Effects of *Trichoderma harzianum* Strain PC01 and Planting Media on Growth and Yield of Chinese Radish

Wirat Phuwiwat and Prapantree Kaewkong
Department of Horticulture, Faculty of Agricultural Technology, King Mongkut' s Institute of Technology Ladkrabang, Bangkok 10520, Thailad.

Kasem Soytong
Department of Plant Pest Management Technology, Faculty of Agricultural Technology, King Mongkut' s Institute of Technology Ladkrabang, Bangkok 10520, Thailad.

Abstract

The effects of *Trichoderma harzianum* strain PC01 at the concentrations of 0, 2.5×10^9, 5×10^9, 10×10^9 conidia / ml (20 ml / pot) and four planting media which consisted of sand : coconut coir : organic compost at the ratio of 1:1:1, 1:2:1, 1:3:1 and 1:2:2 (v/v/v) were studied for the growth and yield of Chinese radish (*Raphanus sativus* var. *longipinnatus*). Significant interaction between the two factors was observed in root diameter , root fresh and dry weights whereas the significant effects of *Trichoderma*' s conidia were found in all parameters measured. The *T. harzianum* strain PC01 at the concentrations of 5×10^9 and 10×10^9 conidia / ml gave significantly better growth and yield of the Chinese radish. On the other hand , planting media at the ratio of 1:1:1 and 1:2:2 showed significantly better plant growth and yield as compared to the others. However the highest root : shoot ratio of the Chinese radish was found when the concentration of 10×10^9conidia/ml was applied and the ratio of planting media at 1:1:1 was used.

Keywords : *Trichoderma harzianum* strain PC 01 ,planting media, Chinese radish, growth and yield.

1. Introduction

Trichoderma harzianum is a naturally occurring soil fungus which has been found to have the potential for plant growth promotion independent of any plant disease [1, 2, 3, 4]. However the effect of *T.harzianum* on plant growth promotion, has been shown to be dependent on many factors such as the strains of *T. harzianum* used, the concentrations and the forms of inocula applied, the kinds of plants and the planting media [5, 6, 7].

In Thailand, *T. harzianum* strain PC01 was indiginously isolated by Assoc. Prof. Dr. Kasem Soytong and was primarily aimed to be used as a plant disease biocontrol agent. Recently, our experiment was conducted to test the potential of *T. harzianum* strain PC 01 on plant growth promotion. The results of our experiment showed that the Chinese radish growth and yield were significantly increased when 53×10^8 spores per pot of *T. harzianum* strain PC 01 were mixed into the planting medium [8]. To confirm and expand our research, the effects of *T. harzianum* strain PC01 at 3 concentrations and 4 ratios of the planting media were used in this experiment. Chinese radish was used as the tested plant.

2. Materials and Methods

T. harzianum strain PC01 was cultured onto potato dextrose agar (PDA) and incubated for 5 days. The planting media were prepared by using sand : coconut coir : organic compost at the ratio of 1:1:1 , 1:2:1 , 1:3:1 and 1:2:2 (v/v/v) and placed in 26 cm. diameter and 22 cm. depth plastic pots. The 5 days old colonies of *T. harzianum* strain PC01 were harvested and added into the planting media at the concentrations of 2.5×10^9, 5×10^9 and 10×10^9 conidia / ml by adding 20 ml / pot. Non-treated

planting media were used as a control to which comparisons were made. All pots were covered with plastic sheets for 10 incubation days before seed sowing. Five seeds of the Chinese radish were sown into each pot and the plants were thinned to 1 seedling per pot after emergence. The 4 × 4 factorial experiment in completely randomized design with 3 replications was done.

At 65 days after sowing, the Chinese radish plants were harvested for growth and yield determination. Plant height from the base of stem to the highest part of the erected leaves, leaf number per plant, leaf area per plant, root length, root diameter at the widest part, fresh and dry weights of the root, shoot and total weight were measured. All data were subjected to analysis of variance and Duncan' s multiple range test was used for mean separation.

3. Results and Discussion

Significant effects of both main factors on growth and yield of the Chinese radish were recorded in all parameters measured (Table 1-3). On the other hand, the significant interactions between the concentrations of *T. harzianum* strain PC01 and the ratio of planting media were only observed in the root diameter (Table 2), root fresh and dry weights (Table 3). Application of *T. harzianum* strain PC01 at the concentration of 5×10^9 conidia / ml gave the result of significantly higher growth and yield as compared to the control and the application of 2.5×10^9 conidia / ml concentration. There were no significantly different effects between the concentration of 5×10^9 and 10×10^9 conidia / ml of *T. harzianum* strain PC01 on all parameters studied. In terms of the planting media, the Chinese radish grown using the ratio of 1:1:1 and 1:2:2 showed significantly better plant growth and yield as compared to the other two planting media. Moreover, the combination of the increasing concentration of the *T. harzianum* strain PC01 to 5×10^9 and 10×10^9 conidia/ml with the use of the planting media at the ratio of 1:1:1 and 1:2:2 significantly promoted the Chinese radish root growth. However, the highest root : shoot ratio of the Chinese radish, on the dry weight basis, was found when the concentration of *T. harzianum* strain PC 01 at 10×10^9 conidia/ml was applied and the planting media at the ratio of 1:1:1 was used.

The results of this research confirmed the potential use of the *T. harzianum* strain PC01 for plant growth promotion as reported previously [8]. The ratio of the planting media was also shown to affect the potential of *T. harzianum* strain PC01 on the Chinese radish growth promotion. This effect therefore might be due to the different conditions of the planting media. The higher ratio of the coconut coir, i.e. 1:2:1 and 1:3:1, would give the result of high moisture level and poor aeration of the planting media which might be the factors that influence the potential of *T. harzianum* in promoting plant growth. However, it is still unclear whether differences in soil mixes directly affect the receptivity of the plant to the growth–promoting factors produced by *T. harzianum* or whether differences in soil environment directly influence the fungal production of some secondary metabolites and enzymes [2].

4. References

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Table 1. Effects of 4 concentrations of *Trichoderma harzianum* strain PC01 and 4 ratios of the planting media on the Chinese radish plant height, leaf number per plant and leaf area per plant at harvesting.

Planting media ratio (v / v / v)	Concentrations of *T. harzianum* (conidia / ml , 20 ml / pot) 0	2.5×10^9	5×10^9	10×10^9	Average 2/
	Plant height (cm) 1/				
1:1:1	21.98	23.49	27.31	24.22	**24.25 A**
1:2:1	18.95	19.01	21.08	21.96	**20.25 B**
1:3:1	16.49	19.27	21.15	21.51	**19.61 B**
1:2:2	22.09	25.26	25.53	24.60	**24.37 A**
Average 3/	**19.88 B**	**21.76 B**	**23.77 A**	**23.07 A**	
	Leaf number per plant 1/				
1:1:1	15.78	17.22	19.56	17.67	**17.56 A**
1:2:1	11.67	11.44	13.22	13.33	**12.42 B**
1:3:1	13.67	13.33	17.44	14.44	**14.72 B**
1:2:2	18.11	15.55	20.56	19.22	**18.36 A**
Average 3/	**14.81 B**	**14.39 B**	**17.70 A**	**16.14 AB**	
	Leaf area per plant (cm^2) 1/				
1:1:1	741.14	871.23	1210.96	1063.02	**974.59 A**
1:2:1	351.23	436.87	503.13	499.32	**447.66 B**
1:3:1	515.21	490.26	702.94	634.89	**585.83 B**
1:2:2	852.23	857.32	1216.55	1259.89	**1046.50 A**
Average 3/	**641.95 B**	**663.92 AB**	**908.40 A**	**864.28 A**	

1/ Means from 3 replications

2/ Average means in the column having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

3/ Average means in the row having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

Table 2. Effects of 4 concentrations of *Trichoderma harzianum* strain PC01 and 4 ratios of the planting media on the Chinese radish root length and diameter at harvesting.

Planting media ratio (v / v / v)	Concentrations of *T. harzianum* (conidia / ml , 20 ml / pot)				Average [2/]
	0	2.5×10^9	5×10^9	10×10^9	
	Root length (cm) [1/]				
1:1:1	11.93	9.93	18.43	18.47	**14.69 A**
1:2:1	7.28	9.94	8.92	10.94	**9.27 B**
1:3:1	8.77	9.09	9.86	9.73	**9.36 B**
1:2:2	12.55	12.00	17.40	19.61	**15.39 A**
Average [3/]	**10.13 B**	**10.24 B**	**13.65 A**	**14.69 A**	
	Root diameter (cm) [1/]				
1:1:1	3.05 ab[4/]	2.11 bc	4.11 a	4.22 a	**3.37 A**
1:2:1	2.29 ab	2.32 bc	1.92 bc	1.75 bc	**2.07 B**
1:3:1	1.59 c	2.71 bc	2.86 bc	2.89 bc	**2.51 B**
1:2:2	2.59 bc	2.61 bc	4.14 a	4.12 a	**3.37 A**
Average [3/]	**2.38 B**	**2.44 B**	**3.26 A**	**3.25 A**	

1/ Means from 3 replications

2/ Average means in the column having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

3/ Average means in the row having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

4/ Small letter indicating the significant interaction between the two factors, means having the same small letter(s) were not significantly different by DMRT (P = 0.01)

Table 3. Effects of 4 concentrations of *Trichoderma harzianum* strain PC01 and 4 ratios of the planting media on the Chinese radish fresh and dry weights at harvesting.

Planting media ratio (v / v / v)	Concentrations of *T. harzianum* (conidia / ml , 20 ml / pot) 0	2.5×10^9	5×10^9	10×10^9	Average [2/]
	Shoot fresh weight (g) [1/]				
1:1:1	50.89	62.89	86.33	78.22	**69.58 A**
1:2:1	21.78	25.33	32.22	32.11	**27.86 C**
1:3:1	40.44	35.00	50.22	40.56	**41.56 B**
1:2:2	61.78	63.56	98.00	88.00	**77.84 A**
Average [3/]	**43.72 B**	**46.70 B**	**66.69 A**	**59.72 A**	
	Shoot dry weight (g) [1/]				
1:1:1	3.79	4.52	6.03	5.70	**5.01 A**
1:2:1	1.89	2.15	2.53	2.68	**2.31 B**
1:3:1	2.93	2.55	3.70	3.00	**3.05 B**
1:2:2	4.20	4.52	6.54	6.32	**5.40 A**
Average [3/]	**3.20 B**	**3.44 B**	**4.70 A**	**4.43 A**	
	Root fresh weight (g) [1/]				
1:1:1	87.00 b[4/]	60.00 bc	150.22 a	173.33 a	**117.64 A**
1:2:1	20.00 c	46.00 bc	21.33 c	46.56 bc	**33.47 B**
1:3:1	26.83 c	38.33 bc	40.11 bc	39.11 bc	**36.10 B**
1:2:2	52.67 bc	54.28 bc	155.00 a	178.22 a	**110.04 A**
Average [3/]	**46.63 B**	**49.65 B**	**91.67 A**	**109.31 A**	
	Root dry weight (g) [1/]				
1:1:1	4.13 bc[4/]	3.17 cd	6.87 a	7.92 a	**5.52 A**
1:2:1	1.16 d	2.06 cd	1.23 d	2.39 cd	**1.71 B**
1:3:1	1.65 cd	2.51 cd	2.12 cd	2.58 cd	**2.22 B**
1:2:2	2.63 cd	3.01 cd	6.14 ab	7.70 a	**4.87 A**
Average [3/]	**2.39 B**	**2.69 B**	**4.09 A**	**5.15 A**	

1/ Means from 3 replications

2/ Average means in the column having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

3/ Average means in the row having the same capital letter(s) were not significantly different by DMRT (P = 0.01)

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