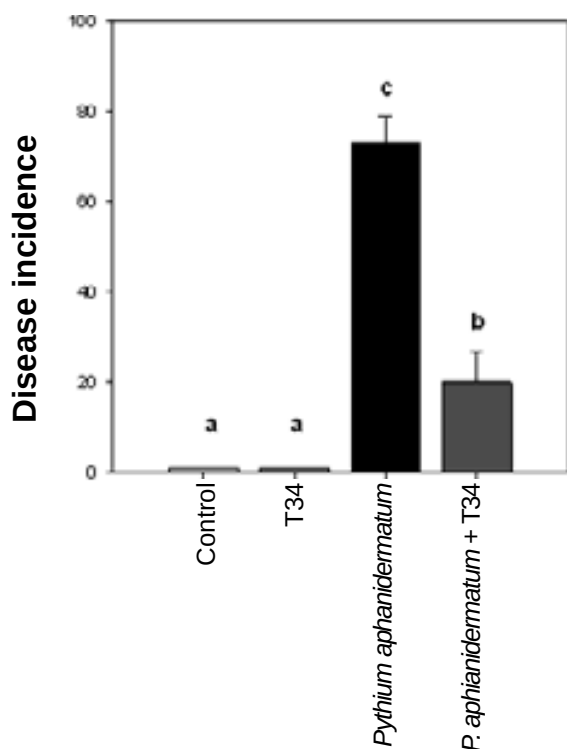


Figure 4: T34 BIOCONTROL reduced *Pythium* spp., pre-emergence damping-off in trials on cucumber plants inoculated with the disease.

Activity on *Sclerotinia*

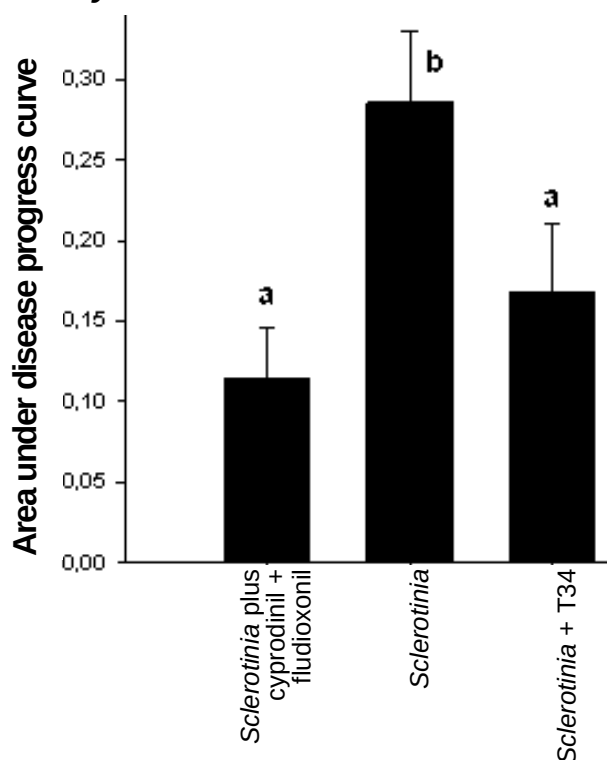


Figure 5: T34 BIOCONTROL reduced *Sclerotinia sclerotiorum* in trials on lettuce planted in infected soil.

Activity on *Phytophthora*:

