INDUS JOURNAL OF ANIMAL AND PLANT SCIENCES
https://induspublishers.com/IJAPS
Volume 2, Issue 1 (2024)

Original Article

" The Interaction of Plant Pathology and Horticulture with Emerging Trends and Technologies"

Fazal Abbas [1], Sajawal[2], Abdul Sami[3], Muhammad Sufyan[4], Sajjad Hussain[5], Khalid Khan[6], Adeel Sajid[7]

1 Department of Agronomy, College of Agriculture, University of Sargodha

2 Department of Plant Pathology, Sindh Agriculture University, Tandojam

3 Department of Plant Pathology, Faculty of Plant Protection, Sindh Agriculture University

4 Department of Seed Science and Technology, University of Agriculture, Faisalabad

5 Department of Plant Pathology, College of Agriculture, University of Sargodha

6 Department of Horticulture, The University of Agriculture, Peshawar

7 Department of Plant Pathology, University of Agriculture, Faisalabad

ARTICLE INFO

Received: 08 Feb 2024
Revised: 15 March 2024
Accepted: 10 May 2024
Published: 30 June 2024

Key Words:
Horticulture, Pathogens, Chemicals, Genes, Soil-Borne Disease

***Corresponding Author:**
Muhammad Sufyan
(sufyanpervez0@gmail.com)

ABSTRACT

A fascinating and valuable area of agriculture, horticulture includes beneficial, flavourful, and spicy crops in addition to vegetable, fruit, and decorative crops. Since these crops provide essential substances and vitamins that promote health, the industry's significance has grown as global demand for healthier diets has grown. However, fresh plant pathogens have emerged as an effect of increasing supply requirements, particularly for nations like Italy. Monoculture, the application of the biological resistance to force, and central cultivation techniques are some of the main culprits. Phytophthora genus and Fusarium oxysporum are two examples of soil-borne diseases that seriously endanger decorative plants in addition to vegetables. The management of these illnesses became even more challenging after methyl bromide was discontinued, particularly in a high level of farming methods. Numerous claims of Fusarium wilt on decorative products like gerbera and chrysanthemum as well as commodities like rocket, lamb's lettuce, and lettuce have brought attention to shortcomings in contemporary gardening. Seed transfer and subsequent farming in comparable soils are contributing factors to the spread of disease. Integrative methods for controlling diseases are becoming more popular as a means of addressing these problems..

INTRODUCTION

The first of the valuable and quickest-growing agricultural sectors in the globe is horticulture. Fruits and veggies decorative plants, crops for plantations, fragrant and medicinal herbs and spices are all included in this category. Horticulture is essential for security of nutrition and food as the global population grows and there is a growing need for better nutrition. Vitamins, minerals, fibre, phytonutrients, and antioxidants are all necessary for human wellness and are found in horticultural crops. Common characteristics of horticultural crops, which are profitable globally, include their high price tag, constant creativity and improvement in cultivation systems, the abundance of fruits and types, and stringent restrictions on the usage of pesticides [1].

Emerging diseases of plants outbreaks can have detrimental effects on global commerce, the agricultural sector, ecology, and, in the worst situations, social stability [2]. Numerous theories exist regarding the beginning of these disorders, including acquires from other nations, pandemics of illnesses that are currently indigenous, the growth of the areas where the germs spread due to warming temperatures, the tolerance of the infections to fresh devices, and modifications in control and cultural practices. In a strict sense, new ailments are those whose prevalence has increased within the past fifteen to twenty years. Emerging illnesses may make their initial appearance or spread to previously unexplored locations. The word is used widely in this overview to include the groups that follow: hazardous ailments, chronic/spreading ailments, resurfacing diseases, and novel diseases. "New diseases" are those that have been stated on host organisms initially in an unfamiliar region within the last five years; "re-emerging" refers to a disease that has been identified in a specific region but that unexpectedly gains attention for a variety of causes, such as the emergence of fungicide obstruction, the arrival or substitution of a product, or changes in the distribution of native infections. Lastly, we classify diseases that are chronic in a particular region but may at times give rise to a widespread breakout under the "chronic/spreading disease" group.

