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Response of Different Bio-control Agents and Fungicides against Pathogen Associated with Rice (*Oryza sativa* L.) Seedling Blight Disease under Nursery Conditions

Patoliya P R[1] and Kedar Nath[2*]

[1]*Department of Plant Pathology, N. M. College of Agriculture, Navsari Agricultural University, Navsari, India*
[2]*Regional Rice Research Station, Navsari, Agricultural University, Vyara, India*
**drkdkushwaha@nau.in*

Abstract: Rice seedling blight in nurseries is more severe in rice that has been seeded early when the soil is usually cold and damp conditions that tend to delay seedling emergence favour seedling blight. Blighted seedlings emerge from the soil and die soon after emergence. Seedlings generally survive a lack of vigor with yellow to pale green colour and do not compete well with healthy seedlings. The object of this study was to identify pathogens associated with rice seedling blight disease and its management in nurseries condition. Three Pathogens, *viz., Sclerotium rolfsii, Fusarium moniliformae* and *Curvularia lunata* were found associated with rice seedling blight disease that occurred in nurseries raised for summer rice cultivation. Four biocontrol agents and seven fungicides were evaluated under *invitro* and *invivo* conditions. Among the bio agents, maximum mycelial growth inhibition (56.11%) of *S. rolfsii* by *Trichoderma viride* was recorded. Maximum mycelial growth of *Fusarium moniliformae* inhibited by *T. harzianum* with 70.56 per cent. While, maximum mycelial growth of *Curvularia lunata* inhibited (71.94%) by *T. harzianum*. Moreover *T. harzianum* and *T. viride* were found most superior over the other bio-agents tested under *in vitro* conditions. In case of fungicide, seven were tested against *S. rolfsii, Fusarium moniliformae* and *Curvularia lunata* to inhibit their mycelium growth. Among the seven fungicides, pyraclostrobin 133g/l + epoxiconazole 50g/l) and tebuconazole 25% EC) at 100 ppm concentration completely inhibit the mycelia growth of fungi. In nursery conditions rice seeds treated with *Pseudomonas fluorescens* $1x10^8$ cfu/ml @ 10 ml/kg seeds and spray with azoxystrobin 23% EC at 0.05% at 15 DAS and seeds treated with azoxystrobin 23% EC at 0.05% solution gave highest seed germination with minimum seedling mortality up to 21 days after sowing.

Keywords: Seed germination**,** seedling blight, fungicides, bio-control root and shoot

1. INTRODUCTION

Rice **(***Oryza sativa* L.*)* is one of the most important food-grain in the world wide, accounting for more than 20 per cent of global calories consumed. Rice is the second largest produced cereal in the world. India is one of the world's largest producers of rice, it occupies an area of 43.79 MHa, production of 116.42MT and productivity of 2.659 tones/ha (Anon., 2019b). In Gujarat it occupies an area of 8.38 lakh ha, production of 1.91MT and productivity of 2278 kg/ha (Anon., 2019a). Rice crop affected by so many diseases such as seedling blight, blast, sheath blight, sheath rot, brown spot, false smut, water-mold and seed-rot and bacterial leaf blight have been reported from many rice growing areas of India. Among that seedling blight or damping off is an important disease complex caused by several seed borne and soil borne fungi *e.i., Cochiobolus* sp.*, Curvularia sp., Sarocladium sp., Fusarium sp., Rhizoctonia sp.,* and *Sclerotium sp.* (Groth, 1991). Rice seedling blight disease is caused by *Sclerotium rolfsii* in the rice nursery of the boro season (Shahjahan *et al.*, 1987). Typically, the

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rice seedlings are weakened or died due to the fungi. Cold and wet weather environmental conditions favourable for disease development (Groth, 1991). Seedling blight is more severe in rice that has been seeded early when the soil is usually cold and damp. Conditions that tend to delay seedling emergence favour seedling blight. Seedling blight of rice affected at the time of germination can be reduced by treating the seed with fungicides. The main objective of the present study was to identifying associated organism caused seedling blight disease in rice and it's management under nurseries conditions.

