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Performance of Stress Tolerant Rice Varieties Treated with *Trichoderma* spp. under Rainfed Condition in Bihar, India

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A B S T R A C T

In Bihar rice is a major food crop and has more than 5.14 M ha area. Recent years environmental stress becoming major threats to rice cultivation and adversely affecting the productivity of crop. Drought resistance varieties and some microbes have proved their potential in mitigation of stresses and enhancing the rice yield under stress condition. In this study, two *Trichoderma* isolates were tested with three drought tolerant varieties i.e. Sahbaghi dhan, DRR44 and Neelam. The interaction effect between variety and treatment was significant. *Trichoderma* treated seed enhanced both growth and yield attributes in rice compared to untreated. Variety i.e. Sahbhjagi dhan + (T1) *Trichoderma* isolate 1 gave maximum grain (42.50 q/ha), followed by Sahbhagi dhan + (T2) *Trichoderma* isolate 2 (41.84 q/ha) and then DRR44 + (T1) *Trichoderma* isolate 1 (39.60 q/ha), DRR44 + (T2) *Trichoderma* isolate 2 (38.93 q/ha) under stress condition. The minimum grain yield (30.20 q/ha) was obtained from drought susceptible variety i.e. IR 64 under stress without seed treatment with *Trichoderma.* The results of this present work could be advised in drought prone area to alleviate stresses under field condition.

Introduction

Rice (*Oryza sativa* L) is the major source of food and income for millions of people in India. Worldwide, more than 3.5 billion people depend on rice and more than 90% of rice is grown and consumed in Asia where 60% of people on the earth live. More than 75% of the annual rice supply comes from 79 million ha of irrigated paddy land. Thus present and future food security of Asia depends largely on the irrigated rice production system. However, rice is a profligate user of water. It takes 3000-5000 liters to produce 1 kilogram of rice, which is about 2 to 3 times more than to produce 1 kilogram of other cereals such as wheat or maize (Bouman *et al.*, 2002). In Asia abiotic and bioric stress becoming major threat to rice cultivation and adversely affecting the productivity of crop under climate changing scenario. The production of rice is increasingly limited by various environmental stresses with about 30% of the 700 million poor affected in rainfed lowlands of Asia alone (Dar *et al.*, 2013). Drought, submergence and the sequential events (drought followed by submergence and viceversa) are the major constraints for rice production in such areas (Fukao *et al.,* 2011). In India, approximately 13.6 M ha of area under rice is affected from drought of varying intensities (Singh *et al.,* 2016). Stress environment induces a number of physiological, biochemical and molecular changes within plants which governs growth and productivity. The incidence, intensity and duration of environmental stresses have posed a serious threat to agricultural productivity and food security across the globe (Jones *et al.*, 2014).

In Bihar rice is premier food crop and 5.4 M ha of area under rice, which has an average productivity of only 1.2 t/ ha. More than half of the rice area is rainfed lowland, including flood-prone ecosystems, which are characterised by low productivity obtained under traditional systems of cultivation. Bihar often faces the drought situation of different scales/levels. This situation necessarily occurs when the summer mansoon gets weak and causes the departure of the seasonal rainfall from the normal. Water deficit, more commonly referred to as 'drought', has been, and continues to be the most limiting factor affecting rice production, especially in areas with inadequate agriculture water resources (Xiao *et al.,* 2008). Therefore, with the global shortage of water, reducing water consumption in crop production is recognized as an essential strategy for sustainable agriculture (Xiao *et al.,* 2008). Rice grain yield and yield components have been known to be highly influenced by water supply. Use of yield as an index for adaptation to drought stress in rice (Atlin, 2001) may be considered as a reasonable approach, as grain yield is a major attribute of interest in most plant breeding programs (Pantuwan *et al.,* 2004). However, drought tolerance is a complex trait that involves various aspects of developmental, physiological, biochemical, and molecular adjustments. Plants under drought condition survive by doing a balancing act between maintenance of turgor and reduction of water loss. Drought tolerant varieties i.e. Sahbhagi Dhan, CR Dhan 405, Sushk Samrat and Abhishek have been recognized to stabilize rice productivity in the rainfed lowlands of eastern India including Bihar (Ismail *et al.,* 2013). There is always the scope of further improvement by manipulating management practices especially under multiple stress conditions (Doni *et al.,* 2014). Recent studies have proved potential of microorganisms against abiotic and biotic stress. *Trichoderma* spp. is a common component of rhizosphere soil and has been reported to suppress a great number of plant diseases, some strains, also, have been reported to colonize the root surface, enhancing root growth and development, crop productivity, resistance to abiotic stresses, and the uptake and use of nutrients (Martínez-Medina *et al.,* 2011). In the present study two *Trichoderma* isolates were tested with three stress tolerance varieties under rainfed condition in Bihar.

