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Screening of *Trichoderma spp* and fungicides against soybean root rot caused by *Rhizoctonia solani*

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Abstract
Soybean is one of the most important legumes, rich in protein and oil, which can be used in agriculture and oil extraction industry. *Rhizoctonia solani*, where causing foot and root rots of young soybean plants which characterized by the browning of the vascular tissue of roots and stems. Seed and soil treatment with *Trichoderma spp* and fungicides alone or combined treatments enhanced plant growth parameters significantly but Seed inoculated with *R. solani* + Seed dressing with Aazoxystrobin + *T. harzianum* and Soil infested with *R. solani* + *T. harzianum* + Seed (untreated) increasing germination percent, mortality fresh weight, dry weights vigour index mass, seedling length and vigour index. Most treatments bio-agents and fungicides combinedly significantly enhanced growth parameters and reduction disease incidence of *Rhizoctonia solani* in soybean crop.

Keywords: Soybean, root rot, *Trichoderma spp*, fungicides

Introduction
Soybean [*Glycine max* (L.) Merill] is the major oilseed crop in the world and is cultivated on an area of 108.83 Lakh ha with a total production of 114.90 Lakh MT. The crop is grown in a wide range of agro climatic zones. Soybean is subjected to many diseases caused by fungi, bacteria, virus and nematodes (Sweets, 2008) [21]. Among all these pathogens, *Rhizoctonia spp.* is the most destructive pathogen for this crop causing heavy yield losses every year. The root rot pathogenic fungi are major threat for this crop as these fungi attack on the root of the plant and damage the crop. *Fusarium* spp., *Rhizoctonia solani* and *Pythium* spp. are considered as major soybean seedling pathogens, which contribute to stand reduction (Inam-Ul-Haq *et al.*, 2012) [8]. Root rot has become an important disease of soybean caused by *Rhizoctonia solani* in recent past. Hence, a detailed and systematic study is required to manage this important disease. *Rhizoctonia solani* Kuhn (telomorph) causes pre- and post-emergence damping off of root, root rot, stem rot and foliar blight of soybean. It is of poly-phagous nature and high saprophytic ability (Nelson *et al.*, 1996) [12].
Biological control is proved to be a promising disease management technology against soil borne pathogens, when applied either alone or in combination with other management practices (Papavizas, 1985) [14]. *Trichoderma* is one of the most common soil inhabitant extensively studied for biocontrol potential in the management of soil borne disease. In India, it was first time isolated by Thakur and Norris, (1928) [22] from Madras. The potential of the genus *Trichoderma* as a bio-agent was first reported by Weindling, (1932) [23]. *Trichoderma* spp. offer biological control against soil borne plant pathogens by utilizing mechanisms such as antibiosis (Sivan *et al.*, 1984) [19]. Now a day's fungicides in plant protection are widely used because fungicide helps to minimize disease incidence and boost up the crop yield. Applications of the synthetic chemicals have many ill effects on ecosystem. Hence, a detailed and systematic study is required to manage this important disease.

Material and Methods
The present investigation entitled "Screening of *Trichoderma spp* and Fungicides against Soybean Root rot Caused by *Rhizoctonia solani*" was undertaken. The experiments in lab and polyhouse were conducted in Department of Plant Pathology, College of Agriculture JNKVV Jabalpur and experimental design used RBD.

Seed infestation

The soil was sterilized and filled in sterilized earthen pots. Soybean seeds (JG 95-60) were inoculated with 10^4 spores/ml concentrations. Five seeds were placed in one earthen pot and three replications were maintained. No soil inoculation with test pathogen, bio-agents and fungicide served as control. Pots sown with bio-agents treated seed (seed treatment with bio-agents *T. harzianum, T. spp, T. longibrachiatum*) served as the bio-agents check. Pots sown with fungicide treated seed (seed treatment with Thiram, Carbendazim, Azoxystrobin and combination of Thirum + Carbendazim 0.25%) served as fungicide check. These pots were kept in a net house. Proper isolation was maintained to avoid other pathogens. Observations were recorded on percent germination, vigour index mass, vigour index percentage and seedling mortality as described.

$$\text{Germination (\%)} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown}} \times 100$$

$$\text{Mortality (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of seedlings}} \times 100$$

Vigour index (%) = Germination percentage × Seedling length on the day of final count.

Vigour index mass = Germination percentage × seedling dry weight on the day of final count.

