# Evaluation of antagonists and the effectiveness of application methods against Sheath blight disease of rice under pot conditions


## ABSTRACT

Rice sheath blight caused by *Rhizoctonia solani* is one of the main disease of rice in the Chhattisgarh region.Three potential Trichoderma species were evaluated against sheath blight disease of paddy under pot conditions. The Trichoderma spp. Obtained/ isolated from three discrictRajnandgaon, Raipur and Durg of Chhattisgarh were compared for their efficacy with check fungicide hexaconazole for foliar sprays. This experiment was conducted under pot condition in completely randomyzed design (CRD) with three replications during kharif 2016 and 2017.Inoculation of sheath blight pathogen was done in two treatments *i.e.* at 30 days after transplanting and at 60 days after transplanting.The inoculation of pathogen and foliar spray of bioagent was done at 30 DAT and 60 DAT. Among the three potential Trichoderma spp., highly effective species against sheath blight pathogen was evaluated. The disease severity was recorded 14 days after inoculation.The results of comparative foliar application of Raipur, Durg and RajnandgaonTrichoderma isolates showed that all isolates of*Trichoderma spp.* significantly reduced the sheath blight disease severity in rice under pot conditions at 30 DAT and 60 DAT planting.Among the *Trichoderma* isolates, foliar spray of Durg isolate (TD3) was effectively showed 26.24% reduction in disease severity at 30 DAT and 24.85% reduction in disease severity at 60 DAT over control treatment. The highest disease severity was reduced by check fungicide hexaconazole. The Durg isolate (TD3) at 30 DAT and 60 DAT also increased the yield per plant as compared to Raipur (TR2) and Rajnandgaon isolates (TR1).



**Key words:**Rice variety Swarna,Trichoderma isolates, three discricts, check fungicide hexaconazole, application methods.


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## INTRODUCTION

Rice (*Oryzae sativa* L.) is the staple food crop of over half of the world's population, and is also widely cultivated across the world, making it possibly the most valuable plant on

earth(Shimamoto, 1995; Goff, 1999).It provides 20 percent of the world's supply of dietary energy followed by maize and wheat. Rice grows in at least 114 countries and more than 50 have a capacity of 100,000 tons or more per year. The production of rice to be adept by 2020 is 128 Mt. to feed the growing population in India. This crop also suffers due to number of diseases accounting for severe losses. Of the several factors known to destabilize rice yields, pests and diseases account for 30-40 percent crop losses.Most parts of the country regularly encounter complete crop failure due to epidemics of pests and diseases. In Chhattisgarh, rice production is comparatively smaller than the national average production.Alotof fungal, bacterial,nematode, and viral diseases are attacked on rice. Serious incidences of diseases such as blast, sheath blight and bacterial blight have been reported from rice growing areas in Chhattisgarh regions.Sheath blight is one of India's widespread and harmful rice diseases. Rice sheath blight disease is causing significant loss, particularly in areas where high yielding varieties are cultivated. *Rhizoctonia solani*(Perfect stage-*Thanatephoruscucumeris*)which causes rice sheath blight in both soil and water borne.The presence of this disease has been confirmed by Andhra Pradesh, Assam, Jammu and Kashmir, Kerala, Tamil Nadu (Anonymous, 1971), Orissa and West Bengal (Das, 1970), Madhya Pradesh (Anonymous, 1975; Verma *et al.*, 1979).It has a wide range of hosts including cultivated crops, weed plants and various family of horticulture crops. Both seedlings and adult plants are equally affected but when the disease occurs in seedlings, mortality is much greater.The initial symptoms usually develop as lesions on sheaths of lower leaves close to the waterline, when plants are in the growth stage of late tillering or nearly internode elongation typically these lesions develop as oval to elliptical, green gray, just below the leaf collar,water soaked spots about 1⁄4 inch wide and 1⁄2 to 1⁄4 inch in length.The disease has been named as “sheath blight” because of primary infection on leaf sheath. High doses of nitrogen fertilizers, intensive cultivation of modern high yielding variety, early maturation, high tillering rice varieties with double farming leads to increased severity of diseases, eventually yield losses of about 50% were recorded in Japan, Vietnam, South Korea, Taiwan, China, USA and India (Anonymous, 1988). Several workers reported, yield loss ranging from 20-50% in highly susceptible cultivars (Lee and Rush, 1983; Rajan and Naidu, 1986; Mizuta, 1956; and Hori, 1969). Ou (1972) also reported a grain yield loss of 25 per cent due to sheath blight. The disease is common in areas where there is high temperature (30±32 oC) and relative humidity (> 95 percent) and in intensive cultivation areas.