Materials and Methods

The experiment was conducted during *Kharif* 2017 at the Research farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. The Experimental farm is located at an altitude of 52.0 meter from mean sea level, at latitude of 25.98^0 N and longitude of 85.67^0 E. The climate is sub-humid type and monsoon receiving an average annual rainfall of 1234.7 mm mainly during the months - June to October. The experimental plot had a uniform topography. Soil was sandy loam well drained and medium fertility. The plot size was 5 x 5 m^2. Field was ploughed then labelled. The experiment consisting of a total 16 treatments was laid out in a Factorial Randomized Block Design with three replications. After layout of experiment, sowing was done on 30 June, 2018.

Recommended fertilizer dose i.e.110:50:30 were applied. The weeds were removed manually after 45 and 75 days of sowing. The data regarding growth and yield attributes including plant height, number of tillers/m^2; panicle/m^2, total grains/panicle, filled grains/ panicle, unfilled grains/ panicle, grain yield and brown disease severity were recorded during the investigation at harvest.

Treatment details

Varieties

V1-Sahbhagi Dhan (Drought tolerant)
V2-DRR44 (Drought tolerant)
V3-Nelam (Drought tolerant)
V4-IR-64 (Drought susceptible)

Treatment

T1- Seed treatment with *Trichoderma* Formulation (IRRI isolate 1) @ 10g/kg seed

T2- Seed treatment with *Trichoderma* Formulation (IRRI isolate 2) @ 10g/kg seed

T3- Sowing of normal water seed soaked variety (Drought stress

T4- Sowing of normal water seed soaked variety (No stress)

Application of *Trichoderma* isolates

Trichoderma isolates were received under the project the STRASA (Stress Tolerant Rice for Africa and South Asia (IRRI), New Delhi, India. Seeds are taken of each treatment and kept for water soaking for 24 hr.

After water soaking, bio-control agent treatment was given @ 10gm/ kg seed and applied next day to the seed and untreated seed served as control. All the operations were done in shade and one day before sowing.

Drought creation

Direct seeded rice method was used for the sowing of treated and untreated seeds and maintained by applying irrigation; day until plants attained the age of five weeks and at this point drought treatment as given by altering the water cycle. Watering was stopped for subsequent days for each drought treatment which included 4, 7, 10 and 13 days drought stress (DDS), while control seedlings plots received water every alternate day. Between the two days drought stress period i.e. 10 and 13 were disturbed by rain but drain out the water from the field.

Results and Discussion

Results of the experiment showed that rice varieties, *Trichoderma* isolates and their interactions have significant influenced on yield under stress condition. Seed bioprimed with *Trichoderma* isolate has a significant effect on rice growth and yield attributes.

Plant height (cm)

The results related to plant height has been presented in Table 1. The statistical analysis showed significant differences among the varieties and treatments but their interaction was not found significant in plant height at harvest. Among the different varieties, the maximum plant height was observed in Neelam (110.10 cm) followed by Sahbhagi Dhan (104.52 cm), DRR44 (96.57) and IR 64 (94.90). In case of the treatments, maximum plant height (105.00 cm) was observed in (T1) *Trichoderma* isolate 1 followed by (T2) *Trichoderma* isolate 2 but both were at par with each other. The minimum plant height (97.22 cm) was observed under stress condition (T4). The results indicate that varieties x treatments interactions did not bring about any significant changes in the plant height. Plant height was significantly affected by water stress and *Trichoderma*. This result is agrees with Islam *et al.,* (1994) who found that moisture stress reduced plant height at 20% soil saturation. Some previous studies have also reported that the application of *Trichoderma* enhances the growth and grain yield in rice under stress conditions (Gusain *et al.,* 2014; Bae *et al.,* 2009) Baker *et al.,* (1988) stated that plant growth responses induced by *Trichoderma* spp. appeared to be due to both the control of minor pathogens and production of a growth-regulating factor. Windham *et al.,* (1986) stated that this fungus may produce a growth promotion substance such as exudation of plant growth stimulating factors and phytohormones like indole acetic acid (IAA) and their analogs and vitamins. Zaidi *et al.,* (2018) reported similar type of observations on plant height in the Sahbhagi dhan under rainfed condition in Bihar.

