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MANAGEMENT OF CAULIFLOWER SEEDLING DISEASE (*Sclerotium rolfsii*) IN SEEDBED WITH DIFFERENT SUBSTRATE BASED *Trichoderma harzianum* BIO-FUNGICIDES

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Abstract

Efficacy of rice bran, wheat bran, grass pea bran and their combinations with or without mustard oilcake (MOC) were tested as substrate of *Trichoderma harzianum* based bio-fungicides for the management of foot and root rot disease of cauliflower caused by *Sclerotium rolfsii* in the seedbed during three consecutive growing seasons from 2011 through 2014 in the net house of Bangladesh Agricultural Research Institute, Gazipur. The seedbed soil was inoculated with pathogen *S. rolfsii* colonized on barley grain before treatment with *T. harzianum* based bio-fungicides. The results of three years trial revealed that *T. harzianum* based bio-fungicides effectively reduced pre-emergence and post-emergence mortality of cauliflower seedling in seedbed. Besides, vegetative growth of cauliflower seedlings viz. shoot length, shoot weight, root length and root weight were enhanced significantly by different substrates based *T. harzianum* bio-fungicides in *S. rolfsii* sick seedbed. The substrates rice bran, wheat bran, grass pea bran and their combination with mustard oilcake (MOC) were equally suitable for effective formulation of *T. harzianum* bio-fungicides against foot and root rot disease of cauliflower in seedbed.

Keyword: Cauliflower, seedling disease, *Sclerotium rolfsii*, bio-fungicide, *Trichoderma harzianum*.

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis*) is cultivated in about 13 thousand hectares of land with a production of about 166 thousand tons in Bangladesh (BBS, 2013). The productivity of cauliflower in Bangladesh is low as compared to that of other countries (FAOSTAT, 2012). It is estimated that about 10% crops are lost worldwide annually due to plant diseases which lead to considerable economic discrepancy to the farmers of underdeveloped countries (Strange and Scott, 2005). Germination failure and seedling mortality caused by the soil borne pathogens are the major constraints of cauliflower in seed bed. Among the soil borne pathogens, *S. rolfsii* is one of the major one for seedling production of vegetable crops including cauliflower especially in seedbed (Najar *et al.,* 2011). The soil borne pathogen *S. rolfsii* produces a unique and specialized structure called sclerotia which can survive in soil under adverse environmental conditions (Mondal *et al.,* 1996). So, it is very difficult to control through conventional

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methods such as application of fungicides, cultural methods, etc. Resistant variety of cauliflower has not yet been developed against *S. rolfsii* in Bangladesh. Besides, chemical fungicides are expensive and also hazardous to health and environment (Brown and Hendrix, 1980; Punja *et. al*., 1982). Biological control methods, on the other hand can be considered as cost-effective, sustainable and environment-friendly option for soil borne disease management (Kulkarni *et al*., 2007; Anand and Reddy, 2009). The biological agent *Trichoderma harzianum* has reported by many researchers describing the scenario and mechanisms of controlling soil-borne plant pathogens (Morsy *et al*., 2009; Sabalpara *et al*., 2009; Benítez *et al.*, 2004; Harman *et al*., 2004). The fungus *Trichoderma harzianum* has a stimulatory effect on plant growth (Naseby *et al*., 2000) as well as having potentiality as antagonists to control *Sclerotium, Phytophthora, Pythium, Sclerotinia, Botrytis, Rhizoctonia* and *Fusarium* (Benítez *et al*., 2004; Roy *et al*., 1989). The native bio-control agents usually perpetuate in low population density in most of the agricultural soil, so up-scaling of their density to a higher stability level in soil through artificial inoculation is necessary for effective management of soil borne pathogens *S. rolfsii*. The major limitation is the lack of appropriate mass culturing techniques and inadequate information on the suitable substrate materials of *T. harzianum* (Harman *et al*., 1991). Several research reported various substrates for *T. harzianum* culture viz. wheat bran, rice bran, maize bran, sawdust (Das *et al*., 1997); rice straw, chickpea bran, grass pea bran, rice course powder, black gram bran (Shamsuzzaman *et al*., 2003); cow dung, poultry manure, ground nut shell, black ash, coir waste, spent straw from mushroom bed, talc, vermiculite (Rettinassababady and Ramadoss, 2000); and jaggery, groundnut cake, neem cake, niger cake, pongamia (Shamarao *et al*., 1998). Most of these substrates are available in Bangladesh but their potentialities to mass culture of *T. harzianum* is yet to be determined in the country. Therefore, the present study was undertaken to find out the suitable and cost-effective substrates for mass culturing of *T. harzianum* to be used as effective bio-fungicides against *S. rolfsii* causing seedling disease of cauliflower in seedbed.

