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Management of banded blight using biological control agents against *Rhizoctonia solani* Kuhn. In Little millet (*Panicum sumatrence*)

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Abstract
The present study was undertaken to manage the banded blight disease of little millet using biocontrol agents therefore, aimed towards developing a sustainable integrated disease management (IDM). The field experiment was conducted during *Kharif* 2016 and 2017, at Agricultural Research Station, Vizianagaram. The disease severity and yield parameters (grain yield and straw yield) were evaluated against banded blight using different combinations of potential biocontrol agents *viz*., *Bacillus subtilis*, *Pseudomonas flourescens* and *Trichoderma asperellum* in the field during 2016 and 2017. Among all treatments applied treatment T_7 (*i.e.* Soil application of value added *P. flourescens* + *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) showed maximum reduction in disease intensity (22.81%) and (50.67 %) with higher grain and fodder yield over control.

Keywords: little millet, biocontrol, *R.solani*, IDM

Introduction

Millets are a group of small seeded species of cereal crops, widely grown around the world for food and fodder. The group includes millets such as little (*Panicum miliare*), foxtail (*Setaria italica*), kodo (*Paspalum scrobiculatum*), common (*Panicum miliaceum*), barnyard (*Echinochloa frumentacea*), pearl millet (*Pennisetum glaucum* (L.) and finger (*Eleusine coracana*) millets. Little millet (*Panicum miliare*) is nutritious and has a significant role in providing nutraceutical components such as phenols, tannins and phytates along with macro and micro-nutrients. It is a fair source of protein (7.70 to 16.50 %), fat (2.45 to 9.04 %), carbohydrates (62.50 to 76.30 %), an excellent source of dietary fiber (15.90 to 18.10 %) with good amount of soluble (3.15 to 5.70 %) and insoluble fractions (10.20 to 14.95 %). Besides, it also contains appreciable amounts of minerals such as iron (9.30 to 20.00 mg/100 g), magnesium (133 mg/100 g) and zinc (3.70 mg/100 g) as revealed by several scientists in the field (Hadimani and Malleshi 1993; Ramulu and Rao 1997 and Itagi 2003) [12, 22, 14].

In India, Little millet (*Panicum miliare*) is one of the important staple cereal crops mainly grown in Karnataka and Tamil Nadu. Dietary fiber content of little millet is the contributing factor for its low glycaemic index and a recent study conducted on little millet indicated that it exhibits hypoglycaemic effect due to its higher proportion of dietary fiber (Itagi *et al.* 2013) [14]. It has a significant role in providing significant amounts of antioxidants and phytochemicals in the diet (Ushakumari and Malleshi 2007; Pradeep and Guha 2011) [28].

Besides, It also exhibited hypoglycemic, hypolipidemic effects and faecal bulking effects (Ravindran 1991; Kumari and Thayumanavan 1997 and Itagi 2003) [23, 16 14].

Banded blight of little millet incited by *Rhizoctonia solani* (Kuhn.) (Basidial stage: *Thanatephorus cucumeris* (Fr.) Donk) is one of the emerging malady in successful cultivation of little millet. Akhtar *et al.* (2009) [1] reported wide spread occurrence of banded leaf and sheath blight of maize caused by Rhizoctonia solani in Jharkhand with disease severity ranging from 30.30 to 80.46 percent. Annonymous (2013) [2] reported sheath blight incidence in little millet entries at Rewa (2.3 to 40.4%), Ranchi (0.0 to 34.5%) and Vizianagaram (0.0 to 60.0%). Three entries namely JK 8, BL 2 and TNAU 160 were shown resistance against sheath blight. Least sheath blight of 7.6% followed by 8.1% was recorded in seed treatment of Hexaconazole and Validamycin @ 0.1% as against 20% in control. 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) [10, 24]. Furthermore, environmental conditions such as low light, cloudy days, high temperature and high relative humidity also favor the disease (Ou, 1985) [13]. 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) [11]. 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) [9]. 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) [5]. So an experiment was conducted at Agricultural Research Station, Vizianagaram during *Kharif* 2016-2017.

Materials and Methods

A field experiment was conducted at Agricultural Research Station, Vizianagaram for the management of banded blight disease in little millet by using potential biocontrol agents like *Bacillus subtilis*, *Pseudomonas flourescens* 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 – 50 kg, 40 kg, 25 kg were followed at the time of crop growth period. A susceptible variety (OLM 203) was used in this experiment by imposing the following treatments: (Table 1)

Two trials were also conducted during *Kharif* 2016 and 2017 for the management of banded blight disease in little millet. Banded blight (Anon, 1996) [3] was recorded by using 0 to 9 scale (Table 2).