Number of Tillers/ m^2

The number of tillers was counted treatments wise at the harvest. The data were statistically computed and mean and data are presented in Table 1. In case of different varieties, the maximum number of tiller was observed with Sahbhagi dhan (301.50 tillers/ m^2) followed by DRR44 (287.58/ m^2) and Neelam (269.00/ m^2) and these were at par with each other. The lowest tillers count (247.75/ m^2) was noted in the IR 64.

In different treatments it ranged from 231.42 to 298.92/ m^2. As regards with the treatments effect, the number of tillers enhanced significantly due to increase due to *Trichoderma* at harvest. The maximum tillers (298.92/ m^2) was observed in (T1) *Trichoderma* isolate 1 followed by (T2) *Trichoderma* isolate 2 (294.83/ m^2), (T4) No stress (280.67/m^2) and these were at par with each other. The minimum tillers (231.42/ m^2) were observed under stress condition in (T4). The interaction effect between variety x treatment on number tiller was found significant and maximum tillers (346.33/ m^2) was observed in variety Shbhagi dhan with (T1) treated with *Trichoderma* isolate 1 and this was at par with other varieties with both the isolates under stress condition. However, tillers formation in varieties under stress condition treated with *Trichoderma* isolates and tillers count in varieties under no stress were at par with each other. The significant lowest tillers formation count was noted in IR64 (216.00/ m^2) under stress condition. The present finding is supported by Doni *et al.,* (2014) who reported that *Trichoderma* strain SL2 treated rice plants exhibited greatest increase in plant height and tiller number, while *Trichoderma* strain SL7 had the greatest effect in enhancing the number of leaves.

Number of panicles/ m^2

The panicles/ m^2were counted treatment wise and the data so obtained were statistically analyzed and the mean data are presented in Table 2. The different *Trichoderma* isolates as well as varieties were found to exert significant influence upon this yield attributing parameter. However, the *Trichoderma* x variety interactions were found to be significant.

Among the varieties, Sahbhagi dhan resulted in significantly higher panicles count (254.92/ m^2) as compared to DRR44 (247.00/ m^2), Neelam (242.25/ m^2) and IR64 (212.17/ m^2). That means the other varieties at par performed to that of Sahbhagi dhan with respect to the formation of panicles except IR 64.

The use of *Trichoderma* increased the panicles formation significantly. Thus the maximum panicles (260.83/ m^2) were recorded from (T1) *Trichoderma* isolate 1, followed by (T2) *Trichoderma* isolate 2 (259.00/ m2) and both were at par with each other. The significantly lowest 194.33 panicles/ m2 from (T3) under stress. The interaction effect between variety x treatment on number of panicles/m^2 was found significant and maximum panicles (286.67/ m^2) was observed in variety Shbhagi dhan with treated (T1) *Trichoderma* isolate 1 followed by variety DRR44 (284.33/ m^2) with treated (T1) *Trichoderma* isolate 1, Shbhagi dhan (282.00/ m^2) with treated (T2) *Trichoderma* isolate 2 and variety DRR44 (275.67/ m^2) with treated (T2) *Trichoderma* isolate 2 under stress condition and these were at par with each other. The significant lowest panicles formation count was noted in IR6 (171.66/ m^2) under stress condition. Several workers reported that *Trichoderma* spp under any stress enhances root growth, helps in water absorption and improves the nutrient uptake (Howell, 2003; Harman *et al.,* 2004; Contreras-Cornejo *et al.,* 2009, Chen *et al.,* 2013, Zaidi *et al.,* 2018) resulted increased growth and yield attributing characters. *Trichoderma* also make the available form of nutrient by secreting some organic acid and other substances.