Soil infestation

The inoculum was thoroughly mixed in sterilized sand + soil (1:1) @ 100g/ 2 kg soil. The sterilized soil was mixed with inoculum multiplied on corn meal sand medium. Soybean seeds (JG 95-60) were surface sterilized with 0.1% mercuric chloride for one minute and washed properly. Five seeds were placed in one earthen pot and three replications were maintained. No soil treatment with bio-agents and fungicide served as control. Pots sown with bio-agents treated soil (soil treatment with bio-agents *T. harzianum, T. spp, T. longibrachiatum*) served as the bio-agents check Pots sown with fungicide treated soil (soil treatment with Thiram, Carbendazim, Azoxystrobin and combination of Thirum + Carbendazim 0.25%) served as fungicide check. These pots were kept in a net house. Proper isolation was maintained to avoid other pathogens. Observations were recorded on percent germination, vigour index mass, vigour index percentage and seedling mortality.

Results and Discussion

Table 1: Screening of *Trichoderma spp* and Fungicides against *Rhizoctonia solani* (*In vivo* conditions Seed inoculated)

Treatment code	Treatment	Germination %	Mortality %
T1	seed inoculated with *R. solani* + Seed (untreated control 1)	53.33	87.50
T2	Seed inoculated with *R. solani* + Seed dressing with *T. harzianum*	86.66	15.38
T3	Seed inoculated with *R. solani* + Seed dressing with *T. viride*	80.00	25.00
T4	Seed inoculated with *R. solani* + Seed dressing with *T. longibrachiatum*	73.33	36.44
T5	Seed inoculated with *R. solani* + Seed dressing with Carbendazim	66.66	50.00
T6	Seed inoculated with *R. solani* + Seed dressing with Aazoxystrobin	86.66	15.38
T7	Seed inoculated with *R. solani* + Seed dressing with Thiram + Carbendazim	80.00	25.00
T8	Seed inoculated with *R. solani* + Seed dressing with T5 + T2	66.66	50.00
T9	Seed inoculated with *R. solani* + Seed dressing with T5 + T3	86.66	15.38
T10	Seed inoculated with *R. solani* + Seed dressing with T5 + T4	86.66	15.38
T11	Seed inoculated with *R. solani* + Seed dressing with T6 + T2	73.33	36.36
T12	Seed inoculated with *R. solani* + Seed dressing with T6 + T3	93.33	36.36
T13	Seed inoculated with *R. solani* + Seed dressing with T6 + T4	73.33	7.14
T14	Seed inoculated with *R. solani* + Seed dressing with T7 + T2	86.66	36.36
T15	Seed inoculated with *R. solani* + Seed dressing with T7 + T3	73.33	15.38
T16	Seed inoculated with *R. solani* + Seed dressing with T7 + T4	80.00	36.36
T17	Control 2 (sterilized soil + healthy seed)	86.66	0.0
SE(m)±		6.05	1.15
CD5%		17.46	3.33

Data presented in the Table 1 indicate that, all the treatments had significantly higher germination percent as compared to control (T17). The germination percent among the treatments varied from 53.33 to 93.33%. Maximum germination percent was recorded with T12 (93.33%) and minimum germination percent was recorded with T1 (53.33). Mortality percent among the treatments varied from 7.14 to 87.5%. Maximum mortality percent recorded withT1 (87.5%) treatment. Minimum mortality percent was recorded with T13 (7.14%) followed by T2, T6, T9, T10, T15 (15.38) treatments.

Table 2: Effect of Seed treatment with *Trichoderma spp* and Fungicides on Fresh weight, Dry weight, and Vigour index mass percent of soybean (*In vivo*- Seed inoculated)