A more sustainable approach for sheath blight management in rice with less reliance on synthetic fungicides, greater use of natural fungicides such as strobilurins and biological agents like *Trichoderma spp., Pseudomonas spp., Gliocladium spp., Bacillus spp.* to restrict disease (Singh *et al.,* 2019).Prasad and Reddi (2011) examined the comparative effectiveness of different isolates of Trichoderma spp. against *Rhizoctonia solani*, instigator of the sheath blight of rice. Three isolates from Trichoderma spp. were isolated and the inoculation of pathogen and leaf spray from bioagents and hexaconazole was carried out at 30 DAT and 60 DAT. Bioagents could effectively reduce the severity of the disease under greenhouse conditions.Kumawa*et al.* (2008) reported that the prior use of bioagent spores protects the plant from an impairment of Drechsleraoryzae infestation, reduces the severity of the disease of rice from 59.21% to 12.40% and also shows that the measure for Soluble protein and all of the phenol from Bioagent's movement showed inclusion in the paddy field have defense induction.The present study was conducted for eco-friendly and economical management of sheath blight of rice by integrating fungicides with Trichoderma species.

## MATERIAL AND METHODS

The experiment was carried out at the SKS College of Agriculture and Research Station, Rajnandgaon and the Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.).

Three potential Trichoderma species were evaluated against sheath blight disease of paddy under pot conditions. The Trichoderma spp. Obtained/ isolated from three discrictRajnandgaon,Raipur and Durg of Chhattisgarh were compared for their efficacy with check fungicide hexaconazolefor foliar sprays. This experiment was conducted under pot condition in completely randomyzed design (CRD) with three replications during kharif 2016 and 2017.The soil was filled in plastic pots of 30 c.m. diameter. The soil in pots were fertilized with requisite quantities of NPK. 21 days old seedlings of susceptible rice variety swarna was transplanted in each pot and two hills/pot were maintained. Inoculation of sheath blight pathogen was done in two treatments *i.e.* at 30 days after transplanting and at 60 days after transplanting. Inoculation of susceptible rice plant was done by placing stem bits covered with mycelium and sclerotia of the pathogen at the centre of each hill above water level (Sudhakar, 1996). Rice stem bits of 2 cm were inoculated aseptically and allowed to overgrew with the pathogen. The inoculation of pathogen and foliar spray of bioagent was done at 30 DAT and 60 DAT. Among the three

potential Trichoderma spp., highly effective species against sheath blight pathogen was evaluated. The disease severity was recorded 14 days after inoculation.Spores of bio-agent were harvested from 10 day old culture grown on PDA with the help of a camel hair brush and the spores were then suspended in distilled water and the concentration was measured with a Haemocytometer to get a final count of about 2 x $10^9$ spores/ml. The first spray of bio-agent @ 2 x $10^9$ spores/mlwas given at the time of pathogen inoculation (30 DAT) until run-off occurred. Second spray was given at 30 days interval (60 DAT). At the time of second spray, second treatment (60 DAT) was done. All the inoculated plants were covered with polythene bags to maintain humidity for one week.

**Disease Scoring:**

The treatments imposed are as follows:

T1: Foliar application of potential Trichoderma sp. from Distt. Rajnandgaon after inoculation of pathogen *i.e.*, 30 DAT,

T2: Foliar application of potential Trichoderma sp. from Distt. Rajnandgaonafter inoculation of pathogen *i.e*., 60 DAT,

T3: Foliar application of potential Trichoderma sp. from Distt. Raipurafter inoculation of pathogen *i.e.*, 30 DAT,

T4: Foliar application of potential Trichoderma sp. from Distt. Raipurafter inoculation of pathogen *i.e.*, 60 DAT,

T5: Foliar application of potential Trichoderma sp. from Distt. Durgafter inoculation of pathogen *i.e.*, 30 DAT,

T6: Foliar application of potential Trichoderma sp. from Distt. Durgafter inoculation of pathogen *i.e.*, 60 DAT,

T7: Foliar application of Hexaconazole @ 0.2% after inoculation of pathogen *i.e.*, 30 DAT,

T8: Foliar application of Hexaconazole @ 0.2% after inoculation of pathogen *i.e.*, 60 DAT,

T9: Inoculated control at 30 DAT,

T10: Inoculated control at 60 DAT.