The disease severity and yield were recorded and the data was statistically analysed by following the standard procedures (Gomez and Gomez, 1984) [8]. The percent disease index (PDI) was calculated by using the following formula:

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

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

In *Kharif* 2016 all the treatments were found significantly superior over check in controlling the disease. Among all the treatments tested, the lowest sheath blight intensity (22.81%) was recorded in T_7 (*i.e.* Soil application of value added *P. flourescens* + *T. asperellum* + *B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) followed by T_5 (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 highest (65.24%) was recorded in T_2 (Seed treatment with *Pseudomonas flourescens* @ 10 g/kg) whereas, 70.00 % was recorded in control. High grain (1176.11 kg/ha) and fodder yield (3800.00 kg/ha) was found in T_7 (Table 3).

Whereas, in *Kharif* 2017 the lowest sheath blight intensity (50.67 %) was recorded in T_7 (*i.e.* Soil application of value added *P. flourescens* + *T. asperellum* + *B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) followed by 53.33 % in T_3 *(i.e.*, Seed treatment with *Bacillus subtilis* @ 10 g/kg) and the highest (65.33 %) in T_4 whereas it was 92.00% in the control. However, high grain (1225.93 kg/ha) and fodder yield (3508.30 kg/ha) was found in T_7 (Table 4).

The experiment conducted in both the seasons *Kharif* 2016 and 2017 revealed that the treatment T_7 (*i.e.* Soil application of value added *P. flourescens* + *T. asperellum* + *B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) was most effective and recorded (22.81%) and (50.67 %) respectively. The yield parameters like grain and fodder were also recorded highest in both the seasons

Patro and Madhuri (2014) [20] reported that *P. flourescens* + *T. harzianum* followed by *P. flourescens* 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. The interaction between host and pathogen resulted significant changes in morphological, phenological parameters, which influence the yield and yield traits adversely, there was significant reduction in grain yield plant and fodder yield plant ranging from 2.1 to 18.5% and 8.5 to 26.6%, respectively was recorded in *Rhizoctonia solani* affected plants of little millet (Shailendra Singh Chouhan, 2014) [25]. Srinivas *et al.*, (2013) [26] depicts that all the bio-agents stopped the growth of *R. solani* after contact. The order of percent inhibition of *Trichoderma viride* (72.65%)>*Penicillium notatum* (64.07%)> *T. atroviride* (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) [17]. Huang *et al* (2012) [13] reported that *B. pumilus* SQR-N43 is a potent antagonist against *R. solani* Q1. *T. harzianum* (Jn14) and *T. hamatum* (T36) were the most effective isolates to inhibit *R. solani* mycelial growth (Barakhat *et al*., 2007). *Trichoderma* strains were effective both *in vitro* and *in vivo* was reported by Das and Hazarika (2000) [5] and Tewari and Singh (2005) [27] who all found that *T. harzianum* was an effective BCA in controlling rice sheath blight. Divya *et al.* (2017) [6] recorded the minimum percent

disease intensity of sheath blight in BL 150 (40.00%) and maximum in DHLT 28-4 (93.33%).
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 1: Treatments:

T1	Seed treatment with *Trichoderma asperellum* @ 10 g/kg
T2	Seed treatment with *Pseudomonas flourescens* @ 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 sowin1g
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

Table 3: Management of banded sheath blight in Little Millet *Kharif* 2016

Treatments	Sheath blight (PDI)	Grain Yield (Kg/ha)	Fodder Yield (Kg/ha)
1	49.76 (44.86)*	1132.78	3322.22
2	65.24 (53.90)	1039.44	3005.56
3	63.23 (52.69)	1043.89	3155.56
4	43.55 (41.29)	1137.78	3494.44
5	31.52 (34.15)	1156.11	3741.67
6	35.42 (36.49)	1140.00	3513.89
7	22.81 (28.51)	1176.11	3800.00
8	70.00 (56.90)	1004.72	2886.11
SEm±	1.61	32.40	196.66
CD(P≤0.05)	4.87	98.26	596.41
CV %	6.38	5.08	10.12

* Figures in parentheses are arc sine transformed values

Table 4: Management of banded sheath blight in Little Millet *Kharif* 2017

Treatments	Sheath blight (PDI)	Grain Yield (Kg/ha)	Fodder Yield (Kg/ha)
1	56.00 (48.48)*	1081.57	3162.96
2	57.33 (49.28)	1033.33	2903.70
3	53.33 (46.94)	1194.75	3444.44
4	65.33 (53.98)	751.85	2666.67
5	61.33 (51.59)	992.59	2811.11
6	64.00 (53.15)	840.74	2722.22
7	50.67 (45.38)	1225.93	3508.30
8	92.00 (73.92)	459.26	2422.22
SEm±	2.64	99.63	143.55
CD(P≤0.05)	8.00	302.14	435.34
CV %	8.64	18.21	8.43

* Figures in parentheses are arc sine transformed values

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