Treatment code	Treatment	Germination %	Fresh weight (gm) per seedling	Dry weight (gm) per seedling	Vigour index mass %
T1	seed inoculated with *R. solani* + Seed (untreated control 1)	53.333	1.01	0.11	6.30
T2	Seed inoculated with *R. solani* + Seed dressing with *T. harzianum*	86.667	1.44	0.90	78.26
T3	Seed inoculated with *R. solani* + Seed dressing with *T. viride*	80.000	1.41	0.32	26.21
T4	Seed inoculated with *R. solani* + Seed dressing with *T. longibrachiatum*	73.333	1.32	0.22	16.25
T5	Seed inoculated with *R. solani* + Seed dressing with Carbendazim	66.667	1.24	0.13	9.04
T6	Seed inoculated with *R. solani* + Seed dressing with Aazoxystrobin	86.667	1.22	0.13	11.73
T7	Seed inoculated with *R. solani* + Seed dressing with Thiram + Carbendazim	80.000	1.23	0.13	10.64
T8	Seed inoculated with *R. solani* + Seed dressing with T5 + T2	66.667	1.21	0.12	8.13
T9	Seed inoculated with *R. solani* + Seed dressing with T5 + T3	86.667	1.22	0.13	11.36
T10	Seed inoculated with *R. solani* + Seed dressing with T5 + T4	86.667	1.20	0.11	10.30
T11	Seed inoculated with *R. solani* + Seed dressing with T6 + T2	73.333	1.21	0.12	9.07
T12	Seed inoculated with *R. solani* + Seed dressing with T6 + T3	93.333	1.20	0.11	10.38
T13	Seed inoculated with *R. solani* + Seed dressing with T6 + T4	73.333	1.23	0.12	8.84
T14	Seed inoculated with *R. solani* + Seed dressing with T7 + T2	86.667	1.22	0.12	10.63
T15	Seed inoculated with *R. solani* + Seed dressing with T7 + T3	73.333	1.22	0.11	8.42
T16	Seed inoculated with *R. solani* + Seed dressing with T7 + T4	80.000	1.21	0.11	9.49
T17	Control 2 (sterilized soil + healthy seed)	86.667	1.19	0.12	10.97
SE(m)±		6.050	0.01	0.00	1.66
CD5%		17.462	0.03	0.01	4.80

Data presented in Table 2 indicated that, all the treatments had significantly higher fresh weight as compared to control (T17). Fresh weight among the treatments varied from 1.01 to 1.44g. Maximum fresh weight was recorded with T2 (1.44g) followed by T3 (1.41g) treatment. Minimum fresh weight was recorded with T1 (1.01g). All the treatments had significantly higher dry weight as compared to control (T17). Dry weight among the treatment varied from 0.111to 0.90g. Maximum dry weight was recorded with T2 (0.90g). Minimum dry weight was recorded with T12 (0.11g) followed by T1 (0.11g), T10 (0.11g), T15 (0.11g) and T16 (0.11g). All the treatments had significantly higher vigour index mass percent as compared to control (T17). Vigour index mass percent among the treatment varied from 6.30 to 78.26%. Maximum vigour index percent was recorded with treatment T2 (78.26). Minimum vigour index mass percent was recorded with T1 (6.30%).

Table 3: Effect of Seed treatment with *Trichoderma spp* and Fungicides on seedling length, and vigour index % against *Rhizoctonia solani* (Seed inoculated)

Treatment code	Treatment	Germination %	Seedling length	Vigour index
T1	seed inoculated with *R. solani* + Seed (untreated control 1)	53.33	30.13	1,609.33
T2	Seed inoculated with *R. solani* + Seed dressing with *T. harzianum*	86.66	41.06	3,555.33
T3	Seed inoculated with *R. solani* + Seed dressing with *T. viride*	80.00	40.80	3,264.00
T4	Seed inoculated with *R. solani* + Seed dressing with *T. longibrachiatum*	73.33	40.40	2,962.00
T5	Seed inoculated with *R. solani* + Seed dressing with Carbendazim	66.66	30.46	2,030.66
T6	Seed inoculated with *R. solani* + Seed dressing with Aazoxystrobin	86.66	30.60	2,653.33
T7	Seed inoculated with *R. solani* + Seed dressing with Thiram + Carbendazim	80.00	27.53	2,202.66
T8	Seed inoculated with *R. solani* + Seed dressing with T5 + T2	66.66	21.60	1,439.33
T9	Seed inoculated with *R. solani* + Seed dressing with T5 + T3	86.66	29.46	2,551.33
T10	Seed inoculated with *R. solani* + Seed dressing with T5 + T4	86.66	30.56	2,650.66
T11	Seed inoculated with *R. solani* + Seed dressing with T6 + T2	73.33	31.46	2,309.33
T12	Seed inoculated with *R. solani* + Seed dressing with T6 + T3	93.33	37.73	3,523.33
T13	Seed inoculated with *R. solani* + Seed dressing with T6 + T4	73.33	31.83	2,332.00
T14	Seed inoculated with *R. solani* + Seed dressing with T7 + T2	86.66	34.76	3,017.33
T15	Seed inoculated with *R. solani* + Seed dressing with T7 + T3	73.33	31.63	2,322.66
T16	Seed inoculated with *R. solani* + Seed dressing with T7 + T4	80.00	33.90	2,712.00
T17	Control 2 (sterilized soil + healthy seed)	86.66	31.63	2,734.00
SE(m)±		6.05	0.35	572.28
CD5%		17.46	1.01	198.27

Data presented in Table 3 indicated that, all the treatments had significantly higher seedling length as compared to control (T17). Seedling length among the treatments varied from 21.60 cm to 41.06 cm. Maximum seedling length was recorded with T2 (41.06 cm) followed by T3 (40.80 cm) and T4 (40.40 cm). Minimum seedling length was recorded with T8 (21.60 cm) followed by T7 (27.53 cm) and T9 (29.14).

