Review

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Microbial antagonists against plant pathogens in Iran: A review

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Abstract: The purpose of this article was to give a comprehensive review of the published research works on biological control of different fungal, bacterial, and nematode plant diseases in Iran from 1992 to 2018. Plant pathogens cause economical loss in many agricultural products in Iran. In an attempt to prevent these serious losses, chemical control measures have usually been applied to reduce diseases in farms, gardens, and greenhouses. In recent decades, using the biological control against plant diseases has been considered as a beneficial and alternative method to chemical control due to its potential in integrated plant disease management as well as the increasing yield in an eco-friendly manner. Based on the reported studies, various species of *Trichoderma*, *Pseudomonas*, and *Bacillus* were the most common biocontrol agents with the ability to control the wide range of plant pathogens in Iran from lab to the greenhouse and field conditions.

Keywords: biological control, *Trichoderma*, *Pseudomonas*, *Bacillus*

1 Introduction

Increasing human population in the world demands more food (70 to 100%) by 2050 to supply human needs (Godfray et al. 2010). Furthermore, different pests and diseases cause annual economic losses (20 to 40%) in agricultural products by decreasing the crop yield, destroying the quality, and pollution of products with toxic chemicals

(Guo et al. 2013). Therefore, growers have generally concentrated on the intensive use of chemicals for the management of pests and diseases which induce several problems, including resistance to pesticides, hazardous effects on human health, loss of beneficial soil microorganisms, entrance of residual toxic material in the food chain, and reduction in macro-microorganism biodiversity (Sindhu et al. 2016). These problems make enhanced attempts for developing ecofriendly microbe-based pesticides or biopesticides which use biological control agents (BCAs) as active ingredients and basically act different from common chemical pesticides (Sindhu et al. 2009).

Biological control, which attracted broad considerations in the past few decades, is defined as a bioeffector strategy that uses other living organisms for controlling insects, mites, weeds, and phytopathogens (Flint et al. 1998). Biocontrol agents either with antagonistic activities, or modifying effects on plant physiology and anatomy, mostly reduce the negative effects of pathogens. The advantages of beneficial microbes for associated plants are establishment of antagonistic microorganisms, prevention of phytopathogens, overall improvement of plant health, plant growth promotion, enhanced nutrient availability and uptake, and increased resistance to both biotic and abiotic stresses in the hosts (Vinale et al. 2014).

The first published studies on biological control of plant pathogens in Iran were presented in 1992. *Trichoderma* spp. and *Gliocladium* spp. were the first biocontrol agents applied against *Athelia rolfsii* (*Sclerotium rolfsii*), *Rhizoctonia solani*, and *Fusarium solani*, the causal agents of diseases on groundnut, bean, and apple, respectively (Asghari and Myee 1992; Bazgir et al. 1992; Karampour and Okhovat 1992). In the twenty-first century, with the improvement of biological control of plant pathogens throughout Iran, different biocontrol agents have been applied against the various pathogens *in vitro*, in greenhouse and field conditions. A large number of fungal and bacterial biocontrol agents have been found as the most important agents for plant disease management with identification of their role in plant pathogen management (Ramadan et al. 2016). *Trichoderma*, *Pseudomonas*, and *Bacillus* species have mostly been used for biological control of phytopathogens in Iran (Peyghami

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and Nishabouri 1998; Shahiri Tabarestani et al. 2000; Mostofizadeh-Ghalamfarsa et al. 2002; Niknejad-Kazempour et al. 2004a,b; Golzary et al. 2008b; Peighami-Ashnaei et al. 2009a,b; Ojaghian et al. 2010; Khalighi and Khodakaramian 2012; Naeimi and Zare 2013; Azizpour and Rouhrazzi 2016; Karimi et al. 2016; Khaledi and Taheri 2016; Abdoli et al. 2018; Hosini et al. 2018; Zeynadini-Riseh et al. 2018). Furthermore, because of increasing the stability of biological agents, the bioformulation progress has recently been evaluated in Iran (Karimi and Sadeghi 2015). The current study is a comprehensive review of applying fungal and bacterial antagonists for biological control of various plant diseases caused by fungal, bacterial, and nematodes in Iran during a period of 26 years.

2 Mechanisms of biocontrol agents for the management of phytopathogens

A key factor for attaining an effective prevention of phytopathogens in their hosts is the knowledge about their mechanism of action. Understanding the mechanisms in the biological control process can allow the establishment of favorable conditions in the interaction between phytopathogen and biocontrol agent that is important in

performing a successful biological control strategy in a specific pathosystem (Handelsman and Stabb 1996). The microorganisms operating for biocontrol of phytopathogens have different modes of action (Nega 2014). In the present study, the most common mechanisms of interspecies antagonisms include direct antagonism, mixed-path antagonism, and indirect antagonism (Pal and McSpadden 2006; Parveen et al. 2016), which lead to biological control of plant pathogens, have been addressed. Microbial biocontrol agents take care of plants against pathogens via different modes. These agents could induce resistance or initial enhanced resistance against pathogens without direct confrontation with the phytopathogen. Also, competitions for nutrients and spaces are additional indirect interactions with phytopathogens (Köhl et al. 2019). These agents might directly interact with the pathogens using hyperparasitism (Ghorbanpour et al. 2018) or antibiosis (Raaijmakers and Mazzola 2012). Without these agents in soil and tissues of plants, the pathogens easily attack plants and could weaken or kill considered hosts (Figure 1). These modes will be discussed in the following sentences.

2.1 Parasitism

Mycoparasitism, direct parasitism or hyperparasitism, is the ability of fungal antagonistic agents to parasitize other fungi

Figure 1: Left: in the absence of antagonists, different pathogens especially fungi, bacteria, and nematodes can cause losses in plants. Over time, affected plants will show the weakness in the development and symptoms of diseases. Right: in the presence of antagonists with different biocontrol mechanisms, such as competition, parasitism, and antibiosis, the pathogens will not be able to progress in the host, and thus, the plant can grow and develop well rather than the absence of antagonists in soil and tissues of hosts.

for utilizing them as food. Mycoparasitism causes either complete death of fungal propagules or destruction and lysis of their structure (Maloy 1993). Mycoparasitism depends upon the sequential occurrence of the following events: coming into close contact with fungal pathogen, mutual recognition between antagonist and pathogen, lytic enzyme secretion by antagonist, penetration into the host, active growth of antagonist into the host, and exit (Spadaro and Gullino 2004; Talibi et al. 2014). Various chemical compounds can be implicated in these processes, such as lectins, during the initial contact and recognition and cell wall-degrading enzymes (CWDEs), such as β -1,3-glucanases, chitinases, proteinases, and lipases, during the penetration process (Vos et al. 2015). Wisniewski et al. (1991) who studied biological control of *Botrytis cinerea* by yeast antagonist *Meyerozyma guilliermondii* (*Pichia guilliermondii*) demonstrated that lectin-like interaction resulted in firm attachment of antagonist's cell to *B. cinerea*. Lysis of fungal cell wall also occurred due to the action of extracellular β -1,3-glucanase enzyme secreted by the antagonistic yeast. *Trichoderma* species are specific mycoparasitic fungi with the species of *T. atroviride*, *T. virens*, and *T. reesei* confirming that mycoparasitism is their ancestral lifestyle (Kubicek et al. 2011).

One of the main components in mycoparasitism event is CWDEs including endochitinases, β -1,3-glucanases, and proteases that are extracellular enzymes secreted by *Trichoderma* (Vos et al. 2015). After initial pathogen recognition by *Trichoderma*, hyphae wind around the pathogen's hyphae by forming hook, the appressorium permeates into the pathogen cell, and chitin is broken down by enzymes such as chitinase and glucanase (Ghorbanpour et al. 2018). Subsequently, mycoparasitic's hyphae release antibiotic compounds which penetrate the affected pathogen's hyphae and resynthesize the host cell wall inhibited by these compounds (Toghuea et al. 2016).

2.2 Antibiotic

Antibiotic is a secreting secondary metabolite with low molecular weight that is deleterious to the other microorganisms at low concentrations (Fravel 1988). The antibiotic produced by biocontrol agents decreases the disease symptoms as a main contributing mechanism particularly under soil conditions (Haas and Défago 2005). Some soilborne microorganisms, such as different strains of fluorescent *Pseudomonas* and *Bacillus* (Weller 1988) and *Trichoderma* species (Benítez et al. 2004), have appropriate features for biocontrol abilities. Furthermore, several strains

of these species are able to promote plant growth and development as well as the disease prevention (Fernando et al. 2006; Arseneault and Filion 2017). The antibiotics at subinhibitory concentrations may inhibit the release of extracellular virulence factors and adherence mechanisms in bacteria (Kumar et al. 2008). Secondary metabolites can impress the community of soil microbial ecosystems in a variety of ways and levels (Abawi and Widmer 2000). The antibiotic production has been confirmed to be an important mechanism applied by microorganisms to manage a wide range of plant pathogens (McSpadden and Fravel 2002). Even at subinhibitory concentrations, antibiotics can create physiological changes in organisms. For instance, in *Pseudomonas aeruginosa* quinolone and macrolide antibiotics can block cell signaling and production of virulence factors (Ulloa-Ogaz et al. 2015). *Bacillus* spp. produce enzymes, exotoxins, and metabolites with nematocidal activity (Engelbrecht et al. 2018). Although several rhizobacteria such as *Pasteuria*, *Pseudomonas*, and *Streptomyces* have nematocidal efficacy, the largest decrease in the hatching of *Meloidogyne javanica* eggs was found in *Bacillus* (74%) and *Pseudomonas* (54.77%) (Turatto et al. 2017). Furthermore, *Bacillus* spp. with antibiotic production are applied as antifungal antagonists for controlling postharvest diseases. Pyrrolnitrin antibiotic produced by *Burkholderia cepacia* has been used against *Penicillium digitatum*, *B. cinerea*, and *Penicillium expansum* pathogens. Similarly, syringomycin produced by *Pseudomonas syringae* was utilized to prevent citrus green mold and apple grey mold (Dukare et al. 2019). Alongside these beneficial microorganisms, *Streptomyces* spp. can help plants with antibiotic production against phytopathogens (Olanrewaju and Babalola 2019).

2.3 Cell wall degradation enzymes

Microorganisms which produce enzymes are able to hydrolyze chitin, proteins, cellulose, and hemicellulose and also may play a role in the suppression of plant pathogens. Chitin and β -1,3-glucans are major constituents of many fungal cell walls (Lam and Gaffney 1993). *Trichoderma* strains with antagonistic potential have been mainly characterized by their ability to secrete enzymes such as chitinases, glucanases, and proteases that hydrolyze the cell walls of pathogens (López-Mondéjar et al. 2011). Geraldine et al. (2013) reported that *N*- β -acetylglucosaminidase and β -1,3-glucanase are the key components of *Trichoderma* species action in biocontrol of *Sclerotinia sclerotiorum* in the field. *Serratia marcescens* which produces chitinases was found to

suppress the growth of *Botrytis* spp., *R. solani*, and *Fusarium oxysporum* (Ningaraju 2006).

2.4 Competition for available resources

Microorganisms' challenge for available resources is named competition. For instance, when pine stumps were inoculated by spores *Phlebiopsis gigantea* (*Phlebia gigantea*), the spores prevent from *Heterobasidion annosum* infections. Considering that the pathogen is non-established on the pine, the severity of root rot disease could be decreased by the biocontrol agent (Cook and Baker 1983). Despite the possibility of existing antagonistic relationship (e.g., antibiosis) between the two fungi, the achievement of available resource sites may be the first mechanism in competition (Maloy 1993). Carbon sources such as glucose and fructose are one of the important action modes in yeasts *Papiliotrema laurentii* (*Cryptococcus laurentii*) and *Sporobolomyces roseus*, which can control *B. cinerea* in decreasing its colonization and sporulation (Ghorbanpour et al. 2018). In the biological control of *P. digitatum* by *Debaryomyces hansenii*, competition plays an important role in obtaining nutrients in occupied sites (Droby et al. 1998). Furthermore, arbuscular mycorrhiza due to the creation of physiological and anatomical modifications can limit the progression of pathogen. These changes involve root lignification, creation of a thick cell wall using pectin, chitinase activation, and transfer of pathogenesis-related protein-1a to the infected area of root (Malik et al. 2016).