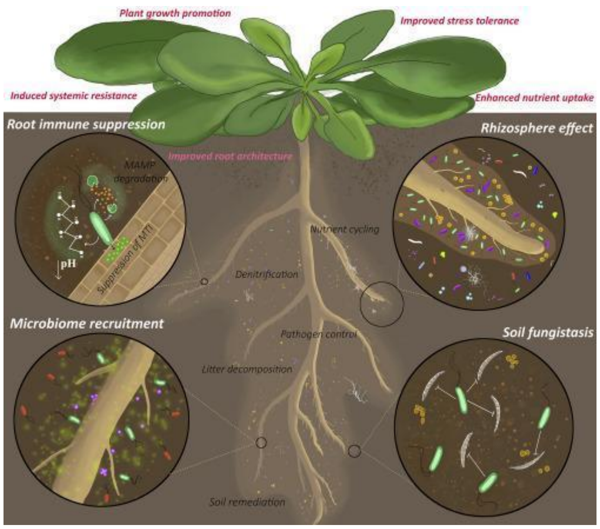
EMERGING DISEASES:

Pest control products, genes for resistance, rotation of crops, and different cultivation techniques that attempt to reduce plants diseases all provide challenges to populations of pathogens in contemporary agricultural ecosystems [3]. Because of its energy, diverse product line, constant advancement in processes or goods, and use of intense methods of cultivation, the crop and ornamental industries are especially vulnerable to the creation of novel illnesses. Italy is an interesting investigation because of its enormous farming of vegetables and ornamentals.

The utilisation of mono- and oligo-genic pathogen obstacles, which promotes the emergence of new distinct kinds and novel genera of pathogenic organisms, and the quick replacement of types to meet market demands are two further distinctive features of these industries. Lastly, structural factors are responsible for the abrupt and nearly modern emergence of plant diseases on multiple nations. Actually, only a few large nursery in this manufacturing line create propagating material, which is then supplied to smaller nurseries in other areas or nations [4]. Intercepting the infections at the line's nodal points would be required to lower the chance of new infections developing.

Soil-borne pathogens

From the first phases (at the nursery level) for manufacturing to commercialisation, soil-borne diseases seriously reduce the yield of decorative and vegetable-based crops. All industrialised nations phase out methyl bromide, a very powerful soil fumigant, on January 1st, 2005. Following its phase-out, some issues are emerging, especially in nations like Italy that historically used this fumigant extensively. While new legislative judgements are the cause of some of the rising issues, others are mechanical in nature [5].



Several distinct F. oxysporum formae speciales have been observed on foliage and vegetables in recent years. Recent research of Fusarium wilts on vegetables include endive [6], lamb's lettuce (Valerianella olitoria) [7], wild (Diplotaxis spp.) and cultivated rocket (Eruca sativa) [8], and lettuce (Lactuca sativa) [9]. In Lumbardy, in northwest Italy, where these crops are grown repeatedly each year on similar soil, these diseases first became significant production issues. They later spread to other places as well. They spread easily because they are seed-transmitted. Seeds coating may offer some disease control in the interim [10].

First identified on basil in the former Soviet Union, Fusarium wilt (F. oxysporum f. sp. basilici) gradually spread to numerous mint-growing regions and caused major harm due to its ground- and aerial activity. First identified in Japan in 1969, Fusarium crown and root rot of tomatoes, caused by F. oxysporum f. sp. radicislycopersici, subsequently spread to numerous tomato-growing regions in North America, Europe, and the Mediterranean [11].

Vegetables output in several regions may be threatened by the newly discovered Fusarium wilts. In the instance of lettuce, the illness was initially identified in Europe on Batavia-type summertime and springtime leaf lettuce that was cultivated for preparation. One of the most effective ways to reduce the occurrence of Fusarium wilt in lettuce is to use resistant varieties [12]. Numerous romaine and Batavia-type lettuces that are produced most often in Italy are vulnerable to Fusarium wilt. Both wild and farmed rockets, which are extensively grown and marketed as ready-to-eat products, have been shown to have the disease.

