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# Study on biocontrol aspect of potential *Alcaligenes faecalis* against *Fusarium* sp., Concept and Approach

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## Abstract

*The world is dealing with vivid pollutions which lead to the degradation of resources and human health. In soil, the yield of crops is enhanced by the rampant use of chemical pesticides and fertilizers. The fungicides are applied on a large scale on almost all crops to control fungal infection which is the primary cause of crop productivity loss globally. The chemical fungicides are nevertheless causing great harm to soil quality and human health as many fungal pathogens are resistant to these chemical fungicides and all applied in bulk. There is a huge need for the substitution of such fungicides by natural components. The work is just an attempt in this aspect only to glorify Alcaligenes faecalis as a natural substitute for chemical fungicides as its bio- remediating aspect is explored earlier. The least explored association of Alcaligenes faecalis with Fusarium sp. which could be a futuristic fungicide is represented. Fusarium sp. (mainly Fusarium oxysporum and Fusarium incarnatum) are quite pathogenic causing great loss to various plants and crops across the globe. They are altogether responsible for wilt, leaf spot and root rot diseases. Alcaligenes faecalis as a potent biocontrol agent is introduced here as this bacterium has plant growth- promoting features too. So, Alcaligenes faecalis could become a natural, futuristic and biological fungicide and fertilizer. The large-scale bioinoculant production with its specific carrier molecules needs to be explored.*

**Keywords:** *Alcaligenes faecalis, Fusarium oxysporum, Fusarium incarnatum, antagonistic activity, biological fungicides, biocontrol agent, sustainable agriculture.*

### *Alcaligenes faecalis:* An emerging biocontrol agent

*Alcaligenes faecalis* was isolated from a wastewater bioprocessor in Texas, Houston, (USA) [1]. This genus is found in water, soil and in humans, generally non-pathogenic in nature. It is Gram-negative, aerobic, motile and rod-shaped which shows reactivation with Tryptone Soya broth (DSMZ medium 220a). It is mesophilic and shows optimum growth at 30-37°C. The genus is urease, gelatinase, arginine dihydrolase, beta-glucosidase negative, and cytochrome oxidase (enzyme activity) positive [2]. It belongs to Domain- Bacteria, Phylum- Pseudomonadota, Class- Betaproteobacteria, Order- Burkholderiales, Family- Alcaligenaceae, Genus- *Alcaligenes* and Species- *faecalis.*

### Applicability of *Alcaligenes faecalis*

The bacteria has multitudinal aspects and cause bioremediation of phenanthrene, polyaromatic hydrocarbons, phenols, pesticides, and azo dyes. *Alcaligenes faecalis* also converts the most toxic form of arsenic, arsenite to a less fatal form, arsenate. It shows tolerance to heavy metals and has nanoparticle production, biocontrol, and nematicidal activity [3]. It also produces detergents, gum, and bioplastics [4]. This genus has high applicability still it remains under-represented and understudied at the whole genomic level [5].

### *Fusarium species:* A virulent phytopathogen

*Fusarium* belongs to the Phylum Ascomycota, Family Nectriaceae, and has a broad host range. 120 various formae speciales showing specificity to the host species are determined. It causes damage and disease in cotton, date palm, banana, and other field crops including flowers and vegetables. The disease symptoms are distinguishable viz., vascular wilt, leaf epinasty, lower leaf yellowing, stunted growth, defoliation, and plant death eventually. The only measure to control this disease to a certain extent is the application of resistant varieties [6].

*Fusarium oxysporum* widely occurs among root region microbes. Mostly it is saprophytic but certain species cause root rot and wilting and are pathogenic. A new approach to biocontrol activity is the application of nonpathogenic *Fusarium* sp. which combats the pathogenic one [7].

### *Fusarium* sp.: A specific study of diseases occurring in plants

The great loss in productivity of tomatoes is caused by wilt disease of *Fusarium oxysporum* f. sp. *lycopersici.* Still, no definite treatment for such a disease is reported. The pathogenic form of *Fusarium oxysporum* causes wilt disease classified under formae speciales depending on its host. The main reason for *Fusarium* wilt is its introduction in certain places rather than the local eruption of this pathogen. The soil population of the fungi is mainly ruled by asexual reproduction [8].

*Musa* spp. (Banana) is widely produced and consumed fruit. Panama disease (*Fusarium* wilt) causes a huge loss in the yield of bananas.

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The most effective measure to deal with this is again the use of resistant cultivars to a certain limit [9].
Vascular wilt of tomato is caused by *Fusarium oxysporum* f. sp. *lycopersici*. Symptoms include dark brown vascular tissues, wilting and apical discoloration leading to plant death. Wilt disease occurs due to mycotoxins, mycelial accumulation around the xylem, tylose production, and host defense inhibition [10]. (Table 1) [18]

***Table 1:*** *Alcaligenes faecalis S18 effect on Fusarium wilt disease severity of tomato cv. Rio Grande plants (60 days of inoculation with Fusarium oxysporum f. sp. lycopersici) than Control + (uninoculated with the pathogen and untreated) [18]*

| Bacterial isolate | Disease severity | Vascular browning extent (cm) | Plant height (cm) | Fresh plant weight (g) |
|---|---|---|---|---|
| Control + | 3.4±0.2 | 8.2±0.6 | 15.8±0.2 | 4.4±0.4 |
| *Alcaligenes faecalis* S18 | 0.2±0.1 | 0.4±0.2 | 30.6±2.2 | 9.63±0.9 |

