

1 Integrated Management of Blast Disease in Finger Millet

4 ABSTRACT

5 **Aims:** To test the effect of bacterial biocontrol agents (*Pseudomonas*-TNAU-Pf1) and fungicides
6 (Tricyclazole) individually and their integration as seed treatment and foliar spray against finger millet
7 blast under field conditions.

8 **Study Design:** The field experiments were conducted in a Randomized Block design.

9 **Place and Duration of Study:** The experiments were conducted at the Regional Research Station farm,
10 Tamil Nadu Agricultural University, Paiyur, Krishnagiri District, Tamil Nadu, India, during 2016-17 and
11 2017-18.

12 **Methodology:** Two field experiments were conducted to evaluate the efficacy of talc-based formulation of
13 *Pseudomonas* -TNAU-Pf1 and Tricyclazole individually and in combination as seed treatment and foliar
14 application for the management of finger millet blast with five treatments and four replications using a
15 variety Paiyur 2. The bioagent and the fungicide were applied as seed treatment and foliar spray.

16 **Results:** The results revealed that seed treatment with talc-based formulation of *Pseudomonas* -TNAU-
17 Pf1 (10g/kg) plus two sprays of tricyclazole (0.1%) one at the maximum tillering phase and another at the
18 heading phase was significantly most effective in reducing leaf, neck and finger blast in both the seasons.
19 The treatment recorded 1.65 and 1.25PDI of leaf blast, 0.33 and 0.22% of neck and 2.55 and 1.33% of
20 finger blast in the first and second season, respectively. The treatment also recorded highest grain yield
21 of 2663 and 2543 kg/ha with BC ratio of 1:3.94 and 1:3.85 in the first and second season, respectively.

22 **Conclusion:** Seed treatment with *Pseudomonas* TNAU-Pf1 (10g/kg) plus two sprays of tricyclazole
23 (0.1%) was found to be effective in reducing the incidence of blast disease and increasing grain yield in
24 finger millet.

25 **Key words:** Blast, Finger Millet, Integrated Disease Management, *Pseudomonas*, Tricyclazole

27 1. INTRODUCTION

28 "Finger millet (*Eleusine coracana* Gaertn.), popularly known as 'Ragi', is an important small millet
29 crop in the world, supporting millions of people around the globe and particularly in developing countries.
30 The crop is mostly grown under rainfed conditions by small and marginal farmers of India ensuring their
31 food security. Even though finger millet is renowned for its ability to withstand a variety of biotic and
32 abiotic stresses, under favourable conditions, some diseases can cause significant losses and even
33 destroy the entire crop. Among the various fungal diseases that affect finger millet crops, blast disease
34 caused by *Pyricularia grisea* Sacc. (Perfect stage = *Magnaporthe grisea* [Hebert]). Barr. is one of the
35 most devastating and destructive foliar disease. The pathogen attacks all aerial parts of finger millet plant
36 causing leaf, neck and finger blast" (1). "In the endemic areas, the average loss due to blast disease in
37 finger millet was reported to be around 28% and was reported as high as 80-90%" (2). "In India, the blast
38 disease is known to occur almost every year in all major finger millet growing areas in the rainy season or
39 in the humid weather, and is considered to be one of the major diseases causing recurrent yield losses in
40 all the Indian states" (3).

41 "Management of finger millet blast is mainly depends on chemical fungicides. Among the various
42 fungicides tested against blast disease both in rice and finger millet, tricyclazole was found to be very
43 effective against blast disease" (4-7). "Similarly, three sprays of carbendazim (0.05%) have been reported
44 to be effective against pearl millet blast" (8). However, information on the use of biocontrol agents with
45 fungicides remains very limited, although it is shown that chemical fungicides such as tricyclazole and
46 carbendazim are highly effective in combating blast disease. In addition, the development of integrated
47 disease management strategies is now viewed not only as environmentally friendly but also as
48 sustainable agriculture. Keeping these facts in view, a study was conducted to test the efficacy of
49 bacterial biocontrol agent (*Pseudomonas*-TNAU-Pf1) and a fungicide (Tricyclazole) individually and in
50 combination against leaf, neck and finger blast under field conditions.

