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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences, 1 (1): 27-28, 1998

Use of Biocontrol Fungi with Carbofuran in the Control of Root Knot Nematodes in Okra

M.J. Zaki and M.A. Maqbool
National Nematological Reseach Centre, University of Karachi, Karachi-75270, Pakistan

Abstract
Use of biocontrol fungi viz., *Verticillium chlamydosporium*, *Paecilomyces lilacinus* and *Talaromyces flavus* alone or mixed with carbofuran significantly (P<0.05) reduced root knot indices on okra plants as compared to control. Maximum reduction in glass formation was observed in the treatments where carbofuran was used either with *V. chlamydosporium* or *P. lilacinus*. Greater increase in fresh weight of shoot was observed where *P. lilacinus* was used with carbofuran followed by the use of *P. lilacinus* alone.

Key words: Biological control, carbofuran, okra, *Meloidogyne favanica*, *Verticillium chlamydosporium*, *Paecilomyces lilacinus*, *Talaromyces flavus*

Introduction

Carbofuran being one product available in the local market is generally recommended for nematode control in Pakistan (Zaki and Maqbool, 1995). Various biocontrol agents viz., *Verticillium chlamydosporium*, authority and *Paecilomyces lilacinus* authority which are parasites of eggs of root knot and cyst nematodes (Jatala *et al*., 1979; Zaki and Maqbool, 1993) have also been found to effectively control root knot nematodes on crop plants. *Talaromyces flavus* authority a biocontrol agent of root infecting fungi (Fahima and Henis, 1990; Ehteshamul-Haque *et al*., 1994a) has been reported to reduce root knot infestation on crop plants (Zaki and Maqbool, 1991a; Ehteshamul-Haque *et al*., 1994b). It was therefore considered useful to study the efficacy of *V. chlamydosporium* Goddard, *P. lilacinus* (Thom) Samson and *T. flavus* (Klocker) Stolk & Samson with carbofuran in the control of the root knot nematode, *Meloidogyne favanica* (Treub) Chitwood in okra.

Materials and Methods

Pure cultures of *V. chlamydosporium*, *P. lilacinus* and *T. flavus* were obtained from the Culture Collection of the Department of Botany, University of Karachi, Karachi, Pakistan. Fungi were multiplied on wheat bran in 250 ml flasks. One month old cultures of *V. chlamydosporium*, *P. lilacinus* and *T. flavus* respectively containing 1×10^6 and 2×10^6 cuf/g were used. Sandy loam soil, pH 8.0, supplemented with farm yard manure (2:1, soil: manure) was inoculated with wheat bran culture of biocontrol agents 1% w/w. In a separate set, soil treated with carbofuran at 11 mg a.i./kg soil mixed with inoculums of biocontrol agents. Five seeds of okra were sown in each pot, 250 g soil/pot. After sowing the seeds, soil was artificially infested with eggs and larval suspension of root knot nematode, *M. javanica* at 3000 eggs+J2/pot. Non inoculated and nonamended soil served as control. There were 3 replicates of each treatment and pots were randomized in green house bench at the National Nematological Research Centre, University of Karachi. The pots were watered daily and after 2 months the plants were removed and washed with running tap water. Weight and length of roots and shoots of okra plants were measured and root knot index determined on 0-5 scale as described by Taylor and Sasser (1978). Data were analysed statistically.

Results and Discussion

Use if biocontrol fungi such as *V. chlamydosporium*, *P. lilacinus* and *T. flavus* individually or in combination with carbofuran significantly (P<0.05) reduced root knot indices on okra plants as compared to control (Table 1). Maximum reduction in root knot indices was observed in the treatment where carbofuran was used with *V. chlamydosporium* or *P. lilacinus* followed by combined used of carbofuran with *T. flavus. V. chlamydosporium* or *P. lilacinus* used alone showed similar results as the nematicide in the control of root knot infestation on okra plants.

Use of biocontrol fungi alone or in combination with carbofuran showed significant (P<0.05) increase in shoot weight of okra as compared to control (Table 1). Maximum increase in shoot weight was observed in treatment where carbofuran was used with *P. lilacinus* (110%) followed by *P. lilacinus* (102%) used alone and where *V. chlamydosporium* was used with the nematicide (84%). Weight of roots of plants was less in all the treatments as compared to untreated control which may presumably be due to infestation of root knot nematodes. Plant height also increased significantly (P<0.05) in all the treatments as compared to untreated control. Maximum plant height was observed in treatment where *P. lilacinus* (27%) was used alone followed by carbofuran (22%) and where carbofuran was used with *T. flavus* (17%).

Table 1: Effect of biocontrol fungi with carbofuran in the control of root knot nematodes in okra

Treatments	Length (cm)		Weight (g)		Root Knot Index 0-5 scale
	Root	Shoot	Root	Shoot	
Control	11.5ab	29.0d	2.5a	3.8c	4.5a
Wheat bran	12.0b	30.0d	2.0ab	5.0b	3.6b
Verticillium chlamydosporium	12.3b	32.6c	1.5ab	6.5ab	2.8bc
Paecilomyces lilacinus	17.6ab	37.0a	2.2ab	7.7a	2.6cd
Talaromyces flavus	14.5ab	33.6bc	1.5ab	5.3b	3.3b
Carbofuran (C)	20.3a	35.6ab	2.3ab	5.6bc	2.5cd
C + *V. chlamydosporium*	14.5ab	33.0bc	1.7ab	7.0ab	2.0d
C + *P. lilacinus*	15.0ab	32.0c	2.5a	8.0a	2.0d
C + *T. flavus*	14.0ab	34.0bc	1.8ab	6.8ab	2.3cd

Means followed by the same letters in each column are not significantly different at 5% level according to Duncan's multiple range test.

In the present study *V. chlamydosporium* and *P. lilacinus* significantly ($P<0.05$) controlled infection of root knot nematode. Use of *V. chlamydosporium* on tomato (De Leij, 1992), chickpea (Ehteshamul-Haque *et al*., 1994b) and on mungbean (Abid *et al*., 1992) has been reported to reduce gall formation. *T. flavus* which is known to parasitize the microselerotia of *Verticillium dahliae* (Fahima and Henis, 1990) also reduced gall formation on chickpea (Ehteshamul-Haque *et al*., 1994b) and okra (Zaki and Maqbool, 1991b). Since greater fresh weight and reduced root knot index was observed in treatments where carbofuran was used either with *P. lilacinus* or *V. chlamydosporium* would suggest that both the antagonists are compatible with carbofuran and could thus be sued for the control of root knot nematodes as also suggested by Crump and Kerry (1986).

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