Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 3164-3167
Received: 11-05-2018
Accepted: 15-06-2018

TSSK Patro
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

A Meena
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

M Divya
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

N Anuradha
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

Correspondence
TSSK Patro
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

Biological control of *Rhizoctonia solani*, the causal agent of sheath blight in foxtail millet

TSSK Patro, A Meena, M Divya and N Anuradha

Abstract
Sheath blight caused by *Rhizoctonia solani* is one of the most serious diseases worldwide. The disease is currently managed only by the excessive application of chemical fungicides which are toxic and not environmentally friendly. Therefore, greater emphasis should be given to biological control as being both safe and effective. A field experiment was conducted during *kharif* 2017, at Agricultural Research Station, Vizianagaram for the management of banded sheath blight disease in foxtail millet by using potential bio control agents *viz*., *Bacillus subtilis, Pseudomonas fluorescens* and *Trichoderma asperellum*. Lowest sheath blight intensity (45.33%) was recorded in T_7 (*i.e.* Soil application of value added *P. fluorescens* + *T. asperellum* + *B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing) and the highest (62.67%) in T_4 whereas it was 92.00% in the control. In mean of all locations the lowest sheath blight intensity (29.24) was recorded in T_7 *i.e.* soil application of value added *P. fluorescens* + *T. asperellum* + *B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) and the highest (43.09%) in T_2 whereas it was 63.59% in the control.

Keywords: foxtail millet, bio control, *R. solani*

Introduction
Millets have been in food use since time immemorial and an array of traditional healthy foods are prepared across rural India. Foxtail millet (*Setaria italica* L.), a crop rich in nutrients, originated in China. Presently, foxtail millet is extensively cultivated as a food and fodder crop throughout Eurasia and the Far East (Ning, 2015) [15]. Millets have been in food use since time immemorial and an array of traditional healthy foods are prepared across rural India. However, food use of millets is fast decreasing due to several reasons. Apart from health benefits, millets are also good source of energy, protein, vitamins and minerals (Ravindran, 1991) [20]. Millet foods are also known for their low glycemic index (Itagi, 2003 and Singh *et al.* 2010) [11, 22]. There is therefore a need to revive these important groups of health promoting foods to enhance nutritional quality of diets of consumers. Among the millets foxtail millet (*Setaria italica*) is an important underutilized grain, grown in various parts of India. It grows well even under adverse agro climatic conditions. It is also called as navane. Among the millets, foxtail millet is a good source of protein (12.3 g/100g) and dietary fiber (14g/100g). The carbohydrate content is low (60.9 g/100g). Besides, it is rich in minerals (3g/100g) and phytochemicals. Foxtail millet is a good source of ß carotene (126-191 µg/100g, Goudar *et al.* 2011) [6]. This millet has been proved to be suitable for people suffering from metabolic disorders (Itagi, 2003) [11]. Hence, in the present study foxtail millet was chosen for development of nutritious bread.

Banded blight of foxtail millet incited by *Rhizoctonia solani* (Kuhn.) (Basidial stage: *Thanatephorus cucumeris* (Fr.) Donk) is one of the emerging malady in successful cultivation of foxtail millet. The *R. solani* is cosmopolitan fungus with a very wide host range (Nagaraj *et al.* 2017) [14]. The fungus has a worldwide distribution (Ogoshi, 1987) [16] and isolates of *R. solani* are highly variable in aggressiveness. Lalu Das and Girija (1989) for the first time reported as sheath blight of ragi from Vellayani in Kerala, where it occurred in a severe form. During *Kharif*, 2007 twenty one entries were screened against banded blight in foxtail millet. Two entries of foxtail millet (SIA 2757 and SIA 326) were free from the disease whereas 6 entries, *i.e.* TNAU 219, TNAU 248, SIA 2723, SIA 3036, SIA 3085 and GPUS 30, were found resistant (Jain and Gupta, 2010) [12]. However, the disease was observed in severe form at the Agricultural Research Station in Vizianagaram, The widespread adoption of new, susceptible, high-yielding cultivars with large numbers of tillers, and the changes in cultural practices associated with these cultivars, favor the development of sheath blight and contribute greatly to the rapid increase in the incidence and severity of this disease in rice-producing

areas throughout the world (Groth *et al*. 1991; Rush and Lee, 1992) [8, 21]. Furthermore, environmental conditions such as low light, cloudy days, high temperature and high relative humidity also favor the disease (Ou, 1985) [17]. The pathogen overwinters as soil-borne sclerotia and mycelium in plant debris; these constitute the primary inoculums. The disease is characterized by oval to irregular, light grey to dark brown lesions on the lower leaf sheath. In advanced stages, the lesions enlarge rapidly and coalesce to cover large portions of the sheath and leaf lamina. At this stage, the disease symptom is characterized by a series of copper or brown color bands across the leaves giving a very characteristic banded appearance.