Materials and Methods

Three organic substrates viz. rice bran, wheat bran, grasspea bran and their combinations were mixed with or without mustard oilcake (MOC) for mass multiplication of *T. harzianum* against seedling disease (*S. rolfsii*) of cauliflower in seedbed of Plant Pathology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur during three consecutive seasons from 2011 to 2014.

a) Seedbed inoculation with *S. rolfsii*

Isolates of *S. rolfsii* was grown on potato dextrose agar (PDA) medium and used as inoculum. Two hundred gram of barley grains were taken in 500 ml

Erlenmeyer flask and sterilized the grains in an autoclave at 121^0C for 15 minutes. The sterilized barley grains were inoculated with mycelial blocks of *S. rolfsii* grown on PDA and allowed to grow. The completely colonized barley grains were air dried and incorporated with the seedbed soils @100 g/m^2 soil. The pathogen was allowed to establish in seedbed soil for 10 days with proper soil moisture.

b) Substrates used for *T. harzianum* multiplication

Seventy two isolates of *T. harzianum* were obtained from different location of Bangladesh and their efficacy was tested against different soil borne pathogens including *S. rolfsii* in the laboratory using dual culture technique. Among them *T. harzianum* TM7 isolate was found most vigorous to suppress *S. rolfsii*. Therefore, a pure culture of *T. harzianum* (TM7) was grown in potato dextrose agar (PDA) medium and was used as source of bio-fungicide. The substrates rice bran, wheat bran, grass pea bran and their combination with or without mustard oilcake (MOC) were used for multiplication of *T. harzianu*.

c) Bio-fungicide application

The experiment was laid out in the *S. rolfsii* sick seedbed under net-house condition using completely randomized design with four replications where the treatment (substrates) combinations were T_1= Rice bran, T_2= Wheat bran, T_3= Grasspea bran, T_4= Rice bran + Wheat bran (1:1), T_5=Rice bran + Grasspea bran (1:1), T_6= Rice bran + Mustard oilcake (1:1), T_7= Rice bran + Wheat bran + Mustard oilcake (1:1:1), T_8= Rice bran + Grasspea bran + Mustard oilcake (1:1:1), T_9= Wheat bran + Grasspea bran + Mustard oilcake (1:1:1), T_{10}= Rice bran + Wheat bran + Grass pea bran+ Mustard oilcake (1:1:1:1), T_{11}=Seed treatment with Provax and T_{12}= Control. According to the treatment combinations 600 g of individual or mixed substrate materials were taken separately in 1000 ml Erlenmeyer flask and were sterilized. The sterilized substrate was inoculated individually with 5 mm diameter mycelia disc of five-day old *T. harzianum* culture grown on PDA and then incubated at room temperature (25±2 ^{0}C) for 15 days until complete colonization. After incubation the colonized substrates were removed from the flasks, air dried and finally preserved in refrigerator at 10 ^{0}C. The inoculum of *T. harzianum*, colonized on different substrates, were incorporated to the previously *S. rolfsii* inoculated seedbed soils @ 100 g/m^2 (Faruk *et. al*., 2014) soil and kept for 7 days maintaining proper soil moisture to establish *T. harzianum* in the soils. The control bed did not receive any colonized substrate of *T. harzianum* except the inoculum of *S. rolfsii*.

d) Raising of Seedling

After 7 days of *T. harzianum* bio-fungicide incorporation in the soil, the seeds of cauliflower variety Rupa were sown in the seedbed @ 200 seeds (split in four which consider as a replication) per treatment. The initial germination of the seeds was 99% in blotter test. The percent emergence of the seedling was calculated on the basis of initial germination status of the seeds. The experiment was laid out in completely randomized design (CRD) with four replications. Proper weeding, irrigation and intercultural operations were done. Data were collected on seedling emergence after 15 days of seed sowing. Similarly seedling mortality was recorded at an interval of 7 days starting from seedling emergence and it was continued up to 35 days of seedling age. The height and weight of shoot and also length and weight of root of cauliflower seedlings were recorded at 35 days of seedling age. The percent data were converted into arcsine transformation values before statistical analysis. Data were analyzed statistically by using the MSTATC program. The treatment effects were compared by applying the least significant different (LSD) test at P=0.05 level.