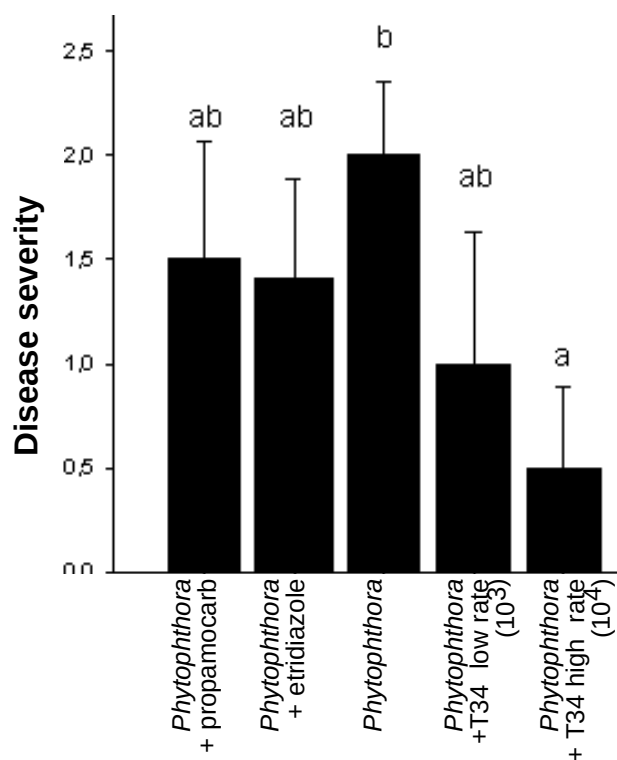


Figure 6: T34 BIOCONTROL significantly reduced *Phytophthora capsici* in trials on peppers inoculated with the disease, outperforming the chemical treatments. Units are cfu/ml.

WHAT DISEASES DOES T34 BIOCONTROL CONTROL?

Trials have shown control of the following diseases:

Soil disease (growing media application):

- *Fusarium oxysporum* (on label),
- *Macrophomina phaesolina* (root rot),
- *Phytophthora capsici*,
- *Pythium aphanidermatum* (damping off), (on label).
- *Rhizoctonia solani*,
- *Sclerotinia cepivarum*.
- *Sclerotinia sclerotiorum*,

Growing media treatment has reduced the following diseases by induction of plant defence:

- Bacteria foliar diseases:
Pseudomonas syringae
 pv. *lachrymans*,
P. syringae pv. *tomato*.
- Fungal Diseases:
Plectosphaerella cucumerina,
Hyaloperonospora parasitica.

Foliar Disease (foliar application):

Botrytis cinerea,
Didymella brioniae.

Some of these diseases appear on crops for which there may be no approval in the UK. Foliar applications are not currently approved in the UK.

ACTIVITY IN THE ABSENCE OF DISEASE

T34 BIOCONTROL *Trichoderma* will establish in the absence of pathogens and in some trials growth benefits have been recorded, due to strengthening of the root system. However it is not known how consistent these benefits are and no recommendations are made for them.

PLANT SAFETY:

T34 BIOCONTROL has been trialled on a wide variety of plants under a wide range of conditions and no phytotoxicity has been observed.

USE IN ORGANIC SYSTEMS?

The product contains a naturally occurring

soil fungus and should be acceptable in organic production systems but check with the certification body before use.

HOW DOES T34 BIOCONTROL WORK?

The fungus *Trichoderma asperellum* strain T34 has multiple modes of action:

- Direct competition with the pathogens for space and nutrients.

It has the capacity to colonise growing media and plant roots where it can build

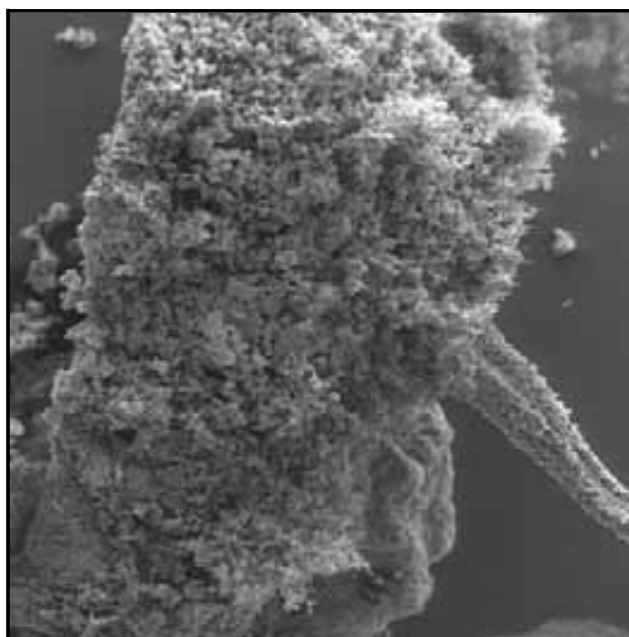


Figure 7: Sclerotia of *Sclerotinium sclerotiorum* parasitised by *T. asperellum* strain T34. Sclerotia from a number of plant diseases can be degraded by *T. asperellum* strain T34 providing control of a range of species of *Sclerotinia* and *Rhizoctonia*.



