

Trichoderma-based Products and their Widespread Use in Agriculture

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Abstract: Governing bodies throughout the world, particularly in Europe, are now implementing legislative mandates with the objective of decreasing dependence on pesticides in agriculture to increase consumer and environmental safety. In order to reduce the risks associated with pesticide applications and reduce dependency on their use, Directives will promote low pesticide-input by implementing integrated pest management (IPM), and provide the means to establish the necessary conditions and measures to employ these practices, as well as to ensure security of commercial products. One approach includes the use of biological control agents and their products as alternatives to synthetic agro-chemicals. *Trichoderma* spp. are widely studied fungi and are among the most commonly used microbial biological control agents (MBCAs) in agriculture. They are presently marketed as bio-pesticides, biofertilizers, growth enhancers and stimulants of natural resistance. The efficacy of this fungus can be attributed to their ability to protect plants, enhance vegetative growth and contain pathogen populations under numerous agricultural conditions, as well as to act as soil amendments/inoculants for improvement of nutrient ability, decomposition and biodegradation. The living fungal spores (active substance) are incorporated in various formulations, both traditional and innovative, for applications as foliar sprays, pre-planting applications to seed or propagation material, post-pruning treatments, incorporation in the soil during seeding or transplant, watering by irrigation or applied as a root drench or dip. *Trichoderma*-based preparations are marketed worldwide and used for crop protection of various plant pathogens or increase the plant growth and productivity in diverse cultivated environments such as fields, greenhouses, nurseries; in the production of a variety of horticultural, fruits, trees and ornamental crops. A survey was conducted of *Trichoderma*-containing products found on the international market to obtain an overall perspective of the: 1) geographical distribution, 2) product composition and identity of *Trichoderma* species selected, 3) contents combined with *Trichoderma* in the products - other microbial species or substances in the mix, 4) number of products available globally and geographically, 5) number of products registered or having use specifications, 6) product formulations and applications, 7) manufacturer claims - target use, target pests, product type and effects of applications. The largest distribution of *Trichoderma* bioproducts is found in Asia, succeeded by Europe, South-Central America and North America. The majority of the labels indicated fungicidal properties, but only 38% of the marketed merchandise are registered. Ten *Trichoderma* species are specifically indicated, but many labels indicate a generic *Trichoderma* sp. or spp. mix in the list of ingredients. The most common formulation is a wettable powder, followed by granules. Generally, *Trichoderma* are applied to the seed or propagation material at the time of planting, then the secondary use is during plant development. On the whole, the target use is for the control of soilborne fungal pathogens such as *Rhizoctonia*, *Pythium* and *Sclerotinia*, and a few foliar pathogens such as *Botrytis* and *Alternaria*; whereas the minor use indication is for plant growth promotion. The use of *Trichoderma*-based biological products will have an important role in agricultural production of the future, in light of changing worldwide perspectives by consumers and governing bodies.

Keywords: Biological control, induced systemic resistance, integrated pest management, pesticides, plant growth promotion.

INTRODUCTION

The use of biological pesticides as an alternative to synthetic pesticides in agricultural production is rapidly increasing due to public concerns about human health, safety of agri-food products consumed and impact to the environment.

Conventional crop protection has been predominantly based on the use of chemical pesticides to control plant diseases and pests, a practice that can produce negative effects to the end user and the agro-ecosystem, including inhibition of pollinators, useful predators/parasitoid and beneficial microbial communities. In Europe alone, the consumption of synthetic agro-chemicals is estimated to be about 250 k tonnes, of which about 180 k tons per year are fungicides [1]. Governing bodies in many countries, particularly in Europe, are now implementing mandates that regulate procedures for

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pre-market assessment of safety, with the objective of decreasing dependence on pesticides in order to increase security for consumers and the natural resources.

European Directive 2009/128/EC established a framework “to achieve a sustainable use of pesticides” by reducing the risks and impacts on human health and the environment by promoting integrated pest management (IPM), including the use of biological control agents and their products as alternatives to chemicals. To this scope, the Directive summons the European Member States to promote low pesticide-input IPM practices, including establishment of necessary conditions and measures for implementation, in order to reduce the risks associated with pesticide applications, as well as lower dependency on their use.

EU legislation Directive 91/414 regulates the marketing and use of plant protection products (PPPs), whereas Regulation EC No. 396/2005 checks the setting, monitoring and control of pesticide residues in products of plant and animal origin (that may occur from their prior use in plant protection). Directive 91/414 aims to harmonize the registration of products throughout the EU based on use of a two-tiered system: first, rules and procedures are defined for approval of the active substances (active ingredients) at the EU-level; second, at the level of each individual Member State, the specific authorization of the particular PPP is released. This Directive states that an active substance must first be included in a “positive” EU list (Annex I), then the substance can be used in plant protection products and its application can be authorized by the Member States.

PPPs are generically defined “pesticides” and comprise insecticides, acaricides, herbicides, fungicides, plant growth regulators, rodenticides, biocides and veterinary medicines that affect crop pests and/or production (http://ec.europa.eu/food/plant/plant_protection_products/index_en.htm). Pesticides protect crops in pre- and post-harvest by eliminating, inhibiting or controlling pests; may have an effect on plant development, inhibit or kill competitive plants, or aid in the conservation of final products. Most importantly, a pesticide can be commercialized and used in the EU only if it has been scientifically proven that its use does not harm human health, has no undesirable effects on the environment and it is effective against the claimed target pests. Biopesticides are crop protection products that are derived from natural sources including naturally occurring chemicals, pheromones, bacteria, fungi and insect predators [2].

Annex I (‘Positive List’) is the list of “active substances authorized for use in crop protection products” in the EU and the products containing these substances can subsequently be registered by the relevant, individual Member State. Annex IIB is specific to microorganisms and lists the requirements for the active substance. Annex IIIB lists the requirements for the microbial pesticide product. The process for deciding whether an active substance can be included in Annex I to Directive 91/414 involves a peer review by all Member States, the European Food Safety Authority (EFSA) and the European Commission. It should be noted that for microorganisms, registration is specific to the strain/isolate, and the process for review does not differ substantially from

that used to evaluate chemical pesticides. Active substances approved by Regulation (EC) No 1107/2009 are constantly inserted in the EU Pesticides database, Directorate General for Health and Consumers and can be consulted at http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=active_substance_detail [3].

Microbial Biological Control Agents (MBCA) currently used in agriculture can be classified in two types based on the mechanisms of action used to directly kill or inhibit the causal agents of plant disease and interact with the plant. The group defined as the “generalists”, includes species of *Bacillus*, *Pseudomonas*, *Streptomyces*, *Trichoderma*, *Clonostachys*, yeasts, etc., that are capable of controlling a large spectrum of taxonomically diverse pathogen hosts by using a variety of mechanisms of action. The group of the “specialists” includes biocontrol species of *Agrobacterium*, *Ampelomyces*, *Coniothyrium*, non-pathogenic *Fusaria*, atoxigenic *Aspergillus*, etc. that can counteract only one or few targeted pathogens. The mechanisms of biological control include direct parasitism or mycoparasitism [4-8] from physical penetration, secretion of numerous lytic enzymes [4, 9-14], antibiosis [4, 15-19], competition for nutrients or ecological niches [13, 15, 16, 20]. The classification becomes complicated when consideration is made to the indirect positive effects that a MBCA can have on the plant. These include reduced susceptibility to pathogen attack in the instance of induce systemic acquired resistance (ISR) activated molecular effectors/elicitors (enzymes, proteins, secondary metabolites) [21-24], as well as improved resistance to abiotic stresses (drought, salinity, nutrients etc.) [18, 25, 26] produced by interactions with rhizobacteria or some fungal antagonists such as *Trichoderma* spp [27]. In reality, many successful microbial BCA use a combination of different modes of action to produce the appreciated beneficial effects on the plant [28, 29].

According to the Pesticide Action Network (PAN) Pesticide Database (<http://www.pesticideinfo.org/>) [30], a pesticide is grouped according to: Use Type (i.e. fungicide) and Chemical Class of the active substance/ingredient, whereby a microorganism is categorized as a “Microbial”. A MBCA can be classified as Chemical Use Type of “Fungicide” or “Plant Growth Regulator”. The registration includes the identification of the specific microbial antagonist/s (generalists or specialists), and the target plant pathogens that can be effectively controlled following criteria similar to those used to evaluate chemical pesticides, considering the direct biochemical mode of action of the PPP on the target pathogen. The involvement of indirect biological control mechanisms, such as ISR, may complicate the registration process since these intrinsic effects are not formally in the criteria used to assess a chemical pesticide. Therefore, a registered biofungicide will have fungicidal properties that are evaluated, but it may also have other beneficial assets such as ISR or plant growth promotion that have not been evaluated, although these characteristics may be indicated on the product label. The difficulty in meeting the criteria of the registration processes means that many potential microbial crop protection products do not pass through the pipeline even though they are considered to produce positive effects in the field.

Trichoderma spp. have been widely studied, are among the microorganisms most commonly used as biological control agents and are presently marketed as active ingredients of bio-pesticides, biofertilizers, growth enhancers and stimulants of natural resistance. This is due to their ability to protect plants, enhance vegetative growth and contain pathogen populations under numerous agricultural conditions, as well as to act as soil amendments/inoculants for improvement of nutrient ability, decomposition and biodegradation [31-41]. The commercial success of products containing these fungal BCAs can also be attributed to the large volume of viable propagules that can be produced rapidly and readily on numerous substrates at a low cost in diverse industrial fermentation systems [42-44]. The living microorganisms can be incorporated into various formulations as pure spores or conidia suspensions, in liquid culture filtrates, and can be integrated with various inert components and stored for months without losing efficacy ([41, 45], Lorito *et al.*, unpublished data). The formulations are applied as a foliar spray, pre-planting application to seed or propagation material, post-pruning treatment, incorporation in the soil during seeding or transplant, watered by irrigation or applied as a root dip or drench. The products are used in the greenhouse, nursery, field, orchards as well as in hydroponics. To date, *Trichoderma*-based preparations are commercialized worldwide and used for crop protection from various plant pathogens or to increase the plant growth and productivity in a variety of fields, greenhouses, nurseries, horticultural, fruits, trees and ornamental crops [18, 41, 46-50].

The "classical mechanism" of biological control for which *Trichoderma* was known for was its direct antagonism of phytopathogenic fungi by competition, antibiosis and direct attack with hydrolytic enzymes [39, 51-57]. In particular, some isolates of *Trichoderma* are well known biocontrol generalists, having the capacity to function against a broad spectrum of fungal pathogens including *Botrytis cinerea*, *Rhizoctonia solani*, *Sclerotinia sclerotiorum*, *Sclerotium* spp., *Pythium ultimum*, *Phytophthora* spp., *Armillaria* spp., *Fusarium oxysporum*, *Verticillium* spp. and *Gaeumannomyces graminis* [10, 46, 49, 50, 58-62]. The species most commonly used in biocontrol include *T. harzianum*, *T. atroviride*, *T. asperellum*, *T. polysporum*, *T. viride*, as well as a few species that belong to the related genus of *Gliocladium* [63]. The antagonistic potential serves as the basis for effective biological control applications of different *Trichoderma* strains as biofungicides against soil, foliar and vascular pathogens, as an alternative to chemical pesticides for treatment against a wide spectrum of plant pathogens, as well as to increase resistance to abiotic stresses [18, 64, 65].

It has been presumed that the effects of *Trichoderma* to the plant were limited to the control of disease causing phytopathogens. Its persistence in the soil, in particular on the rhizosphere, eventually associated as endophytic, would guarantee long-term advantages. However, more and more evidence has been accumulated that demonstrates that these benefits and effects from *Trichoderma* applications are much more extensive. *Trichoderma* is capable of systemically activating plant defence mechanisms including priming, that

anticipate pathogen attack [5, 57, 64, 66-69]. The reaction of the plant to the BCA is similar to the ISR elicited by rhizobacteria [70-76]. In fact, the ISR mechanism activated by *Trichoderma* is now considered to play a very significant role in crop protection as compared to the direct antagonism of the plant pathogens. The phenomenon has been widely observed in a diversity of monocotyledonous and dicotyledonous crops, including graminaceae, solanaceae and cucurbitaceae that have been attacked by pathogens including a variety of fungi (*R. solani*, *B. cinerea*, *Colletotrichum* spp., *Magnaporthe grisea*, *Phytophthora* spp., *Alternaria* spp. etc.), bacteria (*Xanthomonas* spp., *Pseudomonas syringae*, etc.) as well as viruses (cucumber mosaic virus), although the ISR effect seems to be strongly dependent on the strain of the antagonist and species/cultivar of the plant [21].

Another positive effect to the plant from *Trichoderma* applications has been the improvement of plant growth, development, and yield. In particular this result has been noted in terms of root growth promotion, although significant increases have also been observed in above-ground vegetative growth such as stem length and thickness, leaf area, chlorophyll content and yield (size and/or number of flowers and/or fruits) [5, 13, 21, 27, 77]. Numerous hypothesis have been proposed to explain this observation including the improvement of chemical solubilisation, sequester, availability (i.e. siderophores production) [65, 78, 79] and nutrient uptake by the plant [80], as well as the involvement of growth phytohormones from both plant and fungal origin [28, 81]. Not only do these processes improve plant growth, but they also stimulate plant respiration, thus enhancing photosynthesis or photosynthetic efficiency [64], as well as increasing the ability of the plant to withstand abiotic stresses such as drought, salinity, high temperature.

Much more recently, it has been demonstrated that the beneficial effects to the plant can be attributed to the capacity of many *Trichoderma* spp. to produce specific compounds, derived from secondary metabolism [82] that are antimicrobial, thus contribute to phytopathogen control, and/or positively affect the plant in aspects of growth promotion, increased yield and other desirable characters i.e. augmented anti-oxidant properties [78, 83]. It has also been demonstrated that *Trichoderma* during its interaction with plants can also play a crucial role in stimulating the production of plant volatiles that influence plant-insect interaction [84]. Major advantages to using *Trichoderma* derived bioactive compounds i.e. enzymes and other proteins, or secondary metabolites are: i) the removal of constraints associated with development, application and conservation of products containing living microbes; ii) the efficacy in the field is maintained and more precisely dependent on the dose of the active substance used; iii) some applications are more effective, such as foliar spray for the control of aerial pathogens; iv) the direct effect on the plant may be improved and be more reproducible; v) a reduced sensibility to changing environmental conditions; and vi) the possibility of developing highly active synergistic mixtures containing both the bioactive substances and the living MBCA [57, 85].

Furthermore, strains of *Trichoderma* may also be aggressive biodegraders of compost and act as competitors of fungal pathogens in their saprophytic phases, especially when nutrients are a limiting factor. They are also recognized for their potential in bio- and phytobio-remediation of toxic compounds by degrading pollutants particularly in the soil environment [86-88]. The versatility of *Trichoderma* spp. extends to their adaptability to different ecological surroundings or agricultural situations, as well as to their compatibility with numerous commonly used crop protection products and other biocontrol agents, but also to synergism with many chemical pesticides and other natural compounds, thus permitting a reduction in the pesticide doses normally used in the field [89-91]. All of these characteristics enlarge the scope of potential applications of *Trichoderma* based products in the agricultural market not only as a biofungicide against phytopathogens, but also as a general bio-inoculant that stimulates plant resistance to biotic and/or abiotic stresses, enhances plant growth and yield, plus improves the agro-ecosystem. Moreover, the prospective use of *Trichoderma*-based bio-compounds is not limited only to agriculture, but can also be extended to applications in other areas of the earth and life sciences such as environmental ecology [92], medicine [93] or dentistry [94, 95] where detoxification and anti-microbial activity may be required.

A general survey on internet indicates that the number of *Trichoderma*-containing products found on the international market has been growing exponentially in the past 5 years with more than 250 available products (Table 1, Appendix I). A large distribution of *Trichoderma* biological formulations can be found in all geographical regions worldwide: Africa (6 countries), Asia (8 countries), Europe (14 countries belonging to the European Union, 3 countries associated), North America (2 countries), Pacific (2 countries) and South-Central America (14 countries). The numbers indicated are not absolute because counts are based on the presence of a *Trichoderma*-based product in each different zone, but the same product may be available in more than one zone. By far, the country with the greatest distribution of *Trichoderma* biological goods is India, which comprises about 90% of the Asian market, although only one species appears to be registered for use as a microbial fungicide. Another geographical zone that is developing rapidly in terms of executive use of commercial products based on *Trichoderma* for plant diseases is South and Central America, in particular, with the greatest distribution possibility found in Brazil.

Based on the PAN Pesticide Database [30] that surveyed 219 countries worldwide across four continents, only 32 countries (or Unions) had pesticide registration data available from diverse national pesticide evaluation agencies. As of 2010, there were 21 different *Trichoderma* spp. isolates and their corresponding commercialized crop protection products registered internationally, as well as two *Gliocladium* spp. and their products (Table 2a). All products are classified as microbial fungicides. No *Trichoderma* spp. appear to be registered as plant growth regulators. Although eight species of *Trichoderma* have been certified: *T. asperellum*, *atroviride*, *gamsii*, *hamatum*, *harzianum*,

polysporum, *virens* and *viride*, not all are yet available on the commercial market as “finished” fungicide products. The countries where *Trichoderma* has been registered for use include: countries of the European Union (Belgium, Cyprus, France, Italy, the Netherlands, Spain, Sweden, Slovenia and the United Kingdom according to [2], Turkey, two in North America (USA, Canada), Africa (South Africa, Morocco), two in Asia (India, Vietnam) and two in Oceania (Australia, New Zealand). The species of *Gliocladium* comprised *G. catenulatum*, and *G. virens*, and are registered in the countries of USA, Canada, and the European Union (Belgium, Denmark, Estonia, Finland, Sweden and the United Kingdom). By 2013, 12 of these antagonistic fungi have been further approved for inclusion in Annex I as authorized active substances (EU Pesticides Database, http://ec.europa.eu/food/plant/pesticides/pesticides_database/index_en.htm). The number of products indicated in Table 2a refers to those that are registered somewhere in the world, but not necessarily in all indicated zones. It should also be noted that in many cases the available biological products (Appendix I) are noted as being approved for use in organic farming, however, this is not by any means equivalent to, or to be confused with products that have obtained full registration and approval, which signifies that the formulation has passed through the stringent evaluation process applied by given official agencies, normally government, and assessed as safe for use.

The proof that there is extensive interest in the production and commercialization of *Trichoderma* and *Gliocladium* products can be found in publications that have reviewed the international market of biological products since 2010 [96], from which the data in Table 2a was based EU Commission Pesticide Database 13/11/2012 (http://ec.europa.eu/sanco_pesticides/public/index). In general, about 38 *Trichoderma* (comprised of single species and combination mixtures) and one *Gliocladium* commercial products have been indicated as being registered or in the process of being registered, in diverse countries by the European Commission and by other agencies throughout the world, plus four products have received special registration or temporary approval only for use in field experiments. All of these products have been incorporated in Table 2b, have putative registered products, but lack official data that supports the sources of information or authorization [96, 97]. Continuing with the trend noted so far in the use of the different *Trichoderma* spp., approximately 50% of these latest products contain *T. harzianum*.