Numerous novel Fusarium wilts were just recently discovered in the context of decorative crops as well [5]. Beginning in 1997, Fusarium oxysporum was specifically found on chrysanthemum, gerbera, Lisianthus, Paris daisy (Argyranthemum frutescens), and Osteospermum sp. The main region for these fresh epidemics is the northern part of Italy. Due to the existence of several races, Fusarium oxysporum f. sp. chrysanthemi is the most prevalent and capable of attacking the majority of ornamental plants in the Compositae family [13]. In many regions, P. nicotianae var. nicotianae and Phytophthora capsici are frequent issues with plants. P. nicotianae especially is growing in significance on tomatoes.

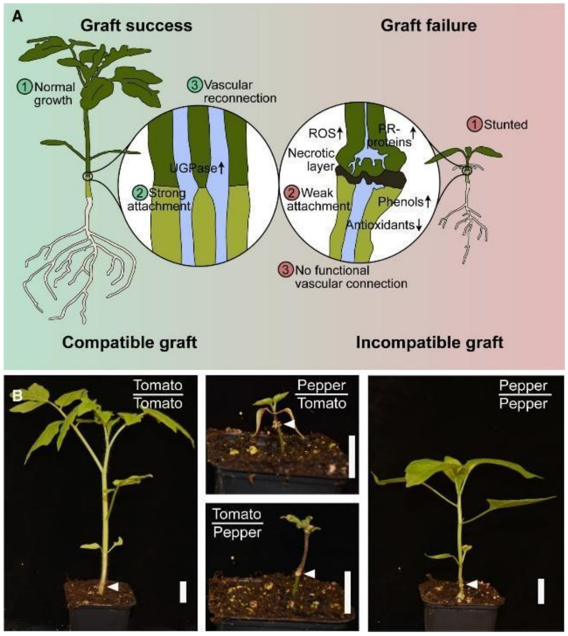
According to a new study, 34 new host-pathogen combinations and 17 Phytophthora species—five of which were novel—had been brought into Spain through nurseries and garden centres [14]. Additionally, Sclerotium rolfsii and Sclerotinia sclerotiorum are becoming more significant on a variety of ornamental crops. According to Garibaldi and Gullino (2009) [6], S. sclerotiorum was recently found on Calendula officinalis, Campanula carpatica, Felicia amelloides, Gazania sp., Hutchinsia alpina, Ranunculus asiaticus, Salvia officinalis, Schizanthus wisetonensis, and Thymus citriodorus in Italy. Recently, Sclerotium rolfsii, a tropical-type pathogen, was found on Dichondra repens and Solanum pseudocapsicum in northern Italy [15].

Recently, Rhizoctonia solani was found on a number of ornamental crops, including aquilegia, heuchera, hosta, lupinus, and periwinkle (Vinca rosea) as well as on Diplotaxis tenuifolia and Valerianella olitoria [15]. Recently, reports of strawberry crown and root rot caused by Macrophomina phaseolina have surfaced in a number of production regions, including the United States, Israel [16], and Spain. The spread of this disease has been linked to the phase-out of methyl bromide and the challenges associated with substituting such a fumigant on strawberries.