Figure 8: *T. asperellum* strain T34 coiling around the hyphae of *Didymella brioniae*, parasitising the pathogen.

up a physical barrier against pathogens.

- Direct effect - synthesis of biostatic compounds.

- Hyperparasitism - T34 grows into and infects the sclerotia and hyphae of fungal pathogens on plants. (Figures 7 & 8).

Activity on *Fusarium*: T34 BIOCONTROL infects the hyphae of *Fusarium* and it has been shown that the populations of *T. asperellum* strain T34 are higher in the presence of the pathogen (*Fusarium*) than in their absence.

- By inducing plant disease resistance mechanisms.

T34 BIOCONTROL stimulates the expression of a group of defence orientated proteins directly involved in protection and can switch the plant's metabolism to a defensive non-assimilatory role.

Research work has demonstrated that germinating pathogen spores can be blocked by the synthesis of callose. (Callose is a plant polysaccharide produced in response to wounding or invasion by plant pathogens). (Figure 9).

- Root colonisation - enhanced plant growth.

T34 BIOCONTROL colonises plant roots and there is evidence that even in the absence of pathogens plants can often show a positive growth response.

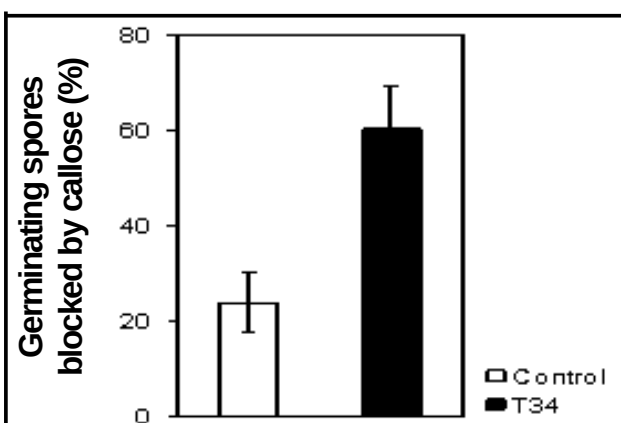


Figure 9: *T. asperellum* strain T34 applied to the roots is able to induce the synthesis of callose in *Arabidopsis* leaves and this blocks the germination and diminishes disease caused by *Hyaloperonospora parasitica*.

CROPS AND SITUATIONS WHERE T34 BIOCONTROL CAN BE USED

T34 BIOCONTROL is approved for use on protected tomato, pepper, chilli, aubergine and carnation (*Dianthus* spp.). Extensions of authorisation (EAMUs*) allow use on other crops. T34 BIOCONTROL may be applied by growing media incorporation, by root dipping (*Dianthus* only) and by drench or irrigation treatments.

Extensions of authorisation (EAMUs)*:

Extension of authorisations EAMUs* have been issued for peat or soil grown crops grown under permanent protection. For a single application either by incorporation or by spraying trays and then by post planting application by irrigation:

1805 of 2016: courgette and summer squash, cucumber, gherkin, melon, winter squash and pumpkin.

1808 of 2016: bilberry, blackcurrant, redcurrant, blueberry, cranberry, elderberry, gooseberry, mulberry, rose hips, blackberry, loganberry and *Rubus* hybrid, raspberry, strawberry.

1809 of 2016: named herbs, leaf vegetables (includes lettuce, endive), brassicas in propagation (broccoli/calabrese, Brussels sprout, cabbage, cauliflower, choi sum, collard, kale, kohlrabi, oriental cabbage,).

1810 of 2016: forest nursery and container grown ornamental plant production.

APPLICATION MIXING AND USE

HOW BEST TO APPLY T34 BIOCONTROL?

Application rate:

The standard application rate is 10 g per cubic metre of growing media. Drench or irrigation treatments may be split into two applications of 5 g per cubic metre 7 days apart.