Number of grains /panicle

The results related to number of grains presented in Table 2. Number of grains/ panicle ranged from 145.16 to 184.66 and 150.33 to 187.17 in varieties and treatments respectively. The statistical analysis showed significant differences among genotypes, treatments and their interaction. Among the varieties, the maximum grain / panicle (184.66) were observed in Sahbhagi dhan followed by Neelam (180.83 grains/ panicle) and both were at par with each other. The minimum grains/panicle (145.16) was observed in IR 64. The use of *Trichoderma* increased the grains formation/ panicle significantly. The maximum grains (184.17/panicle) were recorded from (T1) *Trichoderma* isolate 1, followed by (T2) *Trichoderma* isolate 2 (175.00/ panicle). The significantly lowest 80.33grains /panicle from (T3) under stress. The interaction effect between variety x treatment on number of grains/panicle was found significant and maximum grains (207.33/ panicle) was observed in variety Shbhagi dhan with treated (T1) *Trichoderma* isolate 1 followed by Neelam (200.33/ panicle) with treated (T1) *Trichoderma* isolate 1, and both were at par with each other.

The significant lowest grains formation per panicle count was noted in IR6 (216.00/ panicle) under stress condition. The present finding is supported by Puja Kumari (2016) who reported significantly maximum panicle/ m^2 with seed treated *Trichoderma harzianum* in rice under stress condition compared to control.

Number of filled grains/panicle

The filled grains/panicle were observed and counted and the mean data are presented in Table 3. The statistical analysis showed significant differences among genotypes, treatments and their interaction. Total filled grains/ panicles ranged from 98.17 to 149.25 and 97.92 to 146.83 in varieties and treatments respectively.

Among the varieties, the maximum filled grains / panicle (149.25) was observed in Sahbhagi dhan followed by Neelam (135.33 filled grains/ panicle), DRR 44 (131.42 filled grains/ panicle). The minimum filled grains/panicle (98.17/ panicle) was observed in IR 64 under stress without seed treated with *Trichoderma*. The maximum filled grains (146.83/ panicle) were recorded from (T1) *Trichoderma* isolate 1, followed by (T2) *Trichoderma* isolate 2 (139.41/ panicle) and both were at par with each other under stress condition. The significantly lowest 97.92 filled grains /panicle from (T3) under stress without seed treatment with *Trichoderma*.

Table.1 Average plant height and tillers of rice varieties as influenced by *Trichoderma* isolates

	Plant height (cm)					Tillers/ m^2				
Varieties	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean	T1 (Stress + IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean
Sahbhagi Dhan	108.93	105.87	100.60	102.67	104.52	346.33	317.67	251.00	291.00	301.50
DRR44	100.40	98.53	92.20	95.13	96.57	326.67	305.67	238.00	280.00	287.58
Neelam	113.67	115.33	104.00	107.47	110.12	270.00	315.67	220.67	269.67	269.00
IR64	97.00	94.87	92.07	95.67	94.90	252.67	240.33	216.00	282.00	247.75
Mean	105.00	103.65	97.22	100.23		298.92	294.83	231.42	280.67	

	Variety	Treatment	Variety X Treatment	Variety	Treatment	Variety X Treatment
CD(P=0.05)	4.21	4.21	NS	38.26	38.26	76.53
CV%	5.07			16.60		

Table.2 Average panicles and total grain of rice varieties as influenced by *Trichoderma* isolates

	Panicles/ m^2					Total grain /panicle				
Varieties	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean	T1 (Stress +IRRI isolate1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean
Sahbhagi Dhan	286.67	282.00	206.33	244.67	254.92	207.33	192.67	163.00	175.67	184.66
DRR44	284.33	275.67	194.67	233.33	247.00	183.33	178.33	146.33	153.67	165.42
Neelam	255.67	261.33	204.67	247.33	242.25	200.33	188.33	158.00	176.67	180.83
IR64	216.67	217.00	171.66	243.33	212.17	145.67	140.67	134.07	160.33	145.16
	260.83	259.00	194.33	242.17		184.17	175.00	150.33	166.58	

	Variety	**Treatment**	**Variety X Treatment**	**Variety**	**Treatment**	**Variety X Treatment**
CD(P=0.05)	17.20	17.20	34.40	8.91	8.91	17.84
CV%	8.63			6.32		

Table.3 Average filled and unfilled grain of rice varieties as influenced by *Trichoderma* isolates