2. MATERIAL AND METHODS

2.1. *Invitro* evaluation of bio-agent against fungal pathogens associated with rice seedling blight disease

Fungal pathogens associated with rice seedling blight were isolated from infected rice seedling samples which were collected from rice nurseries of Regional Rice Research Station, NAU, Vyara. Three dominant fungal pathogen *viz.*, *S. rolfsii*, *Fusarium moniliformae* and *Curvularia lunata* were isolated on PDA medium and maintained at 27 ± 2°C on potato dextrose agar media for further studies. Four bio-agents *i.e., Trichoderma viride, Trichoderma harzianum, Pseudomonas fluorescens* and *Bacillus subtillis* were brought from Department of Plant Pathology, N. M. College of Agriculture, Navsari Agricultural University, Navsari. *Invitro* experiment was conducted using completely randomized block (CRD) design with 5 treatments and each repeated four times.

The test bio-agent and the pathogens were grown on PDA and from 10 days old culture, a 5 mm disc of the test organism (antagonist) was cut aseptically from the periphery of the colony and placed at one end of the Petri plate containing 20 ml PDA media. In the opposite place and approximately 60 mm away from the first, a similar disc of the pathogen was aseptically placed. Repetitions of each were kept and the plates with only pathogen served as control. The plates incubated in BOD incubator at 25 ± 2°C and the radial growth of the test organism and pathogen was measured after control plate covered completely with mycelium of the pathogen. The per cent growth inhibition (PGI) was calculated as per formula given by Vincent (1947).

$$PGI = \frac{DC - DT}{DC} \times 100$$

Where;

PGI = Percent growth inhibition

DC = Average diameter of mycelial colony (mm) control

DT = Average diameter of mycelial colony (mm) treated

2.2. *In vitro* evaluation of fungicides against fungal pathogens associated with rice seedling blight disease

Efficacy of different fungicides was studied under *in vitro* condition following by "poisoned food technique" against different isolates (Nene and Thapliyal, 1993). The experiment was conducted using completely randomized block (CRD) design with 8 treatments and each repeated three times. Seven different fungicides were used for study at three concentrations *viz.,* 100 ppm. Required quantity of each fungicide under study was mixed thoroughly in sterilized 100 ml PDA media filled in 250 ml flask separately under aseptic condition. The medium was supplemented with few pinch of streptomycin sulphate to prevent bacterial contamination. The poisoned medium was then poured in sterilized Petri plates (20 ml) and allowed it to solidify. The plates were then inoculated with five mm diameter disc of seven days old culture of test pathogen by placing in the center of the plate. Control was maintained for each set where fungal disc was placed on PDA medium without fungicide. The inoculated plates were then incubated at 25 ± 2°C in BOD incubator. The observations were recorded for radial growth in mm after full growth in control Petri plate. Per cent mycelial growth inhibition was measured after the colony in the control plate was covered with mycelium of pathogen. The per cent growth inhibition (PGI) was calculated as per formula given by Vincent (1947).

$$PGI = \frac{DC - DT}{DC} \times 100$$

Where;

PGI = Percent growth inhibition

DC = Average diameter of mycelial colony (mm) control

DT = Average diameter of mycelial colony (mm) treated

2.3. Field evaluation of bio-agents and fungicides under nursery conditions

Field experiment was conducted to study the efficacy of selective fungicides and bio-agents used as seed treatment for the management of seedling blight disease caused by *S. rolfsii, Fusarium moniliformae* and *Curvularia lunata*. Treatments details are as, T_1:seeds treated with *Trichoderma viride* ($2x10^6$ cfu/g) @ 10g/kg; T_2: seeds treated with *Trichoderma harzianum* ($2x10^6$ cfu/g) @ 10g/kg; T_3: seed treated with *Pseudomonas fluorescens* ($1x10^8$ cfu/ml) @ 10ml/ kg; T_4: seeds treated with with *Trichoderma viride* ($2x10^6$ cfu/g) @ 10 g/ kg and sprayed with pyraclostrobin133g/l+ epoxiconazole 50g/l at 0.05% at 15 DAS; T_5: seeds treated with *Trichoderma harzianum* ($2x10^6$ cfu/g) @ 10 g/ kg and sprayed with tebuconazole 25% EC at 0.05% at 15 DAS; T_6: seeds treated with *Pseudomonas fluorescens* ($1x10^8$ cfu/ml) @ 10 ml/ kg and sprayed with azoxystrobin 23% EC at 0.05% at 15 DAS; T_7: seeds soaked with pyraclostrobin133g/ l+ epoxiconazole 50g/l at 0.05 % solution for 3 hrs; T_8: seeds soaked with szoxystrobin 23% EC at 0.05 % solution for 3 hrs; T_9: seeds soaked with tebuconazole 25% EC at 0.05 % solution for 3 hrs; T_{10}: check.