Data presented in Table 3 indicated that, all the treatments had significantly higher vigour index percent as compared to control (T17). The vigour index percent among the treatments varied from 1439.33% to 3555.33%. Maximum vigour index percent was recorded with T2 (3555.33) followed by T3 (3264.00) and T12 (3523.33). Minimum vigour index percent was recorded with T8 (1439.33) followed by T1 (1609.33).

Table 4: Seed treatment with *Trichoderma spp* and Fungicides against *Rhizoctonia solani (In vivo* as soil infested)

Treatment code	Treatment	Germination %	Mortality %
T1	Soil infested with *R. solani* + Seed (untreated control 1)	53.33	87.50
T2	[Soil infested with *R. solani* +*T. harzianum*] + Seed (untreated)	80.00	25.00
T3	[Soil infested with *R. solani* +*T. viride*] + Seed (untreated)	86.66	15.38
T4	[Soil infested with *R. solani* +*T. longibrachiatum*] + Seed (untreated)	73.33	36.36
T5	[Soil infested with *R. solani* + Carbendazim] + Seed (untreated)	73.33	36.36
T6	[Soil infested with *R. solani* + Azoxystrobin] + Seed (untreated)	86.66	15.38
T7	[Soil infested with *R. solani* Thiram+ Bavestin] + Seed (untreated)	80.00	25.00
T8	[Soil infested with *R. solani*+T5 + T2] + Seed (untreated)	93.33	7.14
T9	[Soil infested with *R. solani*+ T5 + T3] + Seed (untreated)	80.00	25.00
T10	[Soil infested with *R. solani* + T5 + T4] + Seed (untreated)	73.33	36.36
T11	[Soil infested with *R. solani* + T6+ T2] + Seed (untreated)	86.66	15.38
T12	[Soil infested with *R. solani* + T6+ T3] + Seed (untreated)	73.33	36.36
T13	[Soil infested with *R. solani* + T6+ T4] + Seed (untreated)	86.66	15.38
T14	[Soil infested with *R. solani* + T7+ T2] + Seed (untreated)	93.33	7.14
T15	[Soil infested with *R. solani* + T7 + T3] + Seed (untreated)	86.66	15.38
T16	[Soil infested with *R. solani* + T7 +T4] + Seed (untreated)	73.33	36.36
T17	Control 2 (sterilized soil + healthy seed)	86.66	0.0
SE(m)±		6.05	1.15
CD5%		17.46	3.33

Data presented in the Table 4 indicate that, all the treatments had significantly higher germination percent as compared to control (T17). The germination percent among the treatments varied from 53.33 to 93.33%. Maximum germination percent was recorded with T12 (93.33%) and minimum germination percent was recorded with T1 (53.33). Mortality percent among the treatments varied from 7.140 to 87.5. Maximum mortality percent was recorded with T1 (87.50%). treatment. Minimum mortality percent was recorded with T8=14 (7.14%).

Table 5: Effect of *Trichoderma spp* and Fungicides on fresh weight, dry weight and vigour index mass percent of soybean (*In vivo* soil treatment)