The number of days required for the development of first lesions was recorded after imposing the treatments. The number of infected tillers and the number of tillers in the hill were counted and the disease incidence percent was calculated. After harvesting, the grain yield was also recorded.

$$\text{Disease incidence } \% = \frac{\text{No. of infected tillers}}{\text{Total no. of tillers /hill}} \times 100$$

Percent reduction in disease incidence = No. of infected tillers in control – No. of infected tillers in treatment / No. of infected tillers in control x 100

The observations on disease severity were recorded and analyze. All plants from each pot were harvested and threshed separately from which total yield per plant were recorded to know any inhibitory or stimulatory effect of the imposed treatments (Khan and Sinha, 2007). Wherever necessary the data were statistically analyzed (Gomez and Gomez, 1984).Three replications were maintained and following the CRD (Completely Randomyzed Design) for pot culture studies and population assessment.

## RESULTS AND DISCUSSION

**Effects of *Trichoderma* isolates on disease severity at 30 DAT and 60 DAT in pot condition during the year 2016:**

In the kharif 2016 the data presented in table 1.0and fig. 1 and 4 showed that foliar treatment of all the isolates of *Trichoderma* and check fungicide hexaconazole were significantly reduced the disease severityafter inoculation of pathogen at 30 DAT. The chemical check fungicide Hexaconazole was found to be most effective with 19.25% disease severity and 48.14% reduction in disease severity after 15 days of first spray. Among the *Trichoderma* isolates foliar spray ofDurg isolate (TD3) was most effective (27.24% disease severity) and showed 26.80 reduction in percent disease severity followed by Raipur isolate (TR2) with 30.14% disease severity and 19.01 reduction in percent disease severity and Rajnandgaon isolate (TR1) with 33.47% disease severity and 9.92 reduction in disease severity percent over conrol). The highest disease severity was recorded in control treatment (37.27%). The data showed (table 2.0) that all the isolates of *Trichoderma* spp. significantly reduced severity of the disease after inoculation of the pathogen at 60 DAT. The chemical check fungicide Hexaconazole was found to be highly effective with 35.22% disease severity and 49.03% reduction in disease severity. Among the *Trichoderma* isolates foliar spray with Durg isolate (TD3) was most effective (51.28% disease severity) and showed 25.86% reduction in disease severity followed by Raipur isolate (TR2) with 55.16% disease severity and 20.27% reduction in disease severity and

Rajnandgaon isolate (TR1) with 59.45% disease severity and 13.98% reduction in disease severity).The highest disease severity was recorded in control treatment (69.20%).

**Effect of *Trichoderma* isolateson yield per plant when inoculated at 30 DAT and 60 DAT during the year 2016:**

It was evident from the table 1.0effect on yield per plant when inoculated at 30 DATthat all the isolates of *Trichoderma* and Hexaconazole treatment significantly increased the yield per plant as compared to control. The highest grain yield 12.21g per plant (with 32.70%increase in grain yield) was obtained with foliar spray spray of Hexaconazole treatment. Among the *Trichoderma* isolates, the highest yield per plant (11.44g and 28.06% increase in grain yield) was obtained with foliar spray of Durg isolate (TD3) followed by foliar spray of Raipur isolate (TR2) and Rajnandgaon isolate (TR1) isolates which was the yield of 10.39g/plant with 21.02% increase in grain yield and 9.16g/plant with 10.27%increase in grain yield, respectively.The minimum grain yield (8.22g per plant) was obtained in control treatment. It was evident from the table 2.0effect on yield per plant when inoculated at 60 DATthat all the isolates of *Trichoderma* and chemical significantly increased the yield per plant as compared to check. The highest yield per plant (12.94g and 32.60% increase in grain yield) was obtained with foliar spray of Hexaconazole followed by TD3 (12.16g and 29.0%increase in grain yield), TR2 (11.0g and 20.74%increase in grain yield) and TR1 (9.73g and 10.32%increase in grain yield).The minimum grain yield (8.72g per plant) was obtained in control treatment.The disease severityand grain yield was less when inoculated at 30 DAT than the plants inoculated at 60 DAT. These results showed that when the plants attacked by the pathogen at early stages may lead to produce less number of panicles per hill and more empty grains. Among both the treatments, the hexaconazole treatment was found most effective in reducing disease severity and increasing grain yield.