1. Incorporation into growing media

Mix 10 g T34 BIOCONTROL with 100 litres water and apply by spraying to a cubic

metre (1,000 litres) of growing media prior to potting or seed sowing. Mix thoroughly.
OR

2. Drench treatment

Apply 0.5 g T34 BIOCONTROL in at least 50 ml water per square metre of growing media, assuming 5 cm depth, immediately after sowing seeds or sticking cuttings

AND OR

3. Root dip treatment (for *Dianthus* only)

Rooted cuttings may be dipped in a solution of 0.01 g T34 BIOCONTROL per litre of water for several hours or overnight.

The dipping solution can remain active for 1 or 2 days at room temperature or if refrigerated up to a week. Note that this technique can increase the risk of disease cross contamination if some cuttings are infected.

AND OR

4. Irrigation treatment

Apply EITHER

10g T34 BIOCONTROL per 1000 litres growing media

OR

5 g T34 BIOCONTROL to 1000 litres growing media, with 2 applications 7 days apart.

WHEN SHOULD T34 BIOCONTROL BE APPLIED AND WHAT TREATMENT INTERVAL IS RECOMMENDED?

T34 BIOCONTROL is a preventative treatment. For optimum effect T34 BIOCONTROL should be applied repeatedly during the life of the crop beginning during plant propagation (seedlings and cuttings).

For carnations (*Dianthus* spp.) to protect against *Fusarium* T34 BIOCONTROL must be reapplied at appropriate intervals to maintain the fungal population in the growing media especially at re-potting.

T34 BIOCONTROL may be applied:

- Into the growing media before use OR immediately after sowing seeds or rooting cuttings,
- And/or by dipping young plants in a solution.
- And/or by irrigation. Repeat an initial irrigation treatment after one week if the

plants were not treated in propagation. Repeat the treatments at intervals of 2 to 3 months and also prior to a high risk situation or if the plants are stressed.

For other crops:

T34 Biocontrol may be applied:

- Into the growing media before use OR immediately after sowing seeds or rooting,
- And incorporation into soil/peat before transplanting or planting
- And irrigation after transplanting.

WHAT IS THE RECOMMENDED WATER VOLUME FOR DILUTION?

The water volume should be appropriate for the method of application and can be up to 10 % of the container volume. In any event the maximum concentration should not exceed 10 g per litre.

CAN THE MATERIAL BE LEACHED OUT OF THE GROWING MEDIA?

Trichoderma asperellum strain T34 can be leached until it associates with the growing media. It takes 2 to 3 days for the *Trichoderma* to associate with the plant roots or growing media. When associated with plant roots it will then follow the root as it grows. This process will be temperature dependant and at 25°C association would probably take only a few hours. So after 2-3 days it should be OK. If the product is pre-soaked for a few hours prior to application establishment will be faster.

APPLICATION BY MEANS OF DOSING PUMPS

T34 BIOCONTROL can be applied using dosing pumps. Agitation of the stock solution is suggested to prevent precipitation.

The maximum concentration for a stock solution has not been assessed but probably around 100 g per litre.

DOES THE PRODUCT REQUIRE PRE-CREAMING PRIOR TO MIXING?

There is no requirement for pre-creaming, as T34 BIOCONTROL disperses very easily in

water.

ARE THERE ANY ISSUES WITH REGARD TO FILTERS IN SPRAYERS OR IN IRRIGATION SYSTEMS?

T34 conidia will pass through normal filters included in irrigation or spray equipment.

ENVIRONMENT FOR ACTIVITY

EFFECTIVE TEMPERATURE RANGE

Trichoderma asperellum strain T34 is actively growing between 15°C and 35°C. At temperatures above 36°C, the mycelium is not able to grow and may be killed.

IS THERE A LIMIT ON THE ACIDITY OR ALKALINITY OF THE GROWING MEDIA OR SPRAY SOLUTION?

T34 Biocontrol is effective over a wide range of growing media pH levels.

WILL T34 BIOCONTROL WORK IN ANY GROWING MEDIA OR SUBSTRATE?

T34 BIOCONTROL will colonise organic growing media (from peat with low microbial activity to high microbial activity composted waste) and inorganic (rockwool, perlite) growing media. Note that some of the approvals are limited to peat/soil use.

