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Biological Control of Fusarium Wilt of Cucurbits

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ABSTRACT

Cucurbits are economically important vegetable crops throughout the world, and *Fusarium* wilt disease caused by *Fusarium oxysporum* has become the major limiting factor in the cucurbit production. The disease causes serious economic losses to the crop and infects at all stages of plant growth. Due to the soil-borne nature of the pathogen, its management is quite difficult. Although there are several management practices available for *Fusarium* wilt disease, but biological control offers a safe and environmental friendly management of the disease. Association of biological control agents with the plants stimulate plant defense mechanisms and causes induction of systemic acquired resistance (SAR) as well as induced systemic resistance (ISR) in the plants. Due to its several benefits, there is an increasing demand for biologically based management practices specially for soil-borne diseases like *Fusarium* wilt disease of cucurbits.

Fusarium wilt disease of cucurbits is widespread and is accountable for huge losses to the crop even upto 100%. The disease causal agent, *F. oxysporum* is a soil-borne fungus that invades the plant vascular system and eventually led to retarded plant growth, yellowing as well as necrosis of the foliage, and subsequently causes plant death. The pathogen attacks the plant at almost all the growth stages. The affected root portion may turn dark brown with a soft rot near the crown area. The members of the plant family cucurbitaceae which are attacked by *F. oxysporum* include muskmelon, watermelon, cucumber, pumpkin, bitter gourd, ridge gourd etc. The wilt diseases in different crops of family cucurbitaceae are caused by different formae speciales (f.

sp.) of *F. oxysporum*. Although these formae speciales are morphologically similar, but they are generally host-specific i.e. the f. sp. which attack on muskmelon is *F. oxysporum* f. sp. *melonis*, on cucumber (*F. oxysporum* f. sp. *cucumerinum*), on bitter gourd (*F. oxysporum* f. sp. *momordicae*), on watermelon (*F. oxysporum* f. sp. *niveum*) and so on (Shahid *et al*., 2023 a).

Management of *Fusarium* wilt disease is extremely difficult due to the persistent nature of chlamydospores which lasts upto 10-15 years. Secondly, the development of new physiological races of *F. oxysporum* pose a great challenge for its management. Traditional or conventional disease control strategies, have been suggested to manage the *Fusarium* wilt such as cultural practices (deep ploughing, crop rotation, fallowing, sanitation, soil solarization, etc.), chemical control methods (soil fumigation, seed and seedling dip treatments of fungicides), host plant resistance (use of resistant germplasms); however, these strategies are not environmentally friendly, reliable or economical (Shahid, 2023).

In this regard, biological control represents a safe alternative method for the protecting the crops against *Fusarium* wilt disease. Even though the use of chemicals (fungicides) offers some degree of control (Shahid and Khan, 2016 a), but its non-target effects on the human and environment is of great concern. Also, the misuse of chemicals poses several hidden risks and reduces its effectiveness in preventing the disease (Shahid *et al*., 2023 b). Furthermore, the lack of highly resistant cultivars against *Fusarium* wilt and their utilization in grafting is very time-consuming.

Biological control has progressively established as a research hotspot for managing *Fusarium* wilt disease because of its safety, environmental friendliness, widespread availability, and low cost. Biological control is a significant component of integrated disease management (IDM) program, which is biodegradable and does not pollute the environment. It is selective in their mode of action and does not harm human, as well as several other beneficial microorganisms.

Numerous microbial species have been shown to efficiently control *F. oxysporum* such as *Trichoderma* spp., *Pseudomonas* spp., *Bacillus* spp., *Streptomyces* spp., *Aspergillus niger* and non-pathogenic strains of *Fusarium* spp. (Xu *et al*., 2019).