NEW TRENDS IN DISEASE MANAGEMENT

Host Plant Resistance, Including Grafting

Resistant is a useful tactic for controlling or preventing harmful disease epidemics. Many crops of vegetables have variants that are tolerant or resistant to one or more diseases [17]. There's little debate that selection aimed at controlling pathogens can aid in the handling of soilborne diseases, and numerous instances of host resistance are documented in the literature. There are resistant hybrids that are resistant to several diseases. Cucumber (Cucurbita vicifolia as rootstock resistant to Fusarium wilt), melon (Benincasa cerifera resistant to Fusarium wilt), tomato hybrids resistant to Verticillium and Fusarium wilt and Pyrenochaeta lycopersici, and other crops can all be grafted onto resilient rootstocks [18]. Instances demonstrating how host resistance contributes to the control of tomato diseases have been examined. There are Fusarium wilt-resistant lettuce and rocket cultivars on the market that are a good choice for farmers. Illness tolerance is not necessarily flawless, though, and it can be readily overcome by the emergence of new virus races in environments that are very conducive to the spread of illness. Examples of just some resistance in transplanted plants under extremely strong disease stress are established.



It is challenging to implement this approach since maintaining quality is the primary objective in floriculture programs, even if the creation of cultivars that are resistant should offer the best chance for the management of numerous illnesses in this instance of aesthetic crops. Selection that do not meet the strict requirements for plant and bloom development are continually removed. The method of creating and identifying resistant cultivars and clones has been regarded as difficult, time-consuming, and, for the most part, a waste of energy.

Furthermore, floricultural traits must be on par with or better than those of current cultivars, even if a geneticist is successful in creating resistant lines. Even for producers that avoid choosing for obstruction, this is a very challenging goal. However, resistance is increasingly needed as a control measure against wilts.There are economically viable carnation genotypes that are susceptible to a number of Fusarium oxysporum f. sp. dianthi pathotypes. Recent research has demonstrated that many types of gerbera, chrysanthemum, African daisy, and Paris daisy (Argyranthemum frutescens) are immune to Fusarium wilt caused by F. oxysporum f. sp. Chrysanthemi [6].

Soilless Cultivation

Although cultivation without soil eliminates the need for soil fumigation it still necessitates that circulating solutions of nutrients be properly disinfected. High initial expenditures and issues with the disinfestation, reuse and recycling, and dumping of returned treatments are the primary barriers to the widespread use of soilless farming in Italy. But in Italy, this technique is becoming more and more common, especially for crops with high values like lettuce, gerbera, carnations, roses, and basil. By using appropriate disinfection techniques for the recirculation solution, cultivation without soil systems' disease issues can be resolved. Slow sand filtering has worked well for decontaminating water in Northern Europe and Italy. In soilless systems, the newly developed antagonists of microbes and the native microbiota in the circulating fluid both demonstrated efficacy in lowering illness incidence.

By applying bacteria capable of colonising the underground root structure of organisms grown in a highly controlled environment, closed circulatory soilless systems offer an intriguing setting for taking advantage of biological regulation [19]. The use of various antagonistic isolates of Trichoderma and Fusarium spp. in conjunction with a slow sand filtration method proved successful in combating Phytophthora cryptogea of gerbera. The suppressiveness of repurposed surfaces used in soilless agriculture is considered an intriguing characteristic with broad potential for practical applications While isolates of Trichoderma spp. isolated from soilless systems suppressed Pythium ultimum on cucumbers , the choice and introduction of strains of bacteria derived from soilless systems showed efficient towards Fusarium wilt of tomato and rocket [20]. This is a recent advancement in biological oversight.