Treatment code	Treatment	Germination %	fresh weight (gm) per seedling	Dry weight (gm) per seedling	Vigour index mass %
T1	Soil infested with *R. solani* + Seed (untreated control 1)	53.333	0.68	0.12	6.58
T2	[Soil infested with *R. solani* + *T. harzianum*] + Seed (untreated)	80.000	1.42	0.91	72.93
T3	[Soil infested with *R. solani* + *T. viride*] + Seed (untreated)	86.667	1.42	0.38	33.16
T4	[Soil infested with *R. solani* + *T. longibrachiatum*] + Seed (untreated)	73.333	1.31	0.22	16.36
T5	[Soil infested with *R. solani* + Carbendazim] + Seed (untreated)	73.333	1.24	0.10	7.77
T6	[Soil infested with *R. solani* + Azoxystrobin] + Seed (untreated)	86.667	1.25	0.13	11.58
T7	[Soil infested with *R. solani* Thiram+ Bavestin] + Seed (untreated)	80.000	1.23	0.13	10.37
T8	[Soil infested with *R. solani*+T5 + T2] + Seed (untreated)	93.333	1.19	0.11	10.91
T9	[Soil infested with *R. solani*+ T5 + T3] + Seed (untreated)	80.000	1.22	0.11	9.54
T10	[Soil infested with *R. solani* + T5 + T4] + Seed (untreated)	73.333	1.21	0.10	7.90
T11	[Soil infested with *R. solani* + T6+ T2] + Seed (untreated)	86.667	1.22	0.12	10.64
T12	[Soil infested with *R. solani* + T6+ T3] + Seed (untreated)	73.333	1.21	0.13	9.67
T13	[Soil infested with *R. solani* + T6+ T4] + Seed (untreated)	86.667	1.23	0.12	11.22
T14	[Soil infested with *R. solani* + T7+ T2] + Seed (untreated)	93.333	1.22	0.11	10.48
T15	[Soil infested with *R. solani* + T7 + T3] + Seed (untreated)	86.667	1.21	0.11	10.27
T16	[Soil infested with *R. solani* + T7 +T4] + Seed (untreated)	73.333	1.22	0.11	8.70
T17	Control 2 (sterilized soil + healthy seed)	86.667	1.19	0.10	9.48
SE(m)±		6.050	0.08	0.01	1.48
CD5%		17.462	0.23	0.03	4.28

Data presented in Table 5 indicate that, all the treatments had significantly higher fresh weight as to control (T17). Fresh weight among the treatment varied from 1.01 to 1.44g. Maximum fresh weight was recorded with T3 (1.42g) followed by T2 (1.42g) treatment. Minimum fresh weight was recorded with T1 (0.68g). All the treatments had significantly higher dry weight as compared to control (T17). Dry weight among the treatment varied from 0.10 to 0.91g. Maximum dry weight was recorded with T2 (0.91g). Minimum dry weight was recorded with T5 (0.10g) followed by T10 (0.10g). All the treatments have significantly higher vigour index mass percent as compared to control (T17). Vigour index mass percent among the treatments varied from 6.58 to 72.93%. Maximum vigour index percent was recorded with treatment T2 (72.93%). Minimum vigour index mass percent was recorded with T1 (6.58%).

Table 6: Effect of *Trichoderma spp* and Fungicides on Seedling length, and vigour index% against *Rhizoctonia solani* (soil infested)

Treatment code	Treatment	Germination %	Seedling length	Vigour index %
T1	Soil infested with *R. solani* + Seed (untreated control 1)	53.33	30.50	1,635.33
T2	[Soil infested with *R. solani* + *T. harzianum*] + Seed (untreated)	80.00	40.43	3,234.66
T3	[Soil infested with *R. solani* + *T. viride*] + Seed (untreated)	86.66	40.76	3,536.00
T4	[Soil infested with *R. solani* + *T. longibrachiatum*] + Seed (untreated)	73.33	40.26	2,951.33
T5	[Soil infested with *R. solani* + Carbendazim] + Seed (untreated)	73.33	30.50	2,236.66
T6	[Soil infested with *R. solani* + Azoxystrobin] + Seed (untreated)	86.66	30.50	2,644.00
T7	[Soil infested with *R. solani* Thiram+ Bavestin] + Seed (untreated)	80.00	27.40	2,192.00
T8	[Soil infested with *R. solani* + T5 + T2] + Seed (untreated)	93.33	21.63	2,019.33
T9	[Soil infested with *R. solani* + T5 + T3] + Seed (untreated)	80.00	29.93	2,394.66
T10	[Soil infested with *R. solani* + T5 + T4] + Seed (untreated)	73.33	30.53	2,238.00
T11	[Soil infested with *R. solani* + T6+ T2] + Seed (untreated)	86.66	31.43	2,724.00
T12	[Soil infested with *R. solani* + T6+ T3] + Seed (untreated)	73.33	37.56	2,757.33
T13	[Soil infested with *R. solani* + T6+ T4] + Seed (untreated)	86.66	31.53	2,737.33
T14	[Soil infested with *R. solani* + T7+ T2] + Seed (untreated)	93.33	34.86	3,254.00
T15	[Soil infested with *R. solani* + T7 + T3] + Seed (untreated)	86.66	31.60	2,740.00
T16	[Soil infested with *R. solani* + T7 +T4] + Seed (untreated)	73.33	33.70	2,472.00
T17	Control 2 (sterilized soil + healthy seed)	86.66	31.03	2,684.00
SE(m)±		6.05	0.33	590.44
CD5%		17.46	0.95	204.56

