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In vitro Evaluation of Fungicides and Bioagents for the Management of Pearl Millet Blast Caused by *Pyricularia grisea* (Cooke) Sacc.

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A B S T R A C T

Pearl millet crop suffers from many fungal diseases, among them blast caused by *Pyricularia grisea* (Cooke) Sacc, is one of the important diseases in recent years. Hence, with a view to generate information on management of disease using chemicals and bio agents. *In vitro* evaluation of twelve fungicides and six bioagents were carried out against *Pyricularia grisea* causing blast of pearl millet. Among the systemic fungicides evaluated, Tricyclazole 75% EC inhibited 100 per cent mycelial growth of the pathogen, followed by Carbendazim 50% WP (99.50%) and least inhibition was observed in Azoxystrobin 23% SC (19.13%). Among the contact fungicides, Mancozeb 75% WP inhibited 100 per cent mycelial growth of the pathogen followed by Copper oxychloride 50% WP (83.57%) and least inhibition was observed in Zineb 75% WP (38.86%). Among combi fungicides, Carbendazim 12% + Mancozeb 63% (SAAF) inhibited 100 per cent mycelial growth of the pathogen, followed by MERGER (Tricyclazole 18% + Mancozeb 62% WP) 98.64 per cent, and AVTAR (Hexaconazole 4% + Zineb 68% WP) 97.40 per cent. Among the bioagents *Trichoderma harzianum* (Tri 5) and *Pseudomonas fluorescens* (RP-46) gave maximum per cent inhibition of 77.03 and 67.77 respectively. Hence these fungicides and bioagents could be utilised as most important components for the management of blast of pearl millet under field condition.

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a staple cereal grown in India having the largest area of 7.45 m.ha distributed almost over entire country with production of 9.73 mt of grains and productivity of 13.05 q/ha during 2016-17 (Anonymous, 2017). The crop suffers from many fungal diseases, among which blast caused by *Pyricularia grisea* (Cooke) Sacc. [Teleomorph: *Magnaporthe grisea* (Herbert) Barr.] has emerged as serious disease affecting both forage and grain production in pearl millet (Thakur *et al.*, 2011). The disease was first recorded in Uganda in 1933. The disease has geographic

distribution in India, Singapore and the United States. In India, the disease was first reported in 1942 from Kanpur, Uttar Pradesh (Mehta *et al.,* 1953). Blast has become major threat to pearl millet causing considerable yield loss (Thakur *et al.,* 2009). Keeping this in view, the present study was conducted on *in vitro* evaluation of different fungicide and bioagents against *P. grisea* causing blast of pearl millet.

Materials and Methods

The experiment was conducted at Department of Plant Pathology, College of Agriculture, Raichur during 2017-18. In the present study, twelve fungicides, *viz.,* four systemic (Tricyclazole 75% WP, Carbendazim 50% WP, Hexaconazole 5% EC and Azoxystrobin 23% SC), four contact (Mancozeb 75% WP, Zineb 75% WP, Chlorothalonil 75% WP and Copper oxychloride 50% WP) and four combi fungicides *viz*., Custodia (Azoxystrobin 11% + Tebuconazole18.3% SC), Merger (Tricyclazole 18% + Mancozeb 62% WP), SAAF (Carbendazim 12% + Mancozeb 63% WP) and Avtar (Zineb 68% WP+ Hexaconazole 4%) were evaluated for their efficacy against *P. grisea* under *in vitro* by using poisoned food technique. The systemic fungicides evaluated at 0.05, 0.1 and 0.2 per cent whereas contact and combi fungicides were evaluated at 0.1, 0.2 and 0.3 per cent concentrations. The experiment was conducted using completely randomised block design (CRBD) with three replications in each treatment. The per cent inhibition of the mycelial growth of the fungus was determined by formula given by Vincent (1947).

$$I = \frac{C-T}{C} \times 100$$

Where,

I= Per cent inhibition
C= Radial growth of fungus in control
T= Radial growth of fungus in treatment

Six known antagonists *viz., Trichoderma viride* (Tri-4), *T. harzianum* (Tri-5), *Pseudomonas fluorescens* (EP-5), *P. fluorescens* (RP-46), *Bacillus subtilis* (BS-16) and *B. subtilis* (BS-30) were evaluated for their antagonistic effect on *P. grisea* using dual culture technique as followed by Dennis and Webster, (1971). The per cent growth inhibition was recorded as described above.

Results and Discussion

In vitro evaluation of systemic fungicides by using poisoned food technique

In vitro evaluation of four systemic fungicides was carried out against *P. grisea* at 0.05, 0.1 and 0.2 per cent concentrations (Table 1 and Plate 1). Among the four systemic fungicides tested, tricyclazole was found very effective with 100 per cent mycelial inhibition at all the three concentrations, followed by carbendazim with 98.51, 100 and 100 per cent and hexaconazole inhibited 80.36, 96.29 and 100 per cent at 0.05, 0.1 and 0.2 per cent concentrations respectively, as compared to control.