The field experiment was arranged in randomized block design with ten treatments and three replications during *Summer* 2020-21 at Regional Rice Research Station, Navsari Agricultural University, Vyara. In raised bed nurseries, rice variety GNR-3 was sown by broadcasting method in $1.1m^2$ plots sized. 2 kg FYM in each plot and half dose of ammonium sulphate applied at the time of sowing. 25 g ammonium sulphate applied in two equally spit dose at 15 days intervals.

Observations were recorded at 21 DAS. Germination per cent and seedling mortality were recorded.

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

Seedling mortality was calculated by the following formula

$$Seedling\ mortality(\%) = \frac{Initial\ seedling\ population - Final\ seedling\ population}{Initial\ seedling\ population} \times 100$$

3. RESULTS AND DISCUSSION

3.1. *In vitro* evaluation of bio-agent against test pathogens

The results described in table-1 and fig.-1 revealed that all the treatments significantly reduced the mycelial growth of all the pathogens over the control.

3.1.1. Inhibition of *S. rolfsii*: Maximum mycelial growth inhibition (56.11%) was observed in treatment T_1 (*T. viride*) at 4 days after incubation followed by treatment T_4 (*B. subtilis*) and T_2 (*T. harzianum*) by 44.72 and 39.45 per cent, respectively. Least mycelial growth inhibition (28.06%) was recorded in treatment T_3 (*P. fluorescens*). *T. viride* was found most superior to over the other bioagents tested under *in vitro* condition (fig.1 A). The present results are more or less in agreements with the earlier workers reported by Muhammad and Amusa (2003) tested *Bacillus subtilis* against *Sclerotium rolfsii* under *in vitro* condition by the dual culture technique and reveled that *Bacillus subtilis* induced inhibition of growth by 44.4 percent. Similarly reported by Bhuiyan *et al.* (2012) *T. harzianum* reduced more than 60 percent mycelial growth inhibition of *S. rolfsii* over the control. *T. viride* isolates, T_1 (showed higher growth inhibition 75.3 per cent of *S. oryzae* and among *P. fluorescens* isolates, BI-1 showed maximum (77.2%) growth inhibition (Gopika *et al*.2016). *T. harzianum* and *T. viride* mycelial growth inhibition of *S. oryzae* by 40.11 and 39.59 per cent, respectively (Kumar *et al*., 2018). Swain *et al.* (2018) assessed ability of the six *Trichoderma* isolates against *S. rolfsii* and found 80.25–100.00 per cent inhibition by different isolates.

3.1.2. Inhibition of *Fusarium moniliformae*: Maximum mycelial growth inhibition was

observed in treatment T_2 (*T. harzianum*) by 70.56 per cent which was at par with treatment T_1 (*T. viride*) at 69.45 percent at 7 days after incubation. Least mycelial growth inhibition (39.17%) was recorded in T_4 (*P. fluorescens*). *T. harzianum* and *T. viride* were found most superior over the other bioagents tested under *in vitro* condition(fig.1 B). The present results are more or less in agreements with the earlier workers reported by Muhammad and Amusa (2003) tested *Bacillus subtilis* against *Fusarium oxysporum* under *in vitro* condition by the dual culture technique and reveled that *Bacillus subtilis* induced inhibition of growth by 75.5 percent. Verma *et al.* (2018) reported 85.7 percent mycelial growth inhibition of *F. oxysporum* was observed by *Pseudomonas* sp. (strain SY1). Similarly, Deb and Khair (2018) reported that *T. harzianum* inhibited growth of *Fusarium moniliforme* by 65.03 per cent.