**Table 1.0: Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 30DAT during 2016**

| Treatments ( 30 DAT) | Disease severity (%) | Reduction in disease severity (%) | Grain yield (g/plant) | Increase in grain yield (g/plant) |
|---|---|---|---|---|
| T1. Foliar application of Rajnandgaon isolates | 33.47 (35.35) | 9.92 | 9.16 (17.62) | 10.27 |

| | | | | |
|---|---|---|---|---|
| T3 : Foliar application of Raipur isolates | 30.14 (33.30) | 19.01 | 10.39 (18.81) | 21.02 |
| T5. Foliar application of Durg isolates | 27.24 (31.45) | 26.80 | 11.44 (19.77) | 28.06 |
| T7. Foliar application of Hexaconazole @ 0.2% | 19.25 (26.01) | 48.14 | 12.21 (20.46) | 32.70 |
| T9. Control | 37.27 (37.62) | - | 8.22 (16.66) | - |
| SEd | 0.8700 | | 0.0907 | |
| CD (5%) | 1.9385 | | 0.2022 | |
| SE(m)+ | 0.6151 | | 0.0641 | |
| CV (5%) | 3.2538 | | 0.5954 | |

Means of three replications *Data in parenthesis shows Arcsine transformation
Abbreviaitons:**S.Ed**: Standard Error Deviation; **CD**: Critical Difference; **SEm**: Standard Error Mean; **CV**: Coefficient of Variation

**Table 2.0: Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 60 DAT during 2016**

| Treatments ( 60 DAT) | Disease severity (%) | Reduction indisease severity (%) | Grain yield (g/plant) | Increase in grain yield (g/plant) |
|---|---|---|---|---|
| T2. Foliar application of Rajnandgaon isolates | 59.45 (50.45) | 13.98 | 9.73 (18.17) | 10.32 |
| T4 : Foliar application of Raipur isolates | 55.16 (47.96) | 20.27 | 11.0 (19.37) | 20.74 |
| T6. Foliar application of Durg isolates | 51.28 (45.73) | 25.86 | 12.16 (20.41) | 29.0 |
| T8. Foliar application of Hexaconazole @ 0.2% | 35.22 (36.39) | 49.03 | 12.94 (21.08) | 32.60 |
| T10. Control | 69.20 (56.29) | - | 8.72 (17.17) | - |
| SEd | 0.9365 | | 0.2415 | |
| CD (5%) | 2.0867 | | 0.5382 | |
| SE(m)+ | 0.6622 | | 0.1708 | |
| CV (5%) | 2.4215 | | 1.5375 | |

*Data in parenthesis shows Arcsine transformation

**Fig.1:Comparative efficacy of *Trichoderma* isolates with reduced disease severity of sheath blight and increased yield of paddy**

**Effects of *Trichoderma* isolates on disease severity at 30 DAT and 60 DAT in pot condition during the year 2017:**

In the kharif 2017, data (Table 3.0) showed that all the isolates of *Trichoderma* spp. significantly reduced the severity of disease after inoculation of pathogen at 30 DAT. The chemical check fungicide Hexaconazole was found to be most effective with 18.94% disease severity and 46.72% reduction in disease severity after 15 days of first spray. Among the *Trichoderma* isolates foliar spray with Durg isolate (TD3) was most effective (26.45% disease severity) and showed 25.69% reduction in disease severity followed by Raipur isolate (TR2) with 29.47% disease severity and 17.17% reduction in disease severity and Rajnandgaon isolate (TR1) with 31.38% disease severity and 11.82% reduction in disease severity). The highest disease severity was recorded in control treatment (35.57%). The data showed (table 4.0) that all the isolates of *Trichoderma* spp. significantly reduced severity of the disease after inoculation of the pathogen at 60 DAT. The chemical check fungicide Hexaconazole was found to be most effective with 33.61% disease severity and 49.16% reduction in disease severity. Among the *Trichoderma* isolates foliar spray with Durg isolate (TD3) was most effective (50.38% disease severity) and showed 23.84% reduction in disease severity followed by Raipur isolate (TR2) with 54.25% disease severity and 18.0% reduction in disease severity and Rajnandgaon isolate

(TR1) with 57.21% disease severity and 12.85% reduction in disease severity).The highest disease severity was recorded in control treatment (66.15%).