2.5 Siderophore

Low-molecular weight chelators with a very high and specific affinity for Fe(III) are called siderophores (Barbeau et al. 2002). Aerobic and facultative anaerobic microorganisms with the ability of siderophore production may have an important role in microorganism interactions (Haggag and Mohamed 2007). Siderophores have been known to play a significant role in phytopathogen prevention by several bacteria as BCAs which prevent the growth, development, and metabolic activity of phytopathogens by iron chelation (Haggag Wafaa et al. 2000). Different species of *Trichoderma* as biocontrol antagonists release more effective siderophores that chelate iron (Fe^{3+}) and prevent growth and development of other fungal pathogens (Naher et al. 2014). Iron competition can be a limiting factor in alkaline soils for

microbial growth and development (Leong and Expert 1989). Siderophores produced by some bacteria, such as fluorescent pseudomonads, have very high dependency for iron, as a result, sequestering these limited resources from other microflora can inhibit their growth and development (Loper and Buyer 1991). In several studies, it has been reported that *Pseudomonas fluorescens* with siderophore biosynthesis plays an important role in the prevention of pathogen (Costa and Loper 1994). *Rahnella aquatilis* with siderophore production can inhibit *B. cinerea* and *P. expansum* postharvest pathogens (Calvo et al. 2007). The siderophore pulcherrimin produced by *Metschnikowia pulcherrima* and *Monilia fructicola* yeasts was applied for biological control of postharvest apple pathogens *B. cinerea*, *Alternaria alternata*, and *P. expansum* (Saravanakumar et al. 2008). In particular, several species of *Streptomyces* detach iron by siderophore production in a way that some pathogens, owing to a lack of siderophore production, cannot take these ions for growth (Kloepper et al. 1980).

2.6 Induction of host resistance

Plant growth promoting rhizobacteria can protect plants against pathogens using induction of systemic resistance (ISR) (Sikora 1992). *P. fluorescens* with stimulating ISR can prevent the early penetration of *Heterodera schachtii* to roots (Oostendorp and Sikora 1989). The ISR stimulation by *Bacillus subtilis* leads to the protection of cotton plants against *Meloidogyne incognita* and *Meloidogyne arenaria*. The ISR stimulation by *Pseudomonas putida* and *S. marcescens* inhibited cucumber *Fusarium* wilt caused by *F. oxysporum* f.sp. *cucumerinum*. The application of *Pseudomonas* sp. in plants leads to systematic protection against *F. oxysporum* f.sp. *dianthi* (David et al. 2018). *Flavimonas oryzihabitans*, *S. marcescens*, and *Bacillus pumilus* have developed ISR against *P. syringae* pv. *lachrymans* (David et al. 2018).

The direct promotion of plant growth by plant growth promoting bacteria through the production of phytohormones has been called phytostimulation (Bloemberg and Lugtenberg 2001). The enzyme 1-aminocyclopropane-1-carboxylate (ACC) deaminase is a phytostimulation that is the most studied one. Some bacterial endophytes producing ACC deaminase have been shown to enhance plant growth, such as *Arthrobacter* spp., *Bacillus* spp., *P. putida*, *Rhodococcus* spp. (Belimov et al. 2001; Sziderics et al. 2007), and *Streptomyces* spp. (Palaniyandi et al. 2014; Jaemsaeng et al. 2018). The bacterial strains producing

other plant hormones, including indole-3-acetic acid (IAA), jasmonates, and abscisic acid, may also contribute to plant growth stimulation (Patten and Glick 2002; Forchetti *et al.* 2007). IAA is synthesized by different species of *Streptomyces*, such as *S. violaceus*, *S. griseus*, *S. exfoliate*, *S. coelicolor*, and *S. lividans* (Manulis *et al.* 1994). Also, IAA in *S. atrovirens* activates growth promoting bacteria in groundnut and several crops (Reddy *et al.* 2016).

3 Reduction in the population of biocontrol agents

Phytopathogens may significantly alleviate the growth of biocontrol agents by using the nutrition resources within their occupied spaces more rapidly as well as by modifying their efficacy. This was found in several fungal root pathogens which can colonize the wheat rhizosphere despite the presence of *P. fluorescens* biocontrol agent (Mazzola and Cook 1991). Decline in the population of *P. fluorescens* occurs in the existence of some *Pythium* species. In this instance, infection by *Pythium* species leads to the limitation of the root surface which is available for *P. fluorescens* colonization and to the reduction of population of potential antagonists. Fedi *et al.* (1997) reported that a plant pathogenic *P. ultimum* with modification of gene expression of *P. fluorescens* tends to decrease biocontrol agent population. The competition in the rhizosphere for nutrients released from root wounds caused by *P. ultimum* was limited by the reduction of population size. Because of the importance of microbial community in number and diversity, competition and microorganism–microorganism interactions may also happen in phyllosphere (Vorholt 2012). On the other hand, existence of these microbial communities may also impress the efficacy of BCAs. Understanding the rhizosphere, phyllosphere, and endosphere microbial community structure and their interactions in these niches can contribute to the betterment of biocontrol (Bardin *et al.* 2015).

4 Improving the biocontrol agent effects

The use of combinations of BCAs may be a better method for developing biocontrol positive effects

(Duffy and Weller 1995). Combined biocontrol agents with high level of biocontrol protection have been investigated for better efficacy and prevention of several phytopathogens (Mihajlović *et al.* 2017). It has been confirmed that natural prevention of Fusarium wilt in France (Châteaurenard soil) was related to the different mechanisms in which multiple microorganisms singly or together restricted the pathogen activation (Alabouvette *et al.* 1998). However, given that the application of biological control against soilborne pathogens will not be a good replacement of methyl bromide fumigation, these two methods could act together in integrated pest management (Akrami *et al.* 2011).

5 Biological control in Iran

A complete list of all pathogens and the antagonists used against them is provided in Table 1. Results showed that most studies were conducted *in vitro* and in greenhouse conditions, and a few cases were carried out in the farm condition in Iran. Bacterial strains belonging to 24 genera, *Achromobacter*, *Acinetobacter*, *Azotobacter*, *Bacillus*, *Beauveria*, *Bradyrhizobium*, *Brochothrix*, *Burkholderia*, *Enterobacter*, *Erwinia*, *Escherichia*, *Flavobacterium*, *Lactobacillus*, *Mesorhizobium*, *Paenibacillus*, *Pantoea*, *Pasteuria*, *Pseudomonas*, *Rhizobium*, *Serratia*, *Sphingomonas*, *Sporolactobacillus*, *Stenotrophomonas*, and *Streptomyces*, have been used in various studies. Also, fungal strains belonging to 27 genera, *Acremonium*, *Alternaria*, *Arthrinium*, *Arthrotrichum*, *Aspergillus*, *Chaetomium*, *Cladobotryum*, *Coniothyrium*, *Embellisia*, *Fusarium*, *Gliocladium*, *Glomus*, *Hypsizygus*, *Lecythophora*, *Metarhizium*, *Paecilomyces*, *Penicillium*, *Periconia*, *Piriformospora*, *Pleurotus*, *Pythium*, *Scopulariopsis*, *Sebacina*, *Talaromyces*, *Trichoderma*, *Trichothecium*, and *Verticillium*, have been applied in Iranian studies against different plant pathogens. Also, strains of ten genera, *Candida*, *Galactomyces*, *Hanseniaspora*, *Metschnikowia*, *Meyerozyma*, *Pichia*, *Rhodotorula*, *Saccharomyces*, *Torulaspora*, and *Zygoascus*, which belong to the yeast have been used for controlling the phytopathogens in Iran. The bacterial strains related to different species of *Pseudomonas* and *Bacillus* and fungal strains related to *Trichoderma* species had the greatest efficiency in biological control of different plant pathogens in Iran. These antagonists have been mostly used for biological control of fungi, bacteria, and nematodes, respectively.

Table 1: List of pathogens, hosts, and antagonists with procedures based on published research works in Iran from 1992 to 2018

