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Efficacy of *Trichoderma* and Agrochemical Against Grain Smut of Little Millet (*Macalpinomyces sharmae*)

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ABSTRACT

A study was carried out during 2014-15 at Jawaharlal Nehru KrishiVishwaVidyalaya, College of Agriculture, Rewa (M.P.) to see the effect of *Trichoderma* and agrochemicals on grain smut of little millet (*Panicum sumatrense*). The average grain smut incidence ranged 21.3% to 67.7%, severity 1.1 to 3.9% and susceptibility index ranged 5.05 to 16.25 in different treatments. Percent reduction in susceptibility index of grain smut ranged 26.8 to 68.9% and was highest in seed treatment (ST) with Carboxin @ 2g kg^{-1} seed followed by seed treatment with Carbendazim @ 2g kg^{-1}. Among *Trichoderma* isolates, maximum reduction in SI was recorded in seed treatment with Sidhi isolate Tr-7 (41.0%) followed by Rewa isolate Tr-2 (40.9%).Highest grain yield was recorded in seed treatment with Carbandazim @ 2g kg^{-1} seed closely followed by ST with Carboxin (990 kg ha^{-1}).

Key words *Millet, Susceptibility, Seed treatment, Smuts*

Little millet (*Panicum sumatrense* Roth ex Roemer and Schultes), locally known as kutki, mejhari, medois one of the hardiest minor cereal crop belonging to the family Poaceae (Gramineae) and is indigenous to Indian sub continent. The crop is cultivated by tribal and poor farmers in low fertile soils with low or no cash input for food and feed. It has an excellent rejuvenating capacity compared to other cereal crops. In India, the crop is cultivated in an area of 291 thousand hectares with annual production of 102 thousand tones and productivity of 349 kg per hectare (Anonymous, 2011) which is very less as compared to other cereal crops. Andhra Pradesh, Chhattishgarh, Madhya Pradesh, Odisa, Tamil Nadu, Karnataka, Jharkhand and Gujarat are major little millet growing states in the country. In Madhya Pradesh, the crop is cultivated in 51.54 thousand hectare with productivity of 525.5 kg per hectare (www.landrecords.mp.gov.in). Dindori, Mandla, Chhindwara, Balaghat, Seoni, Anuppur, Betal, Singrauli, Umaria, Sidhi, Shahdol, Jabalpur, Narsinghpur, Raisen and Khandwa are major little millet growing districts of Madhya Pradesh.The crop is highly drought tolerant and nutritionally as well as medicinally superior or at par with other cultivated cereals. Grains are recommended for diabetic and patients of cardio –vascular diseases.The grain of little millet posses excellent storage properties and can be stored for several years without fear of store grain pests under ordinary storage conditions. Little millet is well known for its drought tolerance and is considered as one of the least water demanding crop. Being eco-friendly, the crop is suitable for fragile and vulnerable agro-ecosystems. Grain smut (*Macalpinomyces sharmae),* rust (*Uromyceslinearis*), banded leaf and sheath blight (*Rhizoctoniasolani*) and Udbatta (*Ephelisoryzae*) are important fungal diseases occurred at different stages of plant growth and caused economical yield loss under favourable environmental conditions (Pall *et al.*, 1980, Jain *et al.*,1997 and Chauhan, 2014).

In India, grain smut was first reported by Sharma and Khare (1987) from Dindori district of Madhya Pradesh and causal organism was identified as *Tolyposporium sp.*. Later, it was described as *Macalpinomyces sharmae* K. Vanky (Vanky 1995).The disease is also reported from Jharkhand, Chhattisgarh and Tamil Nadu states of the country (Anon. 2004 and 2012, Haider 1997). Sharma and Khare (1987) noticed up to 50 per cent plants/ grains affected by the pathogen whereas Jain *et al.* (2006) reported 9.8 to 53.5 per cent reduction in grain yield per plant, 4.2 to 16.6 per cent in plant height and 6.4 to 38.9 per cent in panicle length. Jain and Joshi (2015) recorded 2.1 to 18.9% loss in grain yield due to grain smut in little millet.

The disease is ovaricolous and symptoms appeared at grain formation stage. The affected ovary is converted into smut sorus, but does not increase in size than the normal grain. Some of the late developing grains remain greenish and increase in size slightly over the normal grains. On pressing such greenish healthy appearing grains release spores (Sharma and Khare 1987). Studies on management of grain smut in little millet is meager in the literature, however few studies on identification of resistant sources and management through seed treatment with Carboxin and Carbendazim has been reported. The present study focused on status of the disease in the farmers field, identification of resistant sources, association of agro – morphological parameters with the disease and biological control of the disease with the objective to study the effectiveness of selected isolates of *Trichoderma* species against grain smut of little millet under field conditions.