**Effectof *Trichoderma* isolateson yield per plant when inoculated at 30 DAT and 60 DAT during the year 2017:**

It was evident from the table 3.0 effect on yield per plant when inoculated at 30 DATthat all the isolates of *Trichoderma* and Hexaconazole treatment significantly increased the yield per plant as compared to control. The highest grain yield 11.22g per plant (with 29.11%increase in grain yield) was obtained with foliar spray spray of Hexaconazole. Among the *Trichoderma* isolates, the highest yield per plant (11.18g and 28.96% increase in grain yield) was obtained with foliar spray of Durg isolate (TD3) followed by foliar spray of Raipur isolate (TR2) and Rajnandgaon isolate (TR1) isolates which was the yield of 10.24g/plant with 22.37% increase in grain yield and 9.55g/plant with 16.83%increase in grain yield, respectively.The minimum grain yield (7.94g per plant) was obtained in control treatment.It was evident from the table 4.0 effect on yield per plant when inoculated at 60 DAT that all the isolates of *Trichoderma* and chemical significantly increased the yield per plant as compared to check. The highest yield per plant (11.94g and 29.68% increase in grain yield) was obtained with foliar spray of Hexaconazole followed by TD3 (11.86g and 29.26%increase in grain yield), TR2 (11.14g and 24.76%increase in grain yield) and TR1 (10.16g and 17.28%increase in grain yield).The minimum grain yield (8.38g per plant) was obtained in control treatment.

The disease severity was less when inoculated at 30 DAT than the plants inoculated at 60 DAT. Though the severity and incidence was less when inoculated at 30 DAT, the grain yield was also low when compared to the plants inoculated at 60 DAT. These results showed that when the plants attacked by the pathogen at early stages may lead to produce less number of panicles per hill and more empty grains. Among both the treatments, the hexaconazole treatment was found most effective in reducing disease severity and increasing grain yield. Among the three potential *Trichoderma* sprayed TD3 isolate was found most effective in reducing disease severity. The TD3was found most effective in controlling the disease and increasing grain yield followed by TR2 and TR1 isolate.

All the isolates of *Trichoderma* and hexaconazole were significantly check the sheath blight disease as well as increase the grain yield significantly. Highest reduction of disease

severity and increase the grain yield was done by hexaconazole while Durg isolates of *Trichoderma* followed by Raipur and Rajnandgaon were significantly reduced the disease severity as well as increase the grain yield over control. After 60 days of transplanting the foliar spray of hexaconazole 0.2% was significantly reduced the disease severity and significantly increase the grain yield over the control. Durg isolate followed by Raipur and Rajnandgaon were significantly reduced the disease severity and increase the grain yield over the control but all the isolates were not at par with hexaconazole in according to disease severity and grain yield.

**Table 3.0 : Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 30DAT during 2017**

| Treatments ( 30 DAT) | Disease severity (%) | Reduction in disease severity (%) | Grain yield (g/plant) | Increase in grain yield (g/plant) |
|---|---|---|---|---|
| T1. Foliar application of Rajnandgaon isolates | 31.38 (34.06) | 11.82 | 9.55 (18.0) | 16.83 |
| T3 : Foliar application of Raipur isolates | 29.47 (32.87) | 17.17 | 10.24 (18.66) | 22.37 |
| T5. Foliar application Durg isolates | 26.45 (30.94) | 25.69 | 11.18 (19.54) | 28.96 |
| T7. Foliar application of Hexaconazole @ 0.2% | 18.94 (25.79) | 46.72 | 11.22 (19.56) | 29.11 |
| T9. Control | 35.57 (36.61) | - | 7.94 (16.37) | - |
| SEd | 0.8462 | | 0.1897 | |
| CD (5%) | 1.8855 | | 0.4228 | |
| SE(m)+ | 0.5983 | | 0.1341 | |
| CV (5%) | 3.2331 | | 1.2612 | |

*Data in parenthesis shows Arcsine transformation

**Table 4.0: Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 60 DAT during 2017**

| Treatments ( 60 DAT) | Disease severity (%) | Reduction in disease severity (%) | Grain yield (g/plant) | Increase in grain yield (g/plant) |
|---|---|---|---|---|
| T2. Foliar application of Rajnandgaon isolates | 57.21 (49.40) | 12.85 | 10.16 (18.58) | 17.28 |
| T4 : Foliar application of Raipur isolates | 54.25 (47.44) | 18.00 | 11.14 (19.50) | 24.76 |
| T6. Foliar application Durg isolates | 50.38 (45.22) | 23.84 | 11.86 (20.14) | 29.26 |
| T8. Foliar application of | 33.61 | 49.16 | 11.94 | 29.68 |

| | | | | |
|---|---|---|---|---|
| Hexaconazole @ 0.2% | (35.43) | | (20.21) | |
| T10. Control | 66.15 | - | 8.38 | - |
| | (54.42) | | (16.83) | |
| SEd | 0.8449 | | 0.2625 | |
| CD (5%) | 1.8825 | | 0.5849 | |
| SE(m)+ | 0.5964 | | 0.1856 | |
| CV (5%) | 2.2308 | | 1.6873 | |