Pathogens	Host	Antagonists	Procedure	Ref.
<i>Rhizoctonia solani</i>	Bean	<i>Gliocladium</i> sp.	<i>In vitro</i> and greenhouse	Bazgir et al. (1992)
<i>Athelia rolfsii</i> (<i>Sclerotium rolfsii</i>)	Groundnut	<i>Trichoderma harzianum</i>	Greenhouse	Asghari and Myee (1992)
<i>Fusarium solani</i>	Apple	<i>T. koningii</i> , <i>T. viride</i> , <i>T. harzianum</i> , and <i>T. virens</i> (<i>Gliocladium virens</i>)	Greenhouse	Karampour and Okhovat (1992)
<i>Colletotrichum coccodes</i>	Potato	<i>Trichoderma</i> spp.	<i>In vitro</i>	Okhovat et al. (1994)
<i>R. solani</i>	Rice	<i>T. koningii</i> , <i>T. viride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Field	Izadyar and Padasht (1994)
<i>R. solani</i>	Rice	<i>Trichoderma</i> sp.	<i>In vitro</i>	Pourabdullah and Binesh (1994)
<i>Phytophthora erythroseptica</i>	Potato	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. koningii</i>	<i>In vitro</i>	Zafari et al. (1994)
<i>R. solani</i>	Bean	<i>T. viride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Greenhouse	Bazgir et al. (1994a)
<i>R. solani</i>	Bean	<i>T. viride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Field	Bazgir et al. (1994b)
<i>Scelotinia sclerotiorum</i>	Eggplant	<i>T. reesei</i> , <i>T. hamatum</i> , <i>T. longibrachiatum</i> , <i>T. koningii</i> , <i>T. viride</i> , <i>T. virens</i> , and <i>Gliocladium</i> sp.	<i>In vitro</i>	Amir-Sadeghi et al. (1994)
<i>Macrophomina</i> sp. and <i>Rhizoctonia</i> sp.	Soybean	<i>Bacillus subtilis</i>	<i>In vitro</i> and greenhouse	Sanei and Ghobadi (1995)
<i>Heterodera schachtii</i>	Sugar beet	<i>Paecilomyces farinosus</i>	<i>In vitro</i>	Ahmadi et al. (1995a)
<i>H. schachtii</i>	Sugar beet	<i>F. solani</i>	<i>In vitro</i>	Ahmadi et al. (1995b)
<i>H. schachtii</i>	Sugar beet	<i>Acremonium</i> spp., <i>Embellisia chlamydospora</i> , <i>Fusarium</i> spp., <i>P. lilacinus</i> , <i>Scopulariopsis brevicaulis</i> , <i>Verticillium chlamydosporium</i> , and <i>Verticillium lecanii</i>	<i>In vitro</i>	Hojjat Jalali and Coosemans (1995)
<i>Tilletia laevis</i>	Cucumber	<i>T. viride</i>	Greenhouse	Peyghami and Babadoost (1996)
<i>T. controversa</i>	Wheat	<i>T. viride</i>	Greenhouse	Peyghami and Babadoost (1996)
<i>F. solani</i>	Chickpea	<i>T. koningii</i> , <i>T. viride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Greenhouse	Okhowat and Karampour (1996)
<i>M. javanica</i>	—	<i>Pasteuria penetrans</i>	Greenhouse	Damadzadeh et al. (1996)
<i>M. javanica</i> , <i>M. incognita</i> , and <i>M. arenaria</i>	—	<i>P. penetrans</i>	<i>In vitro</i>	Ameri et al. (1996)
<i>Macrophomina phaseolina</i> and <i>R. solani</i>	Soybean	<i>B. subtilis</i>	<i>In vitro</i>	Sanei and Ghobadi (1996)
<i>H. schachtii</i>	Sugar beet	<i>E. chlamydospora</i> , <i>Acremonium</i> spp., <i>S. brevicaulis</i> , <i>P. lilacinus</i> , <i>Fusarium</i> spp., <i>V. chlamydosporium</i> , and <i>V. lecanii</i>	<i>In vitro</i>	Hojjat-Jalali and Coosemans (1995)
<i>Pythium ultimum</i>	Chickpea	<i>T. viride</i> and <i>T. virens</i>	Field	Shahriary et al. (1996)
<i>M. javanica</i>	Tomato	<i>P. lilacinus</i>	Greenhouse	Fatemy (1996)
<i>H. schachtii</i>	Sugar beet	<i>P. farinosus</i>	<i>In vitro</i>	Ahmadi et al. (1996a)
<i>H. schachtii</i>	Sugar beet	<i>F. solani</i>	<i>In vitro</i>	Ahmadi et al. (1996b)
<i>R. solani</i> , <i>Colletotrichum coccodes</i> , and <i>Phytophthora drechsleri</i>	—	<i>Trichoderma</i> spp. and <i>Gliocladium</i> sp.	<i>In vitro</i>	Okhovat (1997)
<i>H. schachtii</i>	Beet	<i>Paecilomyces fumosoroseus</i>	Greenhouse	Fatemy and Ahmadian Yazdi (1997)
<i>F. o. f.sp. cucumerinum</i>	Cucumber	<i>T. harzianum</i>	Greenhouse	Peyghami and Nishabouri (1998)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>A. rolfsii</i> (<i>S. rolfsii</i>)	Groundnut	<i>T. aureoviride</i> , <i>T. hamatum</i> , <i>T. longibrachiatum</i> , <i>T. harzianum</i> , <i>T. virens</i>	<i>In vitro</i>	Mirhosaini et al. (1998)
<i>R. solani</i> , <i>Bipolaris sorokiniana</i> , and <i>Fusarium culmorum</i>	Wheat	<i>Penicillium polonicum</i>	Greenhouse	Mansoori (1998)
<i>Ph. capsici</i>	Pepper	<i>Trichoderma</i> sp. and <i>Gliocladium</i> sp.	<i>In vitro</i>	Behboodi et al. (1998)
<i>P. ultimum</i>	—	<i>Pythium oligandrum</i>	<i>In vitro</i>	Rahnama and Cooke (1998)
<i>Pythium butleri</i>	—	<i>Aspergillus niger</i>	<i>In vitro</i>	Rouhani and Safari 1998
<i>Mauginiella scaetiae</i>	Date palm	<i>T. koningii</i> and <i>T. viride</i>	Field	Shetab-Booshehri et al. (1998)
<i>Xanthomonas translucens</i> pv. <i>cerealis</i>	Wheat	<i>Pantoea agglomerans</i> and <i>Pseudomonas fluorescens</i>	Greenhouse	Marefat and Rand Rahimian (1998)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>T. harzianum</i> and <i>T. viride</i>	Greenhouse	Niknejad et al. (2000)
<i>Erwinia amylovora</i>	Pear	<i>Erwinia herbicola</i> and <i>P. fluorescens</i>	<i>In vitro</i> , greenhouse, and field	Ahmadi et al. (2000)
<i>S. sclerotiorum</i>	Aubergine	<i>T. harzianum</i> , <i>T. virens</i> , <i>T. koningii</i> , <i>Trichoderma</i> <i>pseudokoningii</i> , and <i>Gliocladium</i> <i>deliquescens</i>	<i>In vitro</i> and greenhouse	Omrani et al. (2000)
<i>M. phaseolina</i>	Soybean	<i>T. viride</i> , <i>T. koningii</i> , and <i>T. harzianum</i>	<i>In vitro</i>	Ghaffarian et al. (2000)
<i>R. solani</i>	Rice	<i>T. viride</i> , <i>T. koningii</i> , and <i>T. harzianum</i>	Field	Izadyar et al. (2000a)
<i>Verticillium dahliae</i>	Cotton	<i>Talaromyces flavus</i>	<i>In vitro</i> and greenhouse	Naraghi et al. (2000)
<i>V. dahliae</i>	Cotton	<i>Pseudomonas</i> sp. and <i>Bacillus</i> sp.	<i>In vitro</i>	Azad Disfani et al. (2000)
<i>R. solani</i>	Sugar beet	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Shahiri Tabarestani et al. (2000)
<i>R. solani</i>	Rice	<i>T. harzianum</i> , <i>T. viride</i> , <i>T. koningii</i> , and <i>T. virens</i>	<i>In vitro</i>	Izadyar et al. (2000b)
<i>R. solani</i>	Rice	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Niknejad-Kazempour et al. (2000)
<i>Neofusicoccum mangiferae</i>	Citrus	<i>T. harzianum</i> , <i>T. virens</i> , <i>T. koningii</i> , and <i>T. longibrachiatum</i>	<i>In vitro</i>	Taheri et al. (2000)
<i>S. sclerotiorum</i>	Mulberry	<i>T. harzianum</i> , <i>T. viride</i> , <i>T. aureoviride</i> , <i>T. koningii</i> , <i>T. saturniporum</i> , <i>T. pseudokoningii</i> , and <i>T. longibrachiatum</i>	<i>In vitro</i>	Merat et al. (2000)
<i>Fusarium</i> spp., <i>Sclerotium</i> <i>cepivorum</i> , <i>Pythium</i> spp., and <i>R. solani</i>	Onion	<i>T. harzianum</i> and <i>T. viride</i>	Greenhouse	Peyghami (2001)
<i>R. solani</i>	Rice	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Niknejad Kazempour et al. (2002)
<i>Gaeumannomyces graminis</i> var. <i>tritici</i>	Wheat	<i>T. harzianum</i> and <i>T. viride</i>	Greenhouse	Foroutan et al. (2002)
<i>F. avenaceum</i> , <i>F. graminearum</i> , <i>F. culmorum</i> , <i>F. moniliforme</i> , <i>F. oxysporum</i> , <i>F. solani</i> , <i>F. semitectum</i> , <i>F. sambucinum</i> , <i>F. proliferatum</i> , and <i>F. tricinctum</i>	Wheat	<i>P. fluorescens</i> , <i>P. syringae</i> , <i>P. putida</i> , <i>P. cichorii</i> , <i>P. aeruginosa</i> , <i>P. aureofaciens</i> , and <i>P. viridiflava</i>	<i>In vitro</i>	Mostofizadeh- Ghalamfarsa et al. (2002)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>Pseudomonas</i> spp.	<i>In vitro</i> and greenhouse	Sedaghatfar et al. (2002)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>T. harzianum</i> and <i>T. viride</i>	<i>In vitro</i> and greenhouse	Foroutan et al. (2002)
<i>F. graminearum</i> , <i>F. moniliforme</i> , <i>F. nygamai</i> , <i>F. oxysporum</i> , <i>F. proliferatum</i> , <i>F. sambucinum</i> , <i>F. semitectum</i> , <i>F. solani</i> , and <i>F. tricinctum</i>	Wheat	<i>Pseudomonas</i> spp.	<i>In vitro</i>	Mostofizadeh-Ghalamfarsa et al. (2002)
<i>F. o. f.sp. melonis</i>	Melon	<i>Streptomyces</i> sp., <i>T. harzianum</i> , <i>T. virens</i> , and <i>T. viride</i>	<i>In vitro</i> and greenhouse	Ashrafizadeh et al. (2002)
<i>M. javanica</i>	Tomato	<i>P. lilacinus</i>	Greenhouse	Pakniat and Banihashemi (2002)
<i>Ph. drechsleri</i>	Cucurbit	<i>Streptomyces</i> sp.	<i>In vitro</i>	Heidari Faroughi et al. (2002)
<i>F. graminearum</i>	Wheat	<i>Streptomyces</i> sp., <i>Pseudomonas</i> sp., and <i>Bacillus</i> sp.	<i>In vitro</i>	Norouzian et al. (2002)
<i>Sclerotinia minor</i>	Sunflower	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	<i>In vitro</i>	Abdollahzadeh et al. (2003)
<i>Ph. drechsleri</i>	Cantaloupe	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	Greenhouse	Heidari Faroughi et al. (2004)
<i>Tilletia indica</i>	Wheat	<i>T. longibrachiatum</i> , <i>T. harzianum</i> , and <i>T. viride</i>	Greenhouse	Beeazar and Torabi (2004)
<i>F. o. f.sp. ciceri</i>	Chickpea	<i>T. longibrachiatum</i>	Greenhouse	Karimi et al. (2004a)
<i>F. o. f.sp. ciceri</i>	Chickpea	<i>Bacillus</i> sp.	<i>In vitro</i>	Karimi et al. (2004b)
<i>F. o. f.sp. dianthi</i>	Carnation	<i>P. fluorescens</i> and <i>Bacillus</i> sp.	Greenhouse	Karimi et al. (2004c)
<i>R. solani</i>	Chickpea	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	Greenhouse	Mohammadi et al. (2004)
<i>B. sorokiniana</i>	Wheat	<i>B. subtilis</i> , <i>P. fluorescens</i> , and <i>Bacillus pumilus</i>	Greenhouse	Mohammadi et al. (2004)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	Greenhouse	Barari et al. (2004)
<i>Armillaria mellea</i>	—	<i>Cladobotryum polypore</i> , <i>C. varium</i> , <i>C. dendroides</i> , and <i>C. verticillatum</i>	<i>In vitro</i>	Asef and Mohammadi-Gholtapeh (2004)
<i>T. laevis</i>	Wheat	<i>B. subtilis</i>	Greenhouse	Khodaygan et al. (2004)
<i>B. sorokiniana</i>	Wheat	<i>Trichoderma</i> sp. and <i>Streptomyces</i> sp.	Greenhouse	Salehpour et al. (2004)
<i>R. solani</i>	Rice	<i>P. fluorescens</i>	Field and greenhouse	Niknejad-Kazempour (2004)
<i>F. moniliforme</i>	Rice	<i>P. fluorescens</i>	<i>In vitro</i>	Niknejad-Kazempour et al. (2004)
<i>R. solani</i>	Rice	<i>Bacillus cereus</i> and <i>P. fluorescens</i>	<i>In vitro</i>	Sajjadi et al. (2004)
