cysts from each replicate, was crushed and the percentage of parasitized eggs determined, as decribed earlier.

In the first experiment, no parasitization of eggs by any fungus was observed in the controls incubated at either room temperature or 16°C. The level of parasitism by *V. lecanii* was 73.5% at room temperature and 5.4% at 16°C, at one week of exposure ($t > 0.31$) and 86.3 and 68.5%, respectively, at two weeks of exposure. Both *V. lecanii* and *P. lilacinus* parasitized eggs of *Globodera* spp. in the soil in which they were introduced. The extent of parasitism of eggs in soil was 73.5 and 70.9%, by *V. lecanii* and *P. lilacinus*, respectively, one month after treatment, at 16°C. The mode of entry of *V. lecanii* into the cysts and parasitism of eggs, appeared similar to that described for *P. lilacinus* (Jatala, 1986). The ability of *V. lecanii* to thrive in potato soil at a low temperature (16°C) and cause a high degree of egg necrosis indicate its potential as a good candidate biocontrol agent for the potato cyst nematodes.

Key words : *Verticillium lecanii, Paecilomyces lilacinus, globodera* spp.

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# Evaluation of Substrates for Enhanced Growth of *Trichoderma* spp.

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Use of *Trichoderma* species as a biological control agent for various fungal diseases has been reported in literature (Thomas, 1939; Baker and Cook, 1974; Dohroo and Sharma, 1984). *In vitro* inhibition of fungal pathogens causing rhizome rot of ginger by using three species of *Trichoderma viz., T. viride* (ITCC 1433), *T. harzianum* (ITCC 1894) and *T. hamatum* (ITCC 2084) as antagonists, has also been demonstrated by Bhardwaj and Gupta (1987). However, these antagonists were found comparatively less efficient when tried for the control of the same disease under storage conditions (Bhardwaj *et. al.*, 1988) which may be due to the non-availability of suitable substrate for enhanced growth and multiplication of *Trichoderma*. Keeping this in view, the present investigations were carried out to find out an easily available and cheap substrate which could sustain rapid colonization of these antagonistic species so as to enhance their efficiency in biocontrol of rhizome rot of ginger.

Five substrates, *viz.*, shelled cobs, ginger scales, saw dust, wheat straw and farm yard manure were separately crushed to powder and evaluated for

Table 1. Radial and linear growths of three *Trichoderma* species on different substrates

| Substrate | Radial growth (mm) after 72 h | | | Linear growth (mm) after 11 days | | |
|---|---|---|---|---|---|---|
| | *T. viride* | *T. harzianum* | *T. hamatum* | *T. viride* | *T. harzianum* | *T. hamatum* |
| Shelled cobs | 90.0a | 89.8a | 90.0a | 133.0a | 84.3b | 72.0b |
| Ginger scales | 65.2c | 48.4d | 52.4c | 92.3b | 42.5c | 46.3c |
| Saw dust | 56.8d | 52.6c | 54.4c | 43.8c | 43.8c | 43.0c |
| Wheat straw | 90.0a | 89.8a | 89.4a | 130.3a | 101.5a | 86.0a |
| Farmyard manure | 82.6b | 58.2b | 71.8b | 132.3a | 77.5b | 70.8b |

In a column, means followed by same letters are not different statistically (P=0 05) by L. S. D.

enhanced growth by the following two methods.

### Agar plate culture method

For this purpose, Petri plates (90mm) containing agar media with different substrates (substrate 6%, agar 2%) were inoculated with uniform bits (3 mm) of antagonists separately and incubated at 25°C. Radial growth recorded after 72 h of incubation revealed that shelled cobs and wheat straw were found best in supporting maximum growth of all the three species of *Trichoderma*, followed by farmyard manure (Table 1). Least growth of *T. viride* was recorded in sawdust medium whereas, in case of other two species, minimum growth was observed on ginger scale medium.

### Ryan, Beadle and Tatum tube culture method

The evaluation of these substrates was also carried out without the addition of agar by making use of Ryan, Beadle and Tatum tubes (20 x 1.5 x 5 cm) in which well crushed substrates were filled separately to their maximum capacity. After moistening the filled substrates with distilled water (10 ml/tube), both the ends of the tubes were plugged with cotton and the tubes autoclaved. These were then inoculated separately at one end with the mycelial bit (3 mm) of *Trichoderma* spp. The linear growth of antagonistic fungi recorded after 11 days' incubation at 25°C revealed that shelled cobs, wheat straw and farmyard manure were the best in supporting the growth of *T. viride* whereas, wheat straw followed by shelled cobs and farmyard manure, in the order, supported the maximum growth of other two species. Ginger scales and sawdust, however, sustained minimum growth of all the species.

The results obtained suggest the supplimentation of *Trichoderma* applications to rhizomes with wheat straw and/or shelled cobs for improving the growth of these biocontrol agents of rhizome rot disease in storage, as the ginger scales, the only available substrate in storage pits, did not support good growth of *Trichoderma* species.

Key words: *Trichoderma viride, T. harzianum, T. hamatum,* substrate requirement of *Trichoderma* spp., Biocontrol.

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