Management of leaf blight and node blight diseases Indian Barnyard millet (*Echinochloa frumentacea* (Roxb)

Abstract

A study on the management of important diseases of rainfed kuthiraivali was carried out through biological control and fungicides in combination with seed treatment and foliar application methods and different intervals of diseases incidence. The leaf blight pathogen was isolated from the affected leaf; the isolated fungus's dark grayish-colored, fluffy mycelia were observed on the PDA medium. The mycelium was grey to olivaceous green, profusely branched, and septate. Conidiophores were single or in small groups, straight to flexuous, septate, smooth, and dark brown. Measuring 3.5 µm x 0.865 µm (1 µm), The disease incidence was observed at 15-day intervals using the percent disease index. Among three years, the seed treatment (10gm/kg) of Pseudomonas fluorescens (TNAU Pf1) followed by foliar application of Carbendazim + Mancozeb 2 gm/lit decreases the leaf blight diseases (63.63% reduction over control) and also recorded an increased yield of 1075 kg/ha of kuthiraivali. Seed treatment with *Pseudomonas fluorescens* Pf1 combined with foliar fungicide sprays significantly enhances yield and cost-benefit ratio under rainfed conditions while effectively managing seed-borne and foliar diseases.

Keywords: *leaf blight, Seed treatment, foliar fungicide, Pseudomonas fluorescens*

Introduction

Barnyard millet (*Echinochloa frumentacea)* is a highly nutritious crop and fast growing robust crop. It is grown even in higher altitudes up to a height of 2000 m in the Himalayas. Barnyard millet serves as dual purpose for feed and fodder crop. It is mainly grown in India, China, Japan, and Korea (Nehru et al., 2023; Govanakoppa et al., 2024). It is cultivated as a substitute for rice on marginal lands where rice and other crops will not grow well (Gomashe, 2017; Mageshwaran et al. 2023; Harb et al., 2024). The grains of barnyard millet are particularly recommended for diabetics and also are appropriate food for patients intolerant to gluten causing celiac disease and have an excellent storage life and can be stored even up to 100 years. The barnyard millet contains 10.5% protein, 3.6% fat, 68.8% carbohydrate and 398 kcal/100 g energy. The total dietary fiber content was high (12.6%) including soluble (4.2%) and insoluble (8.4%) fractions (Kumar et al., 2020; Rawat et al., 2018; Ramesh et al., 2024). Although this crop is hardy, the crop is challenged by many fungal diseases like leaf spot (*Exserohilum monoceras*), blast (*Pyricularia grisea*), grain smut (*Ustilago panici-frumentacei* Bref.) and head smut (*Ustilago crusgalli*) (Prabu et al., 2020). Among these diseases, leaf spot is one of the most destructive diseases after smut, which if occurs at early stages as blight, reduces the crop yield drastically. Larger cultivation of kuthiraivali in climate changes the Helminthosporium ((*Exserohilum monoceras*) leaf blight incidence was high (47.80%), Leaf spot or blight is incited by the fungus *Exserohilum monoceras* (Drechsler) Leonard & Suggs [Syns. *Helminthosporium monoceras* (Drechsler); *Helminthosporium crusgalli* (Nisikado and Miyake); *Bipolaris monoceras* (Drechs.) Shoemaker; *Drechslera monoceras* (Drechs.) Subram and Jain; and *Luttrellia monoceras* (Dreschler) Chochryakov]. Morita *et al*. (2013) described the perfect stage of the fungus as *Setosphaeria monoceras*. Leonard and Suggs (1974) established the genus *Exserohilum* for *Helminthosporium* species and differentiated from its former group *Drechslera* and *Bipolaris* by its stable strongly protuberant conidial hilum a pot experiment was conducted to study the effect of coir pith compost, bone meal powder and panchagavya on barnyard millet (*Echinochloa frumentacea* (Roxb.). Pot experiment revealed that application of 100% RDF (T2) registered the highest quality characters *viz*., crude protein, crude fiber and ash contents were 5.50, 4.35 and 4.31 per cent, respectively (Srinivasan and Venkatakrishnan, 2021).