*Data in parenthesis shows Arcsine transformation

**Effects of *Trichoderma* isolateson disease severity at 30 DAT and 60 DAT in pot condition during both the year 2016 and 2017 as pooled:**

The pooled data presented in the table 5.0 and fig. 2 showed that all the isolates of *Trichoderma* spp. significantly reduced the severity of disease after inoculation of pathogen at 30 DAT.The chemical check fungicide Hexaconazole was found to be most effective with 19.09% disease severity and 47.44% reduction in disease severity after 15 days of first spray. Among the *Trichoderma* isolates foliar spray with Durg isolate (TD3) was most effective (26.84% disease severity) and showed 26.24% reduction in disease severity followed by Raipur isolate (TR2) with 29.81% disease severity and 18.09% reduction in disease severity and Rajnandgaon isolate (TR1) with 32.43% disease severity and 10.87% reduction in disease severity). The highest disease severity was recorded in control treatment (36.42%). The data showed (table 6.0 and fig. 3) that all the isolates of *Trichoderma* spp. significantly reduced severity of the disease after inoculation of the pathogen at 60 DAT. The chemical check fungicide Hexaconazole was found to be most effective with 34.41% disease severity and 49.09% reduction in disease severity. Among the *Trichoderma* isolates foliar spray with Durg isolate (TD3) was most effective (50.83% disease severity) and showed 24.85% reduction in disease severity followed by Raipur isolate (TR2) with 54.70% disease severity and 19.13% reduction in disease severity and Rajnandgaon isolate (TR1) with 58.54% disease severity and 13.38% reduction in disease severity).The highest disease severity was recorded in control treatment (67.67%).

**Effectof *Trichoderma* isolateson yield per plant when inoculated at 30 DAT and 60 DAT during both the year as pooled:**

The pooled data presentedin the table 5.0 showed that foliar application of all the isolates of *Trichoderma* and Hexaconazole treatment significantly increased the yield per plant as compared to control. The highest grain yield 11.71g per plant (with 30.90%increase in grain

yield) was obtained with foliar spray spray of Hexaconazole. Among the *Trichoderma* isolates, the highest yield per plant (11.31g and 28.51% increase in grain yield) was obtained with foliar spray of Durg isolate (TD3) followed by foliar spray of Raipur isolate (TR2) and Rajnandgaon isolate (TR1) isolates which was the yield of 10.31g/plant with 21.67% increase in grain yield and 9.35g/plant with 13.55%increase in grain yield, respectively.The minimum grain yield (8.08g per plant) was obtained in control treatment.It was evident from the table 6.0 effect on yield per plant when inoculated at 60 DAT that all the isolates of *Trichoderma* and chemical significantly increased the yield per plant as compared to check. The highest yield per plant (12.43g and 31.14% increase in grain yield) was obtained with foliar spray of Hexaconazole followed by TD3 (12.01g and 29.13%increase in grain yield), TR2 (11.07g and 22.75%increase in grain yield) and TR1 (9.94g and 13.80%increase in grain yield).The minimum grain yield (8.52g per plant) was obtained in control treatment.

In the pooled data, the disease severity was less when inoculated at 30 DAT than the plants inoculated at 60 DAT. The grain yield was also low when compared to the plants inoculated at 60 DAT. These results showed that when the plants attacked by the pathogen at early stages may lead to produce less number of panicles per hill and more empty grains. Among both the treatments, the hexaconazole treatment was found most effective in reducing disease severity and increasing grain yield. Among the three potential *Trichoderma* sprayed TD3 isolate was found most effective in reducing disease severity. The TD3was found most effective in controlling the disease and increasing grain yield. TR2 has found effective followed by TR1 isolate.All the isolates of *Trichoderma* and hexaconazole were significantly check the sheath blight disease as well as increase the grain yield significantly. Highest reduction of disease severity and increase the grain yield was done by hexaconazole while Durg isolates of *Trichoderma* followed by Raipur and Rajnandgaon were significantly reduced the disease severity as well as increase the grain yield over control. After 60 days of transplanting the foliar spray of hexaconazole 0.2% was significantly reduced the disease severity and significantly increase the grain yield over the control. Durg isolate followed by Raipur and Rajnandgaon were significantly reduced the disease severity and increase the grain yield over the control but all the isolates were not at par with hexaconazole in according to disease severity and grain yield.