	Filled grain /panicle					Unfilled grain /panicle				
Varieties	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean
Sahbhagi Dhan	173.33	163.33	114.67	145.67	149.25	34.00	29.33	48.33	30.00	35.42
DRR44	152.33	145.67	105.33	122.33	131.42	31.33	32.00	41.00	31.33	33.92
Neelam	156.00	147.00	102.00	136.33	135.33	44.33	41.33	56.00	40.33	45.50
IR64	102.67	101.67	69.67	118.67	98.17	43.00	39.00	64.33	41.67	47.00
	146.83	139.41	97.92	130.75		38.16	35.42	52.41	35.83	

	Variety	**Treatment**	**Variety X Treatment**	**Variety**	**Treatment**	**Variety X Treatment**
CD(P=0.05)	8.71	8.71	17.44	4.32	4.32	8.64
CV%	8.13			12.80		

Table.4 Average severity of brown spot and grain yield of rice varieties as influenced by *Trichoderma* isolates

	Severity of Brown spot					grain yield q/ha				
Varieties	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean	T1 (Stress +IRRI isolate 1)	T2 (Stress +IRRI isolate 2)	T3 (Stress)	T4 (No Stress)	Mean
Sahbhagi Dhan	21.67 (27.71)	23.33 (28.85)	33.33 (35.25)	28.33 (32.14)	26.67 (30.98)	42.50	41.60	35.53	37.67	39.33
DRR44	21.00 (27.27)	23.33 (28.85)	31.67 (34.23)	27.33 (31.48)	25.83 (30.45)	39.60	38.93	33.17	35.70	36.85
Neelam	28.33 (32.15)	31.67 (34.23)	38.67 (38.44)	33.33 (35.25)	33.00 (35.20)	38.57	38.07	31.93	34.73	35.83
IR64	35.00 (36.27)	36.67 (37.26)	39.33 (38.84)	36.67 (37.26)	36.92 (37.41)	33.60	32.98	30.20	35.57	33.09
	26.50 (30.84)	28.75 (32.30)	35.75 (36.70)	31.42 (34.03)		38.57	37.90	32.70	35.92	

	Variety	**Treatment**	**Variety X Treatment**	**Variety**	**Treatment**	**Variety X Treatment**
CD(P=0.05)	2.31(1.47)	2.31(1.47)	4.62	1.83	1.83	3.66
CV%	9.08(5.28)			6.03		

The interaction effect between variety x treatment on number of filled grains/panicle was found significant and maximum filled grains (173.33/panicle) was observed in variety Shbhagi dhan with treated (T1) *Trichoderma* isolate 1 followed by variety Shbhagi dhan (163.33/panicle) with treated (T2) *Trichoderma* isolate 2 and Neelam (156.00/panicle) with treated (T1) *Trichoderma* isolate 1. The minimum filled grains / panicle (69.67) was noted in IR64 (216.00/ panicle) under stress without seed treated with *Trichoderma*. These results are in agreement with the findings of Zaidi *et al.*, (2018) who reported that the application of *Trichoderma* (S2) enhances panicle weight, number of filled grains per panicle and grain yield in rice under stress.

Number of unfilled grains/panicle

The unfilled grains /panicle were also observed and counted treatment wise and the data were subjected to statistical analysis. The mean values are exhibited in Table 3. The different varieties showed significant differences in their unfilled grains/ panicle. The minimum unfilled grains / panicle (33.92) was noted in DRR44 followed by Shbhagi dhan (35.42 filled grains/ panicle) and both were at par with each other, whereas IR – 64 recorded significantly higher unfilled grains (47.00 filled grain /panicle).

Among the treatments, significant maximum unfilled grains/ panicle (35.44) was recorded in (T2) *Trichoderma* isolate 2 followed by (T1) *Trichoderma* isolate 1 (38.16 unfilled grains/ panicle) but both were at par with each other. The maximum unfilled grains/ panicle (52.41) was observed in IR 64 under stress condition without untreated seed of *Trichoderma*. The interaction effect between variety x treatment on number unfilled grains/panicle was found significant and minimum unfilled grains (29.33/panicle) was observed in variety Shbhagi dhan with treated (T2) *Trichoderma* isolate 1 followed by variety DRR44 (31.33/panicle) with treated (T2) *Trichoderma* isolate 2 and DRR 44 (32.00/panicle) with treated (T2) *Trichoderma* isolate 2 and these were at par with each other under stress with seed treatment with *Trichoderma*. The maximum unfilled grains / panicle (64.33) was noted in IR64 under stress without seed treated with *Trichoderma*. Similar finding also reported by Puja Kumari (2016) who observed significantly maximum unfilled grains/panicle in rice variety IR 64 under stress condition.