Materials and Methods

Isolation of pathogens

Barnyard millet leaves showing typical symptoms of brown spot were collected from the field. Leaves with symptoms were first washed in tap water and then cut into small bits of 2 mm size, containing the discolored brown spots. These bits were surface sterilized with 0.1 per cent mercuric chloride solution for two minutes followed by three changes of sterilized distilled water. These bits were placed on potato dextrose agar under aseptic condition. Inoculated plates were incubated at 27 °C and watched for any contamination for seven days. After seven days of incubation, fungal colonies completely covered the plates and become dark greyish in color indicating the production of spores.

Proving pathogenicity

Pathogenicity test was carried out to prove the Koch's postulates on barnyard millet variety CO (KV2). The conidial suspension of *E. monoceras* at 10^5 spores per ml was inoculated at three to four leaf stage by spray inoculation. The initiation of leaf spot symptom started five to six days of inoculation. Initially dark brown longitudinal spots were observed. Later, several such spots coalesced and covered the major portion of leaf causing blight symptom. The infected leaves turned grey and dried up. Re-isolation of the pathogen was made from artificially inoculated plants and was found to be that of *E. monoceras.*

Pot culture experiments:

The pot culture experiments were conducted with eight treatments for seed treatment and foliar spray, Chemical and biocontrol agents.

Field experiments:

The experimental trial consisting of 9 treatments with biocontrol agents and fungicides was laid out at Dryland Agricultural Research Station Chettinad; the test crop is Kudiraivali CO (Kv2). Randomized Block Design was adopted with three replications. The plot size for each treatment was $20m^2$. The disease incidence of recorded at 15 days intervals. The yield parameters were recorded and analyzed statistically. All normal agronomic practices were followed. In addition, growth parameters *viz*., plant height, number of branches. Number of ear heads and ear head length and breadth, and seed yield kg/ha.

Results and Discussion

Leaf blight pathogens

The isolated fungus was identified as *Exserohilum monoceras* based on its cultural and morphological characters. The dark grayish coloured fluffy mycelia of the isolated fungus were observed on PDA medium. The mycelium was grey to olivaceous green, profusely branched and septate. Conidiophores were single or in small groups, straight to flexuous, septate, smooth, dark brown. Conidia pale to mid olivaceous brown, fusoid, smooth, straight or curved, mostly 4-7. Measuring 3, 5 µm x0.865µm (1 µm).

Biocontrol agents and chemicals against leaf blight diseases of Kudiraivali under rainfed conditions

The experiment result revealed that, leaf blight disease incidence ranged from 15.3 to 40.66 per cent disease incidence (Table 1). Seed treatment *Pseudomonas fluorescens* (10gm/kg of seed) + Foliar spraying of Carbendazim + Mancozeb (2gm/lit) and Seed treatment (10gm/kg of seed) + Seed treatment *Pseudomonas fluorescens* (10gm/kg of seed) + Foliar spraying *Pseudomonas fluorescens* (1gm/lit) less disease incidence recorded, 15.99 and 16.97 on par with each other. The treatment Seed treatment *Pseudomonas fluorescens* (10gm/kg of seed) + Foliar spraying of Carbendazim+ Mancozeb (2gm/lit) for maximum control of leaf blight diseases of Kudiraivali significant reduction for 63.63 and 61.40 for per cent disease reduction comparing with other chemical.