51 **2. MATERIALS AND METHODS**

52 A field experiment was conducted at Regional Research Station, Tamil Nadu Agricultural
53 University, Paiyur, Krishnagiri District, Tamil Nadu during November 2016 to February 2017 and
54 December 2017 to March 2018 to evaluate the efficacy of talc-based formulation of bacterial biocontrol
55 agent (*Pseudomonas* -TNAU-Pf1) and a fungicide (Tricyclazole) individually and their integration as seed

56 treatment and foliar spray for the management of finger millet blast with five treatments and four
57 replications under randomized block design using a variety Paiyur 2. The treatments of the experiment
58 were T1: Seed Treatment (ST) with TNAU-Pf1 @ 10g/kg of seed +two sprays of TNAU-Pf1 @ 10g/litre (l)
59 of water; T2: ST with Tricyclazole @ 2 g/kg of seed + two sprays of Tricyclazole @ 1 g/l; T3: ST with
60 TNAU-Pf1 @ 10g/kg of seed + two sprays of Tricyclazole @ 1 g/l; T4: ST with Tricyclazole @ 2 g/kg of
61 seed + two sprays of TNAU-Pf1 @ 10g/l and T5: Untreated control.

62 The seeds were treated with talc-based formulation of TNAU-Pf1 @ 10 g/kg and tricyclazole @
63 2g/kg of seeds. Foliar application of *Pseudomonas* (1%) and fungicide (0.1%) was given during the
64 maximum tillering and heading phase using high volume backpack knapsack sprayer. The incidence of
65 leaf blast was recorded after first spray by visual observation following 0-5 scale as: 0 = No symptoms on
66 the leaves, 1 = Small brown specks of pin head size spot to slightly elongated, necrotic grey spots with
67 brown margin less than 1% leaf area affected, 2 = A typical blast lesion, elliptical 5-10 mm long, 1-5% of
68 leaf area affected, 3 = A typical blast lesion, elliptical 1-2 cm long, 5-25% of leaf area affected, 4 = 25-
69 50% of leaf area affected and 5 = More than 50% leaf area affected and per cent disease index (PDI) was
70 calculated. Percent neck and finger blast were recorded as the percentage of ears showing blast fungus
71 infection on the peduncle and percent of fingers with infection, respectively, at dough stage of the crop
72 (9). The data on plant height (cm) and number of productive tillers/hill was also recorded at heading
73 phase. At crop maturity, the ears were harvested, dried, thrashed, cleaned and per plot yield was
74 recorded from which yield per hectare was computed.

75 **3. RESULTS AND DISCUSSION**

76 The results of the experiment conducted during 2016-17 (Trial I) revealed that all the treatments
77 were significantly effective in reducing the blast disease when compared to untreated control. However,
78 minimum incidence of leaf (1.65 PDI), neck (0.33%) and finger blast (2.55%) was recorded in seed
79 treatment with talc-based formulation of TNAU-Pf1 plus two sprays of tricyclazole (T3) followed by T2 and
80 T1. Untreated control plots recorded the maximum incidence of 20.25 PDI of leaf blast and 10.24 and
81 16.29% neck and finger blast, respectively (Table 1). Similarly, the results of the experiment conducted
82 during 2017-18 (Trial II) revealed that the same treatment T3-ST with TNAU-Pf1 plus two sprays of
83 tricyclazole recorded lesser incidence of leaf blast (1.25 PDI), neck blast (0.22%) and finger blast (1.33%)

84 compared to untreated control which recorded 19.00 PDI of leaf blast, 9.66% of neck blast and 14.88% of
85 finger blast.

86 The results on growth and yield attributes of trial I (2016-17) also revealed that the treatment T3
87 recorded higher plant height (94.74 cm), number of productive tillers/hill (5.50) and grain yield
88 (2663kg/ha) with BC ratio of 1:3.94 followed by T2 and T1 when compared to untreated control recorded
89 only 1954 kg/ha of grain yield with plant height of 77.44 cm and 3.92 number of productive tillers/hill. The
90 treatment T2 recorded higher grain yield (2544 kg/ha) compared to T1 (2425 kg/ha), however treatment
91 T1 recorded higher BC ratio (1:3.53) followed by T2 (1: 3.27) (Table 2). In the field trial II (2017-18) also,
92 the same trend of results were obtained. Seed treatment with TNAU-Pf1@ 10g/kg + two sprays of
93 Tricyclazole (0.1%) treated plots recorded significantly higher plant height (91.67cm), number of
94 productive tillers/hill (5.40) and grain yield (2543 kg/ha) with the BC ratio of 1:3.85 compared to other
95 treatments.