Present investigation and reports showed that both the foliar application of chemical and biocontrol treatments were significantly reduced disease severity. Though the disease severity

was more on plants treated with TD3 than plants treated with hexaconazole, the increase in grain yield was almost same in both the treatments. The bioagents can effectively control the disease and at the same time improve growth characters and thus is a better alternative to chemical application. Though hexaconazole controls the disease severity, it did not enhance plant growth to that extent. But when biocontrol agents were introduced, the growth of the plants was promoted and at the same time they could effectively increased grain yield. The results were in agreement with Windham *et al*, 1986 who reported that the activity of biocontrol agents could also reduce the concentration of substances in soil are inhibitory to plant growth. Baby and Manibhushan Rao (1993) observed 25 per cent increase in growth of rice plants, where antagonists were applied to the soil. Mishra *et al.* (1989) observed that seed treatment or soil application of fungal biocontrol agents (*Trichoderma harzianum*, *Gliocladium virens* and *Aspergillus niger*) significantly increased root and shoot growth of rice plants.

The results are in agreement with the findings of Prasad and Reddi(2011) regarding management strategies to control sheath blight using biocontrol agent*T. harzianum*. Khan and Sinha (2007) reported that all the isolates of *Trichoderma* spp. significantly reduced incidence and severity of sheath blight of rice. *Trichoderma harzianum* was most effective showing 38.8 per cent and 24.6 per cent reduction in disease severity and incidence. The highest increase in grain yield /plant (21%) and 1000 grain weight (6.3%) was obtained with *T. harzianum*. Of the five isolates of *Trichoderma* spp. screened under *in vitro* and glasshouse conditions, *T. harzianum* was found most effective against *R. solani*.

**Table 5.0 : Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 30DAT (Pooled data of kharif 2016 and 2017):**

| Treatments ( 30 DAT) | Disease severity (%) | Reduction in disease severity (%) | Grain yield (g/plant) | Increase in grain yield (g/plant) |
|---|---|---|---|---|
| T1. Foliar application of Rajnandgaon isolates | 32.43 (34.71) | 10.87 | 9.35 (17.81) | 13.55 |
| T3 : Foliar application of Raipur isolates | 29.81 (33.09) | 18.09 | 10.31 (18.73) | 21.69 |
| T5. Foliar application Durg isolates | 26.84 (31.20) | **26.24** | 11.31 (19.64) | **28.51** |
| T7. Foliar application of Hexaconazole @ 0.2% | 19.09 (25.90) | **47.44** | 11.71 (20.01) | **30.90** |
| T9. Control | 36.42 (37.12) | - | 8.08 (16.51) | - |

| | | |
|---|---|---|
| SEd | 0.6188 | 0.1144 |
| CD (5%) | 1.3788 | 0.2550 |
| SE(m)+ | 0.4375 | 0.0809 |
| CV (5%) | 2.3383 | 0.7561 |

