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APPRAISAL OF DIVERSE BIOAGENTS AGAINST SOFT ROT BACTERIA OF POTATO (*SOLANUM TUBEROSUM* L.) CAUSED BY *ERWINIA CAROTOVORA* SUBSP. *CAROTOVORA* UNDER *IN VITRO* TEST

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ABSTRACT

Potato (*Solanum tuberosum* L.) is one of the most nutritious sources of food in the world. It has been recognized as a wholesome food and the richest source of energy in most of the countries of the world where, it forms an important part of the human diet. Among the various disease of potato, soft rot caused by *Erwinia carotovora* subsp. *carotovora* is the major potato tuber rot disease. Results revealed against *Erwinia carotovora*, that the maximum growth inhibition (49.61%) was found in *Pseudomonas fluorescens* after five days of incubation and was statistically superior over rest of the antagonists tested. Other antagonists *viz*., *Trichoderma viride* (4.46%) did not effectively inhibit the growth of *E. carotovora*.

KEYWORDS: *Solanum tuberosum* L., *Erwinia carotovora*, *Trichoderma viride.*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most nutritious sources of food in the world. Besides cereals, the potato is one of the crops, which can supplement food needs of a country. Soft rot is caused by *Erwinia carotovora* subsp. *carotovora*. These bacteria can live in soil, in decaying plant debris and in the seed tubers. Bacteria either enter the seed potatoes and lower stems through wounds and injuries, or move directly from contaminated seeds pieces to lower stems. Abundant moisture at the surface of the wound tissue is needed for infection and continued high humidity after infection favors spread of the disease in the plant. The decay of seed pieces in the soil by fungi and other organisms may also provide conditions for blackleg disease to develop. Tubers harvested from plants which were infected during the growing season may develop a soft rot in storage. Among the various diseases of potato, dry rot, charcoal rot, soft rot and potato cut seed piece decay are the major potato tuber rot diseases. Potato growers of Gujarat state mainly use cut seed pieces with single eye for planting without any seed treatment and thus provide avenue for microbial invasion leading to rottage which resulting in gappy germination and poor yield per unit area. Blackleg begins from a contaminated seed piece, but the symptoms can occur at several stages of plant development. In severe cases, entire seed pieces and developing sprouts may rot in the ground prior to emergence, resulting in a poor stand. Blackleg often develops after plants are well up or even in flower. In this case, stem bases of diseased plants typically show an inky-black to light-brown decay that originates from the seed piece and can extend up the stem from less than an inch to more than two feet. Leaves of infected plants tend to roll upward at the margins, become yellow, wilt, and often die. Aerial stem rot (also called bacterial stem rot or aerial blackleg) is initiated by soft-rot bacteria from sources external to the seed piece. Stem infection can occur through wounds or through natural openings such as leaf scars. Lesions on diseased stems first appear as irregular brownish to inky-black areas. These enlarge into a soft, mushy rot that causes entire stems to wilt and die. Potato tubers with soft rot have tissues that are very soft and watery, and have a slightly granular consistency. In the early stages, soft-rot decay is generally odorless but later a foul odor and a stringy or slimy decay usually develop as secondary decay bacteria invade infected tissues. Most internal tuber tissues may be consumed by soft rot organisms, sometimes leaving only a shell of skin remaining in the soil. Blackleg, aerial stem rot, and tuber soft rot are caused by two closely related bacteria, *Erwinia carotovora* subsp. *atroseptica* and *Erwinia carotovora* subsp. *carotovora*. *E. c. carotovora* is very common and has an extensive host range, including most fleshy vegetables. These bacteria are capable of multiplying and persisting in the root zones of many host and non-host crop and weed species. In contrast, *E. c. atroseptica* is associated mostly with potatoes. These bacteria do not survive well in soil for more than one year, unless they are contained within diseased tubers or other potato plant debris. Blackleg is usually caused by *E. c. atroseptica* carried on contaminated seed tubers.

Moisture and temperature are the two critical factors in initiation and development of soft-rot diseases. High soil temperatures and bruising of seed tubers favor seed-piece decay and pre-emergence blackleg. Blackleg in growing plants is favored by cool, wet soils at planting followed by high temperatures after emergence. High plant strand & canopies with long periods of leaf wetness favor infection of aerial plant parts. When seed pieces in soil or tubers in storage become covered with a film of water, the tissues rapidly become loss of oxygen. This also may be induced by soil flooding or improper drying of washed tubers. Once the infection starts, tuber soft rot can precede progress in storage condition.

Looking to the importance and need, different bioagents have been studied in the laboratory condition for the effective management of the soft rot disease.

MATERIAL AND METHODS

Antagonistic effect of different species and isolates of *Trichoderma*, *(Trichoderma harzianum, Trichoderma viride*), *Bacillus subtilis* and *Pseudomonas fluorescens* were evaluated by Dual culture technique for their antagonism against soft rot pathogen.

***In vitro* efficacy of *Trichoderma harzianum and Trichoderma viride* against soft rot pathogen**

The test organism and pathogen were grown separately on Nutrient Agar (NA) medium for soft rot bacterial pathogen. From seven days old culture, 5 mm discs of the test organism and pathogen were cut aseptically from the periphery of the colony and placed opposite to each other approximately 60 mm apart onto NA medium contained in the Petri plates for soft rot bacteria as adopted by Dennis and Webster (1971) and Sandipan (2014).

Four replications of each treatment were kept and the Petri plates were incubated at 28 ± 2^{o} C temperature and after five days of incubation, the radial growth of the test organism and the pathogen was measured. Observations on radial growth of bacterial pathogen was measured by averaging two diameters of colony at right angle to one another and the per cent growth inhibition (PGI) was calculated by the following equation (Asalmol *et al.*, 1990).

$$PGI = \frac{C - T}{C} \times 100$$

Where,

P G I	-	Per cent Growth Inhibition
C	-	Growth in control (mm)
T	-	Growth in treatment (mm)

***In vitro* efficacy of *Bacillus subtilis* and *Pseudomonas fluorescens* against soft rot pathogen**

To determine an antagonistic action of *Bacillus subtilis* and *Pseudomonas fluorescens* against soft rot pathogen *in vitro*, 20 ml of NA medium was poured aseptically in each of the Petri plate and allowed to solidify. These two bacterial antagonists were then streaked at one end of the Petri plate separately on NA medium. The bacterial isolates were inoculated 24 hrs prior to pathogen inoculation. Just opposite to bacterial streak a 5 mm discs of *E. carotovora* from seven days old culture was placed. Four replications were maintained in each treatment. Petri plates with only pathogen served as control. The per cent inhibition of growth of the pathogen was measured after five days of incubation as mentioned above by (Asalmol *et al.*, 1990).

RESULT AND DISCUSSION

Notable success of disease management through the use of antagonistic bioagents in the laboratory, green house and field has been known during past several years. Making the use of this information there is a possibility of developing biological management for plant diseases. Commercial formulations of bio control agents have gradually started becoming available in the country. However, inadequate information on the performance of bioagents under varying field conditions is a major constraint in the large-scale adoption of this technology especially against soil and seed borne pathogens.

***In vitro* bioefficacy of *Trichoderma harzianum, T. viride, Bacillus subtilis* and *Pseudomonas fluorescens* against soft rot bacteria**

Four known bioagents *viz.*; *Trichoderma harzianum, T. viride, Bacillus subtilis* and *P. fluorescens* were evaluated *in vitro* to test the antagonistic activity against *Erwinia carotovora* subsp. *carotovora* by dual culture technique.

The results presented in Table: 1and Fig:1 revealed that *Pseudomonas fluorescens* produced the maximum growth inhibition (49.61%) of the pathogen after five days of incubation and was statistically superior over rest of the antagonists tested. Other antagonists *viz.*, *Trichoderma viride* (4.46%) did not effectively inhibit the growth of *E. carotovora.*

Similarly, research results were shown by Xu and Gross (1986) found that *Pseudomonas fluorescens* inhibited the growth of *Erwinia carotovora in vitro*. Tanii *et al.* (1990) also found antagonism of *Pseudomonas fluorescens* against the *Erwinia carotovora* subsp. *carotovora* causing soft rot of potato. Thus, present findings are in confirmity with the work of above research workers.

Table 1: ***In vitro*** **microbial antagonism against** ***Erwinia carotovora*** **subsp.** ***carotovora*** **by dual culture technique**

SR. NO.	TEST ORGANISMS	GROWTH INHIBITION *(%) *E. CAROTOVORA*
1	*Trichoderma viride*	12.85(04.46)**
2	*Trichoderma harzianum*	18.19(09.27)
3	*Bacillus subtilis*	10.81(03.02)
4	*Pseudomonas fluorescens*	45.04(49.61)
5	Control	04.05(00.00)
S.Em. ±		0.321
C.D. at 5%		0.969
C.V. %		3.53

*Average of four replications

**Figures in parenthesis are retransformed values

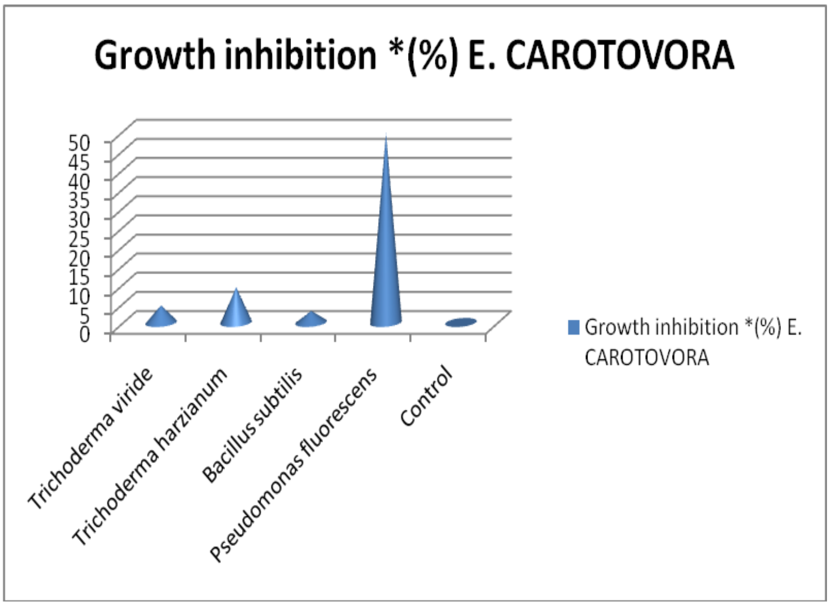

Fig: 1 Growth inhibition pattern for ***Erwinia carotovora*** **subsp.** ***carotovora***

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