<i>Pyricularia grisea</i>	Rice	<i>Bacillus megaterium</i> , <i>B. subtilis</i> , <i>Bacillus circulans</i> , and <i>P. fluorescens</i>	Field	Padasht-Dehkaei et al. (2004)
<i>F. oxysporum</i>	Onion	<i>B. cereus</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	Field	Saberi-Riseh et al. (2004)
<i>Ph. citrophthora</i>	Pistachio	<i>P. fluorescens</i>	Field	Saberi-Riseh et al. (2004)
<i>P. ultimum</i>	Cucumber	<i>B. subtilis</i> , <i>Trichoderma</i> sp., and <i>P. fluorescens</i>	Greenhouse	Taghinasab et al. (2004)
<i>F. oxysporum</i>	Basal	<i>B. cereus</i> and <i>P. fluorescens</i>	Greenhouse and field	Ramezani-Baghmishezad et al. (2004)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>S. sclerotiorum</i>	Rapeseed	<i>Bacillus</i> spp.	<i>In vitro</i>	Akbari-Kiarodi et al. (2004)
<i>R. solani</i>	Cotton	<i>Bacillus</i> sp. and <i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Heydari et al. (2004)
<i>Gibberella fujikuroi</i>	Rice	<i>T. virens</i> , <i>T. harzianum</i> , <i>Bacillus</i> sp., <i>B. subtilis</i> , and <i>B. circulans</i>	<i>In vitro</i> and greenhouse	Padasht Dehkaei et al. (2004)
<i>Xanthomonas axonopodis</i> pv. <i>citri</i>	Citrus	<i>P. fluorescens</i> and <i>P. putida</i>	<i>In vitro</i> and greenhouse	Khodakaramian (2004)
<i>F. oxysporum</i>	Chickpea	<i>B. subtilis</i> and <i>P. fluorescens</i>	Greenhouse and field	Jamali et al. (2004)
<i>R. solani</i>	Sugar beet	<i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Shahiri et al. (2005)
<i>B. sorokiniana</i>	Wheat	<i>B. subtilis</i> and <i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Mohammadi et al. (2005)
<i>Ph. capsici</i>	Pepper	<i>T. viride</i> , <i>T. koningii</i> , <i>T. harzianum</i> , and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Behboudi et al. (2005)
<i>S. sclerotiorum</i>	Rapeseed	<i>B. cereus</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	<i>In vitro</i>	Akbari et al. (2005a,b)
<i>F. graminearum</i>	Wheat	<i>P. aeruginosa</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	Greenhouse	Foroutan et al. (2005)
<i>V. dahliae</i>	—	<i>Streptomyces plicatus</i> and <i>Frankia</i> sp.	<i>In vitro</i>	Shahidi Bonjar and Aghighi (2005)
<i>Pseudomonas tolaasii</i>	<i>Agaricus bisporus</i>	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Khabbaz Jolfaei et al. (2005)
<i>R. solani</i> , <i>F. oxysporum</i> , <i>F. solani</i> , and <i>C. coccodes</i>	Potato	<i>T. harzianum</i>	Greenhouse and field	Soltani et al. (2006)
<i>S. sclerotiorum</i>	Sunflower	<i>T. harzianum</i> , <i>T. viride</i> , and <i>T. virens</i>	<i>In vitro</i>	Abdollahzadeh et al. (2006)
<i>M. javanica</i> and <i>M. incognita</i>	Pistachio	<i>P. penetrans</i>	Greenhouse	Karimipourfard and Damadzadeh (2006)
<i>R. solani</i> , <i>F. oxysporum</i> , <i>F. solani</i> and <i>Lasiodiplodia</i> sp.	Mulberry	<i>P. fluorescens</i> and <i>Bacillus</i> spp.	<i>In vitro</i>	Niknejad-Kazempour et al. (2006)
<i>Ph. cactorum</i>	Apple	<i>P. fluorescens</i> and <i>B. subtilis</i>	Greenhouse	Farzaneh et al. (2006)
<i>F. o. f.sp. tuberosi</i>	Potato	<i>P. fluorescens</i>	Greenhouse	Khorasani-Aghazadeh et al. (2006)
<i>R. solani</i>	Common bean	<i>Burkholderia cepacia</i>	Greenhouse	Ahmadzadeh et al. (2006b)
<i>Ascochyta rabiei</i>	Chickpea	<i>T. harzianum</i>	Greenhouse	Bahrami et al. (2006)
<i>F. graminearum</i>	Wheat	<i>Streptomyces</i> sp., <i>P. fluorescens</i> , and <i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Nourozian et al. (2006)
<i>Bipolaris spicifera</i>	Wheat	<i>Bacillus</i> sp. and <i>P. fluorescens</i>	Greenhouse	Behdani et al. (2006)
<i>R. solani</i>	Bean	<i>P. fluorescens</i>	Greenhouse	Afsharmanesh et al. (2006)
<i>M. phaseolina</i> , <i>R. solani</i> , <i>Ph. nicotianae</i> var. <i>parasitica</i> , <i>Pythium</i> sp., and <i>Fusarium</i> sp.	Soybean, pistachio, bean, pepper, and cucumber	<i>Pseudomonas</i> spp.	<i>In vitro</i>	Ahmadzadeh et al. (2006a)
<i>V. dahliae</i>	Cucumber	<i>B. subtilis</i> , <i>P. fluorescens</i> , and <i>B. pumilus</i>	Greenhouse	Ahmadifar et al. (2006)
<i>R. solani</i>	Rice	<i>P. fluorescens</i>	<i>In vitro</i>	Kazemzadeh et al. (2006)
<i>T. laevis</i>	Wheat	<i>P. putida</i> and <i>P. fluorescens</i>	Greenhouse	Khodaygan et al. (2006)
<i>Ph. sojae</i>	Soybean	<i>Pseudomonas</i> spp.	Greenhouse	Zebarjad et al. (2006)
<i>R. solani</i>	Rice	<i>B. cereus</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	Greenhouse	Sajadi et al. (2006)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>M. phaseolina</i>	Melon	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i> and glasshouse	Etebarian (2006)
<i>F. graminearum</i>	Wheat	<i>B. cereus</i> , <i>B. subtilis</i> , <i>P. fluorescens</i> , and <i>E. herbicola</i>	Greenhouse and field	Alimi et al. (2006)
<i>Ralstonia solanacearum</i> and <i>Pectobacterium carotovorum</i> subsp. <i>carotovorum</i>	Pistachio, olive, potato, and cotton	<i>S. plicatus</i> and <i>Frankia</i> sp.	<i>In vitro</i>	Shahidi Bonjar et al. (2006)
<i>V. dahliae</i>	Pistachio, olive, potato, and cotton	<i>S. plicatus</i> and <i>Frankia</i> sp.	<i>In vitro</i>	Aghighi et al. (2006)
<i>Sclerotinia sclerotiorum</i>	Sunflower	<i>Coniothyrium minitans</i>	<i>In vitro</i>	Pourmehdi Alamdarlou et al. (2006)
<i>Ustilago hordei</i>	Barley	<i>Bacillus licheniformis</i> , <i>B. cereus</i> , and <i>P. fluorescens</i>	Field	Etebarian et al. (2007)
<i>S. sclerotiorum</i>	Canola	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Behnam et al. (2007)
<i>Ophiostoma novo-ulmi</i>	Elm	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i>	Iraqi et al. (2007)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>T. virens</i> , <i>T. koningiopsis</i> , <i>T. koningii</i> , and <i>T. viridescens</i>	<i>In vitro</i> and greenhouse	Mehrabi Koshki et al. (2007)
<i>R. solani</i>	Bean	<i>B. subtilis</i> and <i>P. fluorescens</i>	Greenhouse	Peighamy-Ashnaei et al. (2007)
<i>R. solani</i>	Rape	<i>B. cepacia</i>	<i>In vitro</i>	Sharifi-Tehrani et al. (2007)
<i>Ph. cactorum</i>	Apple	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Farzaneh et al. (2007)
<i>P. grisea</i>	Rice	<i>B. circulans</i> , <i>B. megaterium</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	Field	Padasht and Izadyar (2007)
<i>F. o. f.sp. dianthi</i>	Carnation	<i>B. cereus</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Karimi et al. (2007)
<i>R. solani</i>	Colza	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Sarani et al. (2008b)
<i>S. sclerotiorum</i>	Tobacco	<i>T. citrinoviride</i> , <i>T. harzianum</i> , <i>T. atroviride</i> , <i>T. virens</i> , <i>T. koningii</i> , <i>T. ghanense</i> , and <i>T. longibrachiatum</i>	<i>In vitro</i> and greenhouse	Sajadi and Asemi (2008)
<i>M. phaseolina</i>	Eggplant	<i>T. hamatum</i> , <i>T. harzianum</i> , <i>T. polysporum</i> , and <i>T. viride</i>	<i>In vitro</i> and field	Ramezani (2008)
<i>M. javanica</i>	Tomato	<i>T. harzianum</i>	<i>In vitro</i>	Golzary et al. (2008b)
<i>A. mellea</i>	Fruit trees	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i>	Asef et al. (2008)
<i>Penicillium digitatum</i>	Orange	<i>Pseudomonas</i> spp.	<i>In vitro</i>	Zamani et al. (2008a)
<i>P. digitatum</i>	Orange	<i>P. agglomerans</i>	Greenhouse	Zamani et al. (2008b)
<i>F. o. f.sp. tuberosa</i>	Potato	<i>Brevibacillus brevis</i> , <i>B. subtilis</i> , and <i>P. fluorescens</i>	Greenhouse	Khorasani et al. (2008)
<i>Colletotrichum gloeosporioides</i>	Citrus	<i>B. subtilis</i>	<i>In vitro</i>	Salari et al. (2008a)
<i>Penicillium expansum</i>	Apple	<i>T. virens</i>	Greenhouse	Tabatabaie et al. (2008b)
<i>Aspergillus flavus</i>	Pistachio	<i>B. subtilis</i> , <i>B. licheniformis</i> , <i>B. cereus</i> , and <i>P. fluorescens</i>	<i>In vitro</i>	Haghdel et al. (2008a,b)
<i>M. javanica</i>	Tomato	<i>P. fluorescens</i>	Greenhouse	Mokhtari et al. (2008)
<i>M. javanica</i>	Tomato	<i>P. fluorescens</i>	<i>In vitro</i>	Golzary et al. (2008a)
<i>Magnaporthe salvinii</i>	Rice	<i>P. fluorescens</i>	<i>In vitro</i>	Ahmaddeh et al. (2008)
<i>F. oxysporum</i>	Potato	<i>P. putida</i> , <i>P. fluorescens</i> , and <i>P. aeruginosa</i>	Field	Ommati et al. (2008)
<i>P. digitatum</i>	Citrus	<i>T. viride</i> , <i>P. fluorescens</i> , and <i>B. subtilis</i>	<i>In vitro</i>	Zamani et al. (2008c)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>F. solani</i> and <i>P. ultimum</i>	—	<i>B. subtilis</i>	<i>In vitro</i>	Selselehzakeri et al. (2008)
<i>R. solani</i>	Sugar beet	<i>T. harzianum</i> and <i>T. viride</i>	Field	Safaei et al. (2008)
<i>R. solani</i>	Sugar beet	<i>P. oligandrum</i>	<i>In vitro</i> and greenhouse	Salari et al. (2008b)
<i>R. solani</i>	Canola	<i>P. fluorescens</i> , <i>B. cepacia</i> , <i>B. subtilis</i> , and <i>Streptomyces</i> sp.	<i>In vitro</i> and greenhouse	Sarani et al. (2008a)
<i>Penicillium solitum</i>	Apple	<i>T. viride</i> and <i>T. virens</i>	Greenhouse	Tabatabaie et al. (2008a)
<i>O. novo-ulmi</i>	Elm	<i>B. subtilis</i>	<i>In vitro</i>	Iragi et al. 2008
<i>R. solani</i>	Rice	<i>T. atroviride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	<i>In vitro</i>	Khalili and Sadraei (2008)
<i>Botrytis mali</i>	Apple	<i>Candida membranifaciens</i>	Greenhouse	Alavifard et al. (2008a)
<i>Botrytis cinerea</i>	Apple	<i>C. membranifaciens</i> , <i>Rhodotorula mucilaginosa</i> , and <i>Meyerozyma guilliermondii</i> (<i>Pichia guilliermondii</i>)	<i>In vitro</i> and greenhouse	Alavifard et al. (2008b)
<i>P. expansum</i>	Apple	<i>C. membranifaciens</i>	<i>In vitro</i> and greenhouse	Gholamnejad et al. (2008)
<i>S. sclerotiorum</i>	Potato	<i>T. ceramicum</i> , <i>T. koningii</i> , <i>T. koningiopsis</i> , <i>T. virens</i> , <i>T. viridescens</i> , <i>T. orientalis</i> , and <i>T. atroviride</i>	<i>In vitro</i> and greenhouse	Ojaghian et al. (2008)
<i>G. graminis</i> and <i>M. phaseolina</i>	—	<i>Piriformospora indica</i> and <i>Sebacina vermifera</i>	<i>In vitro</i>	Abbaszadeh and Mohammadi Goltapeh (2008a)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i> , <i>T. viride</i> , <i>P. indica</i> , and <i>S. vermifera</i>	<i>In vitro</i> and greenhouse and field	Abbaszadeh and Mohammadi Goltapeh (2008b)