Brown spot disease severity on rice

The severity of brown spot disease of rice is recorded and data are presented in Table 4. Brown spot disease severity was low in all the varieties compared to untreated. The different varieties showed significant differences in their disease severity. Among the varieties, significant minimum disease severity (25.83%) was recorded in DRR44 followed by Sahbhagi dhan (26.67%) and both were at par with each other. The maximum brown spot disease severity was noted in IR 64 (36.92%).

The minimum disease severity (26.50%) was recorded with (T1) *Trichoderma* isolate 1 followed by (T2) *Trichoderma* isolate 2 (28.75%) but both were at par with each other. The maximum brown spot disease severity (35.75 %) was observed in (T3) under stress and untreated seed. The interaction effect between variety x treatment on brown spot disease severity was significant and minimum disease severity (21.00%) was observed in variety DRR44 with treated (T1) *Trichoderma* isolate 1 followed by variety Sahbhagi dhan (21.67%)) with treated (T1) *Trichoderma* isolate 1, Sahbhagi dhan (23.33%)) with treated (T1) *Trichoderma* isolate 1and DRR 44 (23.33%) with treated

(T2) *Trichoderma* isolate 2. All these were at par with each other under stress with seed treatment with *Trichoderma*. Similarly, Harish *et al.,* (2007) stated that spraying of spore suspension of *Trichoderma* isolates on rice plant significantly inhibited the growth and spore germination of *B. oryzae* besides increasing seedling growth. Kumawat *et al.,* (2008) also found that pre-application of spore suspension of *T. harzianum* and *T. viride* reduced the infection of *B. oryzae,* which was attributed to increased level of total soluble protein and total phenol contents.

Grain yield

The results related to grain yield has been presented in Table 4 and the grain yield q/ha was obtained from after converting the plot wise yield under different treatments. The T*richoderma* isolates as well as varieties exerted significant impact upon the grain yield. The statistical analysis showed significant differences among genotypes treatments and also the interaction between genotypes and treatments was found significant. Among the varieties, significant maximum grain yield (39.33q/ ha) followed by DRR44 (36.85 q/ ha and Neelam (35.83q/ ha). However DRR44 and Neelam were at par with each other. Significantly lowest grain yield (33.09 q/ ha) was observed in IR 64. The treatment interactions were found to be significant, however Sahbhjagi dhan + (T1) *Trichoderma* isolate 1 produced the maximum grain (42.50 q/ ha), followed by Sahbhagi dhan + (T2) *Trichoderma* isolate 2 (41.84 q/ ha) and then DRR44 + (T1) *Trichoderma* isolate 1 (39.60 q/ ha), DRR44 + (T2) *Trichoderma* isolate 2 (38.93 q/ ha). The minimum grain yield (30.20 q/ ha) was obtained from IR 64+ (T3) under stress in untreated with *Trichoderma*. Pantuwan *et al.,* (2001) reported that the drought tends to delay the flowering and higher delay in rice was associated with low grain yield and harvest index. These yield components were very much governed by chaffy seeds and less fertile grains. The application of some microbial formulations has the potential to enhance the stress mitigating effects of rice varieties. On-station evaluation results suggested that the application of some of the microbial formulations either exclusively or in combination with FYM had positive effect on yield and yield parameters of drought tolerant rice variety Sahbhagi dhan (Zaidi *et al.,* 2018). Some previous studies have also reported that the application of *Trichoderma* enhances the growth and grain yield in rice under stress conditions (Gusain *et al.,* 2014; Bae *et al.,* 2009). The high yield associated with potassium application may be due to its greater uptake and active participation in all structure, carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar, entry of water into plants root and development etc. The possible reason of enhancement in yield attributes may be due to these facts. These microbes reduced disease infestation, secretes organic acid which converted insoluble form of nutrient to soluble form and also provided some additional micro nutrient, vitamins, auxin etc. hydrogel solution provides medium to absorb these compound by eliminating water stress condition. Higher amount of nutrient was taken up by the plant which increases photosynthetic ability, photosynthetate translocation and accumulation. In conclusion, drought tolerant variety Sahbhagi dhan treated with *Trichoderma* isolate 1 could be a better option in the drought affected districts of Bihar and we can get significant more yield compared to drought susceptible varieties.

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