Data presented in Table 6 indicate that, all the treatments had significantly higher germination percent as compared to control (T17). The germination percent among the treatments varied from 53.33 to 93.33%. Maximum germination percent was recorded with T12 (93.33%). Minimum germination percent was recorded with T1 (53.33). Data presented in Table 6 indicate that, all the treatments had significantly higher seedling length as compared to control (T17). Seedling length among the treatments varied from 21.63cm to 41.76 cm. Maximum seedling length was recorded with T3 (41.76 cm) followed by T2 (40.43 cm) and T4 (40.26 cm). Minimum seedling length was recorded with T8 (21.63 cm) followed by T7 (27.40 cm) and T9 (29.93cm).Data presented in Table 6 indicate that, all the treatments had significantly higher vigour index percent as compared to control (T17). The vigour index percent among the treatments varied from 1635.33% to 3536.00%. Maximum vigour index percent was recorded with T3 (3536.00) followed by T2 (3234.66) and T14 (3254.00). Minimum vigour index percent was recorded with T1 (1635.33%).

Jensen *et al*. (2002) [9] evaluated the positive effects of *T. harzianum* and *B. subtilis* alone or when combined with carboxin + thiram as biological control agent treatments against the dry bean root rot pathogens. Silimela and Korsten (2001) [18] reported that the efficiency of the bio-agents could further be improved when it was applied with the recommended fungicides at their lower concentrations. Srinivas and Ramakrishnan (2002) [20] reported that integration of bio-agents and fungicides showed positive association by reducing the seed infection compared to fungicide and the fungal antagonists individually. Anjana and kumar, (2008) [1] studied the efficacy of six different fungicides *viz.*, Carbendazim, Mancozeb, Hexaconazole, Propiconazole, Blitox- 50 and Thiram *in vitro* and *in vivo* conditions against *Rhizoctonia solani*, inicitant of aerial blight of soybean.

Dubey (1997) [6] also recorded similar findings. Seedling dip treatment of fungicide was more effective than seedling dip treatment of bio-agents. This finding is supported by Patel *et al*., (2014) [15]. Treatment of seedling dip of bio-agents i.e. *T. harzianum* and *P. fluorescens* significantly control the percent disease incidence. This findings supported by Kumar *et al*., (2012) [10]; Dewangan *et al*., (2014) [4] in which, Kumar *et al*., (2012) [10] reported that biological control of soil born plant pathogens can be achieved successfully by seed coating, furrow application and root dip of seedlings with antagonists. Application of *P. fluorescens* and *Trichoderma spp*. are such example of biocontrol agents with plant growth promoting ability coupled with antagonistic effect in phytopathogens (Dewangan *et al*., 2014) [4]. Seedling dip treatment of bioagent i.e. *T. harzianum* and *P. fluorescens* had minimum *Rhizoctonia* root rot incidence followed by soil application of *T. harzianum* and *P. fluorescens* as compared to control. This finding is in agreement with Rehman *et al*., (2013); Manoranjitham *et al*., (1999) [11]; Bunker and Mathur, (2001) [2]; Faruk *et al*., (2002) [7] and Champawat and Sharma, (2003) [3]. The seedling dip treatment of chemical fungicide Tebuconazole 2DS was more effective in controlling disease incidence as compared to seedling dip treatment of bio-agents i.e *T. harzianum* and *P. fluorescens*. This finding supported by Ngullie and Daiho, (2013) [13]. Dorrance *et al*. (2002) [5] and Ravindra *et al*. (2017) [17]. It is clear from the result that treatment of soil with carbendazim and *T. harzianum* (T8) minimized the mortality caused by *R. solani* in soil.

Conclusion

Seed and soil treatment with *Trichoderma* spp and fungicides alone or combined treatments enhanced plant growth parameters significantly but Seed inoculated with R. solani + Seed dressing with Aazoxystrobin + *T. harzianum* and Soil infested with *R. solani* + *T. harzianum* + Seed (untreated) increasing germination percent, mortality fresh weight, dry weights vigour index mass, seedling length and vigour index. Most treatments bio-agents and fungicides combinedly significantly enhanced growth parameters and reduction disease incidence of *Rhizoctonia solani* in soybean crop

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