Pertanika J. Trop. Agric. Sci. 26(2): 115 - 121 (2003) ISSN: 1511-3701


# Evaluation of Fungal and Bacterial Antagonists' Seed Treatment for Controlling Damping-off Disease in Forest Nurseries

SANJAY ARYA & J.C. KAUSHIK*
*Department of Plant Pathology*
**Department of Forestry*
*CCS Haryana Agricultural University*
*Hisar-125004*

**Keywords: Fungi, bacterial antagonists, damping-off disease, forest nurseries**

**ABSTRAK**

*Potensi kawalan biologi enam agen kawalan bio yang dilaporkan,* Trichoderma viride, T. harzianum, Gliocladium virens, Bacillus sp., B. subtilis *dan* Pseudomonas fluorescens *ke atas* Rhizoctonia solani, R. bataticola, Fusarium oxysporum, F. moniliformae, F. solani *dan* Pythium aphanidermatum *menyebabkan lecuh pangkal dalam tapak semaian hutan dikaji secara in vitro dan disyaratkan di bawah rumah penyaring. Penilaian in vitro agen kawalan bio oleh kaedah penginokulatan duaan mendedahkan bahawa* P. fluorescens, Bacillus sp. *dan* T. viride *secara signifikannya menyekat pertumbuhan miselium kulat lecuh pangkal. Dalam percubaan berpasu, rawatan biji benih* T. viride *dan* P. fluorescens *membuktikan lebih kebaikan kepada agen kawalan bio kulat dan bakteria lain dalam mengurangkan insiden lecuh pangkal (sebelum dan selepas kemunculan) berbanding kawalan yang tidak dirawat*

**ABSTRACT**

*Biological control potential of six well reported biocontrol agents,* Trichomerma viride, T. harzianum, Gliocladium virens, Bacillus *sp.,* B. subtilis *and* Pseudomonas fluorescens *against* Rhizoctonia solani, R. bataticola, Fusarium oxysporum, F. moniliformae, F. solani *and* Phythium aphanidermatum *causing damping-off in forest nurseries was studied in vitro and under screen house conditions.* In vitro *evaluation of biocontrol agents by dual inoculation method revealed that* P. fluorescens, Bacillus *sp. and* T. viride *significantly inhibited mycelial growth of the damping-off fungi. In pot experiments, seed treatment of* T. viride *and* P. fluorescens *proved superior to other fungal and bacterial biocontrol agents in reducing damping-off (pre and post emergence) incidence compared to untreated controls.*

## INTRODUCTION

Damping-off disease in forest nurseries is one of the economically most important diseases causing heavy losses in different parts of the world. Besides inflicting significant economical losses, the disease might disturb the whole forthcoming planting program. The disease complex is caused by species of *Pythium, Phytophthora, Rhizoctonia* and *Fusarium.* Many rhizospheric miroorganisms are known to be equipped with antagonistic potential against soil borne pathogens (Cook and Baker 1983; Elad *et al.* 1986). The damping-off fungal pathogens being predominantly soil and seed-borne, seed treatment with bio control agents can protect the seeds from such seed and soil borne damping-off pathogens. Therefore, the present investigations were carried out to explore the biocontrol potential of six well reported rhizospheric microorganisms, viz. *Trichoderma viride, T. harzium, Gliocladium virens, Bacillus subtilis, Bacillus* sp. and *Pseudomonas fluorescens* against the damping-off pathogens of forest nurseries under *in vitro* and *in vivo* conditions.

## MATERIALS AND METHODS

The rhizospheric antagonistic microorganisms (fungi and bacteria) were isolated from nursery soil by dilution plate method (Johnson 1957) and identified using standard phytopathological techniques. The fungal bio control agents viz., *Trichoderma viride, T. harzium* and *Gliocladium*

*virens* were maintained on potato dextrose agar (PDA) medium while bacterial antagonists, *Bacillus subtilis, Bacillus* sp. and *P. fluorescens* were maintained on yeast peptone glucose agar (YPGA) medium and King's B medium, respectively.

For testing the bio control efficiency of the isolated fungal and bacterial antagonists, the dual inoculation method was followed. Four milimeter (diameter) round bits from actively growing cultures of antagonistic fungus/bacteria were inoculated on one side of Petri plate having PDA/YPGA media (King's B medium for *P. fluorescens)* and on the other side, an equal sized mycelium of the pathogenic fungus was inoculated. A control having only pathogenic fungal culture was paced on one edge of the Petri plate for comparison purposes. Radial growth of the pathogenic fungi was measured after seven days of incubation at 25±1°C and expressed as per cent inhibition after comparison with control following Vincent's (1947) formula-

$$1=100\left(\frac{C-T}{C}\right)$$

Where 1 = per cent inhibition
C = growth of pathogen in control
T = growth of pathogen in treatment

The experiment was run in triplicate and each replication had five Petri plates. The plates were arranged in completely randomized design.

For *in vivo* studies, the experiment was conducted in earthen pots (20 cm diameter) arranged in completely randomized design in a screen house. The experiment was triplicated and each replication had five pots with each pot having two plants. Sandy loam soil collected from the field was sterilized at 15 p.s.i. pressure for two hours and filled in pots. The damping-off pathogens, *Pythium aphanidermatum, Rhizoctonia solani, Rhizoctonia bataticola, Fusarium oxysporum* and *F. moniliformae* cultured on sand maize medium (Muthusamy 1972), were added to soil @1:20 (W/V) ration of pathogen and soil one week before sowing. The pots having seeds of *A. nilotica, A. lebbeck, D. sissoo & P. juliflora* sown in pathogen-infested soil and without any antogonist treatment served as control.

The antagonistic fungi, *Trichoderma viride, T. harzianum* and *Gliocladium virens* were cultured on 20 mL potato dextrose broth in 100 mL Erlenmeyer flasks maintained at 25±1°C for seven days. The resultant fungal mycelial mat and metabolites were mixed with talc powder @ 1:2 (v/w) of fungal mycelia and talc using a mixer. After shade drying, carboxymethyl cellulose was added @10 g per kg of talc powder formulation. These talc-based formulations of *Trichoderma* spp. & G. *virens* were then used for treating the seeds @ 4 g/kg seeds and yielded 1 x $10^7$ and 1.4 x $10^7$ cfu/g of talc on serial dilution.

The bacterial biocontrol agents, *Bacillus* sp. *B. sublitis* and *Pseudomonas fluorescens* were grown on nutrient agar and King's B medium broths respectively at 25±1°C for 72 hours in rotary incubator shaker. The resultant bacterial cultures were diluted with sterile distilled water to obtain a final concentration of 1 x 108 cfu/mL. The seeds of *acacia nilotica, albizia lebbeck, Dalbergia sissoo & Prosopis juliflora* were soaked in the bacterial suspension for 4 h and were sown immediately after in artificially-infested soil.

The data on pre and post emergence damping-off incidence was recorded 10 and 30 days after seed germintaion. The resultant data was analyzed by employing the Analysis of Variance (ANOVA) method.

## RESULTS AND DISCUSSION

*In vitro* biological studies by dual inoculation method revealed significant inhibition in the mycelial growth of the damping-off fungi by all the fungal and bacterial antagonists. *Pseudomonas fluorescens* inhibited growth of *Rhozoctonia solani, R. bataticola, F. oxysporum, F. solani* and *Pythium apahaniermatum* compared significantly to controls (Table 1). Among the fungal antagonists *T. viride* exhibited the maximum antagonistic activity (75.2% mycelial inhibition) against *R. solani* and *P. aphanidermatum* (75.8% mycelial inhibition) while it was statistically at par with *G. virens* and *T. harzianum* against *F. oxysporum* and *Fsolani,* respectively. However, *T. harzianum* inhibited mycelial growth of *F. moniliformae* to the maximum extent ( 80.1% inhibition). Hadar *et al.* (1979), Chet and Baker (1981), Kim and Roh (1987) and Mathew and Gupta (1998) also reported antagonistic activity of *T. harzianum, T. viride* and *G. virens* against *R. solani.*

Results of the pot culture exeriment revealed that fungal antagonists *t. viride, T. harzianum* and *G. virens* when applied as seed coating on seeds of *A. nilotica, A. lebeck, D. sissoo* and *P. juliflora* significantly reduced pre and post emergence damping-off of seedlings in *R. solani*

TABLE 1
In vitro evaluation of fungal an bacterial antagonists against the damping-off fungi

| Sr. No. | Antagonist | Mycelial growth inhibition (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Rhizoctonia solani* | *Rhizoctonia bataticola* | *Fusarium oxysporum* | *Fusariam moniliformae* | *Fusariam solani* | *Pythium aphanidermatum* |
| 1 | *Trichoderma viride* | 75.2 | 70.6 | 74.7 | 73.7 | 77.2 | 75.8 |
| 2 | *Trichoderma harzianum* | 72.4 | 76.3 | 65.9 | 80.1 | 76.7 | 55.7 |
| 3 | *Gliocladium virens* | 66.5 | 68.7 | 71.3 | 74.5 | 70.2 | 64.1 |
| 4 | *Bacillus sp.* | 71.2 | 70.2 | 65.7 | 82.8 | 74.6 | 73.6 |
| 5 | *Bacillus subtilis* | 75.6 | 84.6 | 80.9 | 76.6 | 73.9 | 63.8 |
| 6 | *Pseudomonas* | 80.0 | 85.2 | 83.4 | 75.4 | 88.2 | 75.6 |
| | **C. D. (P=0.05** | **2.3** | **2.6** | **3.5** | **2.8** | **3.1** | **2.9** |

TABLE 2
Evaluation of fungal antagonists against damping-off forest nurseries caused by *Rhizoctonia solani*

| Sr. No. | Treatment | Pre-emergence Damping-off(%) | Post-emergence damping-off(%) |
|---|---|---|---|
| | ***Trichoderma viride*** | | |
| 1 | *Acacia nilotica* | 2.8 | 7.8 |
| 2 | *Albizia lebbeck* | 2.4 | 7.1 |
| 3 | *Dalbergia sissoo* | 3.3 | 6.5 |
| 4 | *Prosopis juliflora*3.4 | 6.2 | |
| | ***Trichoderma harzianum*** | | |
| 5 | *Acacia nilotica* | 3.2 | 10.1 |
| 6 | *Albizia lebbeck* | 4.2 | 8.2 |
| 7 | *Dalbergia sissoo* | 2.1 | 7.2 |
| 8 | *Prosopis juliflora*2.2 | 6.7 | |
| | ***Gliocladium virens*** | | |
| 9 | *Acacia nilotica* | 6.2 | 12.6 |
| 10 | *Albizia lebbeck* | 11.9 | 18.9 |
| 11 | *Dalbergia sissoo* | 12.0 | 14.0 |
| 12 | *Prosopis juliflora* | 12.6 | 14.6 |
| 13 | *Acacia nilotica* (control) | 14.3 | 13.6 |
| 14 | *Albizia lebbeck* (control) | 15.2 | 18.2 |
| 15 | *Dalbergia sissoo* (control) | 17.1 | 19.7 |
| 16 | *Prosopis juliflora* (control) | 13.2 | 22.4 |
| | **C. D. (P=0.05)** | **1.4** | **0.6** |

inoculated pot soil (Table 2). *D. sissoo* (control) plants inoculated with *R. solani* alone recorded as high as 17.1% pre-emergence and 19.7% post-emergence damping-off incidence.

*A. lebbeck* seeds treated with *T. viride* registered the lease (6.8%) pre emergence damping-off while seed treatment with *T. harzianum* recorded the lease (6.4%) post-emergence damping-off (Table 3) in *F. oxysporum* infested pots. Control pots of *A. nilotica, A. lebbeck D. sissoo* and *Juliflora* inoculated with *F. oxysporum* recorded the highest pre and post emergence damping-off incidence.

In pots inoculated with *P. aphanidermatum* and *R. bataticola* together, marked decrease in pre and post emergence damping-off over control was observed in *A. nilotica* seeds treated with *T. viride* (Table 4).

As low as 6.2% pre-emergence damping-off was observed in *P.juliflora* seeds treated with *T. viride* followed by *A. nilotica* (7.2%) and *a. lebbeck* (8.1%) (Table 5) in pots inoculated with *F. moniliformae* and *F.solani*. Seed treatment of *A. nilotica* and *P. juliflora* with *T. harzianum* recorded the minimum (7.8% & 8.5%, respectively) pre-emergence damping-off. *P. juliflora* seeds treated

TABLE 3
Evaluation of fungal antagonists against damping-off forest nurseries caused by *Fusarium oxysporum*

| Sr. No. | Treatment | Pre-emergence Damping-off(%) | Post-emergence damping-off(%) |
|---|---|---|---|
| | ***Trichoderma viride*** | | |
| 1 | *Acacia nilotica* | 7.6 | 10.2 |
| 2 | *Albizia lebbeck* | 6.8 | 8.6 |
| 3 | *Dalbergia sissoo* | 8.9 | 8.5 |
| 4 | *Prosopis juliflora*8.1 | 11.4 | |
| | ***Trichoderma harzianum*** | | |
| 5 | *Acacia nilotica* | 7.7 | 8.3 |
| 6 | *Albizia lebbeck* | 7.5 | 6.4 |
| 7 | *Dalbergia sissoo* | 10.2 | 14.6 |
| 8 | *Prosopis juliflora*7.5 | 10.2 | |
| | ***Gliocladium virens*** | | |
| 9 | *Acacia nilotica* | 10.5 | 17.5 |
| 10 | *Albizia lebbeck* | 12.3 | 20.2 |
| 11 | *Dalbergia sissoo* | 14.5 | 13.3 |
| 12 | *Prosopis juliflora* | 13.2 | 12.2 |
| 13 | *Acacia nilotica* (control) | 21.8 | 26.6 |
| 14 | *Albizia lebbeck* (control) | 25.7 | 24.7 |
| 15 | *Dalbergia sissoo* (control) | 19.0 | 22.0 |
| 16 | *Prosopis juliflora* (control) | 27.6 | 41.3 |
| | **C. D. (P=0.05)** | **1.6** | **1.1** |

TABLE 4
Evaluation of fungal antagonists against damping-off forest nurseries caused by *Pythium aphanidermatum & Rhizoctonia bataticola*

| Sr. No. | Treatment | Pre-emergence Damping-off(%) | Post-emergence damping-off(%) |
|---|---|---|---|
| | ***Trichoderma viride*** | | |
| 1 | *Acacia nilotica* | 3.2 | 9.3 |
| 2 | *Albizia lebbeck* | 8.8 | 10.2 |
| 3 | *Dalbergia sissoo* | 10.1 | 14.6 |
| 4 | *Prosopis juliflora* | 6.7 | 8.1 |
| | ***Trichoderma harzianum*** | | |
| 5 | *Acacia nilotica* | 12.2 | 16.2 |
| 6 | *Albizia lebbeck* | 15.5 | 15.7 |
| 7 | *Dalbergia sissoo* | 11.6 | 18.8 |
| 8 | *Prosopis juliflora* | 10.2 | 10.9 |
| | ***Gliocladium virens*** | | |
| 9 | *Acacia nilotica* | 4.8 | 8.6 |
| 10 | *Albizia lebbeck* | 8.2 | 10.4 |
| 11 | *Dalbergia sissoo* | 10.1 | 15.6 |
| 12 | *Prosopis juliflora* | 13.4 | 20.7 |
| 13 | *Acacia nilotica* (control) | 25.3 | 30.3 |
| 14 | *Albizia lebbeck* (control) | 20.8 | 25.6 |
| 15 | *Dalbergia sissoo* (control) | 41.2 | 38.5 |
| 16 | *Prosopis juliflora* (control) | 33.2 | 36.4 |
| | **C. D. (P=0.05)** | **2.5** | **1.7** |

with *G. virens* exhibited minimum (5.2%) damping-off incidence. The least post-emergence damping-off (7.7%) was registered in *A. nilotica* seeds treated with *T. viride.*

Seed bacterization with bacterial antagonists also led to a significant reduction in pre and post-emergence damping-off over *F.oxysporum* and *R. solani* inoculated controls (Table 6). Seed

TABLE 5
Evaluation of fungal antagonists against damping-off forest nurseries caused by *Fusarium moniliformae* and *Fusarium solani*

| Sr. No. | Treatment | Pre-emergence Damping-off(%) | Post-emergence damping-off(%) |
|---|---|---|---|
| | ***Trichoderma viride*** | | |
| 1 | *Acacia nilotica* | 7.2 | 7.7 |
| 2 | *Albizia lebbeck* | 8.1 | 10.2 |
| 3 | *Dalbergia sissoo* | 9.1 | 12.2 |
| 4 | *Prosopis juliflora* | 6.2 | 15.3 |
| | ***Trichoderma harzianum*** | | |
| 5 | *Acacia nilotica* | 7.8 | 14.6 |
| 6 | *Albizia lebbeck* | 10.1 | 18.2 |
| 7 | *Dalbergia sissoo* | 11.3 | 17.6 |
| 8 | *Prosopis juliflora* | 8.5 | 13.7 |
| | ***Gliocladium virens*** | | |
| 9 | *Acacia nilotica* | 7.4 | 10.1 |
| 10 | *Albizia lebbeck* | 7.3 | 12.7 |
| 11 | *Dalbergia sissoo* | 8.2 | 13.5 |
| 12 | *Prosopis juliflora* | 5.2 | 19.6 |
| 13 | *Acacia nilotica* (control) | 18.2 | 25.7 |
| 14 | *Albizia lebbeck* (control) | 21.6 | 33.3 |
| 15 | *Dalbergia sissoo* (control) | 30.0 | 36.2 |
| 16 | *Prosopis juliflora* (control) | 41.3 | 48.7 |
| | **C. D. (P=0.05)** | **0.9** | **1.3** |

TABLE 6
Evaluation of bacterial antogonists against damping-off forest nurseries caused by *Fusarium moniliformae* and *Fusarium solani*

| Sr. No. | Treatment | Pre-emergence damping-off(%) | Post-emergence damping-off(%) |
|---|---|---|---|
| | ***Trichoderma viride*** | | |
| 1 | *Acacia nilotica* | 10.2 | 13.3 |
| 2 | *Albizia lebbeck* | 8.9 | 17.8 |
| 3 | *Dalbergia sissoo* | 8.2 | 17.6 |
| 4 | *Prosopis juliflora* | 7.1 | 10.2 |
| | ***Trichoderma harzianum*** | | |
| 5 | *Acacia nilotica* | 6.8 | 12.2 |
| 6 | *Albizia lebbeck* | 7.5 | 12.8 |
| 7 | *Dalbergia sissoo* | 13.1 | 18.5 |
| 8 | *Prosopis juliflora* | 6.2 | 13.3 |
| | ***Gliocladium virens*** | | |
| 9 | *Acacia nilotica* | 10.2 | 14.6 |
| 10 | *Albizia lebbeck* | 4.2 | 12.5 |
| 11 | *Dalbergia sissoo* | 11.7 | 16.6 |
| 12 | *Prosopis juliflora* | 8.2 | 15.5 |
| 13 | *Acacia nilotica* (control) | 34.2 | 40.6 |
| 14 | *Albizia lebbeck* (control) | 40.3 | 46.2 |
| 15 | *Dalbergia sissoo* (control) | 42.6 | 47.1 |
| 16 | *Prosopis juliflora* (control) | 40.1 | 50.1 |
| | **C. D. (P=0.05)** | **1.8** | **1.5** |

bacterization of *A. lebbeck* with *P. fluorescens* cell suspension recorded the least (4.2%) pre-emergence damping-off followed by bacterization of *P. juliflora* and *A. nilotica* with *B. sublitis* (6.2 and 6.8%, respectively). *Bacillus* sp. seed bacterization of *P. juliflora* recorded the least post-emergence damping-off incidence.

Both *Trichoderma* spp.and *Gliocladium virens* are known to be potential antagonists of fungal plant pathogens (Papavizas 1985). Biological seed treatment has been found to be an attractive as well as an efficient method for introducing the antagonists into the soil-plant environment. Chao *et al.* (1986) and Dutta and Das (1999) reported significant decrease in stem rot of soybean by seed pelleting with spore suspension of *T. harzianum* along with methyl cellulose. Papavizas (1985) reported detailed account of biocontrol potential of *Trichoderma* and *Gliocladium* spp. Lumsden and Locke (1989) reported biological control of damping-off caused by *P. ultimum* and *R. solani* in soil-less mix. Effectiveness of seed coating with *Trichoderma* spp. spores for the control of *R. solani* in cotton has been reported by Elad *et al.* (1982). A similar observation was made by Clique and Scheffer (1996).

The use of bacterial antagonists in disease management has been well reported (Hubbard *et al.* 1983; Westeijin 1990; Merriman *et al.* 1974; Rao *et al.* 1999). Hamed (1999) reported antagonistic potential of *B. sublitis* against *P. ultimum* and *F. oxysporum* f. sp. *cucumerinum*. Manoranjitham *et al.* (2000) also confirmed the biocontrol efficiency of *T. viride* and *P. fluorescens* in controlling pre and post-emergence damping-off of tomato caused by *P. aphanidermatum* under pot culture experiments.

The present investigation has shown encouraging results in use of fungal bioconrol agents, *T. viride, T. harzianum* and *G. virens* and bacterial antagonists *Bacillus* sp., *B subtilis* and *P. fluorescens* as seed pelleting agent for the successful control of damping–off of forest nurseries and may be exploited for evolving eco-friendly disease management strategies.

## REFERENCES


CHAO, W. L., E. B. NELSON, G. E. HARMAN and H. C. HOCH. 1998. Colonization of the rhizosphere by biological control agents applied to seeds. *Phytopathology* **71:** 60-65.

CHET, L. and R. BAKER. 1981. Isolation and biocontrol potential of *Trichoderma hamatum* from soil naturally suppressive to *Rhizoctonia solani*. *Phytopathology* **71:** 286-290.

CLIQUE, S. and R. T. SCHEFFER. 1996. Biological control of damping-off caused by *Pythium ultimum* and *Rhizoctonia solani* using *Trichoderma* spp. applied as industrial film coating on seeds. *European J. Pl. Path.* **102:** 247-255.

COOK, R. J. and K. F. BAKER. 1983. The nature and practice of biological control of plant pathogens. *American Phytopathological Society:* 539. St. Paul, Minn.

DUTTA, P. and B. C. DAS. 1999. Effect of seed pelleting and soil application of *Trichoderma harzianum* in the management of stem rot of soybean. *J. Mycol. Pl. Pathol.* **29(3):** 317-322.

ELAD, Y., A. KALFON and Y. CHET. 1982. Control of *Rhizoctonia solani* in cotton by seed coating with *Trichoderma* spp. spores. *Plant and Soil* **66:** 279-281.

ELAD, Y., Y. VIELA and L. CHET. 1986. Biological control of *Rhizoctonia solani* damping-off with wheat bran culture of *Trichoderma harzianum*. *Phytopathology* **69:** 64-68.

HADAR, Y., L. CHET and Y. HEINS. 1979. Biological control of *Rhizoctonia solani* damping-off with wheat bran culture of *Trichoderma harzianum*. *Pythopathology* **69:** 64-68.

HAMED, H. A. 1999. Biological control of basal stem rot and wilt of cucumber caused by *Pythium ultimum* and *Fusarium oxysporum* f. sp. *cucumerinum*. *African J. Mycol. Biotech.* **7(1):** 81-91.

HUBBARD, J. P., G. E. HARMAN and Y. HADAR. 1983. Effect of soil borne *Pseudomonas* spp. and the biological control agent *Trichoderma harzianum* on pea seed. *Phytopathology* **73:** 655-659.

JOHNSON, L. Z. 1957. Phytopathological notes. *Phytopathology* **47:** 630.

KIM, H. K. and M. J. ROH. 1987. Isolation, identification and evaluation of biocontrol potential of rhizosphere antagonists to *Rhizoctonia solani*. *Korean J. Pl. Prot.* **26:** 26-87.

LUMSDEN, R. D. and J. C. LOCKE. 1989. Biological control of damping-off caused by *Pythium ultimum* and *Rhizoctonia solani* with *Gliocladium virens* in soil-less mix. *Phytopathology* **79:** 301-305.

MANORANJITHAM, S. K., V. PRAKASAN, K. RAJAPAN and G. ANUTHA. 2000. Effect of two

antagonists ondamping-off disease of tomato. *Indian Phytopath.* **53(40):** 441-443.

MATHEW, K. A. and S. K. GUPTA. 1998. Biological control of root rot of french bean caused by *Rhizoctonia solani. J. Mycol. Pl. Pathol.* **28(2):** 202-205.

MERRIMAN, P. R., R. D. PRICE, J. F. KOLEMORGEN, J. F. RIGGOT and E. H. RIDGE. 1974. Effect of seed inoculation with *Bacillus sublitis* and *Streptomces griseus* on the growth of cereals and carrots. *Austr. J. Agric. Res.* **24:** 219-226.

MUTHUSAMY, M. 1972. Studies on damping-off of tomato incited by *Oythium aphandidermatum* (Edson) Fits. M.Sc. (Ag.)Thesis. TNAU. Coimbatore. 110p.

PAPAVIZAS, G. C. 1985. *Trichoderma and Gliocladium:* biology, ecology and potential for biocontrol. *Annu. Rev. Phytopathol.* **23:** 23-54.

RAO, C. V. S., I. P. SACHAN and B. N. JOHRI. 1999. Influence of fluorescent pseudomonads on growth and nodulation of lentil *(Lens esculents)* in *Fusarium* infested soil. *Indian J. Microbiol.* **39(1):** 23-29.

VINCENT, J. M. 1947. Distribution of fungal hypae in the presence of certain inhibitors. *Nature* **150:** 850.

WESTEIJN, W. A. 1990. Fluorescent pseudomonads isolate E-11-3 as biocontrol agent for *Pythium* root rot in tulips. *Neth. J. Pl. Path.* **96:** 261-272.

*(Received: 15 January 2002)*
*(Accepted: 8 March 2003)*