<i>Pyricularia oryzae</i>	Rice	<i>Streptomyces</i> spp.	<i>In vitro</i> and greenhouse	Ebrahimi-Zarandi et al. (2008)
<i>P. expansum</i>	Apple	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Khazaei et al. (2008)
<i>Ph. nicotianae</i>	—	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Nazerian et al. (2008)
<i>S. sclerotiorum</i>	Canola	<i>B. subtilis</i>	<i>In vitro</i>	Nasrolah Nejad and Rahnama (2008)
<i>P. syringae</i> pv. <i>tomato</i>	Tomato	<i>P. fluorescens</i>	<i>In vitro</i>	Mousavi et al. (2008a)
<i>Clavibacter michiganensis</i> subsp. <i>michiganensis</i>	Tomato	<i>P. fluorescens</i>	<i>In vitro</i>	Mousavi et al. (2008b)
<i>E. amylovora</i>	Pear	<i>P. fluorescens</i> and <i>Pantoea</i> sp.	<i>In vitro</i>	Mirzaei et al. (2008)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	<i>In vitro</i>	Montazernia et al. (2008)
<i>S. sclerotiorum</i>	Canola	<i>P. fluorescens</i> and <i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Mansouripour et al. (2008)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>Azotobacter</i> isolates	<i>In vitro</i>	Maghsodloo et al. (2008)
<i>B. cinerea</i>	Apple	<i>B. subtilis</i> , <i>Pichia membranifaciens</i> , and <i>Candida guilliermondii</i>	<i>In vitro</i> and greenhouse	Zangoie et al. (2008)
<i>X. axonopodis</i> pv. <i>citri</i>	Citrus	<i>P. fluorescens</i>	Greenhouse	Khodakaramian et al. (2008)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>F. graminearum</i> , <i>R. solani</i> AG4, <i>R. solani</i> AG5, <i>M. phaseolina</i> , and <i>Ph. cactorum</i>	Wheat, sugar beet, potato, soyabean, and apple	<i>T. hamatum</i> , <i>T. harzianum</i> , <i>T. virens</i> , and <i>Trichoderma</i> sp.	<i>In vitro</i>	Hajieghrari et al. (2008)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>T. koningiopsis</i> , <i>T. brevicompactum</i> , and <i>T. viridescens</i>	Greenhouse	Zafari et al. (2008)
<i>M. javanica</i>	Tomato	<i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Maleki Ziyarati et al. (2009)
<i>M. phaseolina</i>	Melon	<i>P. fluorescens</i> and <i>P. putida</i>	<i>In vitro</i> and greenhouse	Kheiri et al. (2009)
<i>H. schachtii</i>	Sugar beet	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Mahdikhani Moghadam et al. (2009)
<i>S. sclerotiorum</i>	Canola	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i>	Nasrolah Nejad et al. (2009)
<i>M. javanica</i> <i>T. laevis</i>	Tomato Wheat	<i>T. harzianum</i> <i>T. koningii</i> , <i>T. brevicompactum</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Greenhouse Field	Ziarati et al. (2009) Mehrabi Koshki et al. (2009)
<i>R. solani</i>	Common bean	<i>P. fluorescens</i>	Greenhouse	Ahmadzadeh and Tehrani (2009)
<i>B. cinerea</i>	Apple	<i>P. fluorescens</i> and <i>B. subtilis</i>	Greenhouse	Peighami-Ashnaei et al. (2009a)
<i>S. sclerotiorum</i>	Sunflower	<i>P. fluorescens</i>	Greenhouse	Ashofteh et al. (2009)
<i>Xanthomonas campestris</i> pv. <i>malvacearum</i>	Cotton	<i>P. aeruginosa</i>	Greenhouse	Fallahzadeh-Mamaghani et al. (2009)
<i>R. solani</i>	Bean	<i>B. subtilis</i> and <i>P. fluorescens</i>	<i>In vitro</i>	Peighami-Ashnaei et al. (2009b)
<i>R. solani</i>	Common bean	<i>B. cepacia</i>	<i>In vitro</i> and greenhouse	Ahmadzadeh et al. (2009)
<i>P. expansum</i>	Apple	<i>Saccharomyces cerevisiae</i>	<i>In vitro</i>	Gholamnejad et al. (2009)
<i>H. schachtii</i>	Sugar beet	<i>Pleurotus ostreatus</i> , <i>P. sajor-caju</i> , <i>P. florida</i> , <i>P. flabellatus</i> , <i>P. eryngii</i> , and <i>Hypsizygus ulmarius</i>	<i>In vitro</i> and greenhouse	Palizi et al. (2009)
<i>P. expansum</i>	Apple	<i>R. mucilaginosa</i> and <i>M. guilliermondii</i>	<i>In vitro</i>	Gholamnejad et al. (2009)
<i>V. dahliae</i>	Cotton	<i>Glomus etunicatum</i> , <i>G. intraradices</i> , and <i>G. versiforme</i>	Greenhouse	Norouzi et al. (2009)
<i>Meloidogyne</i> spp.	—	<i>Paecilomyces lilacinus</i>	Greenhouse	Boromand et al. (2010)
<i>F. oxysporum</i> , <i>R. solani</i> , <i>M. phaseolina</i> , and <i>Pythium</i> sp.	Faba bean	<i>Pseudomonas</i> sp.	<i>In vitro</i> and greenhouse	Golpayegani et al. (2010)
<i>R. solani</i>	Rice	<i>T. harzianum</i> , <i>T. atroviride</i> , and <i>T. virens</i>	<i>In vitro</i> , greenhouse, and field	Naeimi et al. (2010)
<i>Phytophthora sojae</i>	—	<i>T. virens</i> , <i>T. orientalis</i> , <i>T. brevicompactum</i> , <i>T. atroviride</i> , <i>T. ceramicum</i> and <i>T. asperellum</i>	<i>In vitro</i>	Ayoubi et al. (2010)
<i>B. sorokiniana</i>	Wheat	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Ranjbar Sistani et al. (2010)
<i>G. fujikuroi</i>	Rice	<i>T. harzianum</i> and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Roodgar et al. (2010)
<i>Pythium aphanidermatum</i>	Cucumber	<i>B. subtilis</i> and <i>B. licheniformis</i>	<i>In vitro</i> and greenhouse	Safari Asl et al. (2010)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>B. cinerea</i>	Tomato	<i>T. harzianum</i> , <i>T. arundinaceum</i> , <i>T. viridescens</i> , <i>T. atroviride</i> , and <i>T. koningii</i>	<i>In vitro</i> and greenhouse	Eivazi <i>et al.</i> (2010)
<i>P. expansum</i>	Apple	<i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Emadi <i>et al.</i> (2010)
<i>Phytophthora drechsleri</i>	Cantaloupe	<i>Pseudomonas fluorescens</i> , <i>P. putida</i> and <i>P. aeruginosa</i>	<i>In vitro</i> and greenhouse	Tabarraie <i>et al.</i> (2010)
<i>P. expansum</i>	Apple	<i>R. mucilaginosa</i>	<i>In vitro</i> and greenhouse	Golamnejad <i>et al.</i> (2010)
<i>Penicillium italicum</i>	Orange	<i>M. guilliermondii</i>	<i>In vitro</i> and greenhouse	Ghasemi Sardareh <i>et al.</i> (2010)
<i>Verticillium albo-atrum</i>	Tomato	<i>T. flavus</i>	<i>In vitro</i> and greenhouse	Naraghi <i>et al.</i> (2010)
<i>F. o. f.sp. ciceri</i>	Chickpea	<i>B. subtilis</i> , <i>P. aeruginosa</i> , and <i>P. putida</i>	<i>In vitro</i>	Karimik Amini <i>et al.</i> (2010)
<i>B. sorokiniana</i>	Wheat	<i>Glomus fasciculatum</i> and <i>B. subtilis</i>	Greenhouse	Hashemi Alizade <i>et al.</i> (2010)
<i>F. o. f.sp. radicle-cucumerinum</i>	Cucumber	<i>B. subtilis</i>	Greenhouse	Yousefi <i>et al.</i> (2010)
<i>S. sclerotiorum</i>	Potato	<i>T. ceramicum</i> , <i>T. koningii</i> , <i>T. koningiopsis</i> , <i>T. viridescens</i> , <i>T. virens</i> , and <i>Coniothyrium minitans</i>	<i>In vitro</i>	Ojaghian <i>et al.</i> (2010)
<i>Sclerotinia sclerotiorum</i>	Sunflower	<i>Pseudomonas fluorescens</i>	<i>In vitro</i> and greenhouse	Khezri <i>et al.</i> (2010)
<i>Sclerotium cepivorum</i>	Garlic	<i>Bacillus spp.</i>	<i>In vitro</i>	Babaei Nasir <i>et al.</i> (2010)
<i>Fusarium oxysporum</i> f.sp. <i>gladioli</i>	Garlic	<i>Trichoderma spp.</i>	<i>In vitro</i>	Bagheri <i>et al.</i> (2010)
<i>Gladiolus</i>				
<i>F. oxysporum</i> and <i>F. solani</i>	Chickpea	<i>T. harzianum</i> and <i>T. asprellum</i>	<i>In vitro</i> and greenhouse	Akrami and Ibrahime (2010)
<i>M. phaseolina</i>	Sunflower	<i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Iraqi and Rahnema (2011)
<i>R. solani</i>	Canola	<i>B. cepacia</i>	<i>In vitro</i> and greenhouse	Sarani <i>et al.</i> (2010)
<i>P. carotovorum</i>	Potato	<i>P. putida</i> , <i>P. aeruginosa</i> , and <i>P. fluorescens</i>	Field	Khodakaramian and Zafari (2010)
<i>X. axonopodis</i> pv. <i>citri</i>	Citrus	<i>P. fluorescens</i> , <i>P. viridiflava</i> , and <i>P. syringae</i>	<i>In vitro</i>	Montakhabi <i>et al.</i> (2010)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>B. subtilis</i> , <i>B. pumilus</i> , <i>P. fluorescens</i> , <i>P. putida</i> , <i>P. aeruginosa</i> , and <i>Chromobacterium</i> sp.	<i>In vitro</i> and greenhouse	Babaeipoor <i>et al.</i> (2011)
<i>Phoma lingam</i>	Rapeseed	<i>B. subtilis</i> and <i>T. koningii</i>	<i>In vitro</i> and greenhouse	Panjehkeh <i>et al.</i> (2011)
<i>H. schachtii</i>	Sugar beet	<i>T. harzianum</i> , <i>T. virens</i> , and <i>B. subtilis</i>	Field	Mahdikhani Moghadam and Rouhani (2011)
<i>F. oxysporum</i>	Lentil	<i>P. fluorescens</i>	Greenhouse	Akrami <i>et al.</i> (2011)
<i>F. culmorum</i>	—	<i>B. subtilis</i>	Greenhouse	Khezri <i>et al.</i> (2011)
<i>S. sclerotiorum</i>	Sunflower	<i>P. fluorescens</i>	Greenhouse	Heidari-Tajabadi <i>et al.</i> (2011)
<i>P. italicum</i> and <i>P. digitatum</i>	Citrus	<i>P. syringae</i> and <i>Candida famata</i>	Greenhouse	Nasrollahi Ofran <i>et al.</i> (2011)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>P. fluorescens</i>	Greenhouse	Bagheri <i>et al.</i> (2011)
<i>P. expansum</i>	Apple	<i>R. mucilaginosa</i>	<i>In vitro</i>	Gholamnejad <i>et al.</i> (2011)
<i>Phytophthora parasitica</i> and <i>Ph. citrophthora</i>	Pistachio	<i>Streptomyces</i> sp.	<i>In vitro</i> and greenhouse	Salari <i>et al.</i> (2011)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>Ph. drechsleri</i>	Sugar beet	<i>T. asperellum</i> , <i>T. atroviride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	Greenhouse	Moayed and Mostowfizadeh-Ghalamfarsa (2011)
<i>M. javanica</i>	Olive	<i>P. fluorescens</i> and <i>P. putida</i>	Greenhouse	Khalighi and Khodakaramian (2012)
<i>Fusarium solani</i>	Potato	<i>T. brevicompactum</i> , <i>T. longibrachiatum</i> and <i>T. asperellum</i>	<i>In vitro</i> and greenhouse	Ommati and Zaker (2012)
<i>M. javanica</i>	Tomato	<i>T. harzianum</i>	Greenhouse	Naserinasab et al. (2012)
<i>P. carotovorum</i>	Potato	<i>Pseudomonas</i> spp.	<i>In vitro</i> and greenhouse	Ghods-Alavi et al. (2012)
<i>P. grisea</i>	Rice	<i>T. harzianum</i>	Greenhouse	Raeesi et al. (2012a)
<i>B. cinerea</i>	—	<i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Raeesi et al. (2012b)
<i>R. solani</i>	Rice	<i>P. fluorescens</i> and <i>P. aeruginosa</i>	<i>In vitro</i> and greenhouse	Kazemzadeh et al. (2012)
<i>Ph. sojae</i>	Soybean	<i>Bradyrhizobium japonicum</i> , <i>T. spirale</i> , <i>T. orientale</i> and <i>T. brevicompactum</i>	<i>In vitro</i> and greenhouse	Ayoubi et al. (2012)
<i>P. aphanidermatum</i>	Cucumber	<i>T. longibrachiatum</i> and <i>T. atroviride</i>	Greenhouse	Ale Aghae et al. (2012)