3.1.3. Inhibition of *Curvularia lunata*: Maximum mycelial growth inhibition (71.94%) was observed in treatment T_2 (*T. harzianum*) at 7 days after incubation followed by treatment T_4 (*B. subtilis*) and T_1 (*T. viride*) with 58.34 and 58.33 per cent, respectively. Least mycelial growth inhibition (55.00%) was recorded in treatment T_3 (*P. fluorescens*). *T. harzianum* was found most superior to over the other bioagents tested under *in vitro* condition (fig.1 C). The present results are more or less in agreements with the earlier workers reported by Verma *et al.* (2018) reported 86.3 per cent mycelium growth inhibition of *Curvularia* sp. was observed by *Pseudomonas* sp. (strain SY1) Deb and Khair (2018) reveled that *T. harzianum* inhibited growth of *Curvularia lunata* by 36.35 per cent.

3.2. *In vitro* evaluation of fungicides against test pathogens

The observations regarding per cent inhibition of mycelial growth are presented in table-2 revealed that all the fungicides were significantly inhibit the growth of the pathogens.

3.2.1. Inhibition of *Sclerotium rolfsii*: The result revealed that all the fungicides significantly inhibited the mycelial growth of *S. rolfsii.* Cent per cent mycelial growth inhibition was recorded in treatment T_4 (pyraclostrobin 133g/l+ epoxiconazole 50g/l) and T_5 (tebuconazole 25% EC) at all the tested concentrations and also found most effective in inhibiting the mycelial growth at 100 ppm concentration over control followed by treatment T_2 (azoxystrobin 23% SC) with 82.59 per cent growth inhibition (table 2). While treatment T_3 (azoxystrobin 11% + tebuconazole 18.3%) was found least effective as compared to other fungicides with 59.99 per cent mycelial growth inhibition (fig.2 A). The present results are more or less in agreements with the earlier workers reported by Khan and Javaid (2015) tested four different fungicides against *S. rolfsii* at 50, 100, 150, 200 and 250 ppm concentrations among them tebuconazole completely inhibited growth of fungi at all concentrations. Gopika *et al.* (2016) evaluated six fungicides against *Sclerotium oryzae* Catt and found that hexaconazole 5 EC at 200 ppm and propiconazole 25 EC at 100 ppm completely inhibited *S. oryzae* by using poisoned food technique. Soyal and Ratnoo (2018) revealed that *S. rolfsii* mycelial growth inhibition was recorded in tebuconazole 25.9 EC by 89.26 per cent at 500 ppm and 93.71 per cent at 750 ppm by hexaconazole 5 EC. Rangarani *et al.* (2018) evaluated fifteen fungicides at three different concentrations against *S. oryzae* found that propiconazole 25 EC at 500 ppm, hexaconazole 5 EC 1000 ppm, tebuconazole 25.9 EC 750 ppm, trifloxystrobin + tebuconazole (75 WG) 400 ppm, Azoxystrobin 23 SC 500ppm completely inhibited the growth of *S. oryzae.* Prameela *et al.* (2018) tested eight fungicides against *S. oryzae* by using poisoned food technique and revealed that propiconazole 25 EC at 100 ppm and hexaconazole 5 EC at 200 ppm showed complete inhibition growth followed by tebuconazole 60 FS (97.77%).

3.2.2. Inhibition of *Fusarium moniliformae*: A significantly mycelial growth inhibition of was observed in all the fungicides under *in vitro* condition (table 2 and fig. 2 B). Completely mycelial growth inhibition was recorded in treatment T_4 (pyraclostrobin 133g/l+ epoxiconazole 50g/l) and T_5 (tebuconazole 25% EC) (table 2) followed by treatment T_1 (trifloxystrobin 25% + tebuconazole 50% WG) at 100 ppm concentration. While treatment T_6 (propiconazole 25% EC) and T_7 (hexaconazole 70% WP) were found least effective at all

concentrations as compared to other fungicides with 64.81 and 65.92 per cent, 67.04 at 100 ppm concentration, respectively. Our findings more or less similar with Bhali *et al.* (2001) observed that propiconazole at 100 ppm concentration inhibit the mycelial growth by 81.82 per cent. Similar finding by Jain *et al.* (2014) reported that hexaconazole and tebuconazole completely inhibited the growth of *Fusarium monoliformae* at 100 ppm. Chowdhury *et al.* (2015) observed that propiconazole showed completely growth inhibition of *F. moniliformae* and hexaconazole at 500 ppm inhibited 65.5 percent mycelial growth. Propiconazole at 0.1 per cent could completely inhibit the growth of *F. moniliformae (*Salma *et al.*, 2015).