*Data in parenthesis shows Arcsine transformation

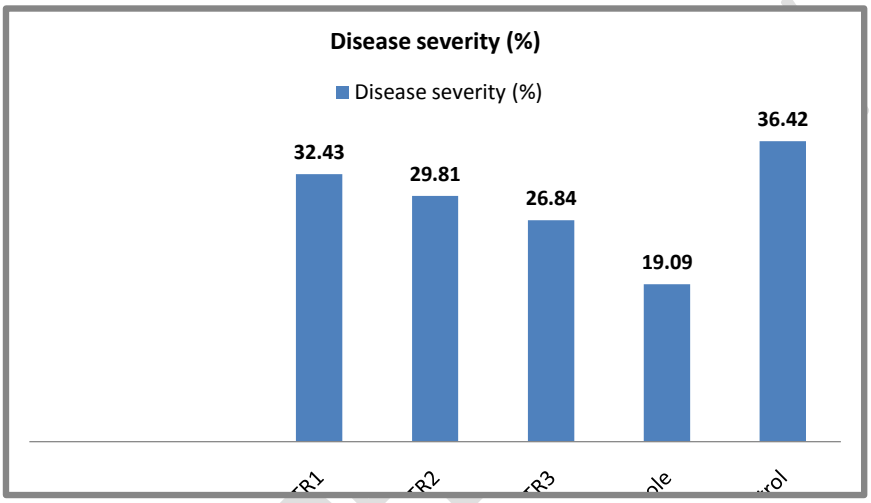


**Fig.2: Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 30DAT (Pooled data of kharif 2016 and 2017)**

**Table 6.0 : Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 60 DAT (Pooled data of kharif 2016 and 2017):**

| Treatments ( 60 DAT) | Disease severity (%) | Reduction in disease severity (%) | Grain yield (g/plant) | IncreaseinGrainyield (g/plant) |
|---|---|---|---|---|
| T2. Foliar application of Rajnandgaon isolates | 58.54 (49.92) | 13.38 | 9.94 (18.37) | 13.80 |
| T4 : Foliar application of Raipur isolates | 54.70 (47.70) | 19.13 | 11.07 (19.44) | 22.75 |
| T6. Foliar application Durg isolates | 50.83 (45.47) | **24.85** | 12.01 (20.27) | **29.13** |
| T8. Foliar application of Hexaconazole @ 0.2% | 34.41 (35.91) | **49.09** | 12.43 (20.65) | **31.14** |
| T10. Control | 67.67 (55.35) | - | 8.52 (16.97) | - |
| SEd | 0.5645 | | 0.1716 | |

| | | |
|---|---|---|
| CD (5%) | 1.2579 | 0.3824 |
| SE(m)+ | 0.3992 | 0.1213 |
| CV (5%) | 1.4743 | 1.0983 |

*Data in parenthesis shows Arcsine transformation

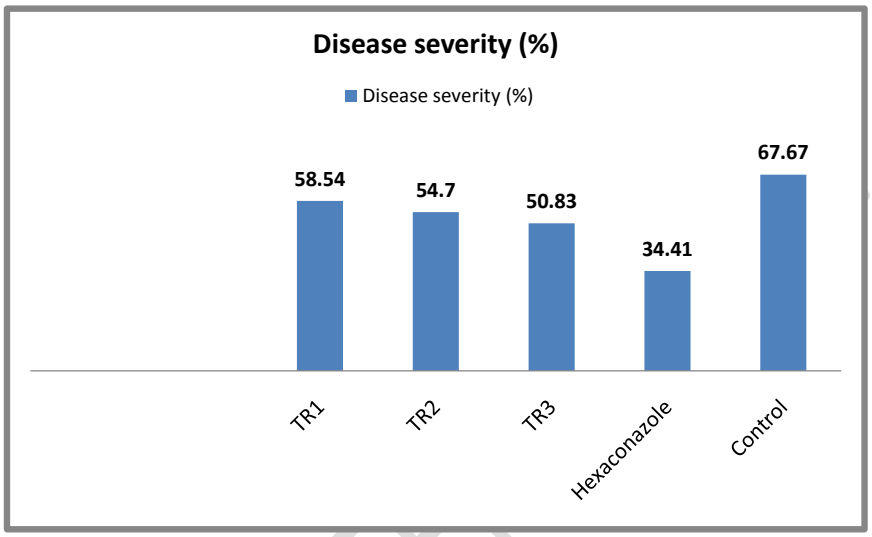


**Fig.3: Comparative efficacy of different isolates of *Trichoderma* spp. on disease severity and yield at 60 DAT (Pooled data of kharif 2016 and 2017):**

**Fig.4: Symptoms developed on plants at 10 days after second inoculation**

## CONCLUSION

In the present study, the results of evaluation of antagonists and the comparative foliar application of Raipur, Durg and Rajnandgaontrichoderma isolates showed that all isolates of*Trichoderma spp*. significantly reduced the sheath blight disease severity in rice under pot conditions at 30 DAT and 60 DAT planting.Both the foliar application of chemical and biocontrol treatments were significantly reduced disease severity. Among the *Trichoderma* isolates, foliar spray of Durg isolate (TD3) was effectively showed 26.24% reduction in disease severity at 30 DAT and 24.85% reduction in disease severity at 60 DAT over control treatment. The highest disease severity was reduced by check fungicide hexaconazole. The Durg isolate (TD3) at 30 DAT and 60 DAT also increased the yield per plant as compared to Raipur (TR2) and Rajnandgaon isolates (TR1).The bioagents can effectively control the disease and at the same time improve growth characters and thus is a better alternative to chemical application.

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