<i>Ph. parasitica</i>	Citrus	<i>Streptomyces</i> sp.	<i>In vitro</i> and greenhouse	Sadeghi (2012)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>Streptomyces</i> sp.	<i>In vitro</i>	Fadaei et al. (2012)
<i>F. solani</i> f.sp. <i>pisi</i>	Chickpea	<i>T. harzianum</i> and <i>T. viride</i>	<i>In vitro</i> and greenhouse	Afrousheh et al. (2012a)
<i>Fusarium subglutinans</i>	Cucumber	<i>Streptomyces</i> spp.	<i>In vitro</i>	Sadeghi and Hatami (2012)
<i>F. solani</i> f.sp. <i>pisi</i>	Pea	<i>T. harzianum</i> and <i>T. viride</i>	<i>In vitro</i> and greenhouse	Afrousheh et al. (2012b)
<i>Phytophthora sojae</i>	Soybean	<i>T. orientalis</i> , <i>T. brevicompactum</i> and <i>T. spirale</i> and <i>Bradyrhizobium japonicum</i>	<i>In vitro</i> and greenhouse	Najmeh et al. (2012)
<i>Rosellinia necatrix</i>	—	<i>T. flavus</i>	<i>In vitro</i>	Masudi and Shahidi (2012)
<i>P. aphanidermatum</i>	Cucumber	<i>T. virens</i> , <i>T. harzianum</i> , and <i>T. atroviride</i>	<i>In vitro</i> and greenhouse	Hosseyini et al. (2012a)
<i>R. solani</i> , <i>M. phaseolina</i> , <i>F. graminearum</i> , and <i>S. sclerotiorum</i>	—	<i>T. viride</i>	<i>In vitro</i>	Soofi et al. (2012)
<i>Bipolaris australiensis</i> and <i>B. cinerea</i>	Saffron	<i>T. virens</i> , <i>T. harzianum</i> , and <i>T. koningii</i>	<i>In vitro</i>	Roohabadi et al. (2012)
<i>F. graminearum</i>	Wheat	<i>T. harzianum</i> and <i>T. virens</i>	Field	Baghani et al. (2012)
<i>F. o. f.sp. radicle-cucumerinum</i>	Cucumber	<i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Javanshir Javid et al. (2012)
<i>Monosporascus cannonballus</i>	Muskmelon	<i>T. atroviride</i> , <i>T. harzianum</i> , and <i>T. virens</i>	<i>In vitro</i> and greenhouse	Keshavarzi et al. (2012a)
<i>F. graminearum</i>	Wheat	<i>T. harzianum</i> and <i>T. virens</i>	Field	Baghani et al. (2012)
<i>R. solani</i> and <i>F. solani</i> f.sp. <i>tuberosa</i>	Sugar beet	<i>P. putida</i>	<i>In vitro</i>	Nazari et al. (2012)
<i>Alternaria alternata</i>	Potato	<i>T. viride</i> , <i>T. orientalis</i> , <i>T. arundinaceum</i> , and <i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Nasiri et al. (2012)
<i>P. aphanidermatum</i>	Cucumber	<i>Bacillus</i> sp. and <i>B. subtilis</i>	Greenhouse	Hosseyini et al. (2012b)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>F. solani</i> and <i>R. solani</i>	—	<i>Streptomyces</i> sp.	<i>In vitro</i>	Vasebi and Dehnad (2012)
<i>B. cinerea</i>	Apple	<i>Hanseniaspora occidentalis</i>	<i>In vitro</i>	Azadrooh <i>et al.</i> (2012)
<i>A. flavus</i>	Pistachio	<i>T. harzianum</i> and <i>T. longibrachiatum</i>	<i>In vitro</i>	Chegini <i>et al.</i> (2012)
<i>M. cannonballus</i>	Cucumis melon	<i>T. harzianum</i> , <i>T. virens</i> , <i>T. atroviride</i> , and <i>Chaetomium globosum</i>	<i>In vitro</i>	Keshavarzi <i>et al.</i> (2012b)
<i>M. javanica</i>	—	<i>Penicillium griseofulvum</i> , <i>Penicillium chrysogenum</i> , and <i>Penicillium coprophilum</i>	<i>In vitro</i>	Karkhaneh <i>et al.</i> (2012)
<i>V. albo-atrum</i> , <i>F. oxysporum</i> , and <i>R. solani</i>	Potato	<i>T. flavus</i>	<i>In vitro</i>	Naraghi <i>et al.</i> (2012a)
<i>R. solani</i>	Common bean	<i>Streptomyces microflavus</i>	<i>In vitro</i> and greenhouse	Moazenian <i>et al.</i> (2012b)
<i>A. flavus</i>	Pistachio	<i>T. harzianum</i> and <i>T. koningii</i>	<i>In vitro</i>	Kahnnooji <i>et al.</i> (2012)
<i>Ph. drechsleri</i>	Pistachio	<i>T. longibrachiatum</i> and <i>T. harzianum</i>	<i>In vitro</i>	Mirkhani <i>et al.</i> (2012)
<i>Ph. drechsleri</i>	Pistachio	<i>T. harzianum</i>	Greenhouse	Alipoor Moghadam <i>et al.</i> (2012)
<i>Paecilomyces variotii</i>	Pistachio	<i>Streptomyces</i> spp.	<i>In vitro</i>	Ansari <i>et al.</i> (2012)
<i>P. tolaasii</i>	<i>A. bisporus</i>	<i>Pseudomonas reactants</i> , <i>Bacillus</i> sp., and <i>P. fluorescens</i>	<i>In vitro</i>	Tajalipour <i>et al.</i> (2012)
<i>V. albo-atrum</i>	Potato	<i>T. flavus</i>	Greenhouse	Naraghi <i>et al.</i> (2012b)
<i>B. oryzae</i>	Rice	<i>T. harzianum</i> , <i>T. atroviride</i> , and <i>T. virens</i>	Greenhouse	Khalili <i>et al.</i> (2012)
<i>F. solani</i>	Bean	<i>T. harzianum</i> and <i>T. viride</i>	<i>In vitro</i> and greenhouse	Khodaei <i>et al.</i> (2012)
<i>F. solani</i> , <i>R. solani</i> , <i>F. oxysporum</i> , <i>Pestalotiopsis</i> spp., <i>C. gloeosporioides</i> , and <i>P. digitatum</i>	Citrus	<i>Streptomyces</i> sp.	<i>In vitro</i>	Noorizadeh <i>et al.</i> (2012)
<i>P. italicum</i>	Orange	<i>Pichia kluyveri</i>	<i>In vitro</i>	Ghasemi Sardareh <i>et al.</i> (2012)
<i>R. solani</i>	Sugar beet	<i>T. harzianum</i>	<i>In vitro</i>	Ghanbari <i>et al.</i> (2012)
<i>P. expansum</i>	Apple	<i>Torulaspora delbrueckii</i>	<i>In vitro</i>	Ebrahimi <i>et al.</i> (2012a,b)
<i>Magnaporthe oryzae</i>	Rice	<i>T. harzianum</i> , <i>T. atroviride</i> , and <i>T. virens</i>	<i>In vitro</i>	Javadi <i>et al.</i> (2012)
<i>F. graminearum</i>	Wheat	<i>P. fluorescens</i> , <i>E. herbicola</i> , <i>B. subtilis</i> , and <i>B. cereus</i>	<i>In vitro</i> and greenhouse	Alimi <i>et al.</i> (2012)
<i>S. sclerotiorum</i>	Bean	<i>B. subtilis</i> subsp. <i>spizizenii</i> and <i>Streptomyces acrimycini</i>	<i>In vitro</i> and greenhouse	Gholami <i>et al.</i> (2012)
<i>S. sclerotiorum</i>	Cucumber	<i>Bacillus</i> sp.	<i>In vitro</i>	Rostami <i>et al.</i> (2012)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Lagzian <i>et al.</i> (2012)
<i>F. oxysporum</i>	Cucurbit	<i>T. harzianum</i> and <i>T. longibrachiatum</i>	<i>In vitro</i>	Abdolahy and Parsaiyan (2012)
<i>F. solani</i>	Cucurbit	<i>T. koningii</i>	<i>In vitro</i>	Abdolahy and Parsaiyan (2012)
<i>V. dahliae</i>	Pistachio	<i>T. harzianum</i> and <i>T. koningii</i>	<i>In vitro</i>	Jamdar <i>et al.</i> (2012)
<i>Pratylenchus loosi</i>	Tea	<i>B. subtilis</i>	<i>In vitro</i>	Rahanandeh <i>et al.</i> (2012)
<i>M. javanica</i>	Cucumber	<i>P. fluorescens</i> , <i>B. subtilis</i> , and <i>Pantoea</i> sp.	Greenhouse	Majzoob <i>et al.</i> (2012)
<i>Meloidogyne javanica</i>	Tomato	<i>Arthrobotrys oligospora</i> and <i>Paecilomyces lilacinus</i>	Greenhouse	Jamshidnejad <i>et al.</i> (2012)
<i>B. cinerea</i>	Strawberry	<i>Trichoderma</i> spp.	<i>In vitro</i> and greenhouse	Naeimi and Zare (2013)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>P. aphanidermatum</i>	Sugar beet	<i>Trichoderma erinaceum</i> , <i>T. koningii</i> , <i>T. longibrachiatum</i> , and <i>T. harzianum</i>	Greenhouse	Abdollahi et al. (2013)
<i>Fusarium oxysporum</i> f. sp. <i>tuberosi</i>	Potato	<i>Trichoderma virens</i> and <i>Trichoderma asperellum</i>	In vitro and greenhouse	Ommati et al. (2013)
<i>B. sorokiniana</i>	Wheat	<i>G. fasciculatum</i> and <i>P. fluorescens</i>	Greenhouse	Hashemi Alizadeh et al. (2013)
<i>Tylenchulus semipenetrans</i>	Citrus	<i>F. solani</i> , <i>F. oxysporum</i> , <i>P. lilacinus</i> , <i>Cladosporium</i> <i>cladosporioides</i> , and <i>Acremonium strictum</i>	Greenhouse	Chavoshisani et al. (2013)
<i>Aspergillus flavus</i>	Pistachio	<i>Trichoderma harzianum</i> and <i>Trichoderma longibrachiatum</i>	In vitro	Chegini et al. (2013)
<i>M. javanica</i>	Tomato	<i>Glomus mosseae</i> and <i>G. intraradices</i>	Greenhouse	Golzari et al. (2013)
<i>A. flavus</i>	Pistachio	<i>B. subtilis</i>	In vitro	Afsharmanesh et al. (2013)
<i>Colletotrichum lindemuthianum</i>	Bean	<i>B. subtilis</i> subsp. <i>subtilis</i> , <i>B. atrophaeus</i> , <i>B. tequilensis</i> , <i>B. subtilis</i> subsp. <i>spizizenii</i> , <i>Streptomyces cyaneofuscatus</i> , <i>S. flavofuscus</i> , <i>S. parvus</i> , and <i>S. acrimycini</i>	In vitro and greenhouse	Gholami et al. (2013)
<i>P. aphanidermatum</i>	Tarragon	<i>T. asperelloides</i>	In vitro	Pakdaman et al. (2013)
<i>E. amylovora</i>	Apple, pear, and quince	<i>P. fluorescens</i> , <i>P. agglomerans</i> , <i>P. putida</i> , and <i>Serratia</i> <i>marcescens</i>	Field	Gerami et al. (2013)
<i>F. culmorum</i>	Wheat	<i>Pseudomonas</i> spp.	Greenhouse	Madloo et al. (2013)
<i>P. loosi</i>	Tea	<i>P. fluorescens</i>	In vitro	Rahanandeh et al. (2013)
<i>V. dahliae</i>	Cotton	<i>B. subtilis</i> , <i>Bacillus coagulans</i> , <i>Bacillus polymyxa</i> , and <i>P. fluorescens</i>	Greenhouse	Mansoori et al. (2013)
<i>F. graminearum</i>	Wheat	<i>T. harzianum</i> and <i>T. viride</i>	Field	Foroutan (2013)
<i>M. phaseolina</i>	Soybean	<i>P. agglomerans</i> , <i>Bacillus</i> sp., and <i>T. harzianum</i>	In vitro and greenhouse	Vasebi et al. (2013)
<i>Ph. drechsleri</i>	Cucumber	<i>P. fluorescens</i>	In vitro and greenhouse	Ghafelebashi et al. (2014)
<i>B. cinerea</i>	Apple	<i>B. subtilis</i> , <i>C. membranifaciens</i> and <i>M. guilliermondii</i>	In vitro and greenhouse	Zanguei et al. (2014)
<i>M. oryzae</i>	Rice	<i>T. harzianum</i> , <i>T. atroviride</i> , and <i>T. virens</i>	In vitro and greenhouse	Javadi et al. (2014)
<i>F. solani</i> f.sp. <i>pisi</i>	Pea	<i>G. mosseae</i> and <i>G. intraradices</i>	Greenhouse	Soharabi et al. (2014)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>T. harzianum</i> and <i>T. virens</i>	Greenhouse	Jalali (2014)
<i>P. tolaasii</i>	Mushroom	<i>P. reactants</i> , <i>P. putida</i> , <i>P. fluorescens</i> , and <i>B. subtilis</i>	Greenhouse	Tajalipour et al. (2014)
<i>M. javanica</i>	Tomato	<i>P. fluorescens</i>	In vitro	Bagheri et al. (2014)
<i>A. flavus</i>	Pistachio	<i>B. subtilis</i>	In vitro	Afsharmanesh et al. (2014)
<i>P. digitatum</i>	Citrus	<i>B. subtilis</i> , <i>Rhizobium rubi</i> , and <i>P. digitatum</i>	In vitro	Mohammadi et al. (2014)
<i>Cercospora beticola</i>	Sugar beet	<i>Bacillus</i> sp., <i>Enterobacter</i> sp., and <i>Enterobacter</i> sp.	In vitro and greenhouse	Mousavi Mirak (2014)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Khaledi and Taheri (2014)
<i>R. solanacearum</i>	Potato	<i>Paenibacillus polymyxa</i>	<i>In vitro</i> and greenhouse	Dadjoo et al. (2014)
<i>F. o. f.sp. melonis</i>	Cantaloupe	<i>B. subtilis</i>	<i>In vitro</i>	Hosseini Haji Abdal et al. (2014b)
<i>F. o. f.sp. melonis</i>	Cantaloupe	<i>T. atroviride</i> and <i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Hosseini Haji Abdal et al. (2014a)
<i>M. incognita</i>	Tea	<i>P. aeruginosa</i> and <i>P. fluorescens</i>	<i>In vitro</i>	Rahanandeh and Moshaiedy (2014)