3.2.3. Inhibition of *Curvularia lunata*: Cent per cent mycelial growth inhibition was recorded in treatmet T_4 (pyraclostrobin 133g/l+ epoxiconazole 50g/l) and T_5 (tebuconazole 25% EC) at all the tested concentrations and also found most effective in inhibiting the mycelial growth at 100 ppm concentration over control followed by treatment T_2 (azoxystrobin 23% SC). While treatment T_1 (trifloxystrobin 25% + tebuconazole 50% WG) was found least effective as compared to other fungicides with 56.67 per cent mycelial growth inhibition(table 2 and fig.2 C). Present results coherence with Chowdhury *et al.* (2015) observed that propiconazole showed completely growth inhibition of *C. lunata* and hexaconazole at 500 ppm inhibited 80 percent mycelial growth.

3.3. Evaluation of bio-agents and fungicides under nursery condition

The experiments results presented in table-3 revealed that all the treatments were found significantly superior to improve seed germination as compared to check. Highest seed germination (71.39%) was observed in treatment T_8 (seeds treated with azoxystrobin 23% SC at 0.05 % conc.) which was at par with treatment T_6 (seeds treated with *Pseudomonas fluorescens* and spray with azoxystrobin 23% SC) and T_9 (seeds treated with tebuconazole 25.9% EC) by 67.77 and 67.35 per cent, respectively. Whereas minimum seed germination was observed in treatment T_{10} (control) with 58.99 per cent. Moreover seeds treated with azoxystrobin 23% SC at 0.05 percent solution or seeds treated with *Pseudomonas fluorescens* and spray with azoxystrobin 23% SC at 0.5% at 15DAS or seeds treated with tebuconazole 25.9% EC found best treatment to improved seed germination. Our findings are similar to early workers by Amein *et al.* (2008) wheat seeds treated with *P. fluorescens* Strains 1 and 3 has significantly increased seedling emergence of wheat by 15 and 17 per cent, respectively. Similarly reported by Sengupta *et al.* (2015) maize seed treatment with PGPR strains of *Pseudomonas* sp. and *Azotobacter* improved seed germination, seedling vigour, seedling emergence and seedling stand over the control.

Seedling mortality results presented in table 3 recorded that all the treatments were found significantly superior over the check. Minimum per cent seedling mortality by 2.60 percent was observed in treatment T_6 (ST with *Pseudomonas fluorescens* $1x10^8$ cfu/ml @ 10 g/ kg seeds and spray with azoxystrobin 23% EC at 0.05% at 15 DAS which was at par with T_5 (seeds treated with *Trichoderma harzianum* @ 10 g/ kg and sprayed with tebuconazole 25% EC at 15 DAS), T_4 (seeds treated with with *Trichoderma viride* @ 10 g/ kg and sprayed with pyraclostrobin133g/ l+ epoxiconazole 50g/l at 0.05% at 15 DAS) and T_8 (seeds soaked with szoxystrobin 23% EC at 0.05 % solution for 3 hrs) with 2.69, 3.20 and 3.25 per cent, respectively. Seedling mortality when seeds treated with T. *harzianum, P. fluorescens* and *T. viride* were showed by 3.87, 3.98 and 5.39 per cent, respectively. While least effect on seedling mortality by treatment T_9 (seeds treated with tebuconazole) with 10.37 per cent. Maximum seedling mortality (16.98%) was observed in treatment T_{10} (check). Moreover all treatments were minimized seedling mortality as compared to check. Our results are more or less agreements with earlier workers, Elad *et al.* (1982) reported that soil application with *Trichoderma harzianum* (TH 294 and TH 203) significantly reduced *P. aphanidermatum* by isolate TH 294 and *S. rolfsii* disease was significantly reduced by isolate TH 203. Amein *et al.* (2008) wheat seeds treated with *P. fluorescens* Strains 1 and 3 reduced wheat seedling blight disease incidence in heavily infested winter wheat by 36 per cent. Plant

