Compatibility of *Pochonia chlamydosporia* with other biocontrol agents and carbofuran

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ABSTRACT

Potato (*Solanum tuberosum* L.) is an important commercial vegetable crop widely grown in more than 100 countries. Potato cyst nematodes, *Globodera rostochiensis* (Wollenweber) and *G. pallida* (Stone) are basically found in temperate climate and are the most important quarantine pests since they are causing concern to potato production and trade throughout the world. Studies were conducted to assess the compatibility of the egg parasitic fungi *Pochonia chlamydosporia* with other bio control agents *viz*., *Pseudomonas fluorescens* and *Trichoderma viride* and carbofuran 3G in the management of cyst nematode, *Globodera* spp in potato. The biocontrol agents were evaluated individually and in different combinations under pot culture conditions. Observations on plant growth and nematode population were recorded. Combined application of the egg parasitic fungi, *P. chlamydosporia* along with *P. fluorescens* and *T. viride* and carbofuran resulted in significantly higher plant growth and lower cyst nematode population in soil and root. The tuber weight increased by 70.57 per cent and the cyst population in soil decreased by 71.93 per cent. There was also significant reduction in the population of eggs and juveniles. The results revealed that the *P. chlamydosporia* is compatible with other biocontrol agents namely *P. fluorescens* and *T. viride* and carbofuran and can be included in integrated cyst nematode management programs.

Key words : Carbofuran, *Globodera* spp., *P. fluorescens*, *Pochonia chlamydosporia*, *T. viride*

INTRODUCTION

The potato (*Solanum tuberosum* L.) is an important commercial vegetable crop widely grown in more than 100 countries. Potato cyst nematodes, *Globodera rostochiensis* (Wollenweber) and *G. pallida* (Stone) are basically found in temperate climate and are the most important quarantine pests since they are causing concern to potato production and trade throughout the world. The potato cyst nematodes, *G. rostochiensis* and *G. pallida* are the major constraint for potato cultivation in the Nilgiri hills of Tamil Nadu State causing up to 80 per cent loss of yield (Krishna Prasad, 1992). The symptoms caused by this nematode are yellowing of leaves and stunting of plants which can easily be confused with fertilizer deficiency. In India, potato cyst nematode *G. rostochiensis* was first reported by Jones (1961), who detected cysts from the roots of potato plants which exhibited the symptoms of yellowing of leaves, in Nilgiris hills of the Tamil Nadu state. Soil treatment with nematicides has been an established practice in India for the control of cyst-forming nematodes of the genus *Globodera*, through it is very expensive for the farming community. Hence, the present study was conducted under glasshouse conditions to study the effect of biocontrol agent *Pochonia chlamydosporia* individualy or combination with other biocontrol agents and carbofuran in the management of *Globodera* spp. in potato.

MATERIALS AND METHODS

A pot culture study was conducted under glasshouse conditions using potato variety-Kufri Jyoti. The tubers were sown @ three tubers per pot in 5 kg capacity pots filled with cyst nematode infected soil (64 cysts/100g soil). The pot culture experiments were conducted under glasshouse conditions at State Horticulture farm, Nanjanadu, The Nilgiris in CRD with three replications.

Seedlings were thinned at 10 days after germination to maintain one seedling/pot. The bio control agents *Pochonia chlamydosporia* isolate were isolated from the Nilgiris. In the native strain of *P. chlamydosporia* were mass multiplied as talc formulation. The test biocontrol agents and the chemical nematicide at different rates and in combinations were mixed with soil thoroughly. The treatments details are: T_1 -*P. chlamydosporia* @ 10 kg/ha; T_2 –*P. fluorescens* @ 10 kg/ha; T_3 –*T. viride* @ 10 kg/ha; T_4 -*P. chlamydosporia* @ 10 kg/ha + *P. fluorescens* @ 10 kg/ha; T_5 -*P. chlamydosporia* @ 10 kg/ha

+ *T. viride* @ 10 kg/ha; T_6 -*P. chlamydosporia* @ 10 kg/ha + Carbofuran 3G @ 2 kg a.i./ha; T_7 -*P. chlamydosporia* @ 10 kg/ha + *P. fluorescens* @ 10 kg/ha + *T. viride* @ 10 kg/ha; T_8 -*P. chlamydosporia* @ 10 kg/ha + *P. fluorescens* @ 10 kg/ha + *T. viride* @ 10 kg/ha + Carbofuran 3G @ 2 kg a.i./ha; T_9 - Carbofuran 3G @ 2 kg a.i./ha and T_{10} –control. Three months after inoculation the observation were taken. Plant growth parameters *viz.*, shoot length, number of tubers, and tuber yield were observed. The observations on cyst and egg population in soil before treatment and at harvest were recorded. Number of females/2.5 cm root, number of juveniles/ g root at 45 DAP and reproduction factor were recorded. The nematode population in roots was determined from five plants pulled off in random at 45 days after planting (DAP). The nematode population in roots was assessed by staining with acid fuchsin-lactophenol. The egg population was counted by crushing 25 cysts selected at random and expressed as number per g soil (Brown, 1969). The data from the experiments were subjected to statistical analysis. The treatment means were compared by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

In potato, *P. chlamydosporia* significantly improved plant growth parameters when applied either alone or in combination with other biocontrol agents and carbofuran. The highest plant height, number of tubers and tuber yield were recorded in T8 compared to untreated control (T10). This was followed by combined application of all the three biocontrol agents (T7) without carbofuran (Table 1). In the present study, the combined soil applications of (T1+T2+T3) biocontrol agents significantly increased the plant growth parameters *viz*., plant growth and yield of potato with significant reduction in the cyst nematode population both under pot culture and field conditions. The egg parasitic fungus, *P. lilacinus* in combination with *V. chlamydosporium* significantly increased the length and weight of root and shoot and reduced the root galling in okra plant (Sobita Simon and Avinash Pandey, 2010). Kumar and Prabhu (2008) reported that combined application of *T. harzianum* + *P. chlamydosporia* significantly reduced the cyst nematode *H. cajani* population in pigeonpea.

In the present study, there was a significant decrease in number of cysts, eggs and females in both the combined and individual treatments compared to untreated control. The combined applications of T8 reduced the number of cysts and eggs by 71.93 and 63.76 per cent respectively over control. There was also 75.81 per cent reduction in the female population in roots. This was followed by T7 treatment (Table 2).

The combination of *P. chlamydosporia*, carbofuran and neem cake gave the highest yield of okra and suppressed root knot

Table 1. Compatibility of *P. chlamydosporia* with other biocontrol agents and carbofuran on plant growth and yield under pot culture conditions

Treatment	Plant height (cm)	Number of tubers/ plant	Tuber weight/ plant (g)
P. chlamydosporia @ 10 kg/ha – T_1	32.07^{b}	9.41^{e}	130.38^{de}
P. fluorescens @ 10 kg/ha – T_2	30.23^{c}	9.35^{ef}	128.38^{e}
T. viride @ 10 kg/ha – T_3	30.21^{c}	9.01^{f}	128.26^{e}
T_1 + *P. fluorescens* @ 10 kg/ha – T_4	33.03^{b}	11.34^{c}	140.48^{c}
T_2 + *T. viride* @ 10 kg/ha – T_5	32.10^{b}	10.64^{d}	130.37^{de}
T_2 + Carbofuran 3G @ 2kg a.i./ha – T_6	33.02^{b}	11.32^{c}	134.35^{d}
T_2 + T_3 + *T. viride* @ 10 kg/ha – T_7	34.53^{a}	12.12^{b}	146.32^{b}
T_1 + T_2 + T_3 + Carbofuran 3G @ 2 kg a.i./ha – T_8	34.76^{a}	12.86^{a}	152.81^{a}
Carbofuran 3G @ 2 kg a.i./ha – T_9	30.14^{c}	9.33^{ef}	127.35^{e}
Control – T_{10}	25.06^{d}	7.55^{g}	89.59^{f}
SEd	0.5155	0.1709	2.1544
CD (P=0.05)	1.0754	0.3566	4.4940

Values are mean of three replications. Column figures followed by different alphabets are significant from each other at 5 per cent level by DMRT

Table 2. Effect of *P. chlamydosporia* alone and along with other biocontrol agents and carbofuran on cyst nematodes in potato infested with PCN under pot culture conditions

Treatments	Soil Population		Number of females/2.5 cm root
	Cysts/100 g soil	Eggs/ g soil	
P. chlamydosporia @ 10 kg/ha – T_1	73.92[d]	69.23[d]	6.46[e]
P. fluorescens @ 10 kg/ha – T_2	86.52[e]	76.12[e]	7.29[f]
T. viride @ 10 kg/ha – T_3	89.93[f]	82.46[f]	8.74[g]
T_1 + *P. fluorescens* @ 10 kg/ha – T_4	62.78[c]	58.62[c]	4.42[c]
T_2 + *T. viride* @ 10 kg/ha – T_5	61.53[c]	60.95[c]	5.37[d]
T_2 + Carbofuran 3G @ 2kg a.i./ha – T_6	73.14[d]	68.47[d]	5.58[d]
T_2 + T_3 + *T. viride* @ 10 kg/ha – T_7	55.80[b]	43.68[b]	3.78[b]
T_1 + T_2 + T_3 + Carbofuran 3G @ 2 kg a.i./ha – T_8	50.12[a]	38.26[a]	2.91[a]
Carbofuran 3G @ 2 kg a.i./ha – T_9	102.56[g]	87.61[g]	8.86[g]
Control – T_{10}	178.56[h]	105.56[h]	12.03[h]
SEd	1.4800	1.1701	0.1156
CD (P=0.05)	3.0873	2.4407	0.2412

Values are mean of three replications. Column figures followed by different letters are significant from each other at 5 per cent level by DMRT

nematode severity in terms of galling, egg production and nematode population with a marginal difference with dual application of biocontrol agent and carbofuran in okra (Dhawan and Satyendra Singh, 2009). Similarly, Cannayane and Rajendran (2001) recorded that single applications of either *P. lilacinus*, *P. chalmydosporia* or oil cakes suppressed *M. incognita*. The integrated application of these agents also significantly reduced *M. incognita* population and increased yield of brinjal. A combination of dazomet followed by soil amendment with *P. chlamydosporia* and neem cake recorded maximum per cent healthy root, flower yield and plant recovery and reduced nematode populations of polyhouse roses (Nagesh and Janakirm, 2004).

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