Results and Discussion

a) Emergence and pre-emergence mortality of cauliflower seedling

Emergence of cauliflower seedling in the *S. rolfsii* was enhanced due to application of different substrate material based *T. harzianum* bio-fungicide in consecutive three years. The seedling emergence varied from 58.33- 67% among the bio-fungicide treated beds whereas untreated control bed gave comparatively low emergence (53%) in 1st year trial (Table 1). Similarly, the bio-fungicides gave higher seedling emergence in 2nd year (59-65.33%) and 3rd year (86-97%) while control seed beds showed 49.33% and 79% seedling emergence, respectively. The *T. harzianum* bio-fungicide treated seed beds showed lower pre-emergence mortality of cauliflower seedlings as compared to untreated control beds in all the years (Table 1).

The pre-emergence mortality was lower among the bio-fungicide treated seedbeds during 1st year (33-41.67%), 2nd year (34.67-41%) and 3rd year (3-14%) although in control bed it was 47, 50.67, and 21%, respectively. The results indicated that the effect of single and mixed substrate based *T. harzianum* bio-fungicides were almost similar among themselves in respect of emergence as well as pre-emergence mortality of cauliflower seedling in *S. rolfsii* sick seedbed. Thus it is revealed from the results that the emergence of cauliflower seedlings was sharply increased by the *T. harzianum* bio-fungicides and better substrates were rice, grasspea, wheat and rice + wheat, rice + grasspea for preparing bio-fungicide (Table 1).

Table 1. Effect of different substrate based *T. harzianum* bio-fungicides on the emergence and mortality of cauliflower seedling in *Sclerotium rolfsii* inoculated seedbed

Name of substrates based bio-fungicide	Emergence (%) of cauliflower seedling in seedbed			Pre-emergence mortality (%) of cauliflower seedling in seedbed		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year
Rice bran	66.33 a (54.53)	59.67 a (50.58)	86.00 d (68.10)	33.67	40.33	14.00
Wheat bran	62.67 ab (52.40)	59.67 a (50.59)	97.00 a (80.46)	37.67	40.33	03.00
Grasspea bran	64.33 ab (53.33)	61.33 a (51.55)	89.00 cd (70.74)	35.67	38.67	11.00
Rice bran + Wheat bran	61.00 ab (51.35)	61.33 a (51.58)	94.00 b (76.42)	39.00	38.67	06.00
Rice bran + Grass pea bran	67.00 a (54.94)	60.67 a (51.16)	89.00 cd (70.68)	33.00	39.67	11.00
Rice bran + Mustard oilcake	60.33 ab (50.96)	64.00 a (53.20)	91.00 bc (72.70)	39.67	36.00	09.00
Rice bran + Wheat bran + MOC	58.33 bc (49.80)	65.33 a (54.04)	93.00 bc (74.68)	41.67	34.67	07.00
Rice bran + Grasspea bran + MOC	61.00 ab (51.34)	61.00 a (51.37)	93.00 bc (74.76)	39.00	39.00	07.00
Wheat bran + Grass pea bran + MOC	60.67 ab (51.16)	59.00 a (50.19)	97.00 a (80.46)	39.33	41.00	03.00
Wheat bran + Grass pea bran+ Rice bran + MOC	64.67 ab (53.53)	60.33 a (51.04)	91.00 bc (72.83)	35.33	39.67	09.00
Seed treatment with Provax	64.33 ab (53.32)	61.00 a (51.37)	90.00 cd (71.70)	35.67	39.00	10.00
Control	53.00 c (46.72)	49.33 b (44.62)	79.00 e (62.83)	47.00	50.67	21.00
LSD (P=0.05)	6.56	4.788	3.712	-	-	-

Values in a column with same letter did not differ significantly (P=0.05) by LSD; values within the parenthesis is the Arcsin Transformed value.

b) Post-emergence mortality of cauliflower seedling

Post-emergence mortality of cauliflower seedling in *S. rolfsii* sick seedbed was significantly reduced each year by different substrate based *T. harzianum* bio-fungicides and Provax as compared to the untreated control. The seedling mortality in 1st year trial was 21% in the untreated control while it ranged from 7 to 9.33% in rest treatments (Table 2). Thus the seedling mortality was reduced ranging from 55.57 to 66.67% over control due to bio-fungicide treatment. In the 2nd year trial, 11.33 to 14.33% seedling mortality was observed in the bio-fungicides and Provax treated seedbeds where control bed showed 38.33% mortality and the reduction of seedling mortality ranged from 62.61 to 70.44%.