Control of the pathogen is difficult because of its ecological behavior, its extremely broad host range and the high survival rate of sclerotia under various environmental conditions (Groth *et al*. 2006) [9]. In the absence of a desired level of host resistance, the disease is currently managed by excessive application of chemical fungicides, which have drastic effects on the soil biota, pollute the atmosphere and are environmentally harmful. Some potentially effective fungicides are highly phytotoxic to the crop and, if the disease is not severe, these fungicides may reduce yield (Groth *et al*. 1990) [7]. It is difficult to achieve control through host resistance or fungicides, therefore, biological control may be effective in minimizing the incidence of sheath blight (Das and Hazarika, 2000) [3]. So an experiment was conducted at Agricultural Research Station, Vizianagaram during *Kharif* 2017.

Materials and Methods

A field experiment was conducted during *kharif* 2017, at Agricultural Research Station, Vizianagaram for the management of banded blight disease in finger millet by using potential biocontrol agents like *Bacillus subtilis*, *Pseudomonas fluorescens* and *Trichoderma asperellum*. These isolates were collected from Department of Biological control, Vizianagaram. The experiment was laid out in randomized block design (RBD) with three replications at spacing of 22.5×10 cm with 3×3 m plot size. Standard agronomic practices of NPK-50kg, 40kg, 25kg were followed at the time of crop growth period. A susceptible variety (Co 5) was used in this experiment by imposing the following treatments: (Table 1).

The disease severity and yield were recorded and the data was statistically analysed by following the standard procedures (Gomez and Gomez, 1984) [5]. Banded blight (Anon, 1996) [1] was recorded by using 0 to 9 scale (Table 2). The percent disease index (PDI) was calculated by using the following formula:

$$PDI = \frac{\text{Sum of all the numerical ratings}}{\text{Number of observations} \times \text{Maximum disease grade}} \times 100$$

Table 1: Treatments

T1	Seed treatment with *Trichoderma asperellum* @ 10 g/kg
T2	Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg
T3	Seed treatment with *Bacillus subtilis* @ 10 g/kg
T4	Soil application of value added *P.f.* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing
T5	Soil application of value added *T.a.* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing
T6	Soil application of value added *B.s.* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing
T7	Soil application of value added *P.f. + T.a. + B.s.* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing
T8	Control

Table 2: Standard Evaluation System (SES) scale for sheath blight disease

Score	Description	Reaction
0	No incidence	No disease/HR
1	Vertical spread of the lesions up to 20% of plant height	R
3	Vertical spread of the lesions up to 21-30% of plant height	MR
5	Vertical spread of the lesions up to 31-45% of plant height	MS
7	Vertical spread of the lesions up to 46-65% of plant height	S
9	Vertical spread of the lesions up to 66-100% of plant height	HS

Statistical Analysis: The data was analyzed by applying statistical tools of ANOVA (Analysis of variance) technique for drawing conclusions from the data. Critical difference (C.D) was calculated to see the significant and non-significant difference between the mean values of sheath blight PDI in all the treatments.

Results and Discussion

All the treatments were found significantly superior over check in controlling the disease. Among all the treatments tested, the lowest sheath blight intensity (24.45%) was recorded in T_7 *i.e.* soil application of value added *P. fluorescens + T. asperellum + B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) followed by 35.56% in T_5 *(i.e.,* Soil application of value added *T.a.* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) applied over an acre at the time of sowing) and the highest (68.60%) in T_2 whereas it was 94.92% in the control. And high grain (1465.22 kg/ha) and fodder yield (2488.89 kg/ha) was found in T_7 whereas, it was 1192.22 kg/ha and 1873.56 kg/ha in the control respectively (Table 3).