The primary mechanism possibly includes-

- Antibiosis (secretion of antimicrobial compounds from these microbes)
- Mycoparasitism
- Competition for space and nutrients between pathogen and biological control agent
- Induced plant resistance

Biological control agents can be applied through several methods as follows-

- Soil application
- Seed treatment
- Foliar spray
- Root dip method
- Slurry treatment

- As bio-fertilizers

Biological control of Fusarium wilt diseases revealed high efficacy in managing numerous *F. oxysporum* worldwide, through the use of antagonistic fungi and bacteria, natural plant extracts, etc. in order to keep the pathogen population below economic injury level (Khan *et al*., 2017; Hussein, 2018). In addition to have excellent antifungal potential, these biocontrol agents or antagonists can boost the seed germination and improve the growth of plants (Mei *et al*., 2019).

Trichoderma has gradually emerged as one of the most important biological control fungi under the criteria for safe, effective and eco-friendly disease management (Khan*et al*., 2011; Shahid and Khan, 2016 b). Since 1920s, *Trichoderma* spp. was used extensively as a biological control agent/antagonist to control several plant diseases (Harman *et al*., 2004; (Shahid and Khan, 2019). Several researchers have worked on the application of biological control agents for the management of *Fusarium* wilt diseases of cucurbits and have achieved efficient disease control. Zhao *et al*. (2011) have done biocontrol experiments on *Cucumis melo* (muskmelon) by using bio-organic fertilizer and found significant control of the *Fusarium* wilt disease. Matrood *et al*. (2022) conducted experiments with some biological control agents and found that *T. koningii* and *A. niger* successfully control *Fusarium* wilt of cucumber caused by *F. oxysporum* f. sp. *cucumerinum*. Lian *et al*. (2023) have also reported the biocontrol activity of *T. harzianum* against *Fusarium* wilt of cucumber.

Some bacterial biocontrol agents are also well-known for their efficacy against *Fusarium* wilt disease such as species of *Bacillus* (*B. subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)* and *Pseudomonas (P. fluorescens, P. putida, P. aeruginosa).* Rahman *et al*. (2021) have also described the environmental friendly strategies including the use of species of *Bacillus, Streptomyces, Pseudomonas* etc. for the management of wilt disease of watermelon due to *F. oxysporum* f. sp. *niveum*. Sultana and Ghaffar (2013) have found that application of biological control agents namely, *Trichoderma harzianum*, *T. viride, Bacillus subtilis, Gliocladium virens* and *Stachybotrys atra* caused a significant reduction in the seedling mortality as well as root-rot infection in cucumber and bottle gourd due to *F. oxysporum*.

Besides the above biocontrol agents, some non-pathogenic isolates of *F. oxysporum* can also act as biocontrol agents against pathogenic *F. oxysporum* isolates (Sajeena *et al*., 2020). They can cause disease suppression through plant growth promotion as well as induced resistance (both local and systemic). It has been reported that these non-pathogenic isolates of *F. oxysporum* evolved from the pathogenic isolates only and the reason behind this is the transfer of some specific genes that encode for pathogenicity due to which they can be converted into pathogenic forms. Hence, the non-pathogenic *F. oxysporum* can be used to control *Fusarium* wilt disease caused by pathogenic *F. oxysporum*.

CONCLUSION

In the present era, more focus has been put on biocontrol approaches for the management of *Fusarium* wilt of cucurbits due to its eco-friendly nature. Biocontrol agents not only control plant disease but also enhance plant growth and development, enhance uptake and utilization of

nutrients from soil and increase crop productivity. Nowadays, there is a growing demand for biologically based disease management strategies which has created interest of researchers for the development of biocontrol products in the form of formulations that will increase the market potential of biocontrol products in the future.

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CONFLICT OF INTEREST

All the authors declare no conflict of interest.

REFERENCES

A. Sajeena, D.S. Nair and K. Sreepavan (2020) Non-pathogenic *Fusarium oxysporum* as a biocontrol agent., *Indian Phytopathology.* 73 177-183.

G.E. Harman, C.R. Howell, A. Viterbo, I. Chet and M. Lorito (2004) *Trichoderma* species opportunistic, avirulent plant symbionts., *Nature ReviewsMicrobiology*. 2 43-56.