The seedling mortality in the bio-fungicides treated seedbeds and untreated control bed in the 3rd year trial were also showed similar trend of results. The effect of Provax was almost similar to bio-fungicides in reducing seedling mortality in each year. The individual and mixed substrate material based *T. harzianum* bio-fungicides were equally effective against the post-emergence mortality of cauliflower seedling in *S. rolfsii* sick seedbeds. The *T. harzianum* destroyed the pathogenic fungi through increasing the expression of cell wall degrading enzymes, mostly chitinases, glucanases and proteases (Harman *et al*., 2004). Most of the *Trichoderma* strains produce volatile and onvolatile toxic metabolites that obstruct colonization by antagonistic microorganisms. Some of these metabolites were harzianic acid, alamethicins, tricholin, peptaibols, 6-penthyl-alpha-pyrone, massoilactone, viridin, gliovirin, glisoprenins, and heptelidic acid (Vey *et al*., 2001).

Table 2. Reduction of cauliflower seedling mortality by different substrate based *T. harzianum* bio-fungicides in *Sclerotium rolfsii* inoculated seedbed

Name of substrates based bio-fungicide	Post-emergence mortality (%) of cauliflower seedling			Reduction of cauliflower seedling mortality (%) over control		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year
Rice bran	8.67 bc (17.13)	11.33 b (19.64)	9.33 b (17.78)	58.71	70.44	67.07
Wheat bran	9.00 bc (17.49)	12.00 b (21.09)	10.00 b (18.38)	57.14	68.69	64.70
Grasspea bran	8.67 bc (17.18)	13.00 b (20.23)	10.33 b (18.74)	58.71	66.08	63.54
Rice bran + Wheat bran	9.33 b (17.81)	12.67 b (20.81)	8.67 b (17.10)	55.57	66.94	69.39
Rice bran + Grasspea bran	8.00 bc (16.43)	13.67 b (21.68)	10.67 b (19.04)	61.90	64.34	62.34
Rice bran + Mustard oilcake	7.67 bc (15.72)	11.33 b (19.64)	9.33 b (17.63)	63.48	70.44	67.07
Rice bran + Wheat bran + MOC	8.67 bc (17.17)	12.33 b (20.56)	11.33 b (19.67)	58.71	67.83	60.00
Rice bran +Grasspea bran +MOC	8.67 bc (17.19)	14.00 b (21.84)	9.67 b (18.05)	58.71	63.47	65.86
Wheat bran + Grasspea bran + MOC	8.33 bc (16.79)	14.33 b (22.21)	10.33 b (18.74)	60.33	62.61	63.54
Wheat bran + Grasspea bran+ Rice bran + MOC	7.00 c (15.35)	12.00 b (20.26)	9.33 b (17.75)	66.67	68.69	67.07
Seed treatment with Provax	7.67 bc (16.12)	12.67 b (20.82)	10.67 b (19.03)	63.48	66.94	62.34
Control	21.00 a (26.57)	38.33 a (38.24)	28.33 a (32.16)	-	-	-
LSD (P=0.05)	1.88	2.621	2.515			

Values in a column with same letter did not differ significantly (P=0.05) by LSD; values within the parenthesis is the Arcsin Transformed value.

c) Shoot growth of cauliflower seedling

The shoot growth of cauliflower seedling was significantly accelerated by the application of various substrate based *T. harzianum* bio-fungicides and Provax in *S. rolfsii* sick seedbed every year. In the 1st year trial, the shoot length of cauliflower seedling varied from 27.53 to 30.17 cm among the *T. harzianum* bio-fungicide treated seedbeds whereas it was 22 cm in the untreated control (Table 3). Taller seedlings (17.20-22.13 cm) of cauliflower were found in the bio-fungicides treated seedbed and shorter seedlings (15.57 cm) were in the control seedbed during 2nd year trial. The shoot length ranged from 18.67 to 22.33 cm in the bio-fungicides treated seedbeds in the 3rd trial and 13.00 cm in the control seedbed.