In mean of all locations the lowest sheath blight intensity (29.24) was recorded in T_7 *i.e.* soil application of value added *P. fluorescens + T. asperellum + B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) and the highest (43.09%) in T_2 whereas it was 63.59% in the control. And high grain (1518.52 kg/ha) and

fodder yield (2477.80 kg/ha) was found in T_7 whereas, it was 1240.74 kg/ha and 1148.20 kg/ha in the control Patro and Madhuri (2014) reported that *P. fluorescens* + *T. harzianum* followed by *P. fluorescens* alone and *T. harzianum* alone are effective against *R. solani*. Pal *et al.* (2015) revealed that seed treatment + 3 spraying with T. viride @ 1% was the most effective bio control treatment recording 10.93% pooled PDI against 34.41% in control plot and its performance was at par with the standard fungicide propiconazole @ 1%. The treatment also exhibited maximum increase in all the yield attributing factors recorded and gave a yield increase of 41.1 % over control. Srinivas *et al.*, (2013) depicts that all the bio-agents stopped the growth of *R. solani* after contact. The order of percent inhibition of *Trichoderma asperellum* (72.65 %) >*Penicillium notatum* (64.07%)> *T. atroasperellum* (62.51%)> *T. harzianum* (42.18%)> *T. longibrachiatum* (38.29%)> *T. koninzii* (3.14%)> *Aspergillus niger* (1.57%). *T. harzianum* (ThF2-1) gave the maximum inhibition of *R. solani* 618 (Montealegre *et al*. 2014) [13]. Huang *et al.* (2012) [10] reported that *B. pumilus* SQR-N43 is a potent antagonist against *R. solani* Q1. Naeimi *et al*. (2010) reported that *T. harzianum* AS12-2 was the most effective strain in controlling rice sheath blight. *T. harzianum* (Jn14) and *T. hamatum* (T36) were the most effective isolates to inhibit *R. solani* mycelial growth (Barakhat *et al*. 2007) [2]. *Trichoderma* strains were effective both *in vitro* and *in vivo* was reported by Das and Hazarika (2000) [3] and Tewari and Singh (2005) [24] who all found that *T. harzianum* was an effective BCA in controlling rice sheath blight.

It is also possible to state that the signs that BCAs will be able to control sheath blight are good. Supplementing biological control with other, non-chemical control methods will improve disease control still more. On the other hand, bio-logical control with the antagonists will lower the dependency on synthetic will it is hoped lead to a cleaner environment and healthier foods.

Table 3: Management of banded sheath blight in Foxtail Millet

Treatments	Sheath blight (PDI) (Vizianagaram)	Sheath blight (Mean of all centres)	Grain Yield (Kg/ha)	Fodder Yield (Kg/ha)
T_1	53.33	40.83	1411.11	2000.0
T_2	56.00	43.09	1374.07	1585.2
T_3	49.33	41.24	1488.89	2248.2
T_4	62.67	43.46	1303.70	1714.8
T_5	49.33	33.65	1500.00	2263.0
T_6	48.00	37.43	1500.00	2329.6
T_7	45.33	29.24	1518.52	2477.8
T_8 (Control)	92.00	63.59	1240.74	1148.2
Mean	57.00	41.57	1417.13	1970.8
CD	13.28	20.98	238.44	687.6
CV %	13.31	21.34	9.61	19.9