However, azoxystrobin was least effective with inhibition of 11.11, 22.22 and 24.07 per cent at 0.05, 0.1 and 0.2 per cent concentrations, respectively. Irrespective of fungicidal concentrations, tricyclazole resulted cent per cent inhibition and found to be the best and significantly superior over other fungicides tested.

In vitro evaluation of contact fungicides by using poisoned food technique

The comparative efficacy of four different contact fungicides allocated at 0.1, 0.2 and 0.3

per cent concentration. The observations on per cent growth inhibition (PGI) of mycelium recorded after seven days of incubation are showed in Table 2 and Plate 2. Results showed that, among the four contact fungicides tested, mancozeb was found highly effective with 100 per cent mycelia inhibition at all the concentrations, followed by copper oxychloride with 81.11, 82.96 and 86.66 per cent and chlorothalonil inhibited 44.44, 47.03 and 54.81per cent at 0.1, 0.2 and 0.3 per cent respectively, as compared to control. However, zineb was least effective with inhibition of 31.40, 40.74 and 44.44 per cent at 0.1, 0.2 and 0.3 per cent concentrations, respectively. Irrespective of fungicidal concentrations, mancozeb resulted cent per cent inhibition and found to be the best and significantly superior over other fungicides tested.

Table.1 *In vitro* evaluation of systemic fungicides against *P. grisea* causing blast of pearl millet by using poisoned food technique

Sl. No.	Fungicides	Per cent inhibition*			Mean
		0.05%	0.1%	0.2%	
1	Tricyclazole 75% WP	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
2	Carbendazim 50% WP	98.51(83.00)	100 (90.00)	100 (90.00)	99.50 (85.95)
3	Hexaconazole 5% EC	80.36 (63.70)	96.29 (78.9)	100 (90.00)	92.22 (73.81)
4	Azoxystrobin 23% SC	11.11(19.48)	22.22 (28.13)	24.07 (29.39)	19.13 (25.94)
5	Untreated control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
		S.Em±		C.D. at 1%	
Fungicide (A)		0.60		2.33	
Concentration (B)		0.47		1.80	
Fungicide x Concentration (A x B)		1.04		4.04	

Table.2 *In vitro* evaluation of contact fungicides against *P. grisea* causing blast of pearl millet by using poisoned food technique

Sl. No.	Fungicides	Per cent inhibition*			Mean
		0.1%	0.2%	0.3%	
1	Mancozeb 75% WP	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
2	Zineb 75% WP	31.40 (34.09)	40.74 (39.67)	44.44 (41.81)	38.86 (38.57)
3	Chlorothalonil 75% WP	44.44 (41.81)	47.03 (43.30)	54.81 (47.77)	48.76 (44.29)
4	Copper oxychloride 50% WP	81.11 (64.24)	82.96 (65.62)	86.66 (68.58)	83.57 (66.09)
5	Untreated control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
		S.Em±		C.D. at 1%	
Fungicide (A)		0.26		1.02	
Concentration (B)		0.20		0.79	
Fungicide x Concentration (A x B)		0.45		1.76	

Table.3 *In vitro* evaluation of combi fungicides against *P. grisea* causing blast of pearl millet by using poisoned food technique

Sl. No.	Fungicides	Per cent inhibition*			Mean
		0.1%	0.2%	0.3%	
1	Azoxystrobin 11% + Tebuconazole18.3% SC (Custodia)	79.62 (63.17)	86.47 (68.43)	96.66 (79.48)	87.58 (69.37)
2	Tricyclazole 18% + Mancozeb 62% WP (Merger)	95.92 (78.38)	100 (90.00)	100 (90.00)	98.64 (83.31)
3	Carbendazim 12% + Mancozeb 63% WP (SAAF)	100 (90.00)	100 (90.00)	100 (90.00)	100 (90.00)
4	Zineb 68% WP+ Hexaconazole 4% (Avtar)	92.22 (73.81)	100 (90.00)	100 (90.00)	97.4 (80.73)
5	Untreated control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
		S.Em±		C.D. at 1%	
Fungicide (A)		0.39		1.49	
Concentration (B)		0.30		1.16	
Fungicide x Concentration (A x B)		0.67		2.59	

Table.4 *In vitro* antagonistic effect of different bioagents against *P. grisea* causing blast of pearl millet by using dual culture technique

SI. NO.	Bio agents	Isolate number	Per cent mycelial inhibition*
1	*Trichoderma viride*	Tri-4	66.66(54.74)
2	*Trichoderma harzianum*	Tri-5	77.03(61.37)
3	*Pseudomonas fluorescens*	EP-5	41.84(40.31)
4	*Pseudomonas fluorescens*	RP-46	67.77(55.41)
5	*Bacillus subtilis*	BS-16	38.51(38.36)
6	*Bacillus subtilis*	BS-30	44.07(41.60)
7	Untreated control	-	0.00(0.00)
S.Em±			0.74
C.D. at 1%			3.11