Table 3. Effect of different substrate based *T. harzianum* bio-fungicides on the shoot growth of cauliflower seedling in *Sclerotium rolfsii* inoculated seedbed

Name of substrates based bio-fungicides	Shoot length of cauliflower seedlings in three years (cm)			Shoot weight of cauliflower seedlings in three years (g/plant)		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year
Rice bran	27.53 ab	18.93 bc	20.67 ab	6.07 a	6.73 b	12.20 bc
Wheat bran	28.47 ab	17.20 bc	18.67 bc	5.87 ab	6.99 b	11.80 bc
Grasspea bran	28.40 ab	17.27 bc	19.47 b	6.20 a	6.57 b	11.93 bc
Rice bran + Wheat bran	29.30 a	20.93 ab	19.93 ab	6.27 a	6.96 b	12.37 b
Rice bran + Grasspea bran	30.17 a	21.07 ab	21.40 ab	6.13 a	6.57 b	13.63 a
Rice bran + Mustard oilcake	27.80 ab	22.13 a	19.70 ab	6.10 a	8.48 a	11.60 bc
Rice bran + Wheat bran + MOC	27.53 ab	21.47 ab	19.87 ab	5.73 ab	8.47 a	11.17 c
Rice bran+ Grasspea bran +MOC	27.80 ab	21.47 ab	20.23 ab	5.80 ab	8.38 a	12.00 bc
Wheat bran + Grasspea bran + MOC	27.83 ab	21.77 ab	22.33 a	5.77 ab	8.83 a	13.70 a
Wheat bran + Grasspea bran+ Rice bran + MOC	27.87 ab	21.97 ab	20.33 ab	6.07 a	8.70 a	11.20 c
Seed treatment with Provax	25.80 b	16.76 c	16.93 c	5.30 b	4.43 c	9.77 d
Control	22.00 c	15.57 c	13.00 d	3.93 c	3.47 d	8.57 e
LSD (P=0.05)	2.335	2.543	2.394	0.546	0.566	0.92

Values in a column with same letter did not differ significantly (p=0.05) by LSD.

The shoot weight of cauliflower seedling was significantly increased by the *T. harzianum* bio-fungicides over untreated control. In the 1st year trial, the shoot weight was 5.73-6.27 g in *T. harzianum* bio-fungicide treated while it was 3.93 g in control (Table 3). The bio-fungicide treated beds gave shoot weight of 6.57 to

8.83 g in the 2nd year and 11.20 to 13.70 g in the 3rd year trial while in untreated seedling it gave 3.47 and 8.57 g shoot weights, respectively. The lower shoot weight was noticed in the Provax treated beds as compared to bio-fungicide treated seedbeds in each year. The results indicated that the substrates rice, wheat + grasspea + mustard oilcake, and wheat + rice + grasspea + mustard oilcake based *T. harzianum* bio-fungicides were better in respect of shoot growth of cauliflower seedling in addition to seedling disease reduction caused by *S. rolfsii* under seed bed conditions. The *T. harzianum* was reported to play a positive role in seed germination, plant growth, rapid flowering and weight of plants (Chang *et al*., 1986).

d) Root growth of cauliflower seedling

The root growth of cauliflower seedling was significantly enhanced by different substrate based *T. harzianum* bio-fungicides as compared to the untreated control. In the 1st year, the root length of cauliflower seedling was ranged from 6.63 cm to 7.33 cm among the bio-fungicides treated seedbeds and it was minimum (5.36 cm) in the untreated control bed (Table 4). Similarly, the root length was varied from 6.53 cm to 8.07 cm in the 2nd year and 4.80 cm to 6.20 cm in the 3rd year experiment due *T. harzianum* bio-fungicides, while minimum root length of 4.26 cm and 3.37 cm were recorded from the control respectively, in 2nd and 3rd trials. Seed treatment with Provax also gave comparatively shorter root length in all the years.

The root weight of individual cauliflower seedling was increased significantly by different substrate based *T. harzianum* bio-fungicides whereas lower root weights were recorded from the Provax and untreated control seedbeds in each year (Table 4). The root weights of individual cauliflower seedling grown in bio-fungicide treated seedbeds were varied from 0.31 to 0.34 g, 0.54 to 0.64 g and 0.93 to 1.13 g during three consecutive years. Root weights of cauliflower seedling were lower in the Provax (0.33-0.81g) and untreated control beds (0.28-0.65 g) in all the years. The results of three years experiments revealed that both individual as well as mixed substrate based *T. harzianum* bio-fungicides were almost equally effective in reducing seedling mortality caused by *S. rolfsii* and also enhancing shoot and root growth of cauliflower seedling in seedbed though the substrates, wheat, rice + wheat, rice +grasspea, and wheat + grasspea+ mustard oilcake were superior in these regards.