Table 1: Evaluation of different bio- agents against fungal pathogens associated with rice seedling blight under *in vitro* condition

Treat ment	*Name of biocontrol agent*	*Mycelial growth inhibition (%)*		
		S. rolfsii	*F.moniliformae*	*C.lunata*
T_1	*Trichoderma viride* Pers., NAU isolate	56.11(48.49)*	69.45(56.43)	58.33(49.78)
T_2	*Trichoderma harzianum* Rifai., NAU isolate	39.45(39.89)	70.56(57.11)	71.94(58.00)
T_3	*Pseudomonas fluorescens* Migula., NAU isolate	28.06(31.97)	39.17(38.73)	55.00(47.85)
T_4	*Bacillus subtilis* Ell., NAU isolate	44.72(41.95)	55.84(48.33)	58.34(49.78)
T_5	Control	00.00(0.00)	00.00(0.00)	00.00(00.00)
SEm±		0.67	0.39	0.45
CD at 5%		2.01	1.19	1.37
CV %		3.95	2.42	2.24

Average of four replications
*Figures in the parenthesis are arc sine transformed value.

Table 2: Effect of different fungicides on mycelial growth of *Sclerotium rolfsii* under *in vitro* condition

Treatment	*Technical name of fungicide*	*Mycelial growth Inhibition (%) at 100 ppm concentration*		
		S. rolfsii	*F.moniliformae*	*C.lunata*
T_1	Trifloxystrobin (25%) + Tebuconazole (50%) WG	68.52(55.85)*	66.66(54.72)	56.67(48.81)
T_2	Azoxystrobin 23% SC	82.59(65.33)	74.07(59.37)	92.22(73.80)
T_3	Azoxystrobin 11% + Tebuconazole18.3%	59.99(50.75)	71.11(57.47)	60.74(51.18)
T_4	Pyraclostrobin133g/l+ Epoxiconazole50 g/l	100.00(90.00)	100.00(90.00)	100.00(90.00)
T_5	Tebuconazole 25% EC	100.00(90.00)	100.00(90.00)	100.00(90.00)
T_6	Propiconazole 25% EC	63.70(52.94)	64.81(53.60)	71.85(57.94)
T_7	Hexaconazole 70% WP	63.33(52.71)	65.92(54.27)	61.11(51.40)
T_8	Control	0.00(0.00)	0.00(0.00)	0.00(0.00)
SEm±		0.44	0.48	0.40
CD at 5%		1.33	1.47	1.22
CV %		1.33	1.46	1.21

Average of three replications. *Figures in the parentheses are arc sine transformed value

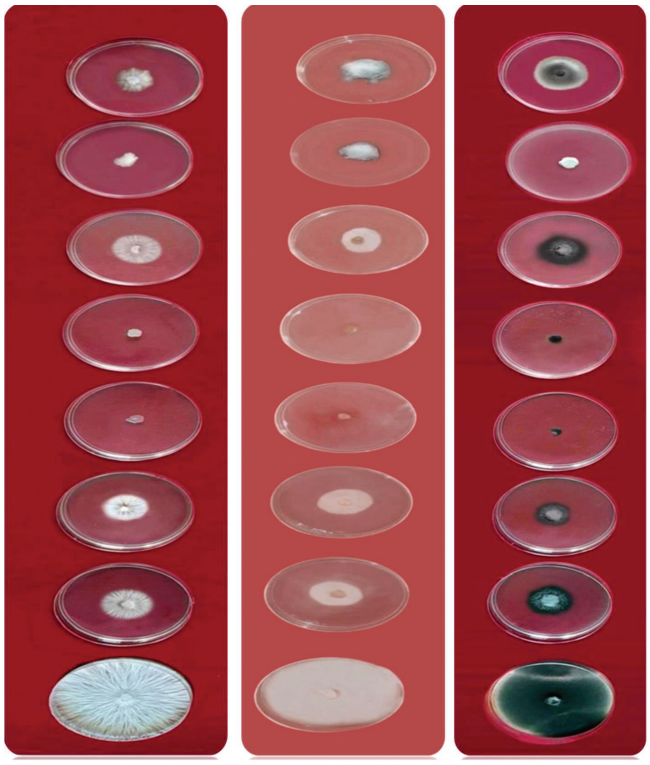
Table 3: Effect of different treatments of bio-agents and fungicides on rice seeds germination and seedling mortality