References

1. Anonymous. Standard evaluation system for rice. International Rice Testing programme. International Rice Research Institute Report, Philippines, 1996.
2. Barakat MR, Al-Mahareeq F, Ali-Shtayeh MS, AL-Masri MI. Biological Control of *Rhizoctonia solani* by Indigenous *Trichoderma* spp. isolates from Palestine. Hebron University Research Journal, 2007; 3(1):1-15.
3. Das BC, Hazarika DK. Biological management of sheath blight of rice. Indian Phytopathology. 2000; 53:433-435.
4. Divya M, Patro TSSK, Sandhya Rani Y, Triveni U, Anuradha N. Reaction of *Eleusine coracana* (L.) Gaertn. Early and medium duration varieties against major maladies. Progressive Research-An International Journal, 2017; 12(1):30-32.
5. Gomez KA, Gomez AA. Statistical procedures for Agricultural research. 2nd Edition. John Wiley & Sons Publications, New York, 1984, 680.
6. Goudar G, Hemalatha S, Naik RK, Kamatar MY. Evaluation of nutritional composition of foxtail millet (Setaria italic) grains cultivated in agro climatic zones of Karnataka by NIR. Paper presented in: National Symp. Recapturing Nutritious millets for Health and Management of Diseases, UAS, Dharwad, December 16-17, 2011, 37.
7. Groth DE, Rush MC, Lindberg GD. Foliar fungicides for control of rice diseases in the United States. In: *Pest Management in Rice* (BT Grayson, MB Green, LG. Copping, ed.), Elsevier, London, UK, 1990, 31-52.
8. Groth DE, Rush MC, Hollier CA. Rice diseases and disorders in Louisiana. Louisiana State University, Agricultural Center, Louisiana Agricultural Experiment Station, Bulletin No. 828. Baton Rouge, LA, USA, 1991.
9. Groth DE, Bond JA. Initiation of rice sheath blight epidemics and effects of application timing of azoxystrobin on disease incidence, severity, yield and milling yields. Plant Disease. 2006; 90:1073-1078.
10. Huang K, Zhang N, Yong X, Yang X, Shen Q. Biocontrol of *Rhizoctonia solani* damping-off disease in cucumber with *Bacillus pumilus* SQR-N43. Microbial Research. 2012; 167(3):135-143.
11. Itagi KS. Development and evaluation of millet based composite food for diabetes II, Ph. D thesis, Uni. Agric. Sci Dharwad (India), 2003.
12. Jain AK, Gupta AK. Occurrence of banded leaf and sheath blight on foxtail and barnyard millets in Madhya Pradesh. Annl. Pl. Prot. Sci. 2010; 18(1):268-270.
13. Montealegre JR, Ochoa F, Besoain X, Herrera R, Pérez LM. *In vitro* and glasshouse biocontrol of *Rhizoctonia solani* with improved strains of *Trichoderma* spp. Ciencia E Investigacion Agraria. 2014; 41(2):197-206.
14. Nagaraj BT, Gururaj Sunkad, Pramesh D, Naik MK, Patil MB. Host Range Studies of Rice Sheath Blight Fungus Rhizoctonia solani (Kuhn). Int. J Curr. Microbiol. App. Sci. 2017; 6(11):3856-3864.
15. Na Ning, Xiangyang Yuan, Shuqi Dong, Yinyuan Wen, Zhenpan Gao, Meijun Guo *et al*. Grain Yield andQuality of Foxtail Millet (*Setaria italic* L.) in Response to Tribenuron Methyl. Plos One, 2015.
16. Ogoshi A. Ecology and pathogenicity of anastomosis and intraspecific groups of *Rhizoctonia solani* Kuhn. Annual Review of Phytopathology. 1987; 25:125-43.

17. Ou SH. Rice Diseases. 2nd ed. Commonwealth Mycological Institute, Kew, UK, 1985, 380.
18. Patro TSSK, Divya M, Ashok S. dentification of resistant sources for major diseases in finger millet. Progressive Research-An International Journal, 2016; 11(4):299-301.
19. Patro TSSK, Divya M, Sandhya Rani Y, Triveni U, Anuradha N. Detection of resistant sources for major diseases in finger millet (*Eleusine coracana* (L.) Gaertn.). Frontiers of Crop Improvement Journal, 2017; 5(1):43-45.
20. Ravindran G. Studies on millets proximate composition, mineral composition, and phytate and oxalate contents. Food Chem. 1991; 39:99-107.
21. Rush MC, Lee FN, Sheath blight. In: *Compendium of Rice Diseases* (RK Webster, PS Gunnell, ed.), APS Press, St. Paul, MN, USA, 1992, 22-23.
22. Singh KP, Mishra HN, Saha S. Moisture-dependent properties of barnyard millet grain and kernel. J Food Eng. 2010; 96:598-606.
23. Srinivas P, Ved Ratan, Narayan Reddy P, Bindu Madhavi G. *In-vitro* evaluation of fungicides, biocontrol agents and plant extracts against rice sheath blight pathogen Rhizoctonia solani. International Journal of Applied Biology and Pharmaceutical Technology. 2013; 5(1):121-126.
24. Tewari L, Singh R. Biological control of sheath blight of rice by *Trichoderma harzianum* using different delivery systems. Indian Phytopathology. 2005; 58:35-40.