GROWING MEDIA MOISTURE LEVELS:

T34 BIOCONTROL will survive at normal growing media water levels suitable for plant growth. In the event of water-logging or drying out the population of T34 will decrease and may necessitate another application. The populations of T34 will recover after a while of normal plant growing conditions. Even if populations decline the conidia (spores) will survive.

IS THERE ANY BENEFIT FROM PRE-MIXING TO ACTIVATE SPORES BEFORE USE?

There is no need to pre-soak the spores but if soaked for a few hours prior to application establishment will be faster.

COMPATIBILITY WITH OTHER COMPONENTS OF A CROP PRODUCTION PROGRAMME

TANK MIXING:

T34 BIOCONTROL should not be applied in mixture with other pesticides or liquid fertilisers, however in limited overseas trials T34 BIOCONTROL was not damaged by mixing with products containing some active ingredients. (Note that these active ingredients may not be approved for use on the label crops or for the method of application approved in the UK at time of writing.)

Tank mixing acceptable in limited trials:

Fungicides:

fosetyl-aluminium, propamocarb (Proplant), metalaxyl-m (Subdue).

Do not tank mix with:

Fungicides:

benomyl, carbendazim, copper fungicides, prochloraz, tebuconazole, thiabendazole, thiophanate-methyl. *Leave an interval of 10 days before or after treatment see below.*

Insecticides

None were found to be damaging.

Fertilisers - compatible when diluted.

COMPATIBILITY WITHIN GROWING MEDIA :

Fungicides

Those products that are tank mixable will not cause a problem but leave an interval of 10 days before or after application of fungicides active on Ascomycetes or Basidiomycetes, e.g. prochloraz and thiophanate methyl.

Insecticides:

Data suggest no issues with compatibility, e.g. imidacloprid (e.g. Imidasect 5GR), thiacloprid.

Bioinsecticides:

Data show no issues with compatibility of *Metarhizium anisopliae* var. *anisopliae* strain F52 (Met52 Granular Bioinsecticide) and *Beauveria bassiana*.

Fertilisers

None were found to be damaging***

***Mixing dry T34 BIOCONTROL concentrate

with a fertiliser concentrate as an admixture technique for incorporating in to potting media is not recommended as trials have shown that T34 BIOCONTROL can be damaged by the fertiliser. Admixing with dry sand prior to incorporation in to the growing media has been shown to be safe to T34 BIOCONTROL.

Biocontrol agents:

Hypoaspis, *Atheta*, *Aphidoletes*, *Amblyseius cucumeris* and *A. andersoni* are all compatible

Microbial inoculants:

It is suggested that mycorrhizae are applied first and then the T34 BIOCONTROL after 2 to 4 weeks.

Wetting agents:

Not known to be damaging.

Nematodes:

Steinernema feltiae, *S. krausai* and *S. carpocapsae* are compatible.

OTHER COMMENTS:

Soil Sterilants:

Leave an interval of 7 to 10 days after the process is complete before treating with T34 BIOCONTROL.

SHELF LIFE AND STORAGE CONDITIONS

At the optimum storage conditions of 4°C the product will keep for two and a half years. Once opened the product can be stored for up to 6 months if the pack is re-sealed and kept at 4°C provided it is handled in a clean area.

T34 BIOCONTROL should be stored at 4°C. Do not freeze.

**** EAMUs / Extension of authorised use provides for the use of T34 BIOCONTROL in respect of crops and situations, other than those included on the product label. No efficacy or phytotoxicity data have been assessed and as such the 'extension of use' is at all times done at the user's choosing, and the commercial risk is entirely theirs.***

Before use of any pesticide under an extension of authorisation users must have a copy of the document which is available at www.pesticides.gov.uk. These documents are frequently revised and therefore it is important to check that the documentation is current and correct before any use.

**** MAPP number 17290**

Pack Sizes: 250g, 500g.

Further product information including warning phrases and symbols is included in the main product manual.

Approval holder:

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Spanish Patent ES 2 188 385 B, European Patent EP 1 400 586 B1, USA Patent US 7 553 657 B2.

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Safety data sheet available on request.

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