Soil Amendments

Both chemical and biological modifications, such as agricultural waste, fertiliser, and fertiliser, can aid in the management of pathogens transmitted by the soil in ornamental and vegetable crops. Solarisation combined with adjustments may also be beneficial. Additives like cruciferous residues and cow or poultry excrement are susceptible to degradation by microbes (breakdown of glucosesinolates, etc.) when they are placed in soil. This leads to the production of biotoxic chemical compounds like sulfur-containing compounds (isothiocyanates, etc.), alcohols, aldehydes, and other volatile compounds. These substances have the ability to boost bacterial combative reaction in soil and promote fungal propagule development, hence promoting biological suppression. Microbial life towards infections in soil can either hinder the propagules' restoration in soil and plant roots following treatment, or it may harm them during solarisation. These impacts have been noted for a number of worms, weeds, and soilborne fungi, including Verticillium spp., Rhizoctonia solani, Pythium spp., and Sclerotium rolfsii [21]. Adopting these techniques is challenging due to a number of drawbacks, particularly with protected crops. These drawbacks include the reliance on external variables, the type, regularity, or accessibility of the manure utilised, as well as the prevalence and type of infections. Practical use is also limited by the high labour costs, the substantial amount of organic amendments needed (50–70 t ha-1), and the potential release of phytotoxic chemicals that would lengthen the time between intervention and seeding. Nonetheless, this strategy is highly intriguing when it comes to plants cultivated in accordance with natural farming regulations. For example, the combination of grass and polyethylene mulch demonstrated efficacy in combatting numerous soil-borne pests and diseases by establishing anaerobic conditions. Additionally, Fusarium oxysporum f. sp. radicis-cucumerinum, the causative agent of cucumber root and stem rot, was well inhibited by lettuce soil amendments.

Biological Control

Currently, biocontrol molecules that are successful towards soil borne infections only work when used in conjunction with other control strategies. This is evident in the cases of saprophytic Fusarium oxysporum and Trichoderma harzianum strains. Since the climate can be controlled, greenhouse-grown crops like ornamentals may have a higher chance of thriving with natural management. Actually, a special niche for biological therapies of plant diseases is provided by the high value of the crops, the regulated environment of greenhouses, and the small number of approved fungicides [22].

One area where biological oversight can be revolutionary is in the treatment of soilborne diseases. Certain soil-borne diseases are known to either not arise at all or to be more mild in certain so-called suppressive soils. In every instance, steaming eliminated the microbial source of suppressiveness. It has been demonstrated that the suppression of Fusarium wilt pathogens is caused by specific bacteria and/or fungi that are naturally present in these soils.Nevertheless, there are also numerous studies to research on the use of composted material for fighting soil-borne plant diseases of turf-grass, even though decomposed content have typically been used in package media outlets, especially as peat substitutes and replacements. Because composts can serve as a food source for BCAs of soilborne pathogens, BCAs have been introduced into compost additions to increase the regularity of disease management using composts. The results show that Rhizoctonia and Pythium are suppressed more effectively by microbial and antifungal BCA combinations than by single BCAs. Due to its recentness, this strategy has not yet received much attention [23]. In the increasing mix or as germ therapies, antagonists like Trichoderma virens (= Gliocladium virens), Trichoderma spp., and Streptomyces griseoviridis have been successfully used to prevent root rots and Fusarium wilt of lettuce. Tomato Fusarium wilt can be effectively prevented by Penicillium oxalicum. Sclerotinia sclerotiorum on lettuce is managed by the well-known mycoparasite Coniothyrium minitans.

Through bacteria optimisation of soilless platforms with the introduction of microbes capable of colonising a rooted structures of organisms developed under a tightly controlled environment, as previously stated (see before), shut passing soilless systems symbolises an intriguing environment for utilising biological regulation.

Diagnostic Tools

For disease control to be efficient, determining an important component of the inoculum is crucial. The use of the business grain grown far from the area of use has increased recently, increasing the risk of introducing and spreading the viruses to formerly unreported locations. The use of contaminated reproduction material is responsible for the quick spread of various recently imported Fusarium wilts of decorative plants and vegetables.

The sensitivity needed to identify seedborne diseases may be lacking in traditional pathogenic methods of detection, hence genetic methods have been created to provide a rapid and precise identification. For a number of Fusarium oxysporum formae speciales, the hunt for biological techniques has been very successful [24]. Pathogens as Phytophthora spp. could be detected more easily thanks to molecular technologies [25]. To determine the viability of the Phytophthora spp. inoculum in soilless environments, several techniques were modified. Pathogen identification is thought to be crucial in order to tailor the control measure to the specific pest in question, as substitutes to methyl bromide typically have a limited range for control.

