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Evaluation of different isolates of *Pseudomonas fluorescens* against *Fusarium oxysporum* f. sp. *ciceri*, causing wilt of chickpea (*Cicer arietinum* L.)

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Abstract

Pseudomonas fluorescens is an efficient antagonist against fungal diseases. Many strains of *P. fluorescens* showed their potential towards suppressing the disease severity in chickpeas caused due to *Fusarium oxysporum*. The present study aimed to the evaluation of operative strains isolated from chickpea fields. Out of 20 isolates of *P. fluorescens*, six isolates (Pf4, Pf13, Pf14, Pf18, Pf19, and Pf20) were identified as strong inhibitors against *Fusarium oxysporum* f. sp. *ciceri* (Foc) in dual culture approach, when compared to other bacterial strains of *P. fluorescens*. Later, the inhibitory activity of the same six isolated strains was validated by all cultural and biochemical tests. The antagonistic activity of (Pf 18, Pf 4, Pf 20, Pf 19, Pf13, and Pf 14) was reduced by (80.1, 79.8, 76.4, 73, 72.6, and 70.3) per cent, respectively, as compared to the control. Pf14 isolate out performed other isolates in terms of enhancing shoot and root growth when compared with control. Selected isolates shown showed significant decrease in wilt incidence percentage both in greenhouse and field trials and also increased seed germination (98%) in Pf13.

1. Introduction

Pseudomonas fluorescens has been documented as a complex collection of a large number of described species (Gardener *et al.*, 2005) and is considered an effective growth-promoting Rhizobacteria and biocontrol agent. Many strains of this bacteria are found worldwide in a wide range of environments and show a substantial amount of physiological and genetic flexibility (Nowak-Thompson *et al.*, 1997). The intimate association of many strains with chickpea and inhibitory action against the wilt causing soil born pathogen, *F. oxysporum*, indicate *P. fluorescens* as a functionally and ecologically worthy micro-organism (Salman, 2010; Hebber *et al.*, 1992; Fridlender *et al.*, 1993; Maurya *et al.*, 2020). *P. fluorescens* occurs naturally in the plant rhizosphere and protects the plant by secreting secondary metabolites containing growth-promoting substances, antimicrobial substances, and hydrolytic enzymes such as chitinase and protease (Kohl *et al.*, 2019; Kumari and Khanna, 2019; Agaras *et al.*, 2020).

In recent years, with an increase in population demand for pulses especially chickpeas have been increased in the food and agriculture industry. Because of the high protein content, calcium, iron, phosphorus, and other minerals; chickpea is an important part of a vegetarian's diet (Latham, 1997). The majority of chickpea production and consumption (95 per cent) takes place in underdeveloped countries. According to Kaur *et al.* (2007), infections brought on by fungal, bacterial, nematode, mycoplasma, and viral pathogens have been documented to affect chickpeas. Throughout, 32 countries around the world have reported having the widespread chickpea wilt caused by *F. oxysporum*, and six fungal infections have been identified as being serious and leading to significant crop loss (Haware *et al.*, 1986; John *et al.*, 2022; Kaur *et al.*, 2007). In India, the fungus causes substantial yield losses of 10-15 per cent, which can rise to 60-70 per cent in years of severe epidemics (Jalali *et al.*, 1999).

Chemically synthesized organic and inorganic compound and their indiscriminate use in agriculture have been continued for many years. Chemical treatments for plant diseases are costly while at the same time, biomagnification and toxic consequences of these chemicals have created environmental and public health issues (Shanmugaiah *et al.*, 2015). In addition, chemical-based treatment causes decreased soil productivity, crop quality, and yield loss.

In this scenario, in contemporary agriculture, the use of biological control agents as fungicide alternatives is steadily expanding. *P. fluorescens* can be used to biologically control several plant pathogens, and using plant growth promoting rhizobacteria strains, especially those from the genus *Pseudomonas*, to do so is an effective alternative to using chemical pesticides to control plant diseases, according to several studies (Kumari and Khanna 2019). The exceptional ability of the soil bacterium, *Pseudomonas* to control phytopathogens through a variety of mechanisms, including the production of antibiotics, siderophores, and lytic enzymes, as well as the release

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COMPARATIVE STUDY OF PHYTOCHEMICAL ACTIVITY OF TULSI SPS. (*OCIMUM TENUIFLORUM* AND *OCIMUM SANCTUM*)

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Abstract:
Tulsi (*Ocimum* spp.), an aromatic plant belongs to the family, Lamiaceae. Tulsi can be grouped to two broad categories, namely holy basil (*Ocimum sanctum*) and mediterranean basil (*Ocimum basilicum*). The present study was carried out to compare phytochemical activity of two Tulsi species, namely Rama Tulsi (*Ocimum sanctum*), Krishna Tulsi (*Ocimum tenuiflorum*).
The study revealed that all the *both* species possess varied amounts of phytochemicals qualitatively and the best therapeutic character . These plants may prove to be a rich source of compounds with possible antimicrobial activities, but more pharmacological investigations are necessary.
Key words: *Ocimum sanctum, Ocimum tenuiflorum*, Phytochemicals, Therapeutic character

Introduction

It is an aromatic plant. Plants have served human kind as sources of medicinal agents since its earliest beginnings. In fact natural product once served as the source of all drugs. The main chemical constituents of Tulsi are: Oleanolic acid, Ursolic acid, Rosmarinic acid, Eugenol, Carvacrol, Linalool, and β-caryophyllene, have been used extensively for many years in food products, perfumery, and dental and oral products.

Ocimum Sanctum also known as Tulsi family of the *ocimum sanctum* is laminaceae. *Ocimum sanctum* are produced in India and Southeast Asia, India is the largest sources of medicinal plant in whole world. Herbs have been provided therapeutic potential to the health of individual. The demand of this plant are increasing day by day for medicinal purpose [1].

Holy Basil also known as Tulsi (*Ocimum sanctum*), an aromatic herb has healing and curative properties. It is a sacred herb in India and is grown in all houses, temples, gardens, etc

Tulsi is used in treatment of a number of diseases like mental illness, cough and fever, gut diseases, bone and joint problems, eye diseases and other optic problems, ringworm, insect bite, snake bite and scorpion bite and malaria [2].

Holy basil is one of the most worshiped and consumed herb in India. There are approximately 60 species identified under the Ocimum genus in plant family lamiaceae. Scientific studies show that it has anti-inflammatory, antioxidant, antibacterial, analgesic, antipyretic, cancer fighting, immune booster properties [3]

Tulsi has antimicrobial activities against many pathogens and can be used as mouth wash agent, for wound healing, and preservation of food stuff. Tulsi is antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, and can be used also for killing mosquitoes [4].

It has anti-oxidants and can be used as anti-cataract agent, anti-inflammatory agent, as well as protects from chemicals and radiations, good for the liver and nerves and heart, anticancerous agent, protects the