<i>P. chrysogenum</i> and <i>B. cinerea</i>	—	<i>Streptomyces griseus</i>	<i>In vitro</i>	Danaei et al. (2014)
<i>R. solani</i>	Cotton	<i>P. aureofaciens</i> and <i>P. fluorescens</i>	Greenhouse	Samavat et al. (2014)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	Field	Barari et al. (2014)
<i>F. sambucinum</i> , <i>Fusarium subglutinans</i> , <i>Phoma glomerata</i> , and <i>N. mangiferae</i>	Cucumber	<i>Streptomyces</i> sp.	<i>In vitro</i>	Sadeghi and Hatami (2014)
<i>M. phaseolina</i>	Soybean	<i>P. agglomerans</i>	<i>In vitro</i> and greenhouse	Vasebi et al. (2015)
<i>M. javanica</i>	Tomato	<i>Trichoderma</i> spp.	<i>In vitro</i> and greenhouse	Kavari et al. (2015)
<i>Ph. drechsleri</i>	Cucumber	<i>T. harzianum</i>	Greenhouse	Delkhal and Behboudi (2015)
<i>M. javanica</i>	Tomato	<i>T. harzianum</i> and <i>P. fluorescens</i>	Greenhouse	Mokhtari et al. (2015)
<i>M. javanica</i>	Tomato	<i>Metarhizium anisopliae</i> and <i>T. harzianum</i>	Greenhouse	Khosravi et al. (2015)
<i>F. graminearum</i>	Wheat	<i>P. fluorescens</i>	Greenhouse	Shahbazi et al. (2015)
<i>P. aphanidermatum</i>	Cucumber	<i>P. fluorescens</i>	Greenhouse	Akbari-Moghadam et al. (2015)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>Trichoderma</i> spp. and <i>T. flavus</i>	<i>In vitro</i>	Mohammadi and Ghanbari (2015)
<i>S. cepivorum</i>	Garlic	<i>T. asperellum</i> , <i>T. harzianum</i> , and <i>T. flavus</i>	Greenhouse	Mahdizadehnaraghi et al. (2015)
<i>F. solani</i> , <i>R. solani</i> , and <i>F. oxysporum</i>	Bean	<i>Pseudomonas</i> sp. and <i>Bacillus</i> sp.	<i>In vitro</i> and greenhouse	Faraji et al. (2015)
<i>R. solani</i>	Cotton	<i>P. fluorescens</i>	Greenhouse	Abdollahipour et al. (2015)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>B. pumilus</i>	Greenhouse	Heidarzadeh and Baghaee-Ravari (2015)
<i>Meloidogyne</i> spp.	Kiwifruit	<i>Pseudomonas chlororaphis</i> subsp. <i>aureofaciens</i> and <i>P. fluorescens</i>	Greenhouse	Bashiri et al. (2015)
<i>Fusarium solani</i> , <i>Rhizoctonia solani</i> , and <i>Fusarium oxysporum</i>	Bean	<i>Pseudomonas</i> sp. and <i>Bacillus</i> sp.	<i>In vitro</i> and greenhouse	Faraji et al. (2015)
<i>V. dahliae</i>	Pistachio	<i>T. harzianum</i>	Greenhouse	Fotoohiyan et al. (2015)
<i>P. aphanidermatum</i>	Cucumber	<i>G. mosseae</i>	Greenhouse	Hosseini et al. (2016)
<i>F. oxysporum</i>	Tomato	<i>P. fluorescens</i>	Greenhouse	Jamali et al. (2016)
<i>B. cinerea</i> , <i>C. cladosporioides</i> , and <i>Aspergillus tubingensis</i>	Grape	<i>T. harzianum</i> and <i>T. hamatum</i>	<i>In vitro</i>	Davari and Ezazi (2016)
<i>B. cinerea</i>	Strawberry	<i>B. subtilis</i> and <i>B. licheniformis</i>	Greenhouse	Amini et al. (2016)
<i>Mycosphaerella rabiei</i>	Chickpea	<i>T. atroviride</i> , <i>T. virens</i> , and <i>T. atroviride</i>	Greenhouse	Naghed et al. (2016)
<i>A. alternata</i> , <i>Alternaria dumosa</i> , <i>Alternaria tenuissima</i> , <i>Alternaria mimicula</i> , <i>Alternaria tomatocola</i> , and <i>C. cladosporioides</i>	Tomato	<i>T. harzianum</i> and <i>T. virens</i>	Greenhouse	Beydaghi et al. (2016)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>M. javanica</i>	Tomato	<i>G. mosseae</i>	Greenhouse	Azami-Sardooie et al. (2016)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>T. harzianum</i>	<i>In vitro</i> and greenhouse	Barari (2016)
<i>M. phaseolina</i> , <i>R. solani</i> , <i>S. sclerotiorum</i> , and <i>F. graminearum</i>	Melon, melon, canola, and wheat	<i>T. harzianum</i>	<i>In vitro</i>	Abbasi et al. (2016)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	Greenhouse	Khalili et al. (2016)
<i>F. solani</i> f.sp. <i>pisi</i>	Chickpea	<i>Streptomyces antibioticus</i>	Greenhouse	Soltanzadeh et al. (2016)
<i>A. rabiei</i>	Chickpea	<i>P. putida</i> , <i>P. fluorescens</i> , <i>Mesorhizobium ciceri</i> , and <i>Burkholderia multivorans</i>	<i>In vitro</i>	Azizpour and Rouhrazi (2016)
<i>R. solani</i>	Sugar beet	<i>Bacillus amyloliquefaciens</i> , <i>B. pumilus</i> , and <i>Bacillus siamensis</i>	Greenhouse	Karimi et al. (2016)
<i>F. o. f.sp. lycopersici</i>	Tomato	<i>B. subtilis</i> and <i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Jalali et al. (2016)
<i>A. flavus</i>	Pistachio	<i>B. subtilis</i>	<i>In vitro</i>	Farzaneh et al. (2016)
<i>Penicillium crustosum</i> and <i>A. tubingensis</i>	Grape	<i>Pichia membranaefaciens</i>	<i>In vitro</i> and greenhouse	Ranjbar Chaharborj et al. (2016)
<i>S. sclerotiorum</i> and <i>P. aphanidermatum</i>	Cucumber	<i>Pseudomonas</i> spp., <i>Stenotrophomonas</i> spp., and <i>Flavobacterium</i> spp.	<i>In vitro</i> and greenhouse	Bagheri et al. (2016)
<i>X. translucens</i> pv. <i>cerealis</i>	Wheat	<i>Pseudomonas</i> spp.	Greenhouse and <i>in vitro</i>	Fallahzadeh-Mamaghani et al. (2016)
<i>F. o. f.sp. cucumerinum</i>	Cucumber	<i>T. flavus</i>	Greenhouse	Shahriari et al. (2016)
<i>M. javanica</i>	Tomato	<i>T. harzianum</i>	Greenhouse	Heidari and Olia (2016)
<i>Agrobacterium tumefaciens</i>	Tobacco	<i>B. subtilis</i>	Greenhouse	Nazari et al. (2016)
<i>R. solanacearum</i>	Potato	<i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Hasani and Khodakaramian (2016)
<i>G. graminis</i> var. <i>tritici</i>	Wheat	<i>B. subtilis</i>	<i>In vitro</i> and greenhouse	Khezri and Manafi Shabestari (2016)
<i>F. solani</i> f.sp. <i>phaseoli</i>	Bean	<i>T. hamatum</i> and <i>P. fluorescens</i>	<i>In vitro</i> and greenhouse	Khosro-Anjom et al. (2016)
<i>V. dahliae</i>	Tomato	<i>B. subtilis</i> , <i>B. pumilus</i> , <i>B. atrophaeus</i> , and <i>Bacillus thuringiensis</i>	<i>In vitro</i> and greenhouse	Safdarpour and Khodakaramian (2016)
<i>E. amylovora</i>	Apple	<i>P. agglomerans</i>	<i>In vitro</i>	Firouzian Bandpey and Rahimian (2016)
<i>F. oxysporum</i>	—	<i>T. harzianum</i> , <i>T. koningii</i> , and <i>T. virens</i>	<i>In vitro</i>	Habibi and Rahnama (2016)
<i>F. oxysporum</i> f.sp. <i>lycopersici</i> and <i>M. javanica</i>	Tomato	<i>G. mosseae</i>	Greenhouse	Amirafzali et al. (2016)
<i>Diplodia bulgarica</i>	Apple	<i>Arthrinium arundinis</i> , <i>Arthrinium saccharicola</i> , <i>Periconia</i> sp., <i>Penicillium</i> sp., <i>Aspergillus persii</i> , <i>C. globosum</i> , <i>Chaetomium</i> sp., <i>Trichothecium roseum</i> , <i>A. tenuissima</i> , and <i>Alternaria infectoria</i>	<i>In vitro</i>	Alijani et al. (2016)
<i>R. necatrix</i>	Apple	<i>B. siamensis</i> and <i>B. pumilus</i>	<i>In vitro</i>	Binandeh et al. (2016)
<i>F. oxysporum</i>	Cucumber	<i>T. harzianum</i>	<i>In vitro</i>	Akhlaghi et al. (2016)
<i>P. aphanidermatum</i>	Cucumber	<i>B. cereus</i> , <i>B. licheniformis</i> , and <i>Bacillus endophyticus</i>	<i>In vitro</i>	Rezaei et al. (2016)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>R. solani</i>	Wheat	<i>T. citrinoviride</i>	<i>In vitro</i> and greenhouse	Sharify et al. (2016a)
<i>R. solani</i>	Wheat	<i>T. asperellum</i>	<i>In vitro</i> and greenhouse	Sharify et al. (2016b)
<i>P. tolaasii</i>	<i>A. bisporus</i>	<i>Brochothrix thermosphacta</i> and <i>Bacillus mycoides</i>	<i>In vitro</i>	Aslani et al. (2016)
<i>B. cinerea</i>	Grape	<i>T. harzianum</i> and <i>C. membranifaciens</i>	<i>In vitro</i>	Kasfi et al. (2016a)
<i>A. niger</i>	Grape	<i>T. harzianum</i> and <i>C. membranifaciens</i>	<i>In vitro</i>	Kasfi et al. (2016b)
<i>H. schachtii</i>	Sugar beet	<i>T. harzianum</i> , <i>Thalaromyces flavus</i> , <i>F. solani</i> , and <i>V. chlamydosporium</i>	Greenhouse	Shirazi et al. (2016)
<i>M. phaseolina</i>	Mungbean	<i>T. harzianum</i> , <i>T. reesei</i> , <i>A. niger</i> , and <i>B. subtilis</i>	Greenhouse	Shahid and Khan (2016)
<i>Curvularia lunata</i> and <i>Bipolaris sorokiniana</i>	Wheat	<i>Achromobacter xylosoxidans</i>	<i>In vitro</i>	Bagheri and Ahmadzadeh (2016)
<i>R. solani</i>	Tomato	<i>Beauveria bassiana</i>	Greenhouse	Azadi et al. (2016)
<i>Bipolaris victoriae</i>	Rice	<i>T. harzianum</i> , <i>A. tenuissima</i> , <i>Fusarium verticillioides</i> , <i>Alternaria citri</i> , <i>A. infectoria</i> , and <i>Preussia</i> sp.	Greenhouse	Safari Motlagh and Mohammadian (2016)
<i>M. javanica</i>	Tomato	<i>P. fluorescens</i>	Greenhouse	Tanha et al. (2016)
<i>M. javanica</i>	Tomato	<i>Talaromyces flavus</i> and <i>T. harzianum</i>	Greenhouse	Abootorabi and Naraghi (2016)
<i>F. solani</i> and <i>F. oxysporum</i>	Chickpea	<i>T. harzianum</i> , <i>T. asperellum</i> , and <i>T. virens</i>	Field	Khomeini et al. (2016)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i>	Greenhouse	Khaledi and Taheri (2016)
<i>C. beticola</i>	Sugar beet	<i>Bacillus</i> sp., <i>Paenibacillus</i> sp., <i>Pseudomonas</i> sp., and <i>Enterobacter</i> sp.	<i>In vitro</i> and greenhouse	Arzanlou et al. (2016)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i> , <i>T. asperellum</i> , and <i>Trichoderma virens</i>	Greenhouse	Barari and Foroutan (2016)
<i>M. phaseolina</i>	Soybean	<i>T. harzianum</i> and <i>T. atroviride</i>	<i>In vitro</i> and greenhouse	Kia and Rahnama (2016)
<i>F. o. f.sp. dianthi</i>	Carnation	<i>T. harzianum</i>	<i>In vitro</i>	Kermajany et al. (2017)
<i>V. dahliae</i>	Pistachio	<i>T. harzianum</i>	Greenhouse	Fotoohiyan et al. (2017)
<i>F. verticillioides</i> , <i>P. aphanidermatum</i> , <i>Penicillium</i> sp., and <i>V. dahliae</i>	—	<i>Lactobacillus fermentum</i> , <i>Lactobacillus plantarum</i> , <i>Lactobacillus paralimentaris</i> , <i>Lactobacillus pentosus</i> , <i>Lactobacillus buchneri</i> , and <i>Sporolactobacillus terrae</i>	<i>In vitro</i> and field	Kharazian et al. (2017)
<i>Rhizoctonia solani</i>	Sugar beet	<i>Bacillus subtilis</i>	<i>In vitro</i> and greenhouse	Ahmadzadeh et al. (2017)
<i>Macrophomina phaseolina</i>	Soybean	<i>Trichoderma harzianum</i> , <i>Trichoderma reesei</i> and <i>Trichoderma atroviride</i>	<i>In vitro</i> and greenhouse	Alamdarlou et al. (2017)
<i>F. oxysporum</i> , <i>X. campestris</i> , and <i>E. amylovora</i>	—	<i>Streptomyces</i> sp.	<i>In vitro</i>	Shams and Shahnava (2017)
<i>M. javanica</i>	Cucumber	<i>Pseudomonas rhodesiae</i> and <i>Acinetobacter</i> sp.	<i>In vitro</i> and greenhouse	Amini et al. (2017)

