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ORIGINAL ARTICLE

Evaluation of Biological Control agents against *Rhizoctonia solani* Kuhn. in Proso millet

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ABSTRACT
A field experiment was conducted during kharif 2016, at Agricultural Research Station, Vizianagaram for the management of banded blight disease in proso millet by using potential biocontrol agents viz., Bacillus subtilis, Pseudomonas flourescens and Trichoderma viride. Lowest sheath blight intensity (15.22%) was recorded in T_7 (i.e. Soil application of value added P. flourescens + T. viride + 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 (63.95%) in T_2 (i.e., Seed treatment with Pseudomonas flourescens @ 10 g/kg) whereas it was 65.61% in the control.
Keywords: *Proso millet, biocontrol, R.solani*

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INTRODUCTION

Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Proso millet (*Panicum miliaceum*), commonly known as broomcorn millet, Common millet, broomtail millet, red millet and white millet. In tribal belts it is a major food crop as well as feed and fodder for livestock. It is an indispensable to Indian agriculture as a source of grain and straw in vast dry land areas. This millet is highly nutritious and even superior to rice and wheat in certain constituents. These grains are richest source of protein (12.5 g), crude fibre (5.2 g), mineral matter (2.7 g), fat (3.5 g), carbohydrates (63.8 g), calcium (8.0 g), phosphorus (283 mg) and iron (2.9 mg) per 100 grams. The grains have high dietary fibre and helps in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood streams during digestion. Nevertheless, lower incidence of cardiovascular disease, duodenal ulcer and hyperglycemia are reported among regular millet consumers. This crop is very hardy and can tolerate drought conditions. It is known to be effected by several diseases viz., blast, banded blight, brown spot, smut, rust, foot rot and viral diseases.

Banded blight caused by *Rhizoctonia solani* (Kuhn.) is one of the emerging malady in successful cultivation of proso millet. The disease was observed in severe form at Agricultural Research Station, Vizianagaram, Andhra Pradesh and Berhampur, Orissa during monitoring survey causing considerable yield losses in proso millet. 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 [5, 14]. Furthermore, environmental conditions such as low light, cloudy days, high temperature and high relative humidity also favor the disease [10]. 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 [6]. So far, no variety completely resistant to this fungus has been found, although evaluation of prosomillet germplasm has been conducted [12, 13]. 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 [4]. It is difficult to achieve control through host resistance or fungicides, therefore, biological control may be effective in minimizing the incidence of sheath blight [2]. So an experiment was conducted at Agricultural Research Station, Vizianagaram during *kharif,* 2016 for the management of banded blight disease in proso millet.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2016, at Agricultural Research Station, Vizianagaram for the management of banded blight disease in proso millet by using potential biocontrol agents like *Bacillus subtilis, Pseudomonas flourescens* and *Trichoderma viride*. 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 (CO 5) was used in this experiment by imposing the following treatments:

T1	Seed treatment with *Trichoderma viride* @ 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.v.* (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.v. + 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

The disease severity and yield were recorded and the data was statistically analysed by following the standard procedures [3]. The percent disease index (PDI) was calculated by using the following formula:

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

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 (15.22%) was recorded in T_7 (*i.e.* Soil application of value added *P. flourescens + T. viride + B. subtilis* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) followed by 21.28% in T_5 *(i.e.,* Soil application of value added *T. viride* (one kg talc formulation mixed in 25 kg FYM or vermicompost, incubated for 15 days) and the highest (63.95%) in T_2 whereas it was 65.61% in the control. And high grain (1552.50 kg/ha) and fodder yield (3305.56 kg/ha) was found in T7 whereas, it was 1255.72 kg/ha and 2408.33 kg/ha in the control respectively (Table 1).

Patro and Madhuri [11] reported that *P. flourescens* + *T. harzianum* followed by *P. flourescens* alone and *T. harzianum* alone are effective against *R. solani*. *T. harzianum* (ThF2-1) gave the maximum inhibition of *R. solani* 618 [8]. Huang *et al* [7] reported that ***B. pumilus*** SQR-N43 is a potent antagonist against ***R. solani*** Q1. Naeimi *et al*., [9] 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 [1]. *Trichoderma* strains were effective both *in vitro* and *in vivo* was reported by Das and Hazarika [2] and Tewari and Singh [15] who all found that *T. harzianum* was an effective BCA in controlling rice sheath blight.

Table 1: Management of banded sheath blight in Proso Millet

Treatments	Sheath blight (PDI)	Grain Yield (Kg/ha)	Fodder Yield (Kg/ha)
T_1	51.74 (46.00)*	1391.39	3008.33
T_2	63.95 (53.12)	1371.39	2750.00
T_3	55.39 (48.10)	1374.17	2961.11
T_4	43.08 (41.01)	1388.06	3019.44
T_5	21.28 (27.41)	1446.67	3200.00
T_6	31.54 (34.12)	1416.11	3019.44
T_7	15.22 (22.95)	1552.50	3305.56
T_8 (Control)	65.61 (54.12)	1255.72	2408.33
SEm±	1.43	43.24	135.56
CD($P \leq 0.05$)	4.34	131.14	411.12
CV %	6.07	5.35	7.93

* Figures in parentheses are arc sine transformed values

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, biological control with the antagonists will lower the dependency on synthetic will it is hoped lead to a cleaner environment and healthier foods.

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