96 The present investigation demonstrates that the integrated approach using the bacterial
97 biocontrol agent and fungicide have the potential to suppress different types of blast in finger millet under
98 field conditions. Similarly, Kumar and Kumar (10) reported that “seed treatment with *Pseudomonas*
99 *fluorescens* Pf 2 (0.6%) plus its two foliar sprays (0.6%) followed by two sprays of ediphenphos (0.1%)
100 were significantly most effective in reducing the incidence of blast disease and also increased the grain
101 yield”. “The fungicides tricyclazole and propiconazole could be effective in controlling blast disease of rice
102 and finger millet” (11-13). “Seed treatment with carbendazim plus two sprays of tricyclazole was found
103 effective in reducing the incidence of finger millet blast” (14). The efficacy of TNAU-Pf1 against blast
104 disease may be attributed to the induction of systemic resistance. The reduction in disease incidence and
105 increase in grain yield might be due to induction of resistance and growth promotion in the plant system
106 by the *Pseudomonas* seed treatment. Fluorescent pseudomonads have been considered as one of the
107 major groups of bacterial bioagents that induce ISR. However, induced resistance is not the only mode of
108 action but a direct action of a fungicide on the pathogen is also involved which is necessary for protecting
109 the finger millet crop against blast disease.

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111 **4. CONCLUSION**

112 Based on the present studies, it can be concluded that seed treatment with a talc-based
113 formulation of TNAU-Pf1 (10g/kg) plus two sprays of tricyclazole (0.1%) one at the maximum tillering
114 phase and another at the heading phase, can be effectively exploited for the management of blast
115 diseases of finger millet.

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 150 (*Pyricularia grisea*) of finger millet with fungicides and biocontrol agents. *Plant Dis. Res.* 2020; 35
 151 (1):36-41.

152
 153 **Table 1. Effect of Bioagent and Fungicide on the Incidence of Finger Millet Blast**

Treatments	Trial I			Trial II		
	Leaf blast (PDI)	Neck blast (%)	Finger blast (%)	Leaf blast (PDI)	Neck blast (%)	Finger blast (%)
T1: ST with TNAU-Pf1@ 10g/kg of seed +two sprays of TNAU-Pf1@ 10g/l	4.75	3.69	6.80	4.00	2.95	4.92
T2: ST with Tricyclazole @ 2 g/kg of seed + two sprays of Tricyclazole @ 1 g/l	3.75	1.95	5.05	3.25	1.66	3.85
T3: ST with TNAU-Pf1@ 10g/kg of seed + two sprays of Tricyclazole @ 1 g/l	1.65	0.33	2.55	1.25	0.22	1.33
T4: ST with Tricyclazole @ 2 g/kg of seed + two sprays of TNAU-Pf1@ 10g/l	6.50	4.60	7.40	6.00	3.98	5.66
T5: Untreated control	20.25	10.24	16.29	19.00	9.66	14.88
CD (0.05%)	1.05	1.53	1.65	1.11	1.29	1.50
S ED	0.50	0.72	0.77	0.58	0.61	0.74

154 ST: Seed treatment

155 Values are mean of four replications

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Table 2. Effect of Bioagent and Fungicide on the Growth and Yield Attributes of Finger Millet

Treatments	Trial I				Trial II			
	Plant	Number of	Grain	BCR	Plant	Number of	Grain	BCR
	Height (cm)	Productive tillers/hill	Yield Kg/ha		Height (cm)	Productive tillers/hill	Yield Kg/ha	
T1: ST with TNAU-Pf1 @ 10g/kg of seed +two sprays of TNAU-Pf1 @ 10g/l	94.60	5.44	2425	1:3.53	89.65	4.7	2340	1:3.32
T2: ST with Tricyclazole @ 2 g/kg of seed + two sprays of Tricyclazole @ 1 g/l	83.20	4.96	2544	1:3.27	80.47	4.9	2412	1:3.23
T3: ST with TNAU-Pf1 @ 10g/kg of seed + two sprays of Tricyclazole @ 1 g/l	94.74	5.50	2663	1:3.94	91.67	5.4	2543	1:3.85
T4: ST with Tricyclazole @ 2 g/kg of seed + two sprays of TNAU-Pf1 @ 10g/l	85.35	5.04	2375	1:3.01	82.27	4.5	2298	1:3.04
T5: Untreated control	77.44	3.92	1954	-	75.52	3.4	1904	-
CD (0.05%)	2.40	0.60	70.65	-	2.55	0.48	69.12	-
S ED	1.17	0.28	32.65	-	1.26	0.23	33.74	-

162 **BCR: Benefit Cost Ratio**
163 ST: Seed treatment
164 Values are mean of four replications
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