Treatment	*Treatment Detail*	*Germination (%)*	*Mortality % at 21 DAS*
T_1	ST with *Trichoderma viride*	59.60 (50.54)*	5.39 (13.34)
T_2	ST with *Trichoderma harzianum*	66.12 (54.41)	3.87 (11.34)
T_3	ST with *Pseudomonas fluorescens*	63.62 (52.95)	3.98 (11.50)
T_4	ST with *Trichoderma viride* and Spray with Pyraclostrobin + Epoxiconazole	59.22 (50.33)	3.20 (10.31)
T_5	ST with *Trichoderma harzianum* and Spray with Tebuconazole	61.94 (51.91)	2.69 (9.41)
T_6	ST with *Pseudomonas fluorescens* and Spray with Azoxystrobin	67.77 (55.43)	2.60 (9.24)
T_7	ST with Pyraclostrobin + Epoxiconazole	59.14 (50.28)	4.84 (12.62)
T_8	ST with Azoxystrobin	71.39 (57.73)	3.25 (10.37)
T_9	ST with Tebuconazole	67.35 (55.24)	10.37 (18.76)
T_{10}	Control	58.99 (50.19)	16.98 (24.32)
	SEm±	1.48	0.67
	CD at 5%	4.40	1.99
	CV %	4.85	8.83

Average of three replication. *Figures in the parentheses are arc sine transformed value

T_1: *Trichoderma viride* Pers., NAU isolate
T_2: *Trichoderma harzianum* Rifai., NAU isolate
T_3: *Pseudomonas fluorescens* Migula., NAU isolate
T_4: *Bacillus subtilis* Ell., NAU isolate
T_5: Control

Figure 1: Evaluation of different bio-control agents against *S. rolfsii, F.monliformoe* and *C.lunata* under *in vitro* condition



T_1: Trifloxystrobin (25%) + Tebuconazole (50%) WG
T_2: Azoxystrobin 23% SC
T_3: Azoxystrobin 11% + Tebuconazole18.3%
T_4: Pyraclostrobin133g/l+ Epoxiconazole50 g/l
T_5: Tebuconazole 25% EC
T_6: Propiconazole 25% EC
T_7: Hexaconazole 70% WP
T_8: Control

Figure 2: Effect of different fungicides on mycelial growth of fungal pathogens associated with rice seedling blight under in vitro condition

establishment was increased by 65, 48 and 15 per cent when seeds treated with *P. fluorescens* Strain 2, Strain 2 and Strain, respectively as compared to control by 5 per cent. Verma *et al.* (2018) observed that rice seedlings treated with SY1(*Pseudomonas* sp.) reduced infection of *Fusarium* by 18.75 per cent as compare to control by 51.50 per cent. Our findings also agreements with earlier workers like Kumar *et al.* (2003), Gopika *et al.* (2016), Gopika *et al.* (2017), Gowdar *et al.* (2018).

4. CONCLUSION

From above results conclude that *T. harzianum* and *T. viride* were found most superior over the other bio-agents tested under *in vitro* condition against *S. rolfsii, F. moniliformae* and *C. lunata*. In case of fungicides, pyraclostrobin 133g/l + epoxiconazole 50g/l) and tebuconazole 25% EC) at 100 ppm concentration completely inhibit the mycelia growth of *S. rolfsii, F. moniliformae* and *C. lunata* fungus. Rice seeds treated with *Pseudomonas fluorescens* $1x10^8$ cfu/ml @ 10 g/ kg seeds and sprayed with azoxystrobin 23% EC (0.05% conc. at 15DAS) and seeds treated with azoxystrobin 23% EC(at 0.05%) gave highest seed germination, minimum seedling mortality up to 21 DAS.

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Author's Contributions: Patoliya Prashant Rajeshbhai and Kedar Nath, both the author's deign an experiment, prepared the materials and conducted experiment. Prashant analyzed data performed the statistical analysis and drafted the manuscript. Kedar Nath, edited previous versions of the manuscript. Both authors have read and approved the final manuscript.

Consent: Not applicable

Ethical approval: This article does not contain any studies on human being or animals by any of the authors

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