Global chickpea productivity is adversely affected by *Fusarium* wilt. The soilborne pathogen (*Fusarium oxysporum* f. sp. *cicer* ) has high survivability and great pathogenic variability [11].
Another globally affected crop of *Fusarium* wilt is cotton (*Gossypium* sp.). This disease was first reported in 1892 in the Alabama cotton field. The causal organism infects all species of cotton plants. *Fusarium oxysporum* f. sp. *vasinfectum* (FOV4) infects cotton in all stages of growth growing in neutral and acidic soil. The symptoms include wilting of the plant, marginal yellowing of leaf, stunting, damage and brown lining in the vascular region, and interveinal chlorosis followed by necrosis and death of the plant Fig 1 [12].


***Fig 1:*** *Fusarium oxysporum f. sp. vasinfectum infection symptoms in cotton [12]*

A. Wilting of cotton seedlings.
B.Brown staining of vascular tissue.
C.Streak of wilt infection in taproot.
Spinach, radish, lamb's lettuce, lettuce, wild rocket, and cultivated rocket production are adversely affected by the *Fusarium incarnatum equiseti* species complex. This leads to leaf spot disease in leafy vegetables [13]. *Fusarium incarnatum* results in crown rot disease in *Cucumis sativus.* White mycelia covered the young fruit leading to its withering. The disease symptom was similar to the fruit rot disease of *Botrytis cinerea* [14]. Postharvest disease, melon rot is caused by the *Fusarium incarnatum equiseti* species complex [15].

### *Alcaligenes faecalis* as a biocontrol agent

Plant growth-promoting rhizobacteria are a group of beneficial rhizospheric bacteria that enhance plant growth and yield. The PGPR attribute of *Alcaligenes faecalis* for different crops has been least explored. It was reported by Jia R. et al (2022)[16], that *Alcaligenes faecalis* Juj 3 upon seed inoculation showed biocontrol activity against *Plasmodiophora brassicae* in cabbage and Chinese cabbage. It reduced clubroot disease in cabbage (51.4%) and Chinese cabbage (37.7%). It enhanced cabbage chlorophyll content (23.3%) and root length (49%). It also enhanced photosynthesis upon treatment in normal and *Plasmidiophora brassicae*-stressed environments.
Antagonistic activity of *Alcaligenes faecalis* against *Fusarium oxysporum* was reported by Sayyed RZ and Chincholkar SB (2009)[17]. The antifungal activity occurred due to siderophore production by *Alcaligenes faecalis*. 75 µl siderophore-broth gave the best inhibition of *Fusarium oxysporum* [17].
*Alcaligenes faecalis* subsp. *faecalis* S18 gave the highest suppression of *Fusarium* wilt of tomato as observed by Abdallah RAB et al. (2016) [18]. This isolate also enhanced plant height, aerial part fresh weight, root length, and fresh weight. The antagonistic activity of the bacteria was due to chitinolytic, pectinolytic and hydrogen cyanide production Table 2 and Fig 2 [18].

***Table 2:*** *Antagonistic activity of Alcaligenes faecalis S18 against Fusarium oxysporum f. sp. lycopersici (FOL) [18]*

| Bacterial treatment | Colony diameter of FOL (cm) | Inhibition zone (mm) |
|---|---|---|
| Control (untreated) | 3.71±0.08 | 0±0 |
| *Alcaligenes faecalis* S18 | 2.15±0.05 | 12.37±0.1 |


Fig 2: Effects of *Alcaligenes faecalis* S18 on tomato plant growth parameters with and without FOL inoculation (60 days of harvesting). FOL: Stunted growth, FOL-S18: Good growth of plant [18]

*Fusarium oxysporum* f. sp. *cepae* growth was inhibited by 67.46% by consortia of *Bacillus mycoides* and *Alcaligenes faecalis* [19]. Biocontrol activity of *Alcaligenes faecalis* N1-4 against *Fusarium graminearum* and *Fusarium equiseti* was reported by Gong AD et al. (2019) [20].

### Conclusions and Future Perspective

The work sheds light on the preambling to the antagonistic effect of *Alcaligenes faecalis*. Biocontrol aspect of *Alcaligenes faecalis* only against a *Fusarium* species viz, *Fusarium oxysporum* and *Fusarium incarnatum* are described as the most virulent species affecting global

crops and leading to great economic loss. Emphasis on biocontrol activity (PGPR attribute) of *Alcaligenes faecalis* is registered here as it is still under-explored. The most problematic content is no fungicides and other specific measures could combat this fungal pathogen.
There is a great demand for such bioinoculants and biological control agents in order to deal with the wilt and rot of *Fusarium* sp. The product should be cost-effective and eco-friendly and promote sustainable agriculture. The future of this study demands examining *Alcaligenes faecalis* inoculant against *Fusarium* sp. under field conditions on different crops and plants.

**Conflict of Interest**

The author has no conflict of interest in publishing this work.

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