H. Lian, R. Li, G. Ma, Z. Zhao, T. Zhang and M. Li (2023) The effect of *Trichoderma harzianum* agents on physiological-biochemical characteristics of cucumber and the control effect against *Fusarium* wilt., *Sci. Rep.* 13 17606.

L. Mei, M. Guang-shu, L. Hua, S. Xiao-lin, T. Ying, H. Wen-kun, M. Jie and J. Xiliang (2019) The effects of *Trichoderma* on preventing cucumber *Fusarium* wilt and regulating cucumber physiology., *Journal of Integrative Agriculture*. 18(3) 607-617.

M.R. Khan, M.A. Anwer and S. Shahid (2011) Management of gray mold of chickpea, *Botrytis cinerea* with bacterial and fungal biopesticides using different modes of inoculation and application., *Biological Control*. 57 13-23.

M.R. Khan, S. Shahid, F.A. Mohidin and U. Mustafa (2017) Interaction of *Fusarium oxysporum* f. sp. *gladioli* and *Meloidogyne incognita* on gladiolus cultivars and its management through corm treatment with biopesticides and pesticides., *Biological Control*. 115 95-104.

M.Z. Rahman, K. Ahmad, A.B. Kutawa, Y. Siddiqui, N. Saad, T. G. Hun, E.M. Hata and M.I. Hossain (2021) Biology, Diversity, Detection and Management of *Fusarium oxysporum* f. sp. *niveum* Causing Vascular Wilt Disease of Watermelon (*Citrullus lanatus*): A Review., *Agronomy*. 11 1310.

N. Sultana and A. Ghaffar (2013) Effect of fungicides, microbial antagonists and oil cakes in the control of *Fusarium oxysporum*, the cause of seed rot and root infection of bottle gourd and cucumber., *Pakistan journal of Botany.* 45 2149-2156.

Q. Zhao, C. Dong, X. Yang, X. Mei, W. Ran, Q. Shen and Y. Xu (2011) Biocontrol of Fusarium wilt disease for *Cucumis melo* melon using bio-organic fertilizer, *Applied Soil Ecology*. 47(1) 67-75.

S. Shahid (2023) Plant diseases-A major limiting factor in production of pulses (Mung bean and Chickpea). In: Recent Research in Agriculture and Plant Sciences., *MKSES Publication, Lucknow, India*. 1-18.

S. Shahid and M.R. Khan (2016 a) Management of root-rot of mungbean caused by *Macrophomina phaseolina* through seed treatment with fungicides., *Indian Phytopathology*. 69 (2) 128-136.

S. Shahid and M.R. Khan (2016 b) Biological Control of Root-rot on Mungbean Plants Incited by *Macrophomina phaseolina* Through Microbial Antagonists., *Plant Pathology Journal.* 15 27-39.

S. Shahid and M.R. Khan (2019) Evaluation of biocontrol agents for the management of root-rot of mungbean caused by *Macrophomina phaseolina*., *Indian Phytopathology.* 72(1) 89-98.

S. Shahid, H. Choudhary and G.S. Jat (2023 a) Fusarium wilt- A major problem in cucurbits., *Agroscience Today*. 4(3) 0570-0572.

S. Shahid, B.B. Sharma, A.A. Khan and N.H. Ansari (2023 b) Management of plant diseases by surfactants., *International Journal of Tropical Agriculture*. 41(1-2) 121-127.

S.N. Hussein (2018) Integrated management of the *Fusarium* vascular wilt disease of Cucurbita pepo in Iraq., Journalof Agricultural and Marine Sciences 23 40-47.

W. Xu, H. Wang, Z. Lv, Y. Shi and Z. Wang (2019) Antifungal activity and functional components of cell-free supernatant from *Bacillus amyloliquefaciens* LZN01 inhibit *Fusarium oxysporum* f. sp. *niveum* growth., *Biotechnol. Biotechnol. Equip.* 33 1042-1052.