Table 1. Effect of biocontrol agents and chemicals against foliar disease of kudiraivali (Pooled analysis)

S.No	Treatments	Leaf blight PDI [Pooled 2020 & 2021]	Percent reduction over control
T1	ST(10gm)+FS *Pseudomonas fluorescens* (Pf1) 1gm/lit	16.97	61.40

		(24.31)	
T2	ST(10gm)+FS *Bacillus subtilis* (Bs) 1gm/lit	24.15 (29.40)	45.07
T3	ST Pf1 (10gm)+FS-Carbendazim+ Mancozeb 2gm/lit	15.99 (23.55)	63.63
T4	ST (10gm) Bs+ FS Carbendazim+ Mancozeb 2gm/lit	21.24 (27.36)	51.69
T5	FS Carbendazim + Mancozeb 2gm/lit	20.98 (27.24)	52.28
T6	FS Mancozeb 2gm/lit	25.33 (30.26)	42.39
T7	FS Copper oxychloride 2gm/lit	24.30 (29.52)	44.73
T8	FS Carbendazim 1gm/lit	24.40 (29.52)	44.50
T9	Control	43.97 (41.50)	-
	C.D.	3.59	
	SE(d)	1.533	
	C.V.	5.25	

Table 2. Effect of biocontrol agents and chemicals yield on kudiraivali (Pooled analysis)

S.No	Treatments	Yield Kg/ha [Pooled 2020 & 2021]	BCR ratio
T1	ST(10gm)+FS *Pseudomonas fluorescens* (Pf1) 1gm/lit	1027.50	2.05
T2	ST(10gm)+FS *Bacillus subtilis* (Bs) 1gm/lit	982.50	2.00
T3	ST Pf1 (10gm)+FS-Carbendazim+ Mancozeb 2gm/lit	1075.00	2.50
T4	ST (10gm) Bs+ FS Carbendazim+ Mancozeb 2gm/lit	1027.50	2.15
T5	FS Carbendazim+ Mancozeb 2gm/lit	997.50	2.08
T6	FS Mancozeb 2gm/lit	925.00	1.97
T7	FS Copper oxychloride 2gm/lit	860.00	1.85
T8	FS Carbendazim 1gm/lit	862.50	1.79
T9	Control	737.50	1.60
	C.D.	85.58	
	SE(d)	36.54	
	C.V.	3.87	

Yield analysis

Among the treatments, Seed treatment *Pseudomonas fluorescens* Pf1 (10gm) + Foliar Spray of Carbendazim+ Mancozeb 2gm/lit received for highest yield 1075 kg / ha and increasing cost benefit ratio (1:2.50) under rainfed conditions comparing to other treatments (Table 2).

The similar study reported by Laxmi Rawat *et al*, (2018) brown spot disease control (75.99) was recorded in the treatment T4 (Soil application of value added vermi-compost impregnated by fluorescent Pseudomonas isolate UUHF Psf- 4 + Seed treatment with fluorescent Pseudomonas isolate UUHF Psf- 4 + One foliar spray with Fluorescent Pseudomonas isolate UUHF Psf- 4 at the time of 50% flowering). Maximum grain yield (23.13 q/ha), highest per cent increase in grain yield (64.86%) and highest per cent avoidable loss (39.34%) Since, the primary infection comes from the seed-borne inoculum; seeds treatment with systemic fungicides before sowing helps in disease control. Spraying of copper fungicides @ 0.3 % helps in reducing the disease intensity (Nagaraja *et al.*, 2007). The management of leaf blight pathogen with nineteen plant extracts tested under *in vitro* conditions. Among twenty plant extracts the 5v (Vilvum, Vembu, Vanni, Vagai and Vengai) plants extracts (10%) effectively inhibited mycelium growth (84.81, 64.77, 63. 26, 61.36 and 48.56 percent reduction over control) of Leaf blight pathogens (Paramasivan *et al.*, 2024).

Conclusion

This study focused on the management of important diseases of rainfed kuthiraivali, which was carried through biological control and fungicides individual and combination with seed treatment and foliar application methods and different intervals of diseases incidence taken the leaf blight pathogen was isolated form affected leaf, the dark grayish coloured fluffy mycelia of the isolated fungus were observed on PDA medium. Among the treatments, Seed treatment *Pseudomonas fluorescens* Pf1 (10gm) with Foliar Spray of Carbendazim and Mancozeb (2gm/lit) received for highest yield and increasing cost benefit ratio under rainfed conditions comparing to other treatments.

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