Table 1: continued

Pathogens	Host	Antagonists	Procedure	Ref.
<i>C. michiganensis</i> subsp. <i>insidiosus</i>	Alfalfa	<i>B. subtilis</i> , <i>Pseudomonas</i> sp., <i>Escherichia coli</i> , <i>Sphingomonas paucimobilis</i> , and <i>Paenibacillus glycanilyticus</i>	<i>In vitro</i> and greenhouse	Omidi Nasab and Khodakaramian (2017)
<i>P. loosi</i>	Tea	<i>P. lilacinus</i>	Greenhouse	Yahyavi Azad et al. (2017)
<i>P. syringae</i> pv. <i>syringae</i>	Oak	<i>Pseudomonas protegens</i> , <i>Stenotrophomonas maltophilia</i> , and <i>Bacillus firmus</i>	<i>In vitro</i>	Tashi-Oshnoei et al. (2017)
<i>F. o. f.sp. radices lycopersici</i>	Tomato	<i>Streptomyces carpaticus</i>	<i>In vitro</i> and greenhouse	Zahed and Behbudi (2017)
<i>A. niger</i> and <i>A. flavus</i>	—	<i>B. cereus</i>	<i>In vitro</i>	Motamedi et al. (2017)
<i>Xanthomonas oryzae</i> pv. <i>oryzae</i>	Rice	<i>Bacillus</i> sp., <i>B. subtilis</i> , <i>P. putida</i> , and <i>Enterobacter</i> sp.	Greenhouse	Yousefi et al. (2018)
<i>R. solani</i>	Common bean	<i>B. pumilus</i> , <i>T. harzianum</i> , and <i>Rhizophagus intraradices</i>	Greenhouse	Nasir Hussein et al. (2018)
<i>P. syringae</i> pv. <i>syringae</i> and <i>P. tolaasii</i>	Pistachio	<i>Pantoea brenneri</i> , <i>P. protegens</i> , <i>S. maltophilia</i> , <i>Bacillus anthracis</i> , <i>B. pumilus</i> , and <i>Serratia plymuthica</i>	Greenhouse	Etminani and Harighi (2018)
<i>M. incognita</i>	Pistachio	<i>P. fluorescens</i> , <i>B. cereus</i> , and <i>B. subtilis</i>	Greenhouse	Zeynadini-Riseh et al. (2018)
<i>Fusarium pseudograminearum</i>	Wheat	<i>P. fluorescens</i> , <i>B. subtilis</i> , and <i>Streptomyces</i> sp.	<i>In vitro</i> and greenhouse	Norouzian et al. (2018)
<i>V. dahliae</i>	Tomato	<i>Bacillus</i> spp., <i>Pseudomonas</i> spp., and <i>Enterobacter</i> spp.	<i>In vitro</i>	Zendehdel et al. (2018)
<i>H. schachtii</i>	Sugar beet	<i>T. harzianum</i> , <i>Talaromyces flavus</i> , <i>F. solani</i> , and <i>Pochonia chlamydosporium</i>	Greenhouse	Hosini et al. (2018)
<i>F. oxysporum</i>	Cucumber	<i>T. harzianum</i> and <i>T. atroviride</i>	<i>In vitro</i>	Nosrati (2018)
<i>P. carotovorum</i> subsp. <i>carotovorum</i>	Potato	<i>Bacillus</i> spp.	<i>In vitro</i>	Abdoli et al. (2018)
<i>S. sclerotiorum</i>	Cucumber	<i>Streptomyces albidoflavus</i>	<i>In vitro</i> and greenhouse	Eini et al. (2018)
<i>P. loosi</i>	Tea	<i>P. lilacinus</i> and <i>Clonostachys rosea</i>	Greenhouse	Yahyavi Azad et al. (2018)
<i>M. phaseolina</i>	Melon	<i>B. amyloliquefaciens</i>	Greenhouse	Bakhshi et al. (2018)
<i>S. sclerotiorum</i>	Cucumber	<i>S. albidoflavus</i>	<i>In vitro</i> and greenhouse	Zahed and Behbudi (2018)
<i>F. o. f.sp. radices lycopersici</i>	Tomato	<i>Streptomyces</i> spp.	<i>In vitro</i> and greenhouse	Vafaie et al. (2018)
<i>F. oxysporum</i>	Cucumber	<i>P. fluorescens</i>	Greenhouse	Saberi-Riseh and Fathi (2018)
<i>B. cinerea</i>		<i>Pichia galeiformis</i> , <i>Galactomyces candidum</i> , <i>M. guilliermondii</i> , <i>S. cerevisiae</i> , <i>Zygoascus meyeriae</i> , <i>Pichia</i> sp., <i>Candida parapsilosis</i> , <i>Metschnikowia</i> sp., <i>Candida boidinii</i> , <i>Lecythophora</i> sp., and <i>Candida catenulata</i>	<i>In vitro</i>	Gharai et al. (2018)

6 Future perspectives

The climate changes and the growing human population with enhancing food demands have been considered as risks to food security in Iran. Different beneficial population of microbes can positively affect agricultural farms, such as pollutant degradation, productivity, and decrease in disease and pest. Maintaining and improving the performance of these microbes can increase agricultural products in different geographical area of Iran with various climates. More studies are needed to reach these aims in Iran. We need to engineer microbes in different parts and various population of plants. We can use beneficial microbes as bioformulation or other methods of treatments on plants. Since the roots are in contact with soil and rhizosphere has high biodiversity, these are the most important parts in plants for engineering the microbes. Therefore, soil improvement with beneficial microorganisms will be able to help farmers and agricultural ecosystems in the future years.

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