*Mean of three replications
Figures in the parentheses are arcsine transformed values

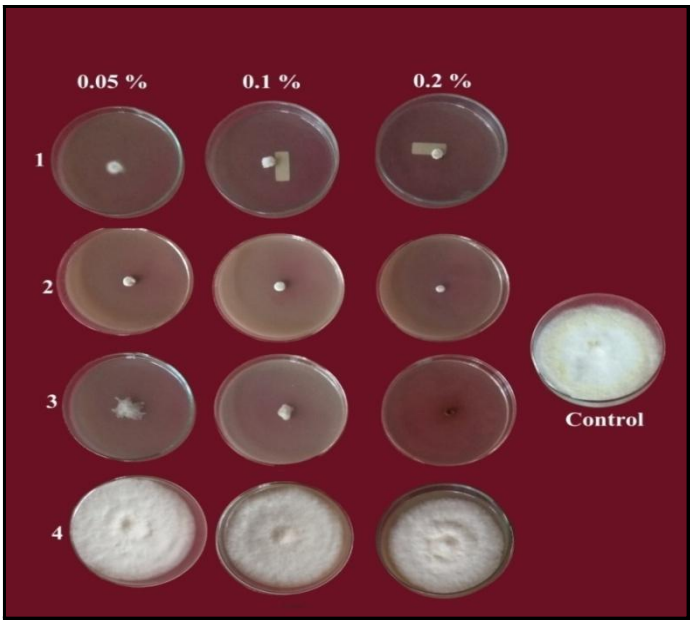

Plate 1. *In vitro* evaluation of systemic fungicides against *P. grisea*

Note: 1-Tricyclazole 75% WP, 2- Carbendazim 50% WP, 3- Hexaconazole 5% EC and 4- Azoxystrobin 23% SC

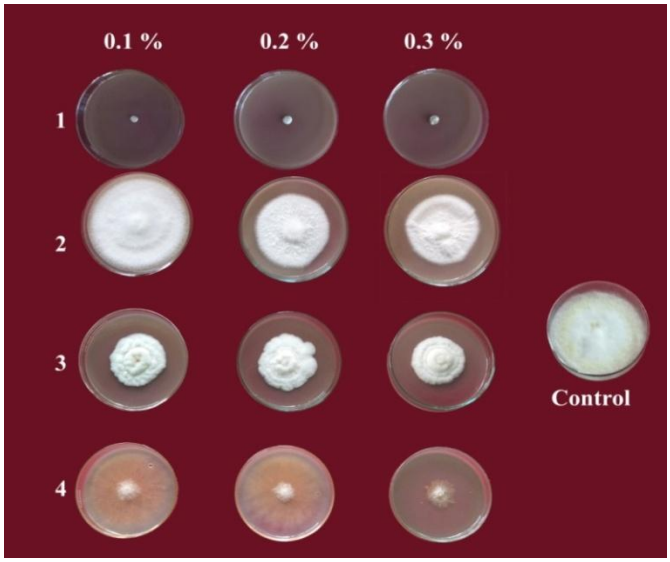

Plate 2. *In vitro* evaluation of contact fungicides against *P. grisea*

Note: 1- Mancozeb 75% WP, 2- Zineb 75% WP, 3- Chlorothalonil 75% WP and 4- Copper oxychloride 50% WP

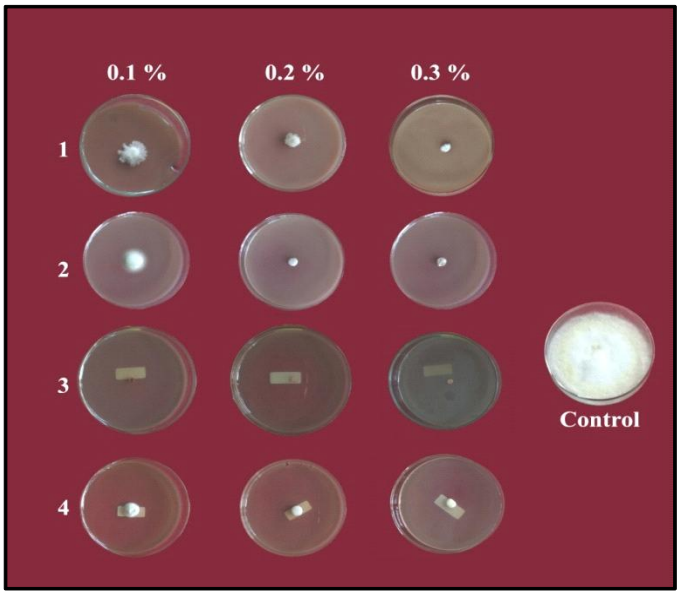

Plate 3. *In vitro* evaluation of combi fungicