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Effect of *Trichoderma* spp. in Plant Growth Promotion in Chilli

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A B S T R A C T

Trichoderma species are commonly used as biological control agents against phytopathogenic fungi and some isolates are able to improve plant growth. In this study, the effects of seven *Trichoderma* isolates from Madhya Pradesh was examined in chilli for enhancing seedling and plant vigor via two way introduction methods (inoculating seed with *Trichoderma* as seed treatment and also seed treatment with three foliar sprays). Different isolates of *Trichoderma* spp. significantly influenced the root length, shoot length and number of leaves of chilli at seedling stage. The maximum root length and shoot length of 6.22 cm 7.33 cm respectively was recorded in seed treatment with *Trichoderma* isolate T_2. Similarly, the same isolate T_2 depicted maximum number of leaves (8.70 per plant). Further, enhanced plant growth promotion activity was shown by isolates of *Trichoderma* when applied as seed treatment coupled with three foliar sprays. It was observed that maximum root length (6.84 cm), shoot length (62.19 cm), number of branches (5.82) was depicted in seed treatment coupled with its three foliar sprays of T_2 isolate of *Trichoderma*. This was followed by T_5 isolate of *Trichoderma*. Similarly, maximum fresh and dry weight (biomass) was recorded in T_2 isolate of *Trichoderma*. Application of different isolates of not only significantly contributed to foliage of the chilli plant but they also enhanced the yield component of chilli. The maximum yield of 69.55 q/ha was recorded in treatment T_2 where *Trichoderma* isolate T_2 was applied as seed treatment along with its three foliar sprays.

Introduction

Chilli (*Capsicum annum* L.) is an important spice cum vegetable crop, often referred to as Capsicum, hot pepper, sweet pepper or paparika. Chilli cultivation has existed for several hundred years as a sustainable form of agriculture in India and in many other countries. It is an annual herbaceous vegetable and spice grown in both tropical and sub-tropical regions. India accounts for 25% of the world's total production of chilli (Ashwini and Srividya, 2014). *Trichoderma*, a filamentous soil inhabiting mycoparasite, is used in commercial preparation for biological control of many fungal plant pathogens (Jash, 2006)

and included the mechanisms like antibiosis, competition for nutrients or space, tolerance to stress through enhanced root and plant development, induced resistance, solublization and sequestration of inorganic nutrients and inactivation of pathogen enzymes (Harman, 2000). However, with the increasing interest in biological control, owing to environmental and economic concerns, and with the rapid development of biotechnology, several *Trichoderma* species were formulated in a commercial production for protection and growth enhancement of a number of crops in several countries (McSpadden and Fravel, 2002). Beside the other necessary factors in its growth, it makes better support for shoot growth and development. The effect of *Trichoderma* isolates on plant growth and development is important, especially in nursery, because improvement of plant vigor to overcome biotic and/or abiotic stresses results in the production of stronger plants and increase in plant productivity and yields. *Trichoderma* being a soil fungus, its growth, multiplication and eventually its biocontrol potential is highly affected by various soil physical, chemical and biological properties. They are reported to be affected by factors like soil pH, soil temperature and moisture level, water potential and most importantly by the activities of the native antagonistic microflora which is present in the soil where they are applied as biocontrol agents (Bull, 2002). Therefore, it becomes important that the selected strain should have the ability to compete with the native microflora, establish itself successfully in the crop rhizhophere/ spermosphere and should have a wide array of mechanisms to inhibit several pathogens. Given these considerations, it is expected that the best method for obtaining a potential biocontrol agent might be to isolate *Trichoderma* strains originally from those areas where they are actually expected to function later as a biocontrol agent and where they are already growing under conditions of temperature, moisture etc. similar to those found in nature (Howell, 2003).

There are relatively few strains of *Trichoderma* that have the ability to stimulate plant growth response (Lo and Lin, 2002). The most beneficial *Trichoderma* strains that are able to colonize the root and inhabit the rhizosphere are known to have the "rhizosphere competence" (Harman *et al.*, 2004). Therefore, screening of *Trichoderma* isolates is beneficial in enhancing plant growth and development, which is highly desirable in order to reduce or eliminate the use of synthetic chemical fertilizers from the point of the view of sustainable agricultural system because application of man-made fertilizer is not economical in the long run for environmental pollution, due to the fact that harmful residues and their highly application cost are left in the soil.

Therefore, information on plant growth promotion activity of different isolates of *Trichoderma* is an important aspect of research not only for coping up with diseases but also to reduce fertilizer application and enhancing plant growth and yield in an eco-friendly manner.

Materials and Methods

Trichoderma harzianum isolates

A set of seven isolates of *T. harzianum* were procured from Department of Plant Pathology, College of Agriculture, Rewa and used in the present investigation. All of these isolates were isolated from Satna, Rewa (Kuthulia), Khargone, Indore, Umaria, Rewa (Birkham) and Sidhi locations of Madhya Pradesh and coded as T_1, T_2, T_3, T_4, T_5, T_6 and T_7 respectively. The procured isolates of *T. harzianum* were maintained throughout the study by periodical transfers on Potato dextrose agar (PDA) medium.

Plant growth promotion activity in chilli

Plant growth promotion activity of *T. harzianum* was studied in experimental area of Department of Plant Pathology, J.N.K.V.V., College of Agriculture, Rewa. The seeds of chilli cv. Kohinoor special were obtained from Department of Plant Pathology, College of Agriculture, Rewa. Further, seeds were sown in lines at a spacing of about 5 cm apart on raised beds of about 15 cm above ground level and covered with soil, thereafter, mulched with dry grasses. Proper moisture was maintained for the growth of the seedlings. After germination of the seedlings, the dry grass was removed to expose the seedlings to sunlight for better growth. The seedlings were transplanted to individual plot size of 1.5 m × 2.5 m with row to row and plant to plant spacing of .75 m and 0.30 m respectively. For seed treatment slurry of different isolates of *Trichoderma* was prepared separately for each isolate and seeds were treated @10 g/Kg seed. Seeds were dipped in the slurry for 30 minutes and dried in shade before sowing. For foliar spray, the first spray was given 25 days after transplanting followed by two more sprays at 15 days interval. The spray solution was prepared by adding 2.5 g culture of *Trichoderma* separately in 1 litre of water. In total seven treatments were formulated using different isolates of *Trichoderma* (T_1 to T_7) as seed treatment and seed treatment with three foliar sprays. Observations were recorded for different parameters at seedling stage (before transplanting) and after three foliar sprays of respective *Trichoderma* isolate. Five plants were randomly selected from each treatment under each replication passing up the border plants. The tagging was done before flowering. Data were recorded on the tagged plants for different attributes including plant height (cm), root length (cm), no. of branches, fresh weight of plant (g) and dry weight of plant (g) after 10 days of last spray. Yield of green chillies were recorded in each pickings from all the plots including control. The total yield of marketable fruits obtained from different treatments was calculated and converted to per hectare yield. The data collected were subjected to Randomized Design for their significance (Gomez and Gomez, 1984).

Results and Discussion

A set of seven isolates of *Trichoderma* spp. (T_1 to T_7) were used for seed treatment and foliar sprays in chilli. The plant growth promotion activity was recorded for different characters at the time of transplanting (seedling stage) and after 10 days of three foliar sprays.

Effect of seed treatment in plant growth promotion at Seedling stage

Observations were recorded for root length, shoot length, number of leaves and plant vigour index at seedling stage after seed treatment with different isolates of *Trichoderma* spp. Different isolates of *Trichoderma* spp. significantly influenced the root length of chilli at seedling stage. Average root length ranged from 5.55 cm to 6.22 cm in seed treatments of different isolates of *Trichoderma* spp. However, in control plants average root length of 5.40 cm was recorded. The maximum root length of 6.22 cm was recorded in seed treatment with *Trichoderma* isolate T_2 followed by isolate T_1 (5.83 cm). The minimum average root length of 5.55 cm was recorded in seed treatment with T_6 isolate of *Trichoderma.* The average shoot length of chilli plants in seedling stage ranged from 5.83 cm to 7.33 cm after seed treatment with different isolates of *Trichoderma* spp. In control plants average shoot length of 5.53 cm was recorded. This showed the plant growth promotion activity in different isolates of

Trichoderma spp. The maximum shoot length of 7.33 cm was recorded in seed treatment with *Trichoderma* isolate T_2 followed by T_1 isolate of *Trichoderma* (6.74 cm). Among different seed treatments, the minimum shoot length of 5.83 cm was recorded in treatment T_6 where chilli seeds were treated with T_6 isolate of *Trichoderma*. Data related to average number of leaves in chilli seedlings at seedling stage revealed that maximum average number of leaves of 8.70 per plant was recorded in seed treatment with *Trichoderma* isolate T_2 followed by isolate T_1 (7.93 per plant). The minimum average number of leaves of 6.93 per plant was recorded in seed treatment with T_6 isolate of *Trichoderma.* However, in control plants 6.68 per plant average number of leaves were recorded. The detailed data for different parameters after seed treatment with *Trichoderma* isolates along with control has been given in table 1.

Effect of seed treatment and foliar spray in plant growth promotion

Different isolates of *Trichoderma* spp. were applied as seed treatment and three foliar sprays at 15 days intervals to identify their role in plant growth promotion in chilli. Root length was measured after carefully uprooting the plant and it was observed that different isolates of *Trichoderma* varied significantly in influencing the root length of chilli plant. Average root length ranged from 5.73 cm to 6.84 cm in different treatments of *Trichoderma* isolates. However, average root length of 5.56 cm was recorded in control plants. Maximum average root length of 6.84 cm was recorded in treatment T_2 where *Trichoderma* isolate T_2 was applied as seed treatment and its three foliar sprays. The minimum average root length of 5.73 cm was recorded in seed treatment and three foliar sprays with T_6 isolate of *Trichoderma*. Further, average shoot length of different plants ranged from 50.63 cm to 62.19 cm among different treatments of *Trichoderma* application as seed treatment and foliar spray. However in control plants average shoot length of 49.40 cm was recorded. The maximum average shoot length of 62.19 cm was recorded in treatment T_2 where *Trichoderma* isolate T_2 was applied as seed treatment and three foliar sprays at 15 days interval. The minimum shoot length of 50.63 cm was recorded in treatment T_6 among different *Trichoderma* applications. In different treatments average number of branches ranged from 4.05 to 5.82. The maximum average number of branches of T_2 was recorded in treatment T3 where seed treatment of *Trichoderma* isolate T_2 was coupled with its three foliar sprays. This was followed by treatment T_5 (5.63) where *Trichoderma* isolate T_5 was applied seed treatment and its three foliar sprays. In control plants, minimum average number of branches of 4.05 was recorded. This showed the plant growth promotion activity of *Trichoderma* with varied level of response. The data related to different plant growth promotion attributes after seed treatment and three foliar sprays of respective isolate of *Trichoderma* has been presented in table 2.

Further, fresh and dry weight of plants was recorded in all the treatments including control to identify the enhancement in dry matter of chilli plants in response of its growth promotion activity. Data revealed that average fresh weight of plants ranged from 90.50 g to 129.78 g in different treatments including control. The maximum fresh weight of 129.78 g was recorded in treatment with *Trichoderma* isolate T_2 followed by isolate T_5 (118.34 g). Similarly, maximum dry weight of 32.25 g was recorded in seed treatment along with its three foliar sprays in *Trichoderma* isolate T_2. The minimum dry weight of 21.19 g was recorded in control plants. However, among different *Trichoderma* isolate, minimum dry weight of 22.50 g was recorded in treatment of

chilli plants with *Trichoderma* isolate T_6. Yield per plot measured in kg and converted into quintal per hectare for all the treatments including control. The data revealed that yield ranged from 58.46 q/ha to 69.55 q/ha. The maximum yield of 69.55 q/ha was recorded in treatment T_2 where *Trichoderma* isolate T_2 was applied as seed treatment along with its three foliar sprays. This was followed by treatment T_5 (68.27 q/ha) where *Trichoderma* isolate T_5 was used as seed treatment and foliar spray. However, lowest yield of 58.46 q/ha was recorded in control. This demonstrated the plant growth promotion activity of *Trichoderma* when applied as seed treatment and foliar sprays. The data related to dry, fresh plant weight and yield of chilli in different treatments has been presented in table 3.

In the present investigation, a set of seven isolates of *Trichoderma*, isolated from seven different locations of Madhya Pradesh, were evaluated for their plant growth promotion activity in chilli with seed treatment alone and also along with its three foliar sprays. Isolates showed variable capacity of plant growth promotion when evaluated upon different parameters of root length, shoot length, plant height, fresh weight, dry weight and yield. Plant growth enhancement by *Trichoderma* isolates is as a result of different mechanisms such as exudation of plant growth regulators and/or their similarity with the fungi (Hoitink *et al.*, 2006; Vinale *et al.*, 2008), solubilization of phosphates, micronutrient and minerals such as Fe, Mn and Mg that have important role in plant growth (Altomare *et al.*, 1999), secretion of exogenous enzymes, siderophores (Jalal *et al.*, 1987) and vitamins (Inbar *et al.*, 1994; Kleifeld and Chet, 1992), as well as indirectly with the control of the major and minor root infesting pathogens (Harman *et al.*, 2004) in rhizosphere. The variety of some of these mechanisms indicate multiple modes of action (Harman, 2006; Harman *et al.*, 2004) that lead to increase in nutrient availability and uptake, resulting in the stronger nutrient uptake by plant, and thereby developing the root system.

Table.1 Effect of different isolates of *Trichoderma* on root length, shoot length and number of leaves at seedling stage

Treatment	Root length(cm)	Shoot length(cm)	No. of leaves
T_1:Seed treatment with *Trichoderma* isolate T_1	5.83	6.74	7.93
T_2:Seed treatment with *Trichoderma* isolate T_2	6.22	7.33	8.70
T_3:Seed treatment with *Trichoderma* isolate T_3	5.73	6.63	7.82
T_4:Seed treatment with *Trichoderma* isolate T_4	5.62	6.5	7.43
T_5:Seed treatment with *Trichoderma* isolate T_5	6.02	6.93	8.52
T_6:Seed treatment with *Trichoderma* isolate T_6	5.55	5.83	6.93
T_7:Seed treatment with *Trichoderma* isolate T_7	5.59	6.21	7.03
T_8:Control	5.4	5.53	6.68
S.Em±	0.26	0.27	0.28
CD 5 %	0.92	0.94	0.99
CV %	8.03	7.31	6.47

Table.2 Effect of different isolates of *Trichoderma* on root length, shoot length and number of leaves at seedling stage

Treatments	Root length (cm)	Shoot length (cm)	No. of branches
T_1:Seed treatment with *Trichoderma* isolate T_1 with its three foliar sprays	6.33	59.96	5.27
T_2:Seed treatment with *Trichoderma* isolate T_2 with its three foliar sprays	6.84	62.19	5.82
T_3:Seed treatment with *Trichoderma* isolate T_3 with its three foliar sprays	6.14	57.94	5.03
T_4:Seed treatment with *Trichoderma* isolate T_4 with its three foliar sprays	6.05	53.17	4.92
T_5:Seed treatment with *Trichoderma* isolate T_5 with its three foliar sprays	6.57	61.26	5.63
T_6:Seed treatment with *Trichoderma* isolate T_6 with its three foliar sprays	5.73	50.63	4.13
T_7:Seed treatment with *Trichoderma* isolate T_7 with its three foliar sprays	5.91	51.40	4.65
T_8:Control	5.56	49.40	4.05
S.Em±	0.29	2.44	0.30
CD 5 %	1.04	8.52	1.06
CV %	8.43	7.61	10.69