FUTURE NEEDS

As the hydroponic business experiences additional shifts in manufacturing, advertising, and shipping practices, many significant issues remain unsolved and fresh problems are appearing. The application of biotech in growing plants and the increased adoption of automation and mechanisation methods for improved cultivation will be the main shifts. Plant pathologists will face challenges as a result of some of those changes, which will impact the severity of diseases. The risk of rapidly spreading novel diseases to other production areas is increased by globalisation and the swift movement that plants produce and seeds. Indeed, a wide range of illnesses affecting a number of crops are included in the pathology of horticulture plants, offering many opportunities for creative study and the use of novel disease control techniques.

Scientists face new hurdles as a result of the energy crisis, growing limits on the application of chemicals, and the utilisation of novel crops. Horticulturists and botanical pathologists will need to collaborate more to ensure that novel methods of management improve plant health or, at worst, have no effect at all. There is an urgent need for techniques to increase the precision and speed of laboratories and field diagnostics. More logical decisions regarding management will be made possible by enhanced and extensively utilized monitoring and diagnostic technologies to identify pathogen populations and economical boundaries.

The amount of energy trouble, expanding restrictions on chemical consumption, and the use of new crops present new challenges for scientists. To make sure that innovative management techniques enhance plant health or, at worst, have no impact at all, gardeners and botanic pathologist will need to work together more. Techniques to improve the accuracy and speed of laboratory and field diagnostics are desperately needed. Improved and widely used tracking or diagnostic methods to determine the number of pathogens and economic boundaries would enable more rational managerial choices.

Conclusion:

Because it produces a wide variety of superior products to meet dietary requirements, landscaping is becoming a more significant sector of global agriculture. The control of illnesses brought on by soil-borne pathogens, such as Phytophthora spp. and Fusarium oxysporum, has become more difficult as a result of improved cultivation methods, monoculture, and the removal of chemicals like methyl bromide. Disease outbreaks in crops like lettuce, rocket, and chrysanthemums show that these diseases are a threat not just to the generation of fruits and vegetables but also to floricultural crops. Acute flaws in modern horticulture systems are reflected in the emergence and return of many plant diseases, which are exacerbated by globalised commerce, seed transfer, and intensive cultivation. The trend towards biological sciences, hydroponic cultivation,mechanization, and automated farming presents both benefits and sophisticated jeopardy, necessitating adaptive approaches toward disease management. In addition, the expanding constraints on chemical use coupled with pressure from energy and environmental considerations compels combined, sustainable responses. To counter effectively these multi-faceted threats, there is an immediate paradigm change that must be prioritized for plant pathology and horticulture. Greater integration between researchers and growers, high-throughput diagnostic method development, enhanced surveillance systems, and biosecure protocols must be given priority. Strategies of the future must aim to reduce plant diseases but also to make horticultural systems both economically and environmentally sustainable.

References:

1. Janbandhu MS, Mehta A, Beese S, Pandey SK, Singh B, Patel A, et al. Advances and emerging trends in horticultural production and management. J Exp Agric Int. 2024;46:47-69.
2. Gamliel A. High consequence plant pathogens. In: Crop biosecurity: assuring our global food supply. Springer; 2008. p. 25-36.
3. Stukenbrock EH, McDonald BA. The origins of plant pathogens in agro-ecosystems. Annu Rev Phytopathol. 2008;46(1):75-100.
4. Gullino ML, Garibaldi A. Evolution of fungal diseases of ornamental plants and main implications for their management. Global Science Books, London, UK; 2006. p. 464-71.
5. Garibaldi A, Gullino ML. Critical aspects in management of fungal diseases of ornamental plants and directions in research. Phytopathol Mediterr. 2007;46:1000-15.
6. Garibaldi A, Bertetti D, Gullino ML. Susceptibility of chrysanthemum and Paris daisy varieties to several isolates of Fusarium oxysporum f. sp. chrysanthemi. Commun Agric Appl Biol Sci. 2009;74(3):651-7.
7. Garibaldi A, Gilardi G, Gullino ML. First report of Fusarium oxysporum causing vascular wilt of lamb's lettuce (Valerianella olitoria) in Italy. Plant Dis. 2004;88(1):83.
8. Garibaldi A, Gilardi G, Gullino M. First report of Fusarium oxysporum on Eruca vesicaria and Diplotaxis spp. in Europe. Plant Dis. 2003;87(2):201.
9. Garibaldi A, Gilardi G, Gullino M. First report of Fusarium oxysporum on lettuce in Europe. Plant Dis. 2002;86(9):1052.
10. Gilardi G, Tinivella F, Gullino ML, Garibaldi A. Seed dressing to control Fusarium oxysporum f. sp. lactucae/Entwicklung eines Saatgutbehandlungsverfahrens zur Kontrolle von Fusarium oxysporum f. sp. lactucae. J Plant Dis Prot. 2005;240-6.
11. Katan J, Katan T. Vegetative compatibility grouping in Fusarium oxysporum f. sp. radicis-lycopersici from the UK, the