MATERIAL AND METHODS

The present investigation entitled "Efficacy of *Trichoderma* and agrochemical against grain smut of little millet (*Panicum sumatrense*)" was carried out during 2014-15 at Jawaharlal Nehru KrishiVishwaVidyalaya, College of Agriculture, Rewa (M.P.). The field trials were conducted at experimental area of All India Coordinated Small Millets Improvement Project, College of Agriculture, Rewa (M.P.). The field experiments were conducted in the experimental area of All India Coordinated Small Millets Improvement Project, J.N.K.V.V., College of Agriculture, Rewa (M.P.) during kharif 2014. The soil of experimental field is Silty clay loam in texture, neutral in reaction (ph 7.1), medium in

Table 1. Source location of *Trichoderma* isolates and treatment details

Treatment code	Treatment details	Doses (g kg^{-1} seed)	Place of collection (District)
T_1	ST with Tr-1	5 g	Satna
T_2	ST with Tr-2	5 g	Kuthulia, Rewa
T_3	ST withTr-3	5 g	Khargone
T_4	ST with Tr-4	5 g	Indore
T_5	ST with Tr-5	5 g	Umaria
T_6	ST with Tr-6	5 g	Birkham, Rewa
T_7	ST with Tr-7	5 g	Sidhi
T_8	ST with Carbendazim	2 g	-
T_9	ST with Carboxin	2 g	-
T_{10}	Untreated check	-	-

ST=Seed treatment, Tr = *Trichoderma* isolate

organic carbon (0.52%), low in available nitrogen (215 kg/ ha), phosphorus (14.3 kg/ha) and high in potash (232.4 kg/ ha).

In vivo, seven isolates of *Trichoderma* procured from Department of Plant Pathology, College of Agriculture, Rewa along with two fungicides namely Carbendazim and Carboxin were tested for their effectiveness against grain smut of little millet. Seeds of grain smut susceptible little millet variety JK 8 were treated with different isolates of *Trichoderma* @ 5 g kg-1 seed and fungicides @ 2 kg-1 seed before sowing. The treated seeds were sown in a plot size of 3x 1.0 m in randomized block design with three replications during kharif season. Row to row and plant to plant spacing was maintained 22.5 cm and 7.5 cm, respectively. Recommended doses of fertilizer i.e40:20:0 kg NPK ha^{-1}, respectively was given for optimum plant growth. Grain smut incidence & severity were recorded in different treatments at dough stage. Grain yield per plot was recorded at maturity and converted into kg per hectare.

Grain smut incidence (%) and severity (%) were recorded at dough stage. Susceptibility index (SI) was calculated using the following formula.

$$\text{Grain smut incidence (\%)} = \frac{\text{Total smutted plants in one row}}{\text{Total plants in one row}} \times 100$$

$$\text{Grain smut Severity (\%)} = \frac{\text{Total smutted grains per panicle}}{\text{Total grains per panicle}} \times 100$$

Susceptibility index= Ö incidence ´ severity

RESULTS AND DISCUSSION

Effectiveness of selected isolates of *Trichoderma* against grain smut of little millet

Grain smut incidence (%), severity (%) and susceptibility index (SI) in seed treatment with isolates of *Trichoderma* and fungicides are presented in table 2. Data revealed that all the isolates of *Trichoderma* showedvariable efficacy to reduce the grain smut incidence. The average grain smut incidence ranged 21.3% to 67.7%, severity 1.1 to 3.9% and susceptibility index ranged 5.05 to 16.25 in different treatments. Percent reduction in susceptibility index of grain smut ranged 26.8 to 68.9% and was highest in seed treatment (ST) with Carboxin @ 2g kg^{-1} seed followed by seed treatment with Carbendazim @ 2g kg^{-1}. Among *Trichoderma* isolates, maximum reduction in SI was recorded in seed treatment with Sidhi isolate Tr-7 (41.0%) followed by Rewa isolate Tr-2 (40.9%). Both the treatments were at par in reducing the grain smut incidence in little millet. Reduction percentage of susceptibility index was recorded in following order. ST with Carboxin (68.9%) followed by ST with Carbendazim (67.7%), ST with Tr-7 (41.0%), ST with Tr-2 (40.9%), ST with Tr-3 (36.5%), ST with Tr-4 and Tr-5 (30.5%), ST with Tr-6 (29.3%) and ST with Tr-1 (26.8%). Grain yield varied from 730 to 1010 kg ha^{-1} in different treatments. Highest grain yield was recorded in seed treatment with Carbandazim @ 2g kg^{-1} seed closely followed by ST with Carboxin (990 kg ha^{-1}). Among the ST with *Trichoderma* isolates, maximum grain yield was recorded in Tr-2 (930 kg ha^{-1}) followed by Tr-7 (900 kg ha^{-1}). Percent increase in grain yield due to ST with *Trichoderma* and fungicides, ranged 11.0 to 38.3%, which was highest in ST with Carbendazim followed by Carboxin (35.6%). Maximum increase in grain yield due to *Trichoderma* application was recorded in Tr-2 (27.4%) followed by Tr-7 (23.3%). *Trichoderma* isolates collected from Sidhi (Tr-7) and KuthuliaRewa (Tr-2) were found effective to minimize the grain smut incidence and enhance the grain yield.