Table.3 Effect of different isolates of *Trichoderma* on fresh and dry weight of chilli plants

Treatment	Fresh weight (g)	Dry weight (g)	Yield (q/ha)
T_1:Seed treatment with *Trichoderma* isolate T_1 with its three foliar sprays	116.03	28.21	65.58
T_2:Seed treatment with *Trichoderma* isolate T_2 with its three foliar sprays	129.78	32.25	69.55
T_3:Seed treatment with *Trichoderma* isolate T_3 with its three foliar sprays	113.56	23.97	63.22
T_4:Seed treatment with *Trichoderma* isolate T_4 with its three foliar sprays	109.14	23.05	61.36
T_5:Seed treatment with *Trichoderma* isolate T_5 with its three foliar sprays	118.34	26.84	68.27
T_6:Seed treatment with *Trichoderma* isolate T_6 with its three foliar sprays	102.16	22.50	59.27
T_7:Seed treatment with *Trichoderma* isolate T_7 with its three foliar sprays	96.47	22.86	59.87
T_8:Control	90.50	21.19	58.46
S.Em±	1.77	0.98	2.52
CD 5 %	6.18	3.41	8.79
CV %	2.81	6.77	6.92

In the present investigation different local isolates of *Trichoderma* from Madhya Pradesh exhibited plant growth promotion activity in chilli which ultimately resulted in enhanced fruit yield. However, growth promotion based on root length, shoot length, fresh weight, dry weight and yield varied in different isolates which showed differential ability of different isolates towards plant growth promotion. Maximum plant growth promotion in chilli under natural conditions of Rewa was depicted by T_2 isolate of *Trichoderma* which was isolated from Kuthulia location of Rewa. This showed that native isolates are better colonizer in roots or rhizospheric region and provide better plant growth promotion activity. Recently, some researchers have however, reported the effect of *Trichoderma* isolates directly on the plant growth parameters in some commercial crops (Shanmugaiah *et al.*, 2009; Bal and Altintas, 2008; Babeendran *et al.*, 2000) and our results pertaining to present investigations are matching with their findings. Seedling height, plant fresh and dry weight, and root length, as well as leaf number were increased significantly by applying *Trichoderma* T_2 isolate as seed treatment with its three foliar sprays. Development of the root system with production of some organic acids in the rhizosphere such as gluconic, citric and/or fumaric acids by *Trichoderma* which decrease soil pH, lead to increased solubility of the insoluble compound and an availability of micronutrient, as well as an increase in plant nutrient uptake. Improvement of plant nutrient uptake and its transport from root to aerial parts, together with the produced plant stimulators, might result in higher photosynthetic rates required for producing enough energy used to derive the enhanced growth response. This hypothesis is supported by the obtained result of *Trichoderma* sp treatment especially in the seed treatment because of the high density of the *Trichoderma* population. In this way, the present result indicated that the effects of *Trichoderma* on seedling growth and vigor consistently depend on *Trichoderma* species/isolate applied. This finding is consistent with the results of other authors (Hajieghrari, 2010; Ousley *et al.*, 1994). Consequently, more detailed studies are still needed among the various isolates of *Trichoderma* species in order to provide a better understanding of the mechanisms of promoting or inhibiting plant growth responses.

References

Altomare, C., Novell, W.A., Bjorkman, T., and Harman, G.E. 1999. Solubilization of phosphate and micronutrients by the plant-growth-promoting and biocontrol fungus *Trichoderma harzianum* Rifai 1295-22. Appl. Environ. Microbiol. 65: 2926-2933.

Ashwini, N., and Srividya, S. 2014. Potential of *Bacillus subtilis* as biocontrol agent for management of anthracnose disease of chilli caused by *Colletotrichum gloeosporioides* OGC1. *3* Biotech, 4(2): 127-136.