The results of the present investigation revealed that *T. harzianum* based bio-fungicides multiplied on rice bran, wheat bran, grasspea bran and mustard oil cake alone and also in different combinations were equally effective against *S. rolfsii* causing pre-emergence as well as post-emergence mortality of cauliflower seedlings grown in seedbed. The *T. harzianum* bio-fungicide also enhanced seed germination and vegetative growth of seedlings effectively. Podder *et al.* (2004) and Rojo *et al.* (2007) recorded the efficacy of *Trichoderma*

spp. as bio-control agents to formulate bio-fungicides after colonization on organic materials. The potentiality of *Trichoderma* species as bio-control agents for enhancing seed germination and seedling growth in addition to suppression of soil-borne plant pathogenic fungi like *Phytophthora, Pythium, Sclerotium, Botrytis, Rhizoctonia* and *Fusarium* of various crops were recorded by many investigators (Benitez *et al.,* 2004; Celar and Valic, 2005; Dubey *et al.,* 2007; Rojo *et al*., 2007). Significant increase in seedling emergence and suppression of pre-emergence mortality of cabbage seedling were also reported by Prasad and Anes (2008) and Mukhtar (2008). Begum *et al*. (1999) reported that *T. harzianum* treated seeds of black gram gave 86.7% to 100% reduction of foot and root rot disease caused by *S. rolfsii* over the control.

Table 4. Effect of different substrate based *T. harzianum* bio-fungicides on the root growth of cauliflower seedling in *Sclerotium rolfsii* inoculated seedbed

Name of substrates based bio-fungicides	Root length of cauliflower seedling in consecutive three years (cm)			Root weight of cauliflower seedling in consecutive three years (g/plant)		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year
Rice bran	7.33 a	6.70 c	5.23 bc	0.31 e	0.57 ab	0.97 ab
Wheat bran	7.17 a	6.87 c	5.00 cd	0.32 d	0.59 a	0.93 b
Grasspea bran	7.07 a	6.53 c	4.80 cd	0.34 b	0.54 ab	0.87 b
Rice bran + Wheat bran	7.00 a	6.77 c	5.33 bc	0.34 b	0.64 a	0.98 ab
Rice bran + Grasspea bran	6.97 a	7.00 bc	6.20 a	0.34 b	0.58 a	0.98 ab
Rice bran + Mustard oilcake	7.00 a	7.87 ab	5.83 ab	0.34 b	0.57 ab	0.98 ab
Rice bran+ Wheat bran + MOC	6.63 a	8.07 a	5.73 ab	0.33 c	0.60 a	0.90 b
Rice bran+ Grasspea bran +MOC	6.63 a	7.47 abc	5.67 ab	0.34 b	0.56 ab	0.98 ab
Wheat bran + Grasspea bran + MOC	6.93 a	8.03 a	6.10 a	0.35 a	0.55 ab	1.13 a
Wheat bran + Grasspea bran+ Rice bran + MOC	7.10 a	7.88 ab	5.73 ab	0.35 a	0.58 a	0.93 b
Seed treatment with Provax	6.87 a	5.03 d	4.43 d	0.33 c	0.47 b	0.81 b
Control	5.36 b	4.26 d	3.37 e	0.28 f	0.36 c	0.65 c
LSD (P=0.05)	0.629	0.834	0.593	0.05	0.093	0.169

Values in a column with same letter did not differ significantly (p=0.05) by LSD.

The promotion of plant growth in terms of length and weight of shoot and root, due to use of *Trichoderma* spp. as soil amendment was documenetd by several investigators (Chang *et al*., 1986; Azarmi *et al*., 2011; Harman *et al*., 2012; Hermosa *et al.,* 2012; Samolski *et al*., 2012). Enhancing root growth of cauliflower seedling in *S. rolfsii* sick soils was observed in the present experiment which was supported by the findings of John *et al.* (2010). Findings of the present investigation i.e. the reduction of post emergence seedling mortality were in agreement with findings of other researchers (Begum *et al.,* 1999; Chowdhury *et al.,* 2000*;* Hossain and Samsuzzaman, 2003; Yeasmin, 2004; Hossain and Naznin, 2005). The findings of the present investigation revealed that treatment of seedbed soil with *T. harzianum* based bio-fungicides multiplied on rice bran, wheat bran and grasspea bran alone or in combinations might be practiced for controlling seedling mortality caused by *S. rolfsii* and thereby producing healthy seedlings of cauliflower in seedbed.

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