Biological agents like *Trichoderma s*pecies have been reported effective against smut causing pathogens. The mode of action in case of *Macalpinomycessharmae* due to *Trichoderma spp.* have been recognized as mycoparasitism, antibiosis and competition for food, space or oxygen (Chet 1987). Effectiveness of *Trichoderma* isolates as seed treatment for the management of grain smut in little millet was observed. All the seven isolates were found to reduce the grain smut susceptibility index (SI) from 26.8 to 41.0% though maximum reduction in SI was recorded in seed treatment with Carboxin @ 2g kg^{-1} seed (68.9%) andCarbendazim @ 2g kg^{-1} seed (67.7%). Among the seven isolate, Tr- 7 (Sidhi isolate) was found more effective to reduce the grain smut incidence as compared to other isolates. In these treatments 23.3 to 27.4% increased grain yield was recorded over the control. Similar results were

Table 2. Effectiveness of selected local isolates of *Trichoderma* species against grain smut of little millet

Treatments	Treatment details	Doses (g kg^{-1} seed)	Grain smut				Grain yield (kg ha^{-1})	% increase in grain yield
			Incidence (%)*	Severity (%)**	Susceptibility index (SI)	% reduction		
T_1	STwith Tr-1	5	48.8 (44.28)	2.9 (1.69)	11.89	26.8	810	11.0
T_2	ST with Tr-2	5	40.2 (39.36)	2.3 (1.49)	9.61	40.9	930	27.4
T_3	ST with Tr-3	5	44.7 (41.98)	2.4 (1.54)	10.32	36.5	850	16.4
T_4	ST with Tr-4	5	45.5 (42.39)	2.8 (1.65)	11.29	30.5	840	15.1
T_5	STwith Tr-5	5	47.3 (43.45)	2.7 (1.63)	11.30	30.5	830	13.7
T_6	ST with Tr-6	5	48.8 (44.33)	2.7 (1.63)	11.48	29.3	840	15.1
T_7	ST with Tr-7	5	39.9 (39.14)	2.3 (1.50)	9.58	41.0	900	23.3
T_8	ST with Carbendazim	2	25.1 (30.02)	1.1 (1.05)	5.25	67.7	1010	38.3
T_9	ST with Carboxin	2	21.3 (27.42)	1.2 (1.07)	5.05	68.9	990	35.6
T_{10}	Untreated check	-	67.7 (55.39)	3.9 (1.97)	16.25	-	730	-
	LSD (5%)		3.645	0.470			151.17	

Figures in parentheses are arc sin (*) and square root (**) transformed values
Trichoderma isolates
(Tr-1=Satna, Tr-2= Kuthulia ,Rewa, Tr-3= Khargone Tr-4= Indore Tr-5= Umaria Tr-6= Birkham, Rewa, Tr-7= Sidhi)

also reported in different crops against smut diseases. Kumar *et al.* (2014) studied the morphological characterization of *Trichoderma harzianum* from Madhya Pradesh and reported fasted radial growth rate on PDA isolate collected from Kuthulia, Rewa. Some *Trichoderma* rhizosphere competent strains have shown to have direct effects on plants including increased growth and nutrient uptake fertilizer efficiency utilization, rate of seed germination and induced systemic resistance to diseases (Chet, 2012). Effectiveness of *Trichoderma viride* against *Ustilagohordei* causing covered smut of barley (Singh, 1999) and loose smut as well as flag smut of wheat (Singh and Maheshwari 2001,Beniwal*et al.* 2002) have been reported. *Trichoderma harzianum* was also found effective against *Tilletiafoetida*and *T. caries* in wheat (Agrawal and Sood, 2000) and *Ustilagopanici-frumentacei* causing grain smut of barnyard millet (Erayya*et al.* 2010). Effectiveness of *Trichoderma koningii*against *Ustilagosegatumtritici* was reported by Mondal *et al.* (1996). Nemade (2012) reported the effectiveness of *Trichoderma* isolates against *Sorosporiumpaspalithunbergii* causing head smut in kodo millet. Rewa isolate of *Trichoderma* was reported most effective in inhibiting the radial growth of head smut causing pathogen.

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