Babeendean, N., Moot, D.J., Jones, E.E., and Stewart, A. 2000. Inconsistent growth promotion of Cabbage and Lettuce from *Trichoderma* isolates. New Zealand Plant Protection, 53: 143-146.

Bal, U., and Altintas, S. 2008. Effects of *Trichoderma harzianum* on lettuce in protected cultivation. J. Cent. Eur. Agric. 9(1): 63-70.

Bull, C.T. 2002. Interactions between myxobacteria, plant pathogenic fungi, and bio control agents. Plant Disease 86: 889-896.

Gomez, K.A. and Gomez, A.A. Statistical procedures for agricultural research 2nd Ed., John Wiely and Sons, New York.1984

Hajieghrari, B. 2010. Effects of some Iranian

Trichoderma isolates on maize seed germination and seedling vigor. Afr. J. Biotechnol. 9(28): 4342-4347.

Harman, G.E. 2006. Overview of mechanisms and uses of *Trichoderma* spp. Phytopathol. 96(2): 190-194.

Harman, G.E., Howell, C.R., Viterbo, A., Chet, I., and Lorito, M. 2004. *Trichoderma* species-opportunistic, avirulent plant symbionts. Nature Reviewer, 2: 43-56.

Harman, G.E. 2000. Myth and dogmas of biocontrol changes in perceptions derived from research on *Trichoderma harzianum. T- 22.* Plant Disease. 84:377-393.

Hoitink, H.A.J., Madden, L.V., and Dorrance, A.E. 2006. Systemic resistance induced by *Trichoderma* spp; Interactions between the host, the pathogens, the biocontrol agent and soil organic matter quality. Phytopathology, 96(2):186-189.

Howell, C.R. 2003. Cotton seedling preemergence damping off incited by *Rhizopus oryzae* and *Pythium* spp. and its biological control with *Trichoderma* spp. Phytopathology. 92:177-180.

Inbar, J., Abramsky, M., Cohen, D., and Chet, I. 1994. Plant growth enhancement and disease control by *Trichoderma harzianum* in vegetable seedlings growth under commercial conditions. Euro. J. Plant Pathol., 100: 337- 346.

Jalal, M.A.F., Love, S.K., and Vander-Helm, D. 1987. Siderophore mediated iron III uptake in *Gliocladium virens* (*Trichoderma virens*). 2. Role of ferric mono- and dihydroxamates as iron transport agent. J. Inorganic Biochem. 29: 259-267.

Jash, S. 2006. Recent approaches of biological control of plant disease with *Trichoderma*. In: Trends in organic Farming in India. Porohit, S.S. and Gehlot, D. eds, 298-315. *Agrobios* (India), Jodhpur, India.

Kleifeld, O., and Chet, I. 1992. *Trichoderma harzianum* interaction with plants and effects on growth response. Plant Soil, 144: 267-272.

Lo, C.T., and Lin, C.Y. 2002. Screening strains of *Trichoderma* spp for plant growth enhancement in Taiwan. Plant Pathol. Bull. 11: 215-220.

McSpadden, Gardener, B.B. and Fravel, D.R. 2002. Biological control of plant pathogens: Research, commercialization, and application in the USA. Online. Plant Health Progress doi: 10.1094/PHP-2002-0510-01-RV.

Ousley, M.A., Lynch, J.M., and Whipps, J.M. 1994. Potential of *Trichoderma* spp. as consistent plant growth stimulators. Biol. Fertil. Soils, 17: 85- 90.

Shanmugaiah, V., Balasubramanian, N., Gomathinayagam, S., Monoharan, P.T., and Rajendran, A. 2009. Effect of single application of *Trichoderma viride* and *Pseudomonas fluorences* on growth promotion in cotton plants. Afr. J. Agric. Res. 4(11): 1220-1225.

Vinale, F., Sivasithamparam, K., Ghisalberti, E.L., Marra, R., Barbetti, M.J., Li, H., Woo, S.L., and Lorito, M. 2008. A novel role for *Trichoderma* secondary metabolites in the interactions with plants. Physiol. Mol. Plant Pathol. 72: 80-86.

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