Netherlands, Belgium and France. Plant Pathol. 1999;48(4):541-9.
12. McCreight JD, Matheron ME, Tickes BR, Platts B. Fusarium wilt race 1 on lettuce. Unpublished or missing journal details. [Please verify].
13. Troisi M, Bertetti D, Gullino ML, Garibaldi A. Race differentiation in Fusarium oxysporum f. sp. chrysanthemi. J Phytopathol. 2013;161(10):675-88.
14. Moralejo E, Pérez-Sierra AM, Álvarez L, Belbahri L, Lefort F, Descals E. Multiple alien Phytophthora taxa discovered on diseased ornamental plants in Spain. Plant Pathol. 2009;58(1):100-10.
15. Garibaldi A, Gullino M. Malattie emergenti su colture ornamentali nell'Italia settentrionale e aggiornamenti sulla difesa. Prot Colture. 2009;4:13-9.
16. Zveibil A, Freeman S. First report of crown and root rot in strawberry caused by Macrophomina phaseolina in Israel. Plant Dis. 2005;89(9):1014.
17. Van Lenteren JC. A greenhouse without pesticides: fact or fantasy? Crop Prot. 2000;19(6):375-84.
18. Leeman M, Den Ouden F, Van Pelt J, Cornelissen C, Matamala-Garros A, Bakker P, et al. Suppression of fusarium wilt of radish by co-inoculation of fluorescent Pseudomonas spp. and root-colonizing fungi. Eur J Plant Pathol. 1996;102:21-31.
19. Postma J, Montanari M, Van den Boogert PH. Microbial enrichment to enhance the disease suppressive activity of compost. Eur J Soil Biol. 2003;39(3):157-63.
20. Srinivasan K, Gilardi G, Garibaldi A, Gullino ML. Bacterial antagonists from used rockwool soilless substrates suppress Fusarium wilt of tomato. J Plant Pathol. 2009;91(1):147-54.
21. Mattner S, Porter I, Gounder R, Shanks A, Wren D, Allen D. Factors that impact on the ability of biofumigants to suppress fungal pathogens and weeds of strawberry. Crop Prot. 2008;27(8):1165-73.
22. Paulitz TC, Bélanger RR. Biological control in greenhouse systems. Annu Rev Phytopathol. 2001;39(1):103-33.
23. Noble R, Coventry E. Suppression of soil-borne plant diseases with composts: a review. Biocontrol Sci Technol. 2005;15(1):3-20.
24. Lievens B, Claes L, Vakalounakis DJ, Vanachter AC, Thomma BP. A robust identification and detection assay to discriminate the cucumber pathogens Fusarium oxysporum f. sp. cucumerinum and f. sp. radicis-cucumerinum. Environ Microbiol. 2007;9(9):2145-61.
25. Grote D, Olmos A, Kofoet A, Tuset JJ, Bertolini E, Cambra M. Specific and sensitive detection of Phytophthora nicotianae by simple and nested-PCR. Eur J Plant Pathol. 2002;108:197-207.