The greater part of the *Trichoderma* commercialized products are comprised, according to the label, of a single species (67%), whereas the remainder include combinations of known and/or unidentified species, isolates, or a mix of *Trichoderma* with other beneficial microbes such as mycorrhize (mainly *Glomus*), bacteria (*Bacillus subtilis*, *Pseudomonas fluorescens* etc.) or other biological compounds (Table 3). Once again, the numbers indicated are not absolute because counts are based on the individual species, but the same species can also be found in mixtures. The species of *Trichoderma* indicated on the labels, as being present in the commercial product include: *T. asperellum*, *T. atroviride*, *T. gamsii*, *T. hamatum*, *T. harzianum*, *T. koningii*,

Table 1. Distribution of *Trichoderma*-containing crop protection products on the worldwide market. The number of countries and the approximate number of products commercially marketed in the region, including those that are registered (anywhere in the world) are indicated. Label description (product claims) for single characteristics: FUNGicide (FUNG), plant growth STIMulator-enhancer (STIM), FERTilizer or improved NUTRient uptake (FERT/NUTR), DEComposer (DEC), Induced Systemic Resistance (ISR), OTHER – NEMatocide, INSEcticide; and combined characteristics. Product formulations: Wettable Powder (WP), Granules (Gran), Liquid (Liq), Solid substrate (Solid), Pellets (Pell), Other formulations: Concentrated Suspension (SC), Emulsion (Emuls), Dry flowable (Flow), Not Indicated (Not Indic). Note: the numbers do not necessarily sum to the number of products indicated since some are available in more than one formulation, or the type use-formulation is not indicated.

Region	Countries	Number Comm. Products	Number Products Register.	Label Description (Single Characteristics and Combinations)									Product Formulation							
				FUNG (F)	STIM (ST)	FERT/NUTR (FERT)	ISR	OTHER	F+ST	F+ST +FERT +ISR	F+ST+ FERT	Other Combos	WP	Gran	Liq	Solid	Pell	Other		
Africa	5 (South Africa, Kenya, Zambia, Morocco, Tunisia)	9	9	7	1					1					4					SC-1 (Conc. Susp.)
Asia	8 (China, India (91%), Indonesia, Japan, Korea, Russia, Vietnam, Philippines)	100	8	79	2	2		F+NEM=2; F+INS=1	7	1	2; +DEC=2	2	51	0	12	6, Rice 1	0		Emuls-1; Not Indic-38	
Europe	17 (BE, CZ, DK, EE, ES, FI, FR, HU, IE, IT, NL, SE, SI, UK) Moldavia, Ukraine, Israel	57	21	24	2				14	3	2	3	27 (Bees 1)	13	5	4 (Peat 1, Coco 2)	1		Powder-2	
North America	2 (USA, Canada)	29	19	16	4					3	3	3	19 (Bees 1)	15	5	3	1		Flow-1	
Pacific	2 (Australia, New Zealand)	22	10	8	1	4; +DEC=2				2; +ISR=3	2		13	3		1 Dowels	1		Flakes-2	
South-Central America	14 (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Honduras, Mexico, Panama, Peru, Uruguay, Venezuela)	40	22	32			1	NEM=1		1; +ISR=1; +ISR+NE M =1		1	24	3	6	3 (Rice 1)	1		Emuls-1; Not Indic-7	

Table 1. contd...

Region	Countries	Number Comm. Products	Number Products Register.	Label Description (Single Characteristics and Combinations)									Product Formulation					
Multiple Regions	ca. 17	16	15	11					1	2	2		13	3			1	
	TOTAL	273	104	177	9	8	1	5	31	11	12	2	151	37	28	17	5	13
	PERCENTAGE		38.1	64.8	3.3	2.9	0.4		11.4	4.0	4.4		55.3	13.6	10.3	6.2	1.8	

Table 2a. *Trichoderma* and *Gliocladium* spp. officially registered as microbial fungicide, crop protection products, in different countries throughout the world as indicated by the Pesticide Action Network, PAN Pesticide Database (Kegley, S.E., Hill, B.R., Orme S., Choi A.H., Pesticide Action Network, North America (San Francisco, CA, USA, 2010), <http://www.pesticideinfo.org>; EU Pesticides Database of Active Substances, Regulation (EC) No 1107/2009 (http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.detail); BPDB - Bio-Pesticides Database, the University of Hertfordshire (2011) <http://sitem.herts.ac.uk/aeru/bpdb/index.htm>

Chemical Name - <i>Trichoderma</i> / <i>Gliocladium</i> spp.	Species Strain; Synonyms; Related Chemicals ¹	Commercial USA Product Name (Manufacturer/Distributor)	Country where Registered for Use ²
<i>Trichoderma polysporum</i> ATCC 20475, <i>Trichoderma harzianum</i> ATCC 20476 and/or <i>Scytalidium</i> spp. ATCC 16675	(parent strain <i>T. harzianum</i> Rifai strain T-39)	No commercial products	Australia, New Zealand, South Africa, Vietnam
<i>T. asperellum</i>	<i>T. asperellum</i> strain T34 (parent strain)	T34 Biocontrol (Biocontrol Technologies S.L., Fargo Ltd.)	European Union (Annex I, approved 01/06/2013-31/05/2023; UK)
<i>T. asperellum</i>	<i>T. asperellum</i> strain ICC 012 (parent strain); formerly <i>T. harzianum</i>	Remedier WP	European Union (Annex I, approved 01/05/2009-30/04/2019; ES, FR, IT, SI), USA regist; available Mor, Slov, Turk
<i>T. asperellum</i>	<i>T. asperellum</i> strain TV1 (parent strain); formerly <i>T. viride</i> strain TV1	VIRISAN (Isagro USA)	European Union (Annex I, approved 01/05/2009-30/04/2019; ES, FR, IT, SI)
<i>T. asperellum</i>	<i>T. asperellum</i> strain T25, <i>T. asperellum</i> strain T11, formerly <i>T. viride</i> strain T25	TUSAL (Isagro USA)	European Union (Annex I, approved 01/05/2009-30/04/2019; ES, FR, IT, SI)
<i>T. atroviride</i>	<i>T. atroviride</i> LC52	Trichopel, Trichodry, Trichospray, Vinevax Biodowel/Pruning, Sentinel*, Tenet* (Agrimm Technologies Ltd.)	New Zealand
<i>T. atroviride</i>	<i>T. atroviride</i> I-1237	Esquive WP (Agrauxine)	Europe Union (Annex I, approved 01/06/2013-31/05/2023; FR), Australia, New Zealand, South Africa, Vietnam
<i>T. atroviride</i>	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040)	BINAB TF WP in combination with <i>T. polysporum</i> IMI 206039, Binab T Vector* (BINAB Bio-Innovation AB);	European Union (Annex I, approved 01/05/2009-30/04/2019; IT, SE)
<i>T. atroviride</i>	<i>T. atroviride</i> T-11 (formerly <i>T. harzianum</i> T-11)	No commercial products, strain of Newbiotechnic S.A.	European Union (Annex I, approved 01/05/2009-30/04/2019; IT, SE)
<i>T. gamsii</i>	<i>T. gamsii</i> ICC080; formerly <i>T. viride</i> strain ICC080	Remedier WP (Isagro USA)	USA, European Union (Annex I, approved 01/05/2009-30/04/2019; ES, SI)
<i>T. hamatum</i>	<i>T. hamatum</i>	No commercial products	New Zealand

Table 2a. contd...

Chemical Name - <i>Trichoderma</i> / <i>Gliocladium</i> spp.	Species Strain; Synonyms; Related Chemicals ¹	Commercial USA Product Name (Manufacturer/Distributor)	Country where Registered for Use ²
<i>T. hamatum</i>	<i>T. hamatum</i> TH382 (ATCC 20765)	Floragard (Sellew Associates, LLC)	USA
<i>T. harzianum</i>	<i>T. harzianum</i> DB 103	T-Gro (Dagutat Biolab)	USA, South Africa
<i>T. harzianum</i>	<i>T. harzianum</i> , ATCC 20476	Binab T wettable powder biorational fungicide (Binab Bio-innovation efr ab)	USA (cancelled)
<i>T. harzianum</i>	<i>T. harzianum</i> Rifai Strain T-22 (ATCC # 20847), <i>T. harzianum</i> Rifai strain KRL-AG2	Rootshield WP biological fungicide, T-22 technical, T-22 wp biological fungicide (Bio-trek nursery drench, Garden solutions biofungicide for soilborne diseases, Root guardian biofungicide for soilborne diseases, Bio-trek hb) (Bioworks inc, Wilbur Ellis Co., Gardens alive!inc), T-22g biological plant protectant granules (T-22g biological plant protectant granules) - (Bioworks inc)	USA; Australia, Canada, European Union (Annex I, approved 01/05/2009-30/04/2019; BE, ES, FR, NL, SE), New Zealand, South Africa
<i>T. harzianum</i>	<i>T. harzianum</i> Rifai strain T-22 (<i>T. harzianum</i> Item 908)	TRIANUM-P and TRIANUM-G (Koppert B.V.)	European Union (Annex I, approved 01/05/2009-30/04/2019; BE, ES, FR, NL, SE), New Zealand
<i>T. harzianum</i> Rifai	<i>T. harzianum</i> Rifai strain T-39, 67892313 (CAS); Parent strain	Trichodex (Cancelled USA; Makhteshim chemical works Ltd)	Australia, New Zealand, South Africa, Vietnam
<i>T. polysporum</i>	<i>T. polysporum</i> IMI 206039	BINAB TF WP in combination with <i>T. atroviride</i> IMI 206040 (BINAB Bio-Innovation AB)	European Union (Annex I, approved 01/05/2009-30/04/2019; SE)
<i>T. polysporum</i>	<i>T. polysporum</i> Rifai ATTC 20475 (T-75)	Binab t wettable powder biorational fungicide in combination with <i>T. viride</i> ATCC 20476 (USA Active), Binab T Vector*, Binab t pellets biorational fungicide - cancelled USA - (Binab Bio-innovation efr ab)	USA, New Zealand, United Kingdom
<i>T. virens</i>	<i>T. virens</i> strain G-41	G-41 Technical, BW240 G, BW240 WP Biological Fungicide (Bioworks inc)	USA, Canada, Vietnam
<i>T. viride</i>	<i>T. viride</i> sensu Bisby, <i>T. viride</i> ATCC 20476 (EPA 119201, CAS 67892-34-6, <i>T. viridae</i>	Binab T Wettable Powder Biorational Fungicide in combination with <i>T. polysporum</i> ATTC 20475 (Binab Bio-innovation efr ab)	USA, Cyprus, India
<i>T. viride</i>	<i>T. viride</i> , <i>T. viride</i> sensu Bisby with <i>T. polysporum</i> Rifai	No commercial products	New Zealand
<i>Gliocladium catenulatum</i>	<i>G. catenulatum</i> strain J1446 (parent strain)	Primastop biofungicide, Prestop Mix (Verdera oy)	USA, Canada, European Union (Annex I, approved 01/04/2005-31/07/2017; BE, DK, EE, FI, FR, IE, SE, UK)
<i>Gliocladium virens</i>	<i>G. virens</i> GL-21 (related)	SoilGard 12G (Certis USA, LLC)	USA
<i>Gliocladium</i> spp.	<i>Gliocladium</i> spp.	GlioMix* (Verdera oy)	USA, European Union (FI, DE)

¹Probable registration (source not confirmed) – registration was noted in 2010 on the same species/isolate, by the same company, in other products

²Many compounds are chemically similar to each other; however, typically only one of a group has been evaluated for its toxicological properties and this compound is assigned as the "parent." Chemicals that are chemically similar ("related" chemicals) will have similar toxicological effects and/or similar chemical reactivity. All chemicals in a group are related to the parent in one or more ways. Where no toxicity information was available for any member of a group, parent status was assigned to the least derivatized member of the group, for example, in the case of *Trichoderma*, unless indicated, the parent strain is *T. harzianum* strain T-39.

²Sources of PAN registration data for countries having microbial chemical products containing Trichoderma

Australia the Australian Pesticides and Veterinary Medicines Authority APVMA (<http://www.apvma.gov.au>) (Record of Approved Active Constituents for Chemical Products, National Registration Authority for Agricultural and Veterinary Chemicals (NRA), December 18, 2009, http://www.apvma.gov.au/actives/subpage_actives.shtml. PAN last checked the currency of this data set on January 31, 2010).

Canada (the Pest Management Regulatory Agencies (PMRA; www.hc-sc.gc.ca) Registered Pesticides, Pest Management Regulatory Agency (PMRA), 2009, http://pr-rp.pmr-arla.gc.ca/portal/page?_pageid=34,6928,34_6956&_dad=portal&_schema=PORTAL&letter=A. PAN last checked the currency of this data set on January 31, 2010).

Table 2a. contd...

European Union European Food Safety Authority (EFSA; <http://www.efsa.europa.eu>) (Status of active substances under EU review , European Commission Services, November 10, 2008, http://ec.europa.eu/food/plant/protection/evaluation/index_en.htm. PAN last checked the currency of this data set on December 4, 2008), EU Pesticides Database of Active Substances, Regulation (EC) No 1107/2009 (http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.detail).

New Zealand (Agricultural Compounds and Veterinary Medicines (ACVM) Database on Currently Registered Pesticides, Food and Safety Authority, February 3, 2010, <http://www.nzfsa.govt.nz/acvm/register-lists/>. PAN last checked the currency of this data set on January 31, 2010).

South Africa (Agricultural remedies, National Department of Agriculture, December 2007, <http://www.nda.agric.za/act36/main.htm>. PAN last checked the currency of this data set on January 31, 2010).

United Kingdom (Annex I, Health and Safety Executive, 2005, <http://www.pesticides.gov.uk/publications.asp?id=44>. PAN last checked the currency of this data set on February 3, 2010).

USA Environmental Protection Agency (EPA; <http://www2.epa.gov>) - Pesticide Action Network North America (PANNA) compiled List of US Registered Active Ingredients from Pesticide Product Information System, and California Registered active ingredients, California Department of Pesticide Regulation. A chemical is listed as 'Registered' because there are U.S. registered products that contain this chemical or it is specifically registered for use in California.

Vietnam (List of Pesticides Permitted, Restricted and Banned to Use in Vietnam Ministry of Agriculture and Rural Development, March 28, 2007, <http://www.spsvietnam.gov.vn/EnglishSPS/Pages/List%20of%20Pesticides.aspx>. PAN last checked the currency of this data set on January 31, 2010)

Table 2b. Crop protection products containing *Trichoderma* spp. or *Gliocladium* spp. indicated as being registered more recently than the information summarized in Table 2a (ca. 2010), in different countries worldwide. Data has not been verified by authorized sources of official registration agencies¹.

Chemical Name - <i>Trichoderma</i> / <i>Gliocladium</i> spp.	Species Strain; Synonyms; Related Chemicals	Commercial Product Name (Manufacturer/Distributor)	Country Indicated for Registration
<i>T. asperellum</i>	<i>T. asperellum</i>	Ecohope, Ecohope-Dry (Kumiai Chemical Industry Co. Ltd.)	Japan
	<i>T. asperellum</i>	Quality WG (Laboratório de Biocontrole Farroupilha Ltda.)	Brazil
	<i>T. asperellum</i>	Trichodermax EC (TURFAL - Industria e comércio de produtos biológicos e agrônômicos Ltda.)	Brazil
	<i>T. asperellum</i>	Trichotech (Dudutech K Ltd)	Kenya
<i>T. harzianum</i>	<i>T. harzianum</i>	Antagon WP (Bio Ecológico Ltda.)	Colombia
	<i>T. harzianum</i>	Trichobiol WP (Control Biológico Integrado ; Mora Jaramillo Arturo Orlando – Biocontrol)	Colombia
	<i>T. harzianum</i>	Unite WP (Agrimm Technologies Limited)	Australia, New Zealand
	<i>T. harzianum</i> DSM 14944	Agroguard WG, Foliguard (Live Systems Technology S.A)	Colombia
	<i>T. harzianum</i> isolate DB 104	Romulus (DAGUTAT BIOLAB)	South Africa
	<i>T. harzianum</i> strain 21	Rootgard (Juanco SPS Ltd.)	Kenya
	<i>T. harzianum</i> strain kd	Eco-T (Plant Health Products (Pty)Ltd.)	South Africa, Kenya and Zambia; in process FR, UK, Morocco, Tunisia and India
	<i>T. harzianum</i> strain SF	Bio-Tricho (Agro-Organics)	South Africa
	<i>T. harzianum</i> strains ESALQ-1306, ESALQ-1303	Trichodermil (Itaforte BioProdutos)	Brazil
	<i>T. harzianum</i>	Supresivit (Fytovita, Ltd.)	Czech Republic
	<i>T. harzianum</i> IHR-TH-2	Ecosom-TH (Agri Life)	India
	<i>T. harzianum</i> strain B77	Eco-77 (Plant Health Products)	South Africa; Kenya, Zambia
	<i>T. harzianum</i> T-22 (ATCC 20847)	Tricho D WP (Orius Biotecnologia)	Colombia, Equador, Panama, Peru, Chile
	<i>T. harzianum</i> , <i>Glomus intraradices</i> and <i>Pseudomonas</i>	Micover Gold e Plus (Agrifutur)	European Union
<i>T. harzianum</i> , <i>T. koningii</i>	<i>T. harzianum</i> , <i>T. koningii</i>	Promot WP (Biofa AG, Bio-farming systems)	R in Germany; Kenya (temp. 2010)

Table 3. contd...

Region	Countries	Number Comm. Products	Products Containing Trichoderma		Trichoderma Species Used in Product:											Gliocladium		In Combination with					
			Singl e sp.	Mix spp., cmpds	asp	atr v	gam	ham	harz	kon	lign	parc	polys	virns	virid	Spp. Mix	Gvirn	Gli spp.	Myco	Bact	Other		
Asia	8 (China, India (91%), Indonesia, Japan, Korea, Russia, Vietnam, Philippines)	100	77	23	1	1			28								69	8			1	6	neem, Paecilomyces
Europe	17 (BE, CZ, DK, EE, ES, FI, FR, HU, IE, IT, NL, SE, SI, UK) Moldavia, Ukraine, Israel	41	24	18	6	7	3		18	1	1						4	5			6 Glomus spp.	2	Fermentation products – spores, mycelia, metabolites; amino acids
North America	2 (USA, Canada)	29	16	13	4	6	4	1	12		1			3	1	2	3	1	1	2	2		
Pacific	2 (Australia, New Zealand)	22	19	5	1	9		1	7	2	4			3		1	3			1			
South-Central America	14 (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Honduras, Mexico, Panama, Peru, Uruguay, Venezuela)	40	19	21 (11 spp)	3	2			19	2	2	1	3	2	1	12					1		Fermentation products – spores, mycelia, metabolites
Multipl eregion s	ca. 17	16	10	6	2	4			8	1			1		2				1		1		
	Total	257	172	67	18	29	7	2	99	7	8	1	11	3	79	39	1	2	4	12			

Mycorrhize - *Glomus aggregatum*, *G. brasilianum*, *G. clarum*, *G. etunicatum*, *G. intraradices*, *G. mosseae*, *G. monosporum*, *Glomus* spp., and *Gigaspora margarita*, *Pisolithus tinctorius*, *Rhizopogon luteolus*, *R. fulvigleba*, *R. villosullus*, *R. amylopogon*, *Scleroderma citrinum* and *S. cepa*
 Bacteria - *Azobacter chroococcum*, *Bacillus subtilis*, *B. licheniformis*, *B. azotofomans*, *B. megaterium*, *B. coagulans*, *B. pumilis*, *B. thuringiensis*, *Bradyrhizobium japonicum*, *Paeni Bacillus durum*, *P. polymyxa*, *Pseudomonas aureofacens*, *Ps. fluorescens*, *Saccharomyces cerevisiae*, *Streptomyces griseus* and *S. lydicus*;
 Other. – chitosan, neem; Fermentation products-spores, mycelia and metabolites; amino acids; *Paecilomyces lilacinus*

T. lignorum, *T. parceanamosum*, *T. polysporum*, *T. virens*, *T. viride* and *Trichoderma* spp. There are also products that contain *G. virens* and *Gliocladium* spp. mixtures. Probably, the taxonomic identity of the species needs to be verified in the advent of various molecular methods and information

available for classification [31, 98, 99] The species that is used most frequently in the biological products and marketed worldwide is *T. harzianum*. This widespread distribution can also be attributed for instance to the great success and commercialization of a few given species-isolates that are

found in exclusive products circulated on the international market. *T. viride* is a species that is largely used as a BCA in Asia, in particular in India where it is found in almost 70% of the available products.

The majority of biological products with different combinations of *Trichoderma* includes the species *T. harzianum* (83%), of which 55% of these are combined with *T. viride* and 28% are with *T. koningii* (Table 4). One company uses a mix of *T. asperellum* and *T. gamsii* in five diverse products. Thirty-three formulations contain a mix of *Trichoderma* species, but the taxonomic identity is not indicated. Other microorganisms used in product mixtures are endomycorrhizas such as *Glomus aggregatum*, *G. brazillanum*, *G. clarum*, *G. etunicatum*, *G. intraradices*, *G. mosseae*, *G. monosporum*, *Glomus spp.*, and *Gigaspora margarita*; and ectomycorrhize such as *Pisolithus tinctorius*, *Rhizopogon luteolus*, *R. fulvigleba*, *R. villosullus*, *R. amylopogon*, *Scleroderma citrinum* and *S. cepa*; beneficial bacteria, yeasts, streptomycetes consisting of *Azobacter chroococcum*, *Bacillus subtilis*, *B. licheniformis*, *B. azotoformans*, *B. megaterium*, *B. coagulans*, *B. pumilis*, *B. thuringiensis*, *Bradyrhizobium japonicum*, *PaeniBacillus durum*, *P. polymyxa*, *Pseudomonas aureofaciens*, *Ps. fluorescens*, *Saccharomyces cervisiae*, *Streptomyces griseus*, *S. lydicus* and a *Paecilomyces lilacinus*. A single product claims to contain 15 different species of mycorrhizal fungi, 11 different species of beneficial bacteria and 2 species of *Trichoderma* all in one. Compounds added for improved crop protection properties or enhanced biological activity of the formulation include chitosan, neem and amino acids. Furthermore, two liquid products contain *Trichoderma* spores, mycelia and culture fermentation broth that includes a mix of enzymes and metabolites.

Trichoderma products are promoted as biopesticides, biofungicides, bioprotectants, bio-inoculants, bio-stimulants, bio-decomposers, bio-fertilizers, plant growth promoters etc. In general, in agriculture worldwide, there is an enormous disparity between the actual number of BCAs in use and the number of BCAs that are registered. In fact, the main reason that BCAs are less used in Europe than in many other parts of the world is because the registration process is long and costly, even when the active principle is generally regarded as being safe [100]. In 2010, only 14 microbial species were listed in Annex I (according to 91/414/EEC), of which 5 were species of *Trichoderma* and one of *Gliocladium*. It is not surprising to note that the largest commercial distribution of biologicals occurs in countries where there are simplified registration procedures. However, to be admitted for commercialization, it is important that bio-pesticides are evaluated by appointed agencies that can estimate the risk assessment to human health and the environment to an appropriate extent

The majority of *Trichoderma*-containing products on the market make claims to be fungicidal (64.8%, Table 1), to be used mainly for the biological control of root diseases for preventative and/or curative control of soilborne pathogens such as *Rhizoctonia*, *Pythium*, *Fusarium*, *Verticillium*, *Sclerotinia*, *Phytophthora* etc. (Appendix I). Additionally, the fungicidal characteristics are used for the control of foliar

diseases, protection of pruning wounds, wood and root decay caused by *Botrytis*, *Chondrostereum*, *Heterobasidion*, *Armillaria*, *Eutypa* etc. Many of these crop protection products are approved for use in organic farming in diverse countries. Other label claims include the use of *Trichoderma* as: a biostimulant or bioactivator (3.3%) for improved seed germination or transplant establishment, an agent for plant and root growth promotion or enhancement and improved yield; a biofertilizer or soil amendment-integrator (2.9%) that increases solubilization, uptake and assimilation of nutrients by the plant; an activator of plant defence mechanisms with induced systemic resistance (ISR, 0.4%) to biotic and abiotic stresses. Some products with *Trichoderma* also claim to be efficient in the control of nematodes and insects, but this may be due to combinations with other fungal species that are also antagonistic to these pathogens in some cases. *Trichoderma* BCA's are applied in the field, nursery, greenhouse, turfgrass (golf courses) and home gardens; on a plethora of crops: cereals, legumes, oilseeds, sugarcane, forages, horticulture, ornamental, spices, fruit orchards, ornamental trees, vineyards, interior plants. Furthermore, *Trichoderma* is indicated as a decomposer and humus/organic matter builder. The product claims are also multiple, consisting in various combinations of the above characteristics, i.e. fungicide and growth stimulator (11.4%), fungicide, growth stimulator, fertilizer and ISR (4.0%), fungicide, growth stimulator and fertilizer (4.4%).

Most *Trichoderma* formulations are commercialized as wettable powders (WP, 55.3%) that comprises of a given concentration of dried fungal conidia spores in a fine dust to be mixed with water (Table 1, Appendix I). One powder preparation is particular because the product is intended for delivery to flowers by using bees. The next commonly used formulations are granular (13.6%), liquid (10.3%), and solids (6.2%) that include substrates such as a coco mat or peat moss, cereal grains such as rice, or broken corn that support the growth of a *Trichoderma* culture until sporulation. A unique system uses dowels impregnated with *Trichoderma* for insertion into holes drilled into the tree or grapevine trunk, providing systemic protection in response to plant stress for 4-5 yrs. Other products consist of emulsions, concentrated liquid suspensions, dry flowable, pellets, powder or talc. The WP, granules, emulsions, suspensions of *Trichoderma* are added to water and mixed for applications such as spray (ground and aerial), root drench, dip, seed treatment, irrigation, hydroponics; whereas the pellets, dry flowables and solid formulations are ready-to-use, and directly applied, for example to the soil by incorporation at time of seeding or transplant.

It should also be noted that in many instances the use of *Trichoderma* in agricultural production is not limited to those products found on the commercial market, but are a result of in-house or on-the-farm production use, with localized distribution [45]. Fungal spores can be produced in solid state fermentation on sterile rice, corn or other grains, and then the biopesticide can be applied directly to the crops or soil by using the *Trichoderma*-colonized substrate or the spores can be separated from the seed support by sifting and re-suspending in water. Another technique involves the production of *Trichoderma* in liquid fermentation, whereby a

Table 4. Commercial biological products found on the worldwide market that contain combinations of different *Trichoderma* species, other microbial beneficials and/or other compounds, including product name and manufacturer¹.

Trichoderma Species											Myc	Bact	Other	Product Name (Company)
asp	atrv	gam	harz	kon	lign	parc	poly	virn	virid	spp.				
X		X												Bioten, Radix, Remedier WP, Bio Tam, Tenet (Isagro Spa)
X							X							Binab T P (in development; Binab bio-innovation efr ab)
	X										<i>Glomus</i> spp.	X		Condor, TIFI (Italpollina)
			X										2 isolates	Root-Pro (Agriance)
			X									<i>Bacillus, Streptomyces</i> sp.		Compete Plus (Plant Health Care)
			X									<i>Bacillus subtilis</i>		Multiplex Annapurna – Manure Chirayu (Multiplex Bio-Tech Pvt Ltd)
			X										chitosan	Biorend T (pela Bioagro S.A.; Biotex S.A.)
			X				X							Binab t wetttable powder biorational fungicide (Binab bio-innovation efr ab)
			X					X						Bio Fit, Bio Traz (Biomycota)
			X										neem	Tricone V (Neuscire Biolab)
			X						X					TUSAL WG (NewBiotechnic, Certis Europe), POABS GREEN Soil guard (Poabs Biotech)
			X								<i>Glomus</i> sp.	<i>Bradyrhizobium japonicum</i>		Bionitrongen G (Agrifutur)
			X								<i>Glomus intraradices</i>	<i>Pseudomonas</i>		Micover Gold e Plus (Agrifutur)
			X	X										Promot WP (Biofa AG (Bio-farming systems))
			X	X					X					Fitotripen WP (Safer Agrobiologicos)
			X	X	X									Nutri-Life TrichoShield (Nutri-Tech Solutions)
			X	X			X		X					Custom GP Beneficial Fungi (Custom Biologicals, Inc.)
			X	X							Endo-, Ecto-mycorrhize			Bio-Vam (T&J Enterprises), Zho Rhizosphere Root Inoculant (Botanicare)
			X	X							15 spp.	11 spp.		Great White Premium Mycorrhize (Plant Success)
					X						X			Nutri-Life Platform, Nutri-Life 4/20 (Nutri-Tech Solutions)
			X			X		X						Trichonativa (Bio-Insumos Nativa Ltda)
			X						X					Biotrich (Biovale Produtos Agropecuários Ltd.), Emerald Tricho (Emerald Bio Fertilizers Pvt. Ltd), NIPROT (Pest Control India Pvt. Ltd.), Root guard Trichomix (Elbitech Innovations Pvt. Ltd), Fertimax (Skymax Crop Science Ltd.), Sun Agro Derma and Sun Agro Derma – H (Sun Agro Chemical Industries)

Table 4. contd...

Trichoderma Species											Myc	Bact	Other	Product Name (Company)
asp	atr	gam	harz	kon	lign	parc	poly	virn	virid	spp.				
									X		X			Ayush (K. N. Bio Sciences Pvt. Ltd)
									X			<i>Pseudomonas fluorescens</i>		ANOKA (K. N. Bio Sciences Pvt. Ltd)
			X						X				<i>Paecilomyces lilacinus</i>	Shakti-AG (Nivshakti Bioenergy Pvt. Ltd.)
			X						X			<i>Pseudomonas fluorescens, Bacillus subtilis</i>		Bio Protector (Bacto Agro Culture Care Pvt. Ltd)
			X	X					X	X				ICB Nutrisolo SC e WP (ICB BIOAGRITEC Ltd)
									X					Bio-Tricure (Chaitra Fertilizers & Chemicals Pvt. Ltd)
										X		<i>Bacillus spp., PaeniBacillus</i>		BiotaMax (CustomBio)
										X			fermentation products, amino acids	Sani-Root (AMC Chemical, S.L. and Trichodex, S.A.)
										X				Biagro TL (Bioagro), Bio Sol Tricho (Biological Solutions Ltd), CANNA AkTRivator (CANNA), DRH Trichoderma Products (GroChem NZ Ltd.), Excalibur (ABM), Oregonism XL Root Organics (Aurora Innovations), <i>T. viride / harzianum</i> (Dr. Rajan Laboratories), Tricho Plus (Biological Control Products Pty Ltd), Trichodel (Empresa Caxiense de Controle Biológico Ltda), Trichoderma (Boothankad Estate), Trichoderma Fungicide (Vedanta Organo World), Trichomax (SolAgro, Trujillo), Trichonat (Natural Rural), Trichoteam (Bioteam Ind. e Com. Ltda.), Trichozam (Hardware & Lumber Limited - Agro Grace Division), Tricodamp (Productividad Biosfera Medio Ambiente - Probioma), Bactiva (Tecnologias Naturales Internacional), Trichosav-55 (Institute for Research in Plant Protection, CANNA Coco (CANNA), Trichoplus JCO (JCO Indústria e Comércio de Fertilizantes LTD), TB62 Trichoderma: Biofungicide for vegetables (Philippine Rice Research Institute), Biospark Trichoderma (Biospark Corp.), Solstice (Metcalf Biologicals)
										X	X	X	fermentation products	BioPlantguard (Saipan srl)
										X		<i>Bacillus spp. PaeniBacillus</i>		Bio Max Soil Probiotic (Custom Biologicals, Inc.)
										X	X	<i>Bacillus</i>		TNC Mycorr -Max, Hydro (The Nutrient Company)
										X		<i>Bacillus</i>		Agrotrich e Agrotrich Plus (Agrosafra Sementes), Bactiva (Tecnologias Naturales Internacional)

Table 4. contd...

Trichoderma Species											Myc	Bact	Other	Product Name (Company)
asp	atrv	gam	harz	kon	lign	parc	poly	virn	virid	spp.				
										X		<i>Azotobacter</i>		PSB SSB <i>Trichoderma Azotobacter</i> (Divya Pruthvi Enterprises)

¹Note: indications of any commercial products by the authors does not by anyway indicate an endorsement of the product or company
Trichoderma species present (as indicated on the label) – *T. asperellum* (asp), *T. atroviride* (atrv), *T. gamsii* (gam), *T. hamatum* (ham), *T. harzianum* (harz), *T. koningii* (kon), *T. lignorum* (lign), *T. parceanamosum* (parc), *T. polysporum* (polys), *T. virens* (virns), *T. viride* (virid), *T. species mix* (spp.).
Mycorrhize - *Glomus sp. or spp.* (species not specified), *G. intraradices*; Endo-, Ecto-mycorrhize (not specified)
Bacteria - *Azobacter chroococcum*, *Bacillus subtilis*, *B. licheniformis*, *B. azotoformans*, *B. megaterium*, *B. coagulans*, *B. pumilis*, *B. thuringiensis*, *Bradyrhizobium japonicum*, *PaeniBacillus durum*, *P. polymyxa*, *Pseudomonas aureofacens*, *Ps. fluorescens*, *Saccharomyces cerevisiae*, *Streptomyces griseus* and *S. lydicus*;
Other. – chitosan, neem; Fermentation products-spores, mycelia and metabolites; amino acids; *Paecilomyces lilacinus*

culture is produced that containing spores, mycelia, lytic enzymes, metabolites etc., and this fungal mixture is directly applied in the field for biological control. In some countries, such as Venezuela and Cuba, the development and use of *Trichoderma*-based bioproducts is Government-supported and officially endorsed for use in agriculture [45].

Generally *Trichoderma* bio-products on the agricultural market have been selected by using “old” methods and criteria of classical biological control. The products have been applied to plants indiscriminately without an appropriate knowledge of the mechanisms of action used by the fungus for disease control. Further, due to insufficient examination, many products have demonstrated problems with reliability and reproducibility in the field, inappropriate formulations, inadequate quality control etc.

The genetic diversity within the genus *Trichoderma* is very high, thus the multitude of useful characteristics for biological applications in agriculture and industry is far from being fully exploited, and requires thorough assessment. A method needs to be employed to select multi-action fungal strains to be tested in the field. Some considerations include the ability to: 1) control plant disease pathogens – a good mycoparasite and/or producer of lytic enzymes; 2) increase plant systemic resistance to biotic and abiotic stresses [57]; 3) promote plant/root growth and development in order to boost yields; 4) persist in the rhizosphere, and eventually be endophytic; 5) produce specific compounds (i.e. secondary metabolites) that affect negatively the pathogen and positively the plant; 6) degrades pollutants in the soil, thus helping in bonificating contaminated environments; 7) solubilise, sequester, allocate nutrients to the plant, 8) be compatible or synergistic with agro-chemicals commonly used, and other biocontrol agents; 9) maintain efficacy in the formulation processes, being a prolific spore/cfu producer in industrial fermentation conditions [57]. Modern scientific technology provides the possibility to conduct pre-field selection for suitable BCAs based on various studied genetic and biochemical characters known to be involved in the biological processes important and useful for crop protection. Screening is performed on the microorganism extracts by using high throughput screening, analysis of the proteome, metabolome transcriptome and other ‘omics, microbiome and metagenomic analysis of “stimulating” plant-microbe environments, whole genome next generation sequencing [6, 8, 77, 101, 102]. Based on known desirable characteristics, new strains can be designed and developed by using hybrid technology (i.e. protoplast fusion in the case

of *T. harzianum* strain T22) for improvement of biological characteristics.

In order to be economically competitive on the commercial market, as well as equivalent to or superior in efficacy to chemical products, a further development of novel formulations of *Trichoderma* is necessary to satisfy these requirements. The costs of industrial production have been reduced substantially by using improved solid or liquid fermentation processes. Low cost substrates for producing pure fungal spores on grains such as rice, or recycled materials from the food manufacturing (material from flour milling, fibre from oil pressing, fruit peels etc.) are being used worldwide without the need for expensive high-tech equipment, for example, placing the inoculated substrate in plastic bags or trays, and processing without the need for highly trained workers and complex apparatus [45, 85]. Or in alternative, fermentation is not focused only on obtaining a commercial product that contains pure spores, but generating a fungal culture in liquid that consists of a mix of spores, mycelia, cell wall degrading enzymes and other biologically active substances that form the natural arsenal of compounds used by *Trichoderma* to control phytopathogens and positively affect the plant. Furthermore, in order to maintain quality and viability during storage, research is focused on meeting the biological requirements of the BCA while minimizing the inconsistency of the results obtained in the field, attempts are being made to buffer the sensitivity of the BCA to the environmental conditions by improving strain selection and product formulations.

Clearly the positive biological effects of *Trichoderma* to the plant are being recognized not only in the laboratory, but also globally in the real agriculture crop production environment. This is acknowledged by the escalating number of products commercially available in the last decade [100], the expanded utilization in a greater diversity of crops, as well as the spread in geographic distribution. Our understanding of the mechanisms of biological control used by agents such as *Trichoderma* is continuously expanding. The use of modern laboratory techniques aids in the study and identification of the molecular activities that this fungus exploits during the interaction with other microbes and the plant [7, 8, 18, 103]. Ideal biological characters can be identified from selected species or isolates and utilized for biotechnological improvement of isolates and natural products there of [5, 8, 103]. This information can be subsequently employed to obtain the next generation products that are actively sought after by the agriculture

market because of the new requirements for greater safety, higher yields and lower operating costs.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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Appendix 1. Biological products found on the international market that contain *Trichoderma* and *Gliocladium*, as determined by a survey on internet. References are made to the product name, manufacturer/distributor, geographical regions and the countries where the product is available, and if it is registered (anywhere in the world). General characteristics according to information specified for each product (if designated): *Trichoderma*, *Gliocladium*, other microbes or compounds included; targeted uses, label claims for application, such as mode of action, recommended crops and approved for organic farming; targeted pests controlled, a general group or specific pathogens; product formulation and application; label claims for use.

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
Africa													
Bio-Tricho	Agro-Organics (http://www.agro-organics.co.za/biotricho.php)	South Africa	<i>T. harzianum</i> strain SF	R	Can be applied to all crops.	Control <i>Botrytis</i> and root diseases such as <i>Rhizoctonia</i> , <i>Phytophthora</i> , <i>Pythium</i> , <i>Fusarium</i> , etc.	WP	F					
Eco-77	Plant Health Products (http://www.plant-health.co.za/)	R South Africa; R in process. Kenya, Zambia	<i>T. harzianum</i> strain B77	R	Control of <i>Botrytis</i> in zucchine, tomatoe and roses; <i>Eutypa</i> in grapes		WP	F					
Eco-T	Plant Health Products (Pty)Ltd (http://www.plant-health.co.za)	R South Africa, Kenya, Zambia, FR, UK, Morocco, Tunisia, India	<i>T. harzianum</i> strain kd	R	control of crop root diseases and for enhanced plant growth	<i>Rhizoctonia</i> , <i>Pythium</i> , <i>Fusarium</i> and <i>Phytophthora</i>	WP, seed trt, irrigation	F	ST				
Promot WP	Biofa AG (Bio-farming systems) - http://www.biofa-farming.de/	Kenya (temp. 2010), R in Germany	<i>T. harzianum</i> , <i>T. koningii</i>	R	Horticultural and ornamental crops	Control of damping-off and root rot caused by <i>Pythium</i>	WP	F					
Romulus	DAGUTAT BIOLAB	South Africa	<i>T. harzianum</i> isolate DB 104	R	Stimulates root development			ST					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			Trichoderma, Gliocladium spp.					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Rootgard	Juanco SPS Ltd	Kenya	<i>T. harzianum</i> Strain 21	R		Root fungal diseases		F					
T-Gro	DAGUTAT BIOLAB	South Africa	<i>T. harzianum</i> isolate DB 103	R			SC	F					
Tricho Plus	Biological Control Products (Pty)Ltd - http://www.beckerunderwood.com	South Africa	<i>Trichoderma</i> spp.	R	Control of soil-borne diseases. Wide range of crops including: Maize, Potatoes, Beans, Strawberries, Cucumbers, Tomatoes and Flowers	<i>Rhizoctonia</i> , <i>Pythium</i> and <i>Sclerotinia</i> spp.		F					
Trichotech	Dudutech (K) Ltd	Kenya	<i>T. asperellum</i>	R		Soil fungal diseases		F					
Asia													
AgriGold Trichogold	Agri Gold Organics Pvt. Ltd.	India	<i>T. viride</i>	Available for use	Bio-fertilizers; cotton, pulses, vegetables, oilseeds, fruit plants and flower bearing plants; stimulates seed germination, plant growth and early flower formation.	Effective application on root and stem rot diseases, wilts, blights/leaf spots, downy mildews and powdery mildews, white rust & smuts fungal diseases	WP, Liquid	F	ST	FERT			
Ankoor	Tender Sips Indore, Madhya Pradesh, India	India	<i>T. viride</i>	Available for use				F					
ANOKA	K N Bio Sciences Private Limited, Ranga Reddi	India	<i>T. viride</i> , <i>Pseudomonas fluorescens</i>	Available for use	Biocontrol agent; Damping off.	Used for the control of seed root, rot, collarrot, Nematodes wilt	WP	F					NEM
Antagon-Trichoderma	Omega Ecotech Products	India	<i>T. viride</i>	Available for use	Biological fungicide, plant growth promotion; Sugarcane, Pulses, Oilseeds, Cotton, Vegetables, Banana, Coconut, Oil palm, Chillies, Lime, Coffee & Tea, Areca nut & Rubber, Flower crops, Spices, & Condiments etc., all Vegetable crops and Horticultural crops	Control of root, Rhizome, Stem, foot and collar rot, wilt and damping off diseases caused by phytopathogenic fungi to crop plants	WP - seed trt, root dip, soil trt	F	ST				
Astha TV	Lila Agrotech Pvt. Ltd., Kolkata	India	<i>T. viride</i>	Available for use	Anti-fungal bio-control agent protects plants from soil and seed born disease.		WP	F					
Ayush	K. N. Bio Sciences (India) Private Limited, Hyderabad	India	<i>T. viride</i> , mycorrhizae	Available for use	Biocontrol agent; control of weevils, Nematodes wilt damping off, especially Banana		WP	F					INS

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma, Gliocladium spp.</i>					F	STIM	FERT/NUTR	ISR	DEC	OTHER
BASDERMA	Basarass Biocon (India) Private Limited' (http://www.basarass.com/index1.html)	India	<i>T. viride</i>	Available for use	Protects the crops from diseases throughout their growth period; Cauliflower, Cotton, Tobacco, Soyabean, Sugarcane, Redgram, Bengalgram, Banana, Tomato, Chillies, Potato, Citrus, Onion, Groundnut, Peas, sunflower, Brinjal, Coffee, Tea, Ginger, Turmeric, Pepper, Betel vine, Cardamom	Parasitizes and kills the pathogenic fungi, exudes certain toxins like gliotoxin, viridin and trichodermin that are harmful for the growth of the pathogenic fungi and reduces their multiplication, enhances the plant growth by secreting certain plant growth stimulating substances	WP	F	ST				
Bio Protector	Bacto Agro Culture Care Private Limited	India	<i>T. viride, T. harzianum, Pseudomonas fluorescens, Bacillus subtilis</i>	Available for use	Bacterial and fungal inoculants for better plant protection from root/soil borne and air born diseases			F					
Bio Protector	Bacto Agro Culture Care Private Limited, Nilgiris	India	<i>T. viride, T. harzianum, Pseudomonas fluorescens, Bacillus subtilis</i>	Available for use	Bio-protector; inoculants for better plant protection from root/soil borne and air born pathogens		WP	F					
Bio Protector <i>T. viride</i>	ManiDharma Biotech Private Limited (http://www.manidharmabiotech.com/)	India	<i>T. viride</i>	Available for use	Wilt control, crop protecting		WP	F					
Bio Protectore <i>T. viride</i>	ManiDharma Biotech Private Limited (http://www.manidharmabiotech.com/)	India	<i>T. viride</i>	Available for use	Cucumbers, tomatoes, cabbages, peppers, various ornamentals, cereals and grain legume crops; Sugarcane, Pulses, Oilseeds, Cotton, Vegetables, Banana, Coconut, Oil palm, Chillies, Lime, Coffee & Tea, Areca nut & Rubber, Flower crops, Spices, & Condiments etc.	Prevents the crops from diseases viz. Root rots, wilts, brown rot, damping off, charcoal rot and other soil born diseases in crops (<i>Pythium, Botrytis, Phoma, Sclerotinia, Fusarium, Ascochyta, Alternaria</i> and others)	WP	F					
BioAgent ST-9	Shree Biotech & Research Inputs	India	<i>T. viride</i>	Available for use	Biofungicide; Cotton, Groundnut, Sunflower, Sessemun, Urad, Moong, Arhar, Gram (Chana), Soyabean, Tomato, Potato, Chillies, Tea, Coffee, Black Pepper, Grapes, Opium Poppy, Beetle Vine, Ginger, Garlic, Corriander, Cumin & other Medicinal Crops.	<i>Fusarium, Pythium, Phytophthora, Rhizoctonia, Sclerotium</i> etc	Seed treatment, soil	F					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma, Gliocladium spp.</i>					F						
Biocure F	T. Stanes and Company Limited, Coimbatore, Tamilnadu; http://www.tstanes.com	EU; available India	<i>T. viride</i>	R in EU	Diverse crops; NPOP, NOP;	IMO OVP; <i>Pythium</i> sp., <i>Rhizoctonia solani</i> , <i>Fusarium</i> spp., <i>Botrytis cinerea</i> , <i>Sclerotium rolfsii</i> , <i>Sclerotinia homoeocarpa</i> e <i>Ustilago tritici</i>	WP, Solid & Liquid	F						
Bioderma	Biotech International Ltd.; Criyagen Agri & Biotech Private Limited (http://www.biotech-int.com/)	India	<i>T. viride</i>	Available for use	Biofungicide; Cotton, Cereals, Pulses, Vegetables, Oilseeds, Fruit plants and Floriculture. Fungicides, Soil borne pathogens; immunization of soil and plant against fungal pathogens.	Active on root and stem rots caused by <i>Sclerotinia</i> & <i>Rhizoctonia</i> , wilts caused by <i>Fusarium</i> and <i>Verticillium</i> and blights / leaf spots caused by <i>Alternaria</i> , <i>Ascochyta</i> , <i>Cercospora</i> , <i>Macrophomina</i> , <i>Myrothecium</i> , <i>Ramularia</i> , Downy mildews & Powdery mildews, fungal diseases	WP, seed, soil	F						
Bioderma H	Biotech International Ltd.; Criyagen Agri & Biotech Private Limited; (http://www.biotech-int.com/)	India	<i>T. harzianum</i>	Available for use	Biofungicide; bacterial and fungal diseases of cotton, cereals, pulses, vegetables, oilseeds, fruit plants and floriculture. Seed treatment provides a protective zone around seeds, metabolites stimulate seed germination, plant growth and early flower formation; immunization of soil and plant against fungal pathogens.	Root and foliar pathogens, <i>Phytophthora</i> , <i>Fusarium</i> and bacteria; damping off <i>Pythium</i> ; foliar <i>Alternaria</i> , <i>Ascochyta</i> , <i>Cercospora</i> , <i>Collectotrichum</i> , <i>Macrophomina</i> , <i>Myrothecium</i> e <i>Ralstonia</i>	WP seed	F	ST		ISR			
Bio-fungicide	Redox Industries Ltd.	India	<i>T. harzianum</i>	Available for use	Control the growth of wide range of plant pathogenic fungi, responsible for most of soil borne diseases			F						
Bio-Fungicides	Monarch Scientific Works, Chennai	India	<i>T. viride</i>	Available for use	Control different diseases in crops and also repel pests and rodents		Liquid	F						
Bioharz	International Panaacea Limited	India	<i>T. harzianum</i>	Available for use	Highly effective in controlling crop diseases such as root rots, collar rots, wilts, bunts, damping off, leaf blights, leaf spots of paddy, cotton, pulses, oil seeds, vegetables, ornamentals and fruit crops	<i>Fusarium</i> , <i>Rhizoctinia</i> , <i>Sclerotium</i> , <i>Verticillium</i> , <i>Macrophomina</i> , <i>Alternaria</i> , <i>Helminthosporium</i> , <i>Pythium</i> , <i>Phytophthora</i> etc.	Liquid	F						

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma, Gliocladium spp.</i>					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Biohit	Indore Biotech Inputs & Research Private Limited	India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens		WP	F					
Bio-Shield	Ambika Biotech (http://www.indiamart.com/ambikabiotech/)	India	<i>T. viride</i>	Available for use	Cotton, Groundnut, Sunflower, Sesemun, Urad, Moong, Arhar, Gram (Chana), Soyabean, Tomato, Potato, Chillies, Tea, Coffee, Black Pepper, Grapes, Opium Poppy, Beetle Vine, Ginger, Garlic, Corriander, Cumin and other Medicinal Crops	Used against seed born plant pathogenic fungi, e.g. <i>Fusarium</i> , <i>Pythium</i> , <i>Phytophthora</i> , <i>Rhizoctonia</i> , <i>Sclerotium</i> etc.	WP	F					
Biospark Trichoderma	Biospark Corp. (http://www.biospark.com/annual-product-revenue-goal)	Philippines	<i>Trichoderma</i> spp.; three tropical fungi strains isolated from the Philippine forests	Available for use	Biofertilizer, biofungicide, growth promotant, and composting agent; rice, corn, vegetables, mango, durian horticulture, decomposing agent		Wp	F	ST	FERT		DEC	
Biostar	Peak Chemical Industries Limited, Siliguri, West Bengal	India	<i>T. viride</i>	Available for use	NPOP, NOP; IMO OVP		Liquid & Powder	F					
BiotaMax	CustomBio (http://custombio-indonesia.com/biota-max)	Indonesia	<i>Trichoderma</i> spp. (4), <i>Bacillus</i> spp. (5), <i>PaeniBacillus</i>	Available for use	Soil probiotic					FERT			
Bio-Tricure	Chaitra Fertilizers & Chemicals Private Limited	India	<i>T. viride</i> included	Available for use	Biopesticide; fungal diseases of Cotton, Tobacco, Cereals, Pulses, Vegetables, Oilseeds, Fruit plants and Floriculture	Root and stem rots by <i>Sclerotinia</i> and <i>Rhizoctonia</i> , wilts by <i>Fusarium</i> and <i>Verticillium</i> , blights or leaf spots caused by <i>Alternaria</i> , <i>Ascochyta</i> , <i>Cercospora</i> , <i>Macrophomina</i> , <i>Myrothecium</i> , <i>Ramularia</i> ; effective over Downy mildews and Powdery mildews, and fungal diseases of Cotton	WP	F					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Bioveer	Ambika Biotech (http://www.indiamart.com/ambikabiotech/)	India	<i>T. viride</i>	Available for use	Biofungicide, phosphate Biofertilizer and also produces plant growth promoting substances; patchouli, coleus, melissa and pulses, oil seeds, cucurbitaceous crops like cucumber, pumpkin, bottle gourds, ridge gourds: Solanaceous crops like tomato, brinjal, chillies, capsicum: Cole crops i.e. cabbage, cauliflower: root crops diseases	Active on root rot, foot rot, collar rot, stem rot, damping off, wilt, blight/leaf spot; sheath rot, sheath blight and bacterial leaf blight (BLB) of rice.	WP	F	ST	FERT				BACT
Biovidi	-	India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens			F						
Coimbatore	GreenMax AgroTech; Tamil Nadu Agricultural University (TNAU), Coimbatore	India	<i>T. viride</i>	Available for use	Bio-fertilizer; plant growth promoter, nutrient solubilization and sequestre, induce resistance; biocontrol of soilborne plant-pathogenic fungi; Sugarcane, Pulses, Oilseeds, Cotton, Vegetables, Banana, Coconut, Oil palm, Chillies, Lime, Coffee & Tea, Areca nut & Rubber, Flower crops and Spices	Prevents the crops from diseases such as Root rots, Wilts, brown rot, damping off, Charcoal rot and other soil born diseases in crops	WP - seed trt, root dip, soil trt	F	ST	FERT	ISR			
Commander Fungicide	H. T. C. Impex Private Limited	India	<i>T. harzianum</i>	Available for use	Bio-control agent, protects the root system against diseases caused by soil borne pathogens	Soil Nematode, <i>Fusarium</i> Wilt & Blister Blight		F						NEM
Deepa Bio Plus-Tricho	Deepa Farm Inputs Private Limited, Trivandrum	India	<i>T. viride</i>	Available for use	Fungal biocontrol agent, used in most crops	Controls fungal diseases	WP, Liquid	F						
Defense SF		India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens		WP	F						
DNA Genetics Rocklock	Zen Cropcare India Pvt. Ltd.	India	<i>T. harzianum</i>	Available for use	Fungicide; soil and seed treatment for controlling of different disease that lead to fungal pathogens		WP	F						
Dritricho	Drishiti Biotech Pvt. Ltd.	India	<i>T. viride</i>	Available for use	Recommended in: Bengal gram, Brinjal, Cabbage, Cauliflower, Chickpea, Cowpea, Paddy, Pigeonpea, Sunflower, Tomato.	Pest / Disease: Damping, Root Rot, Seed rot, Seedling wilt, Sheath blight, Stalk rot, Wilt		F						

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma, Gliocladium spp.</i>					F						
Ecoderma	P.J. Margo Private Limited Bangalore	India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens; NPOP, NOP, JAS, IMO OVP			F						
EcoFit	Agr Evo India Ltd. (formerly Hoechst Schering Agrevo Ltd.)	India	<i>T. harzianum</i>	Available for use			WP	F						
ECOGOLD TRICHA	Paks Veterinary Drug Manufacturing Company Private Limited	India	<i>T. harzianum</i>	Available for use	Bio pesticide to dissolve cell walls of pathogenic fungi		WP; soil, foliar	F						
Ecohope, Ecohope-Dry	Kumiai Chemical Industry Co. Ltd.	Japan	<i>T. asperellum</i> (=T. atroviride) SKT-1	R	Seed and root diseases	<i>Giberella fujikuroi, Burkholderia glumae e Acidovorax avenae.</i>	Emulsion, seed trt	F						
Ecosom-TH	Agri Life SOM Phytopharma (India) Limited (www.agrilife.in)	India (registered by Indian Pesticides Regulatory Authority - Central Insecticides Board, Govt of India)	<i>T. harzianum</i> IIHR-Th-2	R	Biological fungicide and biological nematicide; protects crops from; fruit rots caused by <i>Botrytis</i> and plant pathogenic nematodes	<i>Rhizoctonia</i> spp, <i>Pythium</i> spp, <i>Fusarium</i> spp and <i>Alternaria</i> spp.	WP, Liquid, Lyophilized	F		FERT				NEM
Ecosom-TV	Agri Life SOM Phytopharma (India) Limited (www.agrilife.in)	India (registered by Indian Pesticides Regulatory Authority - Central Insecticides Board, Govt of India)	<i>T. viride</i> (TNAU Strain)	R	Biofungicide; seed / soil treatment of root rot of pulses, damping off of chilli seedling, wilting and other root rot diseases; Cereals , Millets , Pulses, Oilseeds, Fibre Crops , Sugar Crops , Forage Crops, Plantation crops, Vegetables, Fruits, Spices , Flowers , Medicinal crops , Aromatic Crops , Orchards and Ornamentals.	<i>Rhizoctonia</i> spp, <i>Pythium</i> spp, <i>Fusarium</i> spp. and <i>Alternaria</i> spp.	WP, Liquid, Lyophilized	F						
Emerald Harz	Emerald Biofertilizers Pvt. Ltd.	India	<i>T. harzianum</i>	Available for use	Fungal-based Biocontroller; NPOP; IMO OVP	Root rot, leaf rot, wilts caused by <i>Phytophthora</i> , <i>Fusarium</i> and Bacteria, damping off caused by <i>Pythium</i> , blights / leaf spots caused by <i>Cercospora</i> , <i>Colletotrichum</i> , <i>Alternaria</i> , <i>Ascochyta</i> , <i>Macrophomina</i> ,		F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.												
						<i>Myrothecium</i> , <i>Ralstonia</i> , bacterial and fungal diseases of cotton, cereals, pulses, vegetables, oilseeds, fruit plants and floriculture									
Emerald Tricho	Emerald Bio Fertilizers Private Limited Chennai	India	<i>T. viride</i> (50%) + <i>T. harzianum</i> (50%)	Available for use	NPOP, IMO OVP			F							
Enpro-Derma	Enpro Bio Sciences Private Limited	India	<i>T. viride</i>	Available for use	Controls Root rot & Wilt diseases in Tomato, Brinjal, Pomegranate & other Crops; control the growth of harmful fungi on leaves		WP	F							
Esquive WP	Agrauxine, ZA de Troyalac'h (http://www.agrauxine.com/)	Europe (France), Australia, New Zealand, South Africa, Vietnam	<i>T. atroviride</i> 1237	R, Annex I (2012)	Vineyards, nursery, Grapes - root, dieback	<i>Eutypa</i> , <i>Botryosphaeria</i> spp., <i>Phaeoconiella</i> , <i>Phaeoacremonium</i>	WP, pruning, dip, aerial spray	F							
Eswin Tricho	-	India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens			F							
Fertimax	Skymax Crop Science Ltd.	India	<i>T. viride</i> + <i>T. harzianum</i>	Available for use	Root rots, Wilts, brown rot, damping off, Charcoal rot and other soil born diseases in crops			F							
Gliocladin (Trichodermin T, Z)		Russia	<i>T. harzianum</i>	Available for use		Fungal diseases (rots, fusarioses, verticilliosis)		F							
Harzina Gold	Super Agro (I) Pvt.Ltd Kolkata	India	<i>T. harzianum</i>	Available for use	NPOP, NOP, IMO OVP			F							
Jai Vjai	Chaitra Fertilizers & Chemicals Private Limited	India	<i>T. viride</i> (Mycelia fragments, Conidia and Clamydospore)	Available for use	Fungal biopesticide	Highly active on root and stem rots caused by <i>Sclerotinia</i> and <i>Rhizoctonia</i> , wilts caused by <i>Fusarium</i> and <i>Verticillium</i> and blights or leaf spots caused by <i>Alternaria</i> , <i>Ascochyta</i> , <i>Cercospora</i>	WP, Liquid	F							

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma, Gliocladium spp.</i>					F						
NIPROT	Pest Control India Private Limited; Corporate Marketing Division	India	<i>T. viride</i> or <i>T. harzianum</i>	Available for use	Fungicides, Soil borne pathogens			F						
Niprot TH	Bio Control Research Laboratories – A Division of Pest Control (India) Pvt. Ltd Bangalore	India	<i>T. harzianum</i>	Available for use	NPOP IMO OVP; Solid Formation		WP, SOLID	F						
Niprot TV	Bio Control Research Laboratories – A Division of Pest Control (India) Pvt. Ltd Bangalore	India	<i>T. viride</i>	Available for use	NPOP IMO OVP (National Program for Organic production NPOP); Solid Formation		WP	F						
Phalada 106TV		India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens			F						
Phytotric	Elbitech Innovations Ltd Chennai, Tamil Nadu	India	<i>T. viride</i>	Available for use	NPOP, NOP, IMO OVP			F						
Phytotric h	Elbitech Innovations Ltd Chennai, Tamil Nadu	India	<i>T. harzianum</i>	Available for use	NPOP, NOP, IMO OVP			F						
POABS GREEN Soil guard	Poabs Biotech (http://poabsbiotech.com/soilguard.html)	India	<i>T. harzianum, T. viride</i>	Available for use	Antifungal biopesticide which forms a natural protective barrier around root zone against pathogen entry		WP	F						
Prabhaderma	PRABHAT FERTILIZER & CHEMICAL WORKS (http://www.indiamart.com/prabhatfertilizerandchemicalworks/)	India	<i>T. viride</i>	Available for use	Biopesticide	Wilts caused by <i>Fusarium</i> and <i>Rhizoctonia</i> blights / leaf spots caused by <i>Alternaria, Ascochyta, Cercospora, Macrophomina</i> , Downy Mildews & powdery mildews; root & stem rots caused by <i>Sclerotinia Rhizoctonia</i> wilts caused by <i>Fusarium</i> and blights / leaf spots caused by <i>Alternaria, Ascochyta, Cercospora, Macrophomina</i> , Downy Mildews & powdery mildews,	Liquid	F						

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.											
PSB SSB <i>Trichoderma</i> <i>Azotobacter</i>	Divya Pruthvi Enterprises	India	<i>Trichoderma</i> spp. and <i>Azotobacter</i>	Available for use	Organic farming biofertilizer					FERT				
Ramederma plus	Ramel Industries Ltd. Barasat, Kolkata	India	<i>T. viride</i>	Available for use	NPOP; IMO OVP		Solid	F						
Root guard trichomix	Elbitech Innovations Ltd Chennai, Tamil Nadu	India	<i>T. viride</i> (50%)+ <i>T. harzianum</i> (50%)	Available for use	NPOP, NOP, IMO OVP			F						
SAKTHI	Nova Agri Tech Pvt. Ltd.	India	<i>T. viride</i>	Available for use	Biofungicide			F						
Sanjeevni	International Panaacea Limited	India	<i>T. viride</i>	Available for use	Highly effective in controlling devastating crop diseases such as root rots, collar rots, wilts, bunts, damping off, leaf blights, leaf spots of paddy, cotton, pulses, oil seeds, vegetables, ornamentals and fruit crops	<i>Fusarium</i> , <i>Rhizoctinia</i> , <i>sclerotium</i> , <i>Verticillium</i> , <i>Macrophomina</i> , <i>Alternaria</i> , <i>Helminthosporium</i> , <i>Pythium</i> , <i>Phytophthora</i> etc.	WP	F						
Sardar Eco Green	Gujrat State Fertilizers & Chemicals Ltd. (http://www.gsfclimited.com/)	India	<i>T. harzianum</i>	Available for use	Cotton, Pea, Tomato, Capsicum, Chilies, Cauliflower, Cabbage, Brinjal, Bhindi, Cucurbits, Sugarcane, Mango, Citrus, Cheeku, Grapes, Guava, Papaya, Banana, Pomegranate	Damping off, root & stem rots, wilts / blights, leaf spots, downy & powdery mildews, white rust & smut; post harvest care of fruits & vegetables and planting materials in horticulture during storage	WP	F						
Shakti <i>Trichoderma</i>	Nivshakti Bioenergy Pvr. Ltd. (http://www.indiamart.com/nivshakti-bioenergy/)	India	<i>T. viride</i>	Available for use	Protects crops from paria, root rots, wilts, damping off and other soil borne diseases in all crops		WP	F						
Shakti-AG	Nivshakti Bioenergy Pvr. Ltd. (http://www.indiamart.com/nivshakti-bioenergy/)	India	<i>T. viride</i> , <i>T. harzianum</i> and <i>Paecilomyces lilacinus</i>	Available for use	control primary & secondary diseases along with nematode			F						NEM
Sun Agro Derma	Sun Agro Chemical Industries Tamil Nadu, India	India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens			F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma, Gliocladium spp.</i>												
Sun Agro Derma and Sun Agro Derma - H	Sun Agro Chemical Industries Tamil Nadu, India	India	<i>T. viride, T. harzianum</i>	Available for use	Biopesticide controls wilts, root & stem rots, damping off, several seed & soil borne disease and various foliar diseases rice, sugarcane, tobacco, groundnut, soybean, pepper, cardamom, turmeric, ginger, coffee, tea, rubber, vegetables and fruit crops.		WP	F							
<i>T. harzianum</i>	Bharat Biocon Private Limited	India	<i>T. harzianum</i>	Available for use	Biocontrol fungus that protects the root system of plant & kills the target pest effectively		WP	F							
<i>T. viride</i>	East Coast Biotech Project (http://www.indiamart.com/eastcoast-biotechproject/)	India	<i>T. viride</i>	Available for use	Seed dressing; reduces growth of pathogens quick multiplication of disease causing bacteria; tea, coffee, tea, cereals, coconut and cardamom			F							
<i>T. viride</i>	Govinda Agro Tech Ltd (http://www.indiamart.com/govinda-agrotech/)	India	<i>T. viride</i>	Available for use	Helps in preventing the growth of pathogens causing plant diseases like root rot		WP	F							
<i>T. viride</i>	Bharat Biocon Private Limited	India	<i>T. viride</i>	Available for use	Bio-fungicide, effective against wide variety of soil-borne plant pathogenic fungi		WP	F							
<i>T. viride</i>	ROCKY Imports and Exports	India	<i>T. viride</i>	Available for use	Biocontrol agent, antagonistic fungus; crops like sugar cane, oil seeds, cotton, vegetables, Banana, Coconut, Oil palm, Chillies, Pulses etc.		WP Seed trt	F							
<i>T. viride</i>	Nandhini Bio Tech	India	<i>T. viride</i>	Available for use	Seed and soil treatment for suppression of various diseases caused by fungal pathogens	seed dressing in the control of seed and soil-borne diseases including <i>Rhizoctonia solani</i> , <i>macrophomina phaseolina</i> and <i>Fusarium</i> species		F							

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma, Gliocladium spp.</i>												
<i>T. viride</i>	Zen Cropcare India Pvt. Ltd.	India	<i>T. viride</i>	Available for use	Biofungicide; soil and seed treatment for controlling of different disease that lead to fungal pathogens			F							
<i>T. viride</i> / Harzianum	Dr. Rajan Laboratories	India	<i>Trichoderma</i> spp.	Available for use	Limits growth and activity of plant pathogenic fungi		WP	F							
TB62 Trichoderma: Biofungicide for vegetables	Philippine Rice Research Institute (http://www.scribd.com/doc/61293557/TB62-Trichoderma-Biofungicide-for-vegetables)	Philippines	<i>Trichoderma</i> spp. IPM-CRSP isolate	Available for use			Rice	F							
Tricho	Peak Chemical Industries Limited, Siliguri, West Bengal	India	<i>T. viride</i>	Available for use	NPOP, NOP; IMO OVP		Solid & Liquid	F							
Tricho Gold, Green-all T WP	Green Biotech Co. Ltd., Korea	Korea	<i>T. harzianum</i> GBF-0208	Available for use				F	ST						
Tricho H	Peak Chemical Industries Limited, Siliguri, West Bengal	India	<i>T. harzianum</i>	Available for use	NPOP, NOP; IMO OVP		Solid & Liquid	F							
Tricho Rich	Prathibha Biotech	India	<i>T. viride</i>	Available for use	A bio fungicide for seed treatment and basal application to protect against seed and soil borne diseases in all crops			F							
Tricho Shield Combat	Kan Biosys Pvt. Ltd. (http://www.indiamart.com/kanbiosys/)	India	<i>T. viride</i>	Available for use	Biofungicide for bio-management of seed & soil borne plant pathogenic fungi	Bio-management of soil borne fungal infections of crops.	WP	F							
Trichoderma	Boothankad Estate	India	<i>Trichoderma</i> spp.	Available for use	Control cardamom katte disease and banana buncy top; pepper wilt, areca yellow disease, bud rot, stem bleeding, etc. ; fungal diseases in vegetables, flower crops and fruit crops.	<i>Rhizoctonia e Sclerotina</i>		F							
Trichoderma Bio-Fungicide	Ruchi Biochemicals	India	<i>T. viride</i>	Available for use	Introduced along with seeds or at root zone protect the seedlings from attack by soil borne pathogens that cause root / collar / stem rots, wilts, damping offs, leaf blights spots etc. and promote healthy growth in early stages of crop	<i>Pellicularia rolfsii, Pellicularis filamentosa, Macrophomina phaseoli, Ustilago segetum, Phytophthora</i> sp., silver leaf on plum, peach & nectarine, <i>Botrytis cinerea</i> , rots <i>Fusarium, Rhizoctonia</i> , and <i>Pythium, Sclerotinia & Sclerotium</i>	WP	F	ST						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma, Gliocladium spp.</i>					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Trichoderma Fungicide	Vedanta Organo World	India	<i>Trichoderma</i> spp.	Available for use	Kills the soil born fungus; Enhance plant and root growth			F	ST				
Trichoderma spp.		China	<i>Trichoderma</i> spp.	R	Only fungal biological control agent used against plant disease, mainly <i>Botrytis</i>	Downy mildew, <i>Rhizoctonia cerealis</i> , Botrytis grey mould		F					
Trichoderma side	Bengal Biotech & Research Midnapur, West Bengal, India	India	<i>T. viride</i>	Available for use	Preventing soilborne crop diseases			F					
Trichoguard	<u>Goldfarms Plant Tech Privet Limited</u>	India	<i>T. viride</i>	Available for use	control root rot, damping-off and wilt diseases of Groundnut, Pulses (Cowpea, mungbean, Urdbean), Chilli seedings, Cowpea, Sesamum and Pigeon pea		WP	F					
Tricholife	Gujarat Life Science Private Limited, Vadodara	India	<i>T. viride</i>	Available for use	Effective remedy against soil borne pathogens effecting groundnut, Bt cotton, Cumin, Onion, Garlic, pulses, sugarcane, vegetable crops, tobacco, banana, papaya etc. It is effective against root rot, wilt, stem rot etc disorders in the crops.		WP; Seed coating, spray	F					
Trichostar	Super Agro (I) Pvt. Ltd Kolkata	India	<i>T. viride</i>	Available for use	Biopesticide, used for controlling plant diseases, helps in the growth and promotion of plants and induces systemic resistance; fertilizer for controlling soil borne diseases, collar, root, and stem rots, wilts, and damping offs, leaf spots of sugarcane plantation, cereals, flowers, pulses, oilseeds		WP	F	ST	FERT	ISR		

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			Trichoderma, Gliocladium spp.												
Tricone V	Neuscire Biolab	India	<i>T. harzianum</i> , with neem	Available for use	Plant growth promoter; disease control, Quick wilt of pepper, root rot of membrins rhizome rot of ginger, capsule rot of cardamom root rot of ornamentals, damping off and other nursery diseases, nematodes in banana wilt and mildew in vegetables	All soil borne fungal diseases, against <i>Pythium</i> sp, <i>ganaderma</i> sp, <i>Rhizoctonia solani</i> , <i>Fusarium</i> sp; plant parasitic nematodes. Banana nematode - <i>radopholus similis</i> , citrus nematode tylenchulus semipenetrans and reniform nematode rotelenechulus reniformis).	WP	F	ST						
Tricontrol		India	<i>T. viride</i>	Available for use	Fungicides, Soil borne pathogens			F							
Trieco	Ecosense Lab India Private Limited	India	<i>T. viride</i>	Available for use	Contributes to the development of various plant growth stimuli for root and shoot elongation; suppress root infesting diseases		WP; seed trt, propagation material, soil drench	F	ST						
Yash Derma	Yash Krishi, Takniki Ewam Vigyan Kendra, Allahabad, UP	India	<i>T. viride</i>	Available for use	NPOP, IMO OVP		Solid	F							
Europe (EU - 22 countries; others)															
Binab T P (in development)	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion); USA (cancelled)	<i>T. atroviride</i> IMI 206040 (formerly <i>T.harzianum</i> IMI 206040) + <i>T. polysporum</i> IMI 206039	R, Annex I (2008)	Fruit trees	<i>Chondrostereum purpureum</i> ; biocontrol of Silver Leaf caused by <i>Chondrostereum purpureum</i> transmitted by pruning wound infection or root contacts; pathogenic fungi that cause wilt, take-all, root rot, and internal decay of wood products and decay in tree wounds	Pellets	F							
Binab T Vector	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	USA, EU (SE, DN)	<i>T. atroviride</i> IMI 206040 (formerly <i>T.harzianum</i> IMI 206040)	R	A powder for treating flowers against fungal pathogens through vector transmission; Strawberries	<i>Botrytis cinerea</i> , controls fungal pathogens such as <i>Botrytis</i> , <i>Verticillium</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Rhizoctonia</i> , fairy rings and other soil-borne fungal pathogens, and <i>Didymella</i> , <i>Chondrostereum</i> and <i>Heterobasidion</i>	WP (bumblebee vectoring);	F							

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.												
Binab T WG	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html); Biofa AG (Bio-farming systems), Rudolf-Diesel-Str. 2, D-72525 Münsingen, Alemanha.	EU (SE, DN, Germany (biofortifciant))	<i>T. atroviride</i> IML 206040 (formerly <i>T. harzianum</i> IML 206040)	R, Annex I (2008)	<i>Botrytis cinerea</i> on Strawberries	<i>Chondrostereum purpureum</i> on Ornamental trees	WP (spray)	F							
Binab TF WP	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	R in EU (SE, DN); Chile (imported by Agro-Connexion)	<i>T. atroviride</i> IML 206040 (formerly <i>T. harzianum</i> IML 206040)	R, Annex I (2008)	<i>Botrytis cinerea</i> on Strawberries	<i>Chondrostereum purpureum</i> on Ornamental trees	WP (spray)	F							
Biocure F	<i>T. Stanes</i> and Company Limited, Coimbatore, Tamilnadu; http://www.tstanes.com/bio_cure_f.html	EU; available India	<i>T. viride</i>	R	Diverse crops; NPOP, NOP; IMO OVP	<i>Pythium</i> sp., <i>Rhizoctonia solani</i> , <i>Fusarium</i> spp., <i>Botrytis cinerea</i> , <i>Sclerotium rolfsii</i> , <i>Sclerotinia homoeocarpa</i> e <i>Ustilago tritici</i>	WP, Solid & Liquid	F							
Bionitrogen G	Agrifutur (http://www.agrifutur.com/IT/c/bionitrogen-g-39/)	Italy	<i>T. harzianum</i> , <i>Glomus</i> e <i>Bradyrhizobium japonicum</i>	Available for use				F							
BioPlantguard	Saipan SRL	Italy	<i>Trichoderma</i> spp., <i>mycorrhizae</i> , <i>bacteria</i> , fermentation products	Available for use	Treatment of seeds, plants and fruit to augment their resistance to biotic and abiotic stresses	Antagonistic to soilborne and foliar pathogens: <i>Fusarium</i> , <i>Verticillium</i> , <i>Sclerotinia</i> , Botrite, <i>Pythium</i> , <i>Rhizoctonia</i>	Liquid	F	ST	FERT					
Bioten	Isagro Spa	Spain	<i>T. asperellum</i> ICC 012 + <i>T. gamsii</i> ICC 080	Availabe for use	Flowers, Ornaments in vase (<i>Chrysanthemums</i> , <i>cyclamens</i> , poinsettia, <i>primula</i> etc.); Horticulture (tomato, peppers, salads (lettuce, radicchio, indivia, rucola), melon, fennel, artichoke, basil, celery, beans, zucchini, eggplant, cucumber, aromatic herbs	<i>Rhizoctonia solani</i> , <i>Sclerotinia sclerotiorum</i> , <i>Verticillium dahliae</i> , <i>Thielaviopsis basicola</i> , <i>Phytophthora capsici</i> .	WP	F							

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
CANNA AkTRivator	CANNA (http://www.canna-uk.com/aktrivator)	UK	<i>Trichoderma</i> spp.	Available for use	Stimulates the plants and increases root development, reduced disease,	It stimulates plant growth.	WP, Granules	F	ST					
CANNA Coco (Slabs, Professional Plus, Natural)	CANNA (http://www.canna-uk.com/aktrivator)	UK	<i>Trichoderma</i> spp. included	Available for use	coco-based growing medium contains a special mould (<i>Trichoderma</i>) that protects the plants against soil diseases	stimulates the plants and increases root development, reduced disease,	solid (coco)	F	ST					
Compete Plus	Plant Health Care (http://www.planthealthcare.com)	Spain, USA	<i>T. harzianum</i> + <i>Bacillus</i> (6 spp.) + <i>Streptomyces</i>	Available for use	Soil inoculant, root promotions		WP	F	ST					
Condor	Italpollina (http://www.italpollina.com/Product/36/TIFI)	uk	<i>T. atroviride</i> 898G + <i>Glomus</i> spp.+ Bacteria	Available for use,	Horticulture, orchards and trees. Direct action on many pathogenic fungi, stimulates plant growth, protects leaves and fruits against attacks by <i>Botrytis</i> spp. and <i>Phytophthora</i> spp.	It protects the plants' roots in soils contaminated with pathogenic fungi.		F	ST					
Eco-T	Plant Health Products (Pty)Ltd - http://www.plant-health.co.za/	R South Africa, Zambia, FR, UK, Morocco, Tunisia, India	<i>T. harzianum</i> strain kd	R	Control of crop root diseases and for enhanced plant growth	<i>Rhizoctonia</i> , <i>Pythium</i> , <i>Fusarium e</i> <i>Phytophthora</i>	WP, seed trt, irrigation	F	ST					
Esquive WP	Agrauxine, ZA de Troyalac'h (http://www.agrauxine.com/)	Europe (France), Australia, New Zealand, South Africa, Vietnam	<i>T. atroviride</i> 1237	R, Annex I (2012)	Vineyards, nursery, Grapes - root, dieback	<i>Eutypa</i> , <i>Botryosphaeria</i> spp., <i>Phaeoconiella</i> , <i>Phaeoacremonium</i>	WP, pruning, dip, aerial spray	F						
Fungistop	Nyva/Bionaservice Ltd.	Ukraine, Certified according to EU , NOP 05/04/12-05/07/13	<i>T. viride</i>	Available for use	Control of fungal diseases in greenhouses			F						
GlioMix	Verdera Oy (Formerly Kemira Agro Oy), http://www.verdera.fi/homeeng.html	USA; Finland, Germany	<i>Gliocladium</i> spp.	R	Prevention and control of soilborne pathogens; ornamentals and diverse crops		WP (soil, substrate)	F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F	STIM	FERT/ NUTR	ISR	DEC	OTHER
Great White Premium Mycorrhize	Plant Success (www.plant-success.com)	UK	<i>T. koningii</i> , <i>T. harzianum</i> , mycorrhize fungi (15 spp.), bacteria (11 spp.)	Available for use	Plant and root growth promoter		WP, seeds, cuttings, transplants, hydroponics		ST				
GROW BOOST Plant Strengthenener	dragonfli (http://www.dragonfli.co.uk)	UK	<i>T. harzianum</i> T-22	Available for use	Wide range of plants including vegetables and salads, vegetables of the brassica family	Healthier and stronger plants, Suppression of soil borne diseases, Greater survival rates of transplants, seedlings and young plants	WP - sachet	F					
Lycomax	Russelli PM (http://www.russellipm.com)	UK	<i>T. harzianum</i>	Available for use	Soilborne pathogens; potatoes, root crops, ornamentals		Granules	F					
Micover Gold e Plus	Agrifutur (http://www.agrifutur.com/)	EU	<i>T. harzianum</i> , <i>Glomus intraradices</i> e <i>Pseudomonas</i>	R	Soilborne pathogens		Granules	F					
Mycofungicyd (Trichodermin)		Ukraine	<i>T. viride</i>	R		Root rots, white rot, fusariosis, verticilliosis		F					
Micosat F, Micosat F (for organic farming)	C.C.S Aosta s.r.l.	Italy	<i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (3), <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i> , <i>Beauveria</i> , <i>Pichia</i>	Available for use	All granular formulations increment root development and protection from soilborne diseases		Granules, manuale or mechanical soil distribution	F	ST				
Micosat F cereali, Micosat F cereali (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. atroviride</i> TA 28, <i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (3), <i>Bacillus</i> , <i>Beauveria</i>	Available for use	All granular formulations increment root development and protection from soilborne diseases		Granules, manuale or mechanical soil distribution	F	ST				
Micosat F patata, Micosat F patata (for org. farm.)	C.C.S Aostas.r.l.	Italy	<i>T. atroviride</i> TA 28, +spp. of <i>Glomus</i> (3), <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i> , <i>Beauveria</i> , <i>Pochonia</i>	Available for use	All granular formulations increment root development and protection from soilborne diseases		Granules, manuale or mechanical soil distribution	F	ST				

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Micosat F vite, Micosat F vite (for org. farm.); Micosat F olivo, Micosat F olivo (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. viride</i> TV 03, <i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (3), <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i> , <i>Pichia</i>	Available for use	All granular formulations increment root development and protection from soilborne diseases		Granules, manuale or mechanical soil distribution	F	ST					
Micosat F forestali, Micosat F forestali (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (3), <i>Habelom</i> , <i>Cenococcum</i> , <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i> , <i>Pichia</i>	Available for use	All granular formulations increment root development and protection from soilborne diseases		Granules, manuale or mechanical soil distribution	F	ST					
Micosat F TAB PLUS WP, Micosat F TAB PLUS WP (for org. farm.)	C.C.S Aostas.r.l.	Italy	<i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i> , <i>Beauveria</i> , <i>Pichia</i>	Available for use	WP formulations induce resistance to bacteria, soilborne fungi, pathogens, insects and nematodes (depending on the formulation)		WP, foliar spray	F				ISR		
Micosat F DP 10 WP, Micosat F DP 10 WP (for org. farm.)	C.C.S Aostas.r.l.	Italy	<i>T. harzianum</i> TH27, <i>T. viride</i> TV 03, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Agrobacterium</i> , <i>Bacillus</i> , <i>Streptomyces</i>	Available for use	WP formulations induce resistance to bacteria, soilborne fungi, pathogens, insects and nematodes (depending on the formulation)		WP, foliar spray	F				ISR		
Micosat F PO WP, Micosat F PO WP (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. harzianum</i> TH01, <i>T. viride</i> TV 03, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Bacillus</i> , <i>Streptomyces</i> , <i>Pichia</i>	Available for use	WP formulations induce resistance to bacteria, soilborne fungi, pathogens, insects and nematodes (depending on the formulation)		WP, foliar spray	F				ISR		
Micosat F TAB WP, Micosat F TAB WP (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. harzianum</i> TH01, <i>T. viride</i> TV 03, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Bacillus</i> , <i>Pichia</i>	Available for use	WP formulations induce resistance to bacteria, soilborne fungi, pathogens, insects and nematodes (depending on the formulation)		WP, foliar spray	F				ISR		

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Micosat Ffito	C.C.S Aostas.r.l.	Italy	<i>T. harzianum</i> TH01, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Pseudomonas</i> (2), <i>Pichia</i>	Available for use	WP formulations induce resistance to bacteria, soilborne fungi, pathogens, insects and nematodes (depending on the formulation)		WP, foliar spray	F			ISR		
Micosat F semi WP, Micosat F semi WP (for org. farm.)	C.C.S Aostas.r.l.	Italy	<i>T. harzianum</i> TH01, <i>T. atroviride</i> TA 28, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Bacillus</i> , <i>Beauveria</i>	Available for use	Powder formulations for seed treatments increase root development and protection to soilborne diseases		Powder, dry seed treatment	F	ST				
Micosat F grano, Micosat F grano (for org. farm.)	C.C.S Aosta s.r.l.	Italy	<i>T. harzianum</i> TH01, <i>T. atroviride</i> TA 28, +spp. of <i>Glomus</i> (5; 8 isolates), <i>Bacillus</i> , <i>Streptomyces</i> , <i>Pichia</i>	Available for use	Powder formulations for seed treatments increase root development and protection to soilborne diseases		Powder, dry seed treatment	F	ST				
Plagron Coco Substrate	Plagron - http://www.plagron.co.uk/mediums/plagron-coco-substrate-coir	UK	<i>Trichoderma</i> spp. Included	Available for use		protection against malicious fungi	Solid coco	F					
PLANT BOOST plant strengthener	dragonfli (http://www.dragonfli.co.uk/product/ps-02)	UK	<i>T. harzianum</i> T-22	Available for use	Increased plant root development, Suppression of soil borne diseases, Increased yield for vegetables and fruits, Improved establishment of plants after planting. wide range of plants including vegetables and salads	Natural protection from soil borne diseases such as <i>Pythium</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> and <i>Sclerotinia</i>	Granules	F	ST				
Promot WP	Biofa AG (Bio-farming systems) - http://www.biofa-farming.de	R in Germany; Kenya (temp. 2010)	<i>T. harzianum</i> , <i>T. koningii</i>	R	horticultural and ornamental crops	Control of damping-off and root rot caused by <i>Pythium</i>	WP	F					
Radix	Isagro Spa	Italy	<i>T. asperellum</i> ICC 012 + <i>T. gamsii</i> ICC 080	Availabe for use			WP	F					

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.												
Remedier WP	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> strain ICC 012 + <i>T. gamsii</i> ICC080	R - Annex I (2013)	Tomato	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP,drench, drip irrigation	F							
Root-Pro	Agriance, Israel (http://www.agriance.com)	Israel	<i>T. harzianum</i> T-35 + <i>T. harzianum</i> T-315	Available for use	Nursery and field soil amendment; soil-fungicide for use on greenhouse and nursery crops	Control of soil-borne diseases <i>Pythium</i> spp., <i>Sclerotium rolfsii</i> , <i>Fusarium</i> spp., <i>Rhizoctonia solani</i>	peat moss like material	F							
RootShield PLUS WP, RootShield (WP, Granules), RootShield HC	Bioworks inc (http://www.bioworksinc.com/)	USA, Canada, EU	<i>T. harzianum</i> Rifai strain T-22 (KRL-AG2)	R	Horticulture and agriculture. Pathogen control, promotes a healthier root system, increasing root mass potential. For media incorporation – nursery, greenhouse and vegetables; Drench for use on nursery, greenhouse and vegetables	Root disease control <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Thielaviopsis</i> and <i>Cylindrocladium</i> ; PLUS <i>Phytophthora</i> , <i>Pythium</i> (P. <i>aphanidermatum</i>),	WP, Granules, seed, propagation material, drench, dip, spray	F	ST						
Sani-Root	AMC Chemical, S.L. and Trichodex, S.A. (http://www.amchemical.com/ventana_ingles.html)	Spain	<i>Trichoderma</i> fermentation products + amino acids	Available for use	Vegetables, ornamentals, fruits, turf: stimulates and protects root system, plant growth promotion		Liquid		ST						
Supresivit	Fytovita, Ltd.	Czech Republic (R in 1994?)	<i>T. harzianum</i>	R	Biological control; Strawberry	Soil-borne fungal pathogens such as <i>Verticillium dahlia</i> , <i>Kleb</i> , <i>Pythium</i> spp., <i>Phytophthora</i> spp., <i>Rhizoctonia</i> spp.; other pathogens <i>Botrytis cinerea</i>	WP	F							
<i>T. harzianum</i> IAB-32	IAB S.L. (Investigaciones y Aplicaciones biotecnológicas) http://www.iabiotec.com	Spain	<i>T. harzianum</i>	Available for use	Preventive disease control, metabolite producer, competition, ISR	<i>Fusarium</i> , <i>Rhizoctonia</i> e <i>Pythium</i>	Liquid	F			ISR				
T34 Biocontrol	Biocontrol Technologies S.L., Fargro Ltd.	European Union, UK	<i>T. asperellum</i> T34	R - Annex I (2012)	In greenhouse, carnations	<i>Fusarium oxysporum</i>	WP (propagation, seeding)	F							

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F	STIM	FERT/NUTR	ISR	DEC	OTHER
TIFI	Italpollina (http://www.italpollina.com/Product/36/TIFI)	fr, it, es	<i>T. atroviride</i> 898G + <i>Glomus</i> spp.+ Bacteria	Available for use	Seeds, nursery, vegetables (field and greenhouse), trees, ornamentals, grass. Direct action on many pathogenic fungi. A fertilizer allowed in organic farming according to Italian Decreto	Soils (<i>Fusarium</i> spp., <i>Rhizoctonia</i> spp., <i>Verticillium</i> spp., <i>Armillaria</i> spp.) and plants (<i>Phytophthora</i> spp., <i>Botrytis</i> spp. ecc.).		F		FERT			
TNC Mycorr (Max, Hydro)	The Nutrient Company - www.thenutrientcompany.com/	UK	<i>Trichoderma</i> spp. (5) + <i>mycorrhize</i> (15 spp.) + <i>Bacillus</i> spp. (13)	Availabe for use	Biostimulant, increased nutrient uptake, drought tolerance, pathogen resistance	Unique strain for great adaptability to soils and environmental conditions.			ST	FERT	ISR		
TRIANUM-G	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. Vegetables, soft fruit, herbs, bulbs, ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.		Granules	F	ST	FERT	ISR		
TRIANUM-P	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Tomato, Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. Vegetables, soft fruit, herbs, bulbs, ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP, drench, irrigation - propagation, sowing, transplant	F	ST	FERT	ISR		
<i>Trichoderma</i> BioFlower	Terranaturale (http://www.terranaturale.com/)	Spain	<i>T. harzianum</i>	Available for use,	Biological control, biostimulant, increased assimilation of nutrients	Diverse root pathogenic fungi (<i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i> , etc)	WP	F	ST	FERT			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma, Gliocladium spp.</i>					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Trichomic	AMC Chemical, S.L. and Trichodex, S.A. (http://www.amcchemical.com/ventana_ingles.html)	Spain	<i>T. viride</i>	Available for use	Ecological Biofungicide and plant growth promoter, fertilizer; bioactivator for root growth and vegetative crop plants; inductor and supportive of self-defense; horticulture, ornaments, fruit, olives, turf		Liquid	F	ST	FERT	ISR		
Trifender	Bioved	Hungary	<i>T. asperellum</i>	Available for use	Prevention and control of root pathogens; diverse crops	<i>Pythium, Phytophthora, Fusarium, Sclerotinia, Rhizoctonia</i>	Granules	F					
Trihodermina Th-7F-BL		Moldova	<i>T. harzianum</i>	Available for use		<i>Sclerotinia sclerotiorum, Pythium debaryanum, Rhizoctonia solani, Fusarium spp., Botrytis cinerea, Ascochyta hortorum</i>		F					
Trihodermina-BL		Moldova	<i>T. lignorum</i>	Available for use				F					
TUSAL WG	NewBiotechnic SA (NBT) Spain (http://www.nbt.es); Certis Europe (http://www.certiseurope.com)	EU (Spain), USA regist; available Mor, Slov, Turk	<i>T. harzianum</i> + <i>T. viride</i>	R - Annex I (2013)	Prevention and control of root pathogens; Horticulture crops	<i>Rhizoctonia solani, Sclerotinia sclerotiorum, Fusarium sp., Pythium sp., Phytophthora sp.</i>	WG,drip irrigation; W, soil, seed treatment	F					
VIRISAN	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> TV1	R - Annex I (2013)	Tomato	<i>Rhizoctonia spp., Fusarium sp., Pythium sp.</i>	WP, drench, drip irrigation	F					
North America													
Binab T P (in development)	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion); USA (cancelled)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040) + <i>T. polysporum</i> IMI 206039	R, Annex I (2008)	Biocontrol; Fruit trees	<i>Chondrostereum purpureum</i> Silver Leaf transmitted by pruning wound infection or root contacts; pathogenic fungi that cause wilt, take-all, root rot, and internal decay of wood products and decay in tree wounds	Pellets	F					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Binab T Vector	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	USA, EU (SE, DN)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040)	R	A powder for treating flowers against fungal pathogens through vector transmission; Strawberries	<i>Botrytis cinerea</i> , <i>Verticillium</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Rhizoctonia</i> , fairy rings and other soil-borne fungal pathogens, and <i>Didymella</i> , <i>Chondrostereum</i> and <i>Heterobasidion</i>	WP (bumblebee vectoring);	F						
Binab t wettable powder biorational fungicide	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	USA	<i>T. harzianum</i> ATCC 20476 and <i>T. polysporum</i> ATCC 20475	R	Control of fungal pathogens in crops, in greenhouses and open ground for cut flowers, pot plants, vegetables and mushrooms, flower bulbs and nurseries, berries and fruit , ornamental trees and grass fields	Fungi that infect tree wounds, <i>Botrytis</i> , <i>Verticillium</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Rhizoctonia</i> , fairy rings and other soil-borne fungal pathogens, and <i>Didymella</i> , <i>Chondrostereum</i> and <i>Heterobasidion</i>	WP	F						
Bio Max Soil Probiotic	Custom Biologicals, Inc. (http://www.biotamax.com/Tech_Info.html)	USA	<i>Trichoderma</i> spp. (4), <i>Bacillus</i> spp. (5), <i>Paeni Bacillus</i>	Available for use	Seed and Soil Treatment - Increase seed germination, plant growth, root mass		WP		ST					
Bio Tam	Isagro s.p.a.	USA	<i>T. asperellum</i> + <i>T. gamsii</i>	Available for use			WP	F						
Bio-Vam	T&J Enterprises	USA	<i>T. harzianum</i> , <i>T. koningii</i> , ecto-, endo-mycorrhizae	Available for use	Root enhancer; bulbs, seeds, transplants, trees, shrubs, established plants		WP		ST					
Compete Plus	Plant Health Care (http://www.planthealthcare.es)	Spain, USA	<i>T. harzianum</i> + <i>Bacillus</i> (6 spp.) + <i>Streptomyces</i>	Available for use	Soil inoculant, root promotions		WP		ST	FERT				
Custom GP Beneficial Fungi	Custom Biologicals, Inc. (http://www.biotamax.com/Tech_Info.html)	USA	<i>T. harzianum</i> , <i>T. viride</i> , <i>T. koningii</i> , <i>T. polysporum</i>	Available for use	Biological Soil Amendment - Increase plant growth, root mass, yield		WP		ST					
Excalibur Gold, Excalibur Green	ABM, (http://www.abm1st.com/international/products)	USA	<i>Trichoderma</i> spp.	R	Field crops (corn, legumes, cereals, forage), ornamentals, vegetables. Produce a larger root system, inducing disease and drought resistance and increasing nutrient uptake to help plants better utilize the nutrients readily available				ST	FERT	ISR			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma, Gliocladium spp.</i>					F						
Floragard	Sellew & associates llc	USA	<i>T. hamatum</i> isolate 382	R				F						
G-41 Technical, BW240 G, BW240 WP Biological Fungicide (Bioworks inc)	Bioworks inc (http://www.bioworksinc.com/)	USA	<i>T. virens</i> G-41	R	Agricultural, greenhouse, and nursery crops, as well as plants in residential settings (vegetables, fruit, and ornamentals)	control soilborne plant pathogens and plant root diseases	wp, Granules (seed, propagation material, drench, spray)	F						
GlioMix	Verdera Oy (Formerly Kemira Agro Oy), http://www.verdera.fi/homeeng.html	USA; Finland, Germany	<i>Gliocladium</i> spp.	R	Prevention and control of soilborne pathogens; ornamentals and diverse crops		WP (soil, substrate)	F						
Oregonism XL Root Organics	Aurora Innovations, http://www.aurorainnovations.org/oregonism_xl.html	USA, Canada	<i>Trichoderma</i> spp.	Available for use	Biostimulant, increased nutrient uptake, drought tolerance, pathogen resistance		potting soil, hydroponics		ST	FERT	ISR			
Plant Helper	AmPac Biotech, Fresno CA (http://www.ampacbiotech.net/products/main.htm)	USA	<i>T. atroviride</i> (cold tolerant)	Available for use	Plant Growth promotion, natural disease resistance; allow plants to absorb more nutrients from the soil and enhance water transport while maintaining plant health all season long		Liquid, Flowable	F	ST	FERT				
PlantShield HC	Bioworks inc (http://www.bioworksinc.com/)	USA	<i>T. harzianum</i> Rifai strain KRL-AG2	R, Active (California only)	Drench into soil for nursery, greenhouse and vegetables; Pathogen control, promotes a healthier root system, increasing root mass potential; media incorporation – nursery, greenhouse and vegetables	Root disease control, foliar spray to prevent Botrytis and mildews on ornamentals	WP, drench	F	ST	FERT				
Prestop; Prestop Mix; Primastop	Verdera Oy (Formerly Kemira Agro Oy)	Canada, USA	<i>Gliocladium catenulatum</i> J1446	R	For efficient control of soil and foliar pathogens on greenhouse vegetables and ornamentals, herbs, seedling production, control of grey mould on strawberry and raspberry	Control of soil and foliar pathogens <i>Pythium</i> sp., <i>Rhizoctonia</i> sp., <i>Botrytis</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Verticillium</i> , <i>Alternaria</i> , <i>Cladosporium</i> , <i>Helminthosporium</i> , <i>Penicillium</i> , <i>Plicaria</i> , <i>Didymella</i>	WP (drench, dip, spray, soil)	F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Remedier WP	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> strain ICC 012 + <i>T. gamsii</i> ICC080	R - Annex I (2013)	Tomato	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP (drench, drip irrigation)	F						
Root guardian biofungicide for soilborne diseases	Gardens alive! Inc (http://www.gardensalive.com/)	USA	<i>T. harzianum</i> Rifai strain KRL-AG2	R	Application to seeds, plant roots and soil for control of plant root diseases; preventative control of root diseases of vegetable, flower and ornamental plants, promotes bigger, faster-growing, vigorous root systems, releases compounds that make nutrients more available to plants		Granules	F	ST	FERT				
RootShield PLUS WP, RootShield (WP, Granules), RootShield HC	Bioworks inc (http://www.bioworksinc.com)	USA, Canada, EU	<i>T. harzianum</i> Rifai strain T-22 (KRL-AG2)	R	Horticulture and agriculture. Pathogen control, promotes a healthier root system, increasing root mass potential. For media incorporation – nursery, greenhouse and vegetables; Drench for use on nursery, greenhouse and vegetables	Root disease control <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Thielaviopsis</i> and <i>Cylindrocladium</i> ; PLUS <i>Phytophthora</i> , <i>Pythium</i> (P. <i>aphanidermatum</i>),	WP, Granules, seed, propagation material, drench, dip, spray	F	ST	FERT	ISR			
SoilGard 12G	AgBio Development Inc., Certis USA, LLC (http://www.certisusa.com/)	USA	<i>Gliocladium virens</i> GL-21 (Trichoderma virens)	R	Preventative disease control (not curative) in ornamental and food crop plants grown in greenhouses, nurseries, homes, and interiorscapes	<i>Sclerotinia</i> minor & <i>S. sclerotiorum</i> , <i>Pythium</i> , <i>Rhizoctonia</i> and <i>Fusarium</i>	Granules (soil incorporation)	F						
<i>T. gamsii</i> icc 080 technical	Isagro s.p.a.	USA	<i>T. gamsii</i>	R Active				F						
T-22 HC, technical, biological fungicide	Bioworks inc (http://www.bioworksinc.com/)	USA	<i>T. harzianum</i> Rifai strain KRL-AG2	R (Active)	Use for seed treatment, transplants, planting mixes, in-furrow applications; protection root pathogens, enhances nutrient utilization, increases stress tolerance	Root disease control <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Cylindrocladium</i> and <i>Thielaviopsis</i>	wp, Granules	F	ST	FERT	ISR			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F	STIM	FERT/NUTR	ISR	DEC	OTHER
T-22 Planter Box, Bio-trek hb, nursery drench	Bioworks inc., Wilbur ellis co.	USA	<i>T. harzianum</i> Rifai strain KRL-AG2	R (Cancelled 2008)				F	ST	FERT	ISR		
Tenet	Isagro s.p.a.	USA	<i>T. asperellum</i> + <i>T. gamsii</i> 2+2%	Available for use		<i>Pythium</i> , <i>Phytophthora</i> , <i>Botrytis</i> , <i>Rhizoctonia</i>	wp	F					
Trichodex	Makhteshim Chemical Works Ltd.	South Africa, Australia, USA (Cancelled 2004)	<i>T. harzianum</i> Rifai strain T-39 (IMI 206039)	R		<i>Botrytis cinerea</i> , <i>Collectotrichum</i> spp., <i>Fulvia fulva</i> , <i>Monilia laxa</i> , <i>Plasmopara viticola</i> , <i>Pseudoperonospora cubensis</i> , <i>Rhizopus stolonifera</i> , <i>Sclerotinia sclerotiorum</i>		F					
TUSAL WG	NewBiotechnic SA (NBT) Spain (http://www.nbt.es); Certis Europe http://www.certiseurope.com	EU (Spain), USA regist; available Mor, Slov, Turk	<i>T. harzianum</i> + <i>T. viride</i>	R - Annex I (2013)	Prevention and control of root pathogens; Horticulture crops	<i>Rhizoctonia solani</i> , <i>Sclerotinia sclerotiorum</i> , <i>Fusarium</i> sp., <i>Pythium</i> sp., <i>Phytophthora</i> sp.	WG,drip irrigation; W, soil, seed treatment	F					
VIRISAN	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> TV1	R - Annex I (2013)	Tomato	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP, drench, drip irrigation	F					
Zho Rhizosphere Root Inoculant	Botanicare (http://www.botanicare.com/ZHOtrade-Root-Inoculant-P81.aspx)	USA	<i>T. koningii</i> , <i>T. harzianum</i> , <i>Glomus</i> spp. (4)	Available for use	Root inoculant specifically formulated for fruits, vegetables, and soft stemmed plants.		WP - soil treatment		ST				
South and Central America													
Agroguard WG	Live Systems Technology S.A., Colombia (http://ltsa.com)	Colombia	<i>T. harzianum</i> DSM 14944	R	Diverse crops	<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Sclerotinia</i> , <i>Sclerotium</i> <i>e Phoma</i>	Granules	F					
Agrotrich e Agrotrich Plus	Agrosafra Sementes (http://www.agrosafra.a.br)	Brazil	<i>Trichoderma</i> spp. (6 strains)	R Temp.	Potatoes, beans, tomatoes	<i>Sclerotinia</i> , <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Phytophthora</i> , <i>Verticillium</i> , <i>Phomopsis e Roselinia</i>	WP	F					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F	STIM	FERT/NUTR	ISR	DEC	OTHER
Antagon WP	Bio Ecológico Ltda., (http://www.agricultorallimpia.com/)	Colombia	<i>T. harzianum</i>	R	Antibiosis, competition, parasitism, growth promotion; potatoes, rice, beans, soya, onions, tobacco, coffee, strawberry, chrysanthemum and other crops	Preventative control of phytopathogenic fungi - <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Sclerotinia</i> , <i>Sclerotium</i> , <i>Botrytis</i> , <i>Ceratocystis</i> , <i>Rosellinia</i>	WP	F	ST				
Bactiva	Tecnologías Naturales Internacional (http://www.bactiva.com/index.php/it/impresa)	Mexico	<i>Trichoderma</i> spp. + <i>Bacillus subtilis</i>	Available for use	Biofungicide and root biofertilizer/biostimulant		WP	F	ST	FERT			
Biagro TL	BIOAGRO	Argentina	<i>Trichoderma</i> spp.	Available for use		Phytopathogenic fungi		F					
Bioben	Agrícola Innovación (http://www.agricolainnovacion.com)	Mexico		Available for use	OMRI approved	Root pathogens <i>Phytophthora</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Sclerotinia</i> , <i>Sclerotium</i> , <i>Fusarium</i> , <i>Verticillium</i>	WP	F					
Binab T P (in development)	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion); USA (cancelled)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040) + <i>T. polysporum</i> IMI 206039	R, Annex I (2008)	Fruit trees	<i>Chondrostereum purpureum</i> ; biocontrol of Silver Leaf caused by <i>Chondrostereum purpureum</i> transmitted by pruning wound infection or root contacts; pathogenic fungi that cause wilt, take-all, root rot, and internal decay of wood products and decay in tree wounds	Pellets	F					
Binab TF WP	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040)	R, Annex I (2008)	<i>Botrytis cinerea</i> on Strawberries	<i>Chondrostereum purpureum</i> on Ornamental trees	WP (spray)	F					
	Biomycota, Chile. Site: http://www.biomycota.com/	Chile	<i>T. harzianum</i> e <i>T. virens</i>	R	Fruit trees	<i>Phytophthora</i> , <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Verticillium</i> , <i>Macrophomina</i> , <i>Venturia</i>	WP	F					

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Bio Traz	Biomycota, Chile. Site: http://www.biomycota.com/	Chile	<i>T. harzianum</i> e <i>T. virens</i>	R	Protecting the plant from pathogens, nutrient competition	Recommended for control of foliar/aerial diseases caused by Botrytis in grape, Monilinia on stone fruits and cherries.	WP	F		FERT				
BioFungo WP	Orius Biotecnología (http://www.oriusbiotecnologia.com)	Colombia, Ecuador	<i>T. harzianum</i> ATCC 52443	R Colombia, Ecuador	Biofungicide	<i>Botrytis cinerea</i> e <i>Sphaerotheca pannosa</i> on roses	WP	F						
Bioprotection TR	Laboratorios Doctor Obregón (http://www.doctor-obregon.com/Pages/default.aspx)	Costa Rica	<i>T. asperellum</i>	Available for use	Antagonistic fungus, stimulates resistance and plant growth promoter	<i>Rhizoctonia Pythium</i> , <i>Phytophthora</i> , <i>Fusarium</i> , <i>Rhizopus</i> , <i>Mucor</i> , Botrytis, <i>Colletotrichum</i>	WP, Solid (rice), Liquid contains fungus and culture filtrate	F	ST		ISR			
Biorend T	pela Bioagro S.A.; Biotex S.A. (http://www.biorend.cl)	Chile	<i>T. harzianum</i> and chitosan	Available for use	Induction of the mechanism of defence of the plant	<i>Phytophthora</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Cylindrocarpon</i> , <i>Verticillium</i> e <i>Botrytis cinerea</i> .	WP seed, root dip, foliar, irrigazione				ISR			
Biotrich	Biovale Produtos Agropecuários Ltd. (http://www.biovale.com.br)	Brazil	<i>T. viride</i> (1 strain), <i>T. harzianum</i> (3 isolates)	Available for use	Diverse crops	<i>Rhizoctonia</i> , <i>Phytophthora</i> , <i>Sclerotinia</i> , <i>Fusarium</i> , <i>Verticillium</i> , <i>Pythium</i> , <i>Phomopsis</i> , <i>Rosellinia</i> , <i>Pasmodiophora</i>	WP for irrigation	F						
Ecotrich ES	Ballagro Agro Tecnologia Ltd (http://www.ballagro.com.br)	Brazil	<i>T. harzianum</i>	R, Special Temp. Regist. in Brazil	Lettuce, cotton, potatoes, onion, ginger, carrot, sunflower, beans, tobacco, corn, strawberry, cabbage, soya, tomatoes, wheat	<i>Rhizoctonia solani</i> in beans, strawberry and soya, <i>Sclerotinia</i> spp. in beans and soya, <i>Pythium</i> in lettuce	Liquid, seed	F						
Fitotripen WP	Safer Agrobiológicos http://www.agrobiologicos.safer.com/joomla2009/	Colombia	<i>T. harzianum</i> , <i>T. koningii</i> , <i>T. viride</i>	R	Diverse crops	<i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Sclerotinia</i> , Botrytis, Mycosphaerella	WP	F						
Foliguard	Live Systems Technology S.A (http://www.ltsa.com/)	Colombia	<i>T. harzianum</i> DSM 14944	R	Diverse crops; preventive	<i>Botrytis cinerea</i> , <i>Sphaerotheca pannosa</i> , <i>Oidium</i> , <i>Alemaria</i> e <i>Cladosporium</i>	Liquid	F						
ICB Nutrisolo SC e WP	ICB BIOAGRITEC Ltd	Brazil	<i>T. viride</i> , <i>T. harzianum</i> , <i>T. koningii</i> , <i>Trichoderma</i> spp.	R, Temp.	Soilborne pathogens; diverse crops	<i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Phytophthora</i> e <i>Sclerotinia</i>	WP	F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
Mycobac WP	Laboratórios Laverlam (http://www.laverlam.net/catalogo/es/linea-agricola)	Honduras, Colombia	<i>T. lignorum</i>	Available for use	Diverse crops	<i>Rhizoctonia, Sclerotinia, Fusarium, Botrytis, Sclerotium, Rosellinia, Pythium, Armillaria, Alternaria</i> and nematodes		F							NEM
Natibiol	Probiagro S.A., Acarigua, Venezuela	Venezuela	<i>T. harzianum</i>	Available for use	Diverse crops	<i>Rhizoctonia</i>		F							
NatuControl	Biokrone (http://www.biokrone.com)	Mexico	<i>T. harzianum</i>	Available for use	Biofungicide, activate defence mechanisms, growth promotion (fitoalexin production), increased nutrient absorption; OMRI approved	Root fungal pathogens <i>Fusarium, Phytophthora</i> etc.	WP	F	ST	FERT	ISR				
PHC T-22, PHC PlanterBox	Plant Health Care Mexico (http://www.phcmexico.com)	Mexico	<i>T. harzianum</i> strain T-22 (KRL-AG2)	R	Horticulture crops. Pathogen control, promotes a healthier root system, increasing root mass potential; OMRI approved	Root disease control <i>Fusarium, Pythium, Rhizoctonia, Thielaviopsis</i> and <i>Cylindrocladium</i>	WP, Granules (seed, propagation material, drench, dip, spray)	F	ST	FERT	ISR				
Quality WG	Laboratório de Biocontrole Farroupilha Ltda. (http://www.grupofarroupilha.com/)	Brazil	<i>T. asperellum</i>	R	Soya, beans and cotton	Soil pathogens	Granules	F							
Tricho D WP	Orius Biotecnologia /Colômbia, (http://www.oriusbiotecnologia.com/)	Colombia, Ecuador, Panama, Peru, Chile	<i>T. harzianum</i> T-22 (ATCC 20847)	R	Diverse crops - horticulture, ornamentals, fruits	<i>Rhizoctonia, Sclerotinia, Fusarium, Botrytis, Sclerotium, Rosellinia, Pythium, Armillaria, Alternaria</i>	WP	F							
Trichobiol WP	Control Biológico Integrado (http://www.controlbiologicointegrado.com/quienes-somos/); Mora Jaramillo Arturo Orlando – Biocontrol	Colombia	<i>T. harzianum</i>	R	Antagonistic fungus, stimulates resistance and plant growth promoter; reduces incidence of nematodes	<i>Rhizoctonia Pythium, Phytophthora, Fusarium, Rhizopus, Mucor, Botrytis, Colletotrichum</i>	WP	F	ST		ISR				NEM
Trichodel	Empresa Caxiense de Controle Biológico Ltda (http://www.eccb.com.br)	Brazil	<i>Trichoderma</i> spp.	R	Horticultural and fruit crops; hydroponics	<i>Botrytis, Plasmopara, Fusarium, Colletotrichum, Glomerella, Botryosphaeria, Alternaria, Penicillium, Pythium</i>	WP, Liquid (seed, soil, propagation material)	F							

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								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Trichodermax EC	TURFAL - Industria e comércio de produtos biológicos e agrônômicos Ltda. http://www.bioag.no http://www.vozymes.com	Brazil	<i>T. asperellum</i>	R	Preventative disease control, metabolite producer, competition, ISR	<i>Rhizoctonia</i> , <i>Sclerotinia</i> , <i>Fusarium</i> , <i>Botrytis</i> , <i>Monilinia</i> , <i>Verticillium</i> , <i>Pythium</i>	Emulsion	F			ISR			
Trichodermil	Itafor BioProdutos, http://www.itaforbio.com.br	Brazil	<i>T. harzianum</i> strains ESALQ-1306, ESALQ-1303	R	Beans, soya, peppers	<i>Rhizoctonia solani</i> , <i>Fusarium</i> spp., <i>Sclerotinia</i> spp., <i>Pythium</i> spp., <i>Botrytis cinerea</i> , <i>Phytophthora infestans</i>	WP, seed incorporation	F						
Trichodermus WP	Biológicos y ecológicos de Colômbia Ltda	Colombia	<i>T. harzianum</i>	Available for use			WP	F						
Trichogen	Agroquímicos Genéricos, Cali (Colômbia).	Colombia	<i>T. lignorum</i>	Available for use	Control of soil pathogens		WP	F						
Trichol	Productos Biologicos Perkins Ltda, http://www.perkinsltda.com.co/	Colombia	<i>Trichoderma</i> spp.	Available for use	Control of soil pathogens		WP	F						
Trichomax	SolAgro, Trujillo – Peru, http://www.solagro.com.pe	Peru	<i>Trichoderma</i> spp.	Available for use	Diverse crops	<i>Botrytis</i> , <i>Alternaria</i> , <i>Stemphylium</i> , <i>Rhizoctonia</i> , <i>Verticillium</i> , <i>Sclerotium</i> , <i>Sclerotinia</i> , <i>Pythium</i> , <i>Phoma</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Oidium</i> , <i>Peronospora</i> , <i>Alternaria</i>	WP	F						
Trichonat	Natural Rural, Brasil. Site: http://www.naturalrural.com.br	Brazil	<i>Trichoderma</i> spp.	Available for use		<i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i> , <i>Sclerotinia</i> , <i>Sclerotiorum</i> , <i>Botrytis</i> , <i>Alternaria</i> , <i>Phytophthora</i> , <i>Verticillium</i> , <i>Colletotrichum</i> , <i>Armillaria</i> , <i>Rhizopus</i> , <i>Venturia</i> , <i>Endothia</i> , <i>Diaporthe</i> , <i>Fusicladium</i> , <i>Crinipellis</i>	WP, soil, seed	F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.											
Trichonativa	Bio-Insumos Nativa Ltda, http://www.bionativa.cl	Chile	<i>T. virens</i> , <i>T. harzianum</i> , <i>T. parceanamosum</i>	R	Fruit, grapes, tomato, horticultural crops	<i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i> , <i>Sclerotinia</i> , <i>Sclerotium</i> , <i>Botrytis</i> , <i>Phytophthora</i> , <i>Armillaria</i> , <i>Venturia</i>	WP	F						
Trichoplus JCO	JCO Indústria e Comércio de Fertilizantes LTDA, http://www.jcofertilizantes.com.br	Brazil	<i>Trichoderma</i> spp., <i>T. harzianum</i> (spore, mycelia, metabolites)	Available for use		<i>Fusarium</i> , <i>Sclerotinia</i> , <i>Sclerotium rolfsii</i> , <i>Macrophomina</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Cercospora</i> , <i>Phoma</i> , <i>Rosellinia</i> , <i>Phytophthora</i> .	WP, Granules, seed trt, incorporation	F						
Trichosav-34	Institute for Research in Plant Protection (INISAV)	Cuba	<i>T. harzianum</i> A-34	R, Use permit only	Fungicide for control of soil pathogens in vegetables and ornamentals	<i>Rhizoctonia solani</i> , <i>Pythium aphidermatum</i> , <i>Phytophthora parasitica</i> , <i>P. capsici</i> , <i>Sclerotium rolfsii</i> , <i>Fusarium</i> spp.	Homemade - Solid or Liquid	F						
Trichosav-55	Institute for Research in Plant Protection (INISAV),	Cuba	<i>Trichoderma</i> spp. A-55	R, Use permit only	Fungicide for tobacco	<i>Rhizoctonia solani</i> , <i>Pythium aphidermatum</i> , <i>Phytophthora parasitica</i> , <i>P. capsici</i> , <i>Sclerotium rolfsii</i> , <i>Fusarium</i> spp.		F						
Trichosoil	Lage S.A., Uruguay	Uruguay	<i>T. harzianum</i>	Available for use	Prevention and control of root pathogens	<i>Fusarium</i> , <i>Sclerotinia</i> , <i>Pythium</i>		F						
Trichoteam	Bioteam Ind. e Com. Ltda	Brazil	<i>Trichoderma</i> spp.	Available for use	Soil conditioner	<i>Fusarium</i> spp.; <i>Rhizoctonia</i> spp., <i>Crinipellis</i> , <i>Phytophthora</i> sp; <i>Colletotrichum</i> , <i>Cylindrocladium</i> spp.; <i>Alternaria helianthi</i> ; <i>Sclerotinia sclerotiorum</i> , <i>Rosellinia</i> ; <i>Botrytis cinerea</i> ; <i>Verticillium dahliae</i> , <i>Plasmopara viticola</i> .		F		FERT				

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
			<i>Trichoderma</i> , <i>Gliocladium</i> spp.					F						
Trichozam	Hardware & Lumber Limited (Agro Grace Division). Centro de Control Biológico de Centroamérica de Zamorano, Honduras	Honduras, Colombia	<i>Trichoderma</i> spp.	R	Horticultural, ornamentals, maize	<i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Phytophthora</i>	Homemade - Solid or Liquid	F						
Tricodamp	Productividad Biosfera Medio Ambiente (Probioma), Bolivia, http://www.probioma.org.bo	Bolivia	<i>Trichoderma</i> spp.	Available for use	Diverse crops	<i>Fusarium</i> , <i>Verticillium</i> , <i>Sclerotium</i> , <i>Pythium</i> , <i>Rhizoctonia solani</i> , <i>Botrytis</i> , <i>Alternaria</i> , <i>Phytophthora</i>	Seed treatment	F						
Tricovab	Comissão Executiva do Plano da Lavoura Cacaueira - CEPLAC, http://www.ceplac.gov.br	Brazil	<i>T. stromaticum</i> strain 3550	Available for use	Cocoa; use in organic farming	<i>Moniliophthora perniciosa</i>	WP (conidia)	F						
Trifesol	BioCultivos S.A., Bogotá, Colômbia	Colombia	<i>T. viride</i> 2684	Available for use	Prevention and control of nematodes		WP							NEM
Pacific-Oceania														
Bio Sol Tricho	Biological Solutions Ltd (http://www.biosolutions.co.nz/about-bio-solutions)	New Zealand	<i>Trichoderma</i> spp.	Available for use	Biostimulant, increase plant and root growth, defense mechanisms, yield and quality				ST		ISR			
Colonizer	Metcalf Biologicals	Australia	<i>T. koningii</i> Td67	Available for use	Bio-inoculant; natural barrier to the early infection and establishment of latent infection of <i>Botrytis</i> in grapes		WP	F						
DRH <i>Trichoderma</i> Products - DRH Fine, DRH CI, DRH Pellets	GroChem NZ Ltd. http://grochem.co.nz/	New Zealand	<i>Trichoderma</i> (5 isolates)	Available for use	Beneficial soil fungi for improving soil microflora.		WP, Pellets			FERT				
Esquive WP	Agrauxine, ZA de Troyalac'h (http://www.agrauxine.com/)	Europe (France), Australia, New Zealand, South Africa, Vietnam	<i>T. atroviride</i> 1237	R, Annex I (2012)	Vineyards, nursery, Grapes - root, dieback	<i>Eutypa</i> , <i>Botryosphaeria</i> spp., <i>Phaeomoniella</i> , <i>Phaeoacremonium</i>	WP, pruning, dip, aerial spray	F						

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
LettuceMate	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. hamatum</i>	Available for use	Nursery, lettuce; Rootzone seedling inoculant, stimulates root growth		Flake, WP		ST					
Nemesis/Antagonizer	Metcalfe Biologicals	Australia	<i>T. harzianum</i> td81b	Available for use	Bio-inoculant; late season Botrytis in grapes and also Brown rot in Stone fruit		WP	F						
Nutri-Life 4/20	Nutri-Tech Solutions (http://www.nutri-tech.com.au)	Australia	<i>T. lignorum</i> included, Bacteria spp.	Available for use	Freeze-dried blend of bacterial strains and beneficial fungi, nitrogen fixation, humus production, improved nutrient uptake		WP			FERT		DEC		
Nutri-Life Platform	Nutri-Tech Solutions (http://www.nutri-tech.com.au)	Australia	<i>T. lignorum</i> included, mycorrhize	Available for use	Builds humus, improved nutrient uptake, boosts phosphate and zinc availability, nitrogen fixation		Liquid			FERT		DEC		
Nutri-Life TrichoShield	Nutri-Tech Solutions (http://www.nutri-tech.com.au)	Australia	<i>T. harzianum</i> , <i>T. lignorum</i> , <i>T. koningii</i>	Available for use	Root-zone balance is coupled with plant growth promotion, applied to seeds, transplants, bulbs, cuttings, grafts and established crops		Liquid		ST	FERT				
Sentinel (formerly Trichoprotectio n)	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. atroviride</i> LC52	R	bio-fungicide for grey mould or bunch rot of grapes and stem rot of tomatoes	Control of <i>Botrytis cinerea</i>	WP	F						
Solstice	Metcalfe Biologicals	Australia	<i>Trichoderma</i> Td82 and Td84	R	Reduce the level of infection of raspberry canes by <i>Phytophthora</i>			F						
Tenet	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. atroviride</i> LC52	R	Biofungicide applied during field planting of onions and garlic, protection from pathogens, improving plant emergence and establishment	Control of onion white rot and reduction of <i>Fusarium</i> basal rot	Granules	F	ST					
Tenet WP	Isagro USA	Australia	<i>T. asperellum</i> strain ICC012	Available for use				F						
TRIENUM-G	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. For use in the cultivation of vegetables, soft fruit, herbs, bulbs,		Granules	F	ST	FERT	ISR			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵							
								F	STIM	FERT/NUTR	ISR	DEC	OTHER		
			<i>Trichoderma, Gliocladium spp.</i>												
					ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.										
TRIANUM-P	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Tomato, Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. For use in the cultivation of vegetables, soft fruit, herbs, bulbs, ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP, drench, irrigation - propagation, sowing, transplant	F	ST	FERT	ISR				
Trich-A-Soil	Organic Crop Protectants (http://www.ocp.com.au/products.aspx?id=25)	Australia	<i>T. viride</i>	Available for use	Bio-inoculant; growth effects on plants in the presence of diseases like <i>Pythium</i> and <i>Rhizoctonia</i> in horticultural crops, hydroponics and professional turf			F	ST						
Trichodex	Makhteshim Chemical Works Ltd.	South Africa, Australia, USA (Cancelled 2004)	<i>T. harzianum</i> Rifai strain T-39 (IMI 206039)	R		<i>Botrytis cinerea</i> , <i>Collectotrichum</i> spp., <i>Fulvia fulva</i> , <i>Monilia laxa</i> , <i>Plasmopara viticola</i> , <i>Pseudoperonospora cubensis</i> , <i>Rhizopus stolonifera</i> , <i>Sclerotinia sclerotiorum</i>		F							
Trichodry, Trichoflow	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. atroviride</i> LC52	R	Nursery bio-inoculant/fertilizer, distribution in the root zone for establishment		Flake, WP, dry incorporation, drench			FERT					

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Trichopel	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. atroviride</i> LC52	R	Nursery and field bio-inoculant/fertilizer; orchards and vineyards; Root zone starter granule, nutrient start-up and sustainability		Granules			FERT				
Trichospray	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand	<i>T. atroviride</i> LC52	R	Nursery bio-inoculant/fertilizer, foliar spray distribution on foliage and flowers for establishment and growth		WP			FERT				
Unite WP	Agrimm Technologies Limited (http://www.tricho.com/)	Australia, New Zealand	<i>T. harzianum</i>	R	Rootzone Drench - Registered for Control of damping off and root rot	Barrier against damping off and root rots while boosting the resilience and strength of the plant's own immune system	WP	F			ISR			
Vinevax Biodowel	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand, Australia	<i>T. atroviride</i> LC52	R	Natural "vaccination" treatment lasting 4 -5 years protecting orchard, ornamental trees and grapevines against many wood-infecting fungi causing trunk and root diseases. Improves crop productivity by stimulating a systemic protective response to plant stress	Eutypa dieback	Solid (wood dowels)	F	ST		ISR			
VINEVAX™ Bio-injection (formerly Trichobject)	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand, Australia	<i>T. atroviride</i> LC52	R	Liquid injection plant defence booster. Protects kiwifruit vines against <i>Armillaria</i> root rot; orchard and ornamental trees against wood and root decay fungi	Eutypa dieback	WP	F	ST		ISR			
VINEVAX™ Pruning Wound Dressing	Agrimm Technologies Limited (http://www.tricho.com/)	New Zealand, Australia	<i>T. atroviride</i> LC52	R	Living barrier treatment for pruning wounds. Protects orchard trees against many wood decay fungi including silver leaf and grapevines against dieback, dead arm and vine decline diseases	Eutypa dieback	WP	F	ST		ISR			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵					
								F	STIM	FERT/NUTR	ISR	DEC	OTHER
Multiple Worldwide Zones													
Binab T P (in development)	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion); USA (cancelled)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040) + <i>T. polysporum</i> IMI 206039	R, Annex I (2008)	Biocontrol; Fruit trees	Silver Leaf caused by <i>Chondrostereum purpureum</i> transmitted by pruning wound infection or root contacts; pathogenic fungi that cause wilt, take-all, root rot, and internal decay of wood products and decay in tree wounds	Pellets	F					
Binab T Vector	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	USA, EU (SE, DN)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040)	R	A powder for treating flowers against fungal pathogens through vector transmission; Strawberries	Controls fungal pathogens such as <i>Botrytis</i> , <i>Verticillium</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Rhizoctonia</i> , fairy rings and other soil-borne fungal pathogens, and <i>Didymella</i> , <i>Chondrostereum</i> and <i>Heterobasidion</i>	WP (bumblebee vectoring);	F					
Binab TF WP	Binab bio-innovation efr ab (www.algonet.se/~binab/index2.html)	EU (SE, DN); Chile (imported by Agro-Connexion)	<i>T. atroviride</i> IMI 206040 (formerly <i>T. harzianum</i> IMI 206040)	R, Annex I (2008)	<i>Botrytis cinerea</i> on Strawberries	<i>Chondrostereum purpureum</i> on Ornamental trees	WP (spray)	F					
Biocure F	T. Stanes and Company Limited, Coimbatore, Tamilnadu; http://www.tstanes.com	EU; available India	<i>T. viride</i>	R	Diverse crops; NPOP, NOP; IMO OVP	<i>Pythium</i> sp., <i>Rhizoctonia solani</i> , <i>Fusarium</i> spp., <i>Botrytis cinerea</i> , <i>Sclerotium rolfsii</i> , <i>Sclerotinia homoeocarpa</i> , <i>Ustilago tritici</i>	WP, Solid, Liquid	F					
Compete Plus	Plant Health Care (http://www.planthealthcare.com)	Spain, USA	<i>T. harzianum</i> + <i>Bacillus</i> spp. (6) + <i>Streptomyces</i>	Available for use	Soil inoculant, root promotion		WP	F	ST	FERT			
Eco-T	Plant Health Products (Pty)Ltd - http://www.plant-health.co.za/	Reg. South Africa, Kenya and Zambia; in process. FR, UK, Marocco, Tunisia and India	<i>T. harzianum</i> strain kd	R	Control of crop root diseases and for enhanced plant growth	<i>Rhizoctonia</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i>	WP, seed trt, irrigation	F	ST				

Appendix 1. contd...

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
Esquive WP	Agrauxine, ZA de Troyalac'h (http://www.agrauxine.com)	Europe (France), Australia, New Zealand, South Africa, Vietnam	<i>T. atroviride</i> 1237	R, Annex I (2012)	Vineyards, nursery, Grapes - root, dieback	<i>Eutypa</i> , <i>Botryosphaeria</i> spp., <i>Phaeoniella</i> , <i>Phaeoacremonium</i>	WP, pruning, dip, aerial spray	F						
GlioMix	Verdera Oy (Formerly Kemira Agro Oy), http://www.verdera.fi/homeeng.html	USA; Finland, Germany	<i>Gliocladium</i> spp.	R	Prevention and control of soilborne pathogens; ornamentals and diverse crops		WP, soil, substrate	F						
Promot WP	Biofa AG (Bio-farming systems) - http://www.biofarming.de	R in Germany; Kenya (temp. 2010)	<i>T. harzianum</i> , <i>T. koningii</i>	R	Horticultural and ornamental crops	controle de podridões radiculares e tombamentos causados por <i>Pythium</i>	WP	F						
Remedier WP	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> strain ICC 012 + <i>T. gamsii</i> ICC080	R - Annex I (2013)	Tomato	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP (drench, drip irrigation)	F						
RootShield PLUS WP, RootShield (WP, Granules), RootShield HC	Bioworks inc (http://www.bioworksinc.com/)	USA, Canada, EU	<i>T. harzianum</i> Rifai strain T-22 (KRL-AG2)	R	Horticulture and agriculture. Pathogen control, promotes a healthier root system, increasing root mass potential. For media incorporation – nursery, greenhouse and vegetables; Drench for use on nursery, greenhouse and vegetables	Root disease control <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Thielaviopsis</i> and <i>Cylindrocladium</i> ; PLUS <i>Phytophthora</i> , <i>Pythium</i> (<i>P. aphanidermatum</i>),	WP, Granules, seed, propagation material, drench, dip, spray	F	ST	FERT				
TRIANUM-G	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. Vegetables, soft fruit, herbs, bulbs, ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.		Granules	F	ST	FERT	ISR			

Product Name	Company/Distributor (website)	Country ¹	Active Substances	Registered ²	Target Uses, Label Claims, Recommended Crops, Organic Farming Approval Agency ³	Target Pests	Formulation ⁴	Product Claims for Use ⁵						
								F	STIM	FERT/NUTR	ISR	DEC	OTHER	
TRIENUM-P	Koppert B.V. (http://www.koppert.com/diseases/overview/)	EU, New Zealand, Australia	<i>T. harzianum</i> strain T-22 (Item 108)	R, Annex I	Tomato, Turf- greens. Increases resistance of plants to stress caused by diseases, sub-optimal feeding and watering. Vegetables, soft fruit, herbs, bulbs, ornamentals, perennials, turf and arboriculture (both protected and open field), regimes or climatic conditions, and increases nutrient uptake; enhanced growth and development of roots and above-ground plant parts.	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP, drench, irrigation - propagation, sowing, transplant	F	ST	FERT	ISR			
Trichodex	Makhteshim Chemical Works Ltd.	South Africa, Australia, USA (Cancelled 2004)	<i>T. harzianum</i> Rifai strain T-39 (IMI 206039)	R		<i>Botrytis cinerea</i> , <i>Collectotrichum</i> spp., <i>Fulvia fulva</i> , <i>Monilia laxa</i> , <i>Plasmopara viticola</i> , <i>Pseudoperonospora cubensis</i> , <i>Rhizopus stolonifera</i> , <i>Sclerotinia sclerotiorum</i>		F						
TUSAL WG	NewBiotechnic SA (NBT) Spain (http://www.nbt.es); Certis Europe (http://www.certiseurope.com)	EU (Spain), USA regist; available Mor, Slov, Turk	<i>T. harzianum</i> + <i>T. viride</i>	R - Annex I (2013)	Prevention and control of root pathogens; Horticulture crops	<i>Rhizoctonia solani</i> , <i>Sclerotinia sclerotiorum</i> , <i>Fusarium</i> sp., <i>Pythium</i> sp., <i>Phytophthora</i> sp.	WG, drip irrigation; W, soil, seed treatment	F						
VIRISAN	Isagro USA	European Union, USA regist; available Mor, Slov, Turk	<i>T. asperellum</i> TV1	R - Annex I (2013)	Tomato	<i>Rhizoctonia</i> spp., <i>Fusarium</i> sp., <i>Pythium</i> sp.	WP, drench, drip irrigation	F						

Note: This list is not considered to be complete; any omissions or errors are regretted. Furthermore, indications to commercial products by the authors does not in anyway signify an endorsement of the product or manufacturer/distributor.

¹Country – where product is commercially marketed

²Registration: **R** – registered for use by authorized agency anywhere in the world; **R, Annex I** (date) – registered for use by the European Commission; active product included in Annex I list (date of approval); **R** – putative registered product, sources not confirmed; Available for use – distributed on the commercial market, not registered

³Organic Farming Agencies: IMO OVP (Institute for Marketecology - Off farm input Verification Procedure) approved list of inputs and manufacturers, IMO India, 20130325; EU Organic according/equivalent to EU Reg (EC) 834/2007 and 889/2008 (http://www.imo.ch/logicio/pmws/indexDOM.php?client_id=imo&page_id=home&lang_iso639=en); JAS (Japanese Agricultural Standard); NOP (US National Organic Program NOP); NPOP (National Program for Organic production NPOP); ORMI – Organic Materials Review Institute

⁴Formulations: WP - wettable powder; Gran – Granules; Liq – Liquid; Pell – Pellets; Solid - Rice, dowels, coco, soil

⁵Product claims: F - Fungicide, fungal pathogen control, preventative, curative; ST - Stimulant, growth promoter/enhancer of roots, plant or yield; FERT - Fertilizer, or improved nutrient availability, uptake, solubilization; ISR - Induced Resistance to pathogens and/or abiotic stresses; DEC- Decomposer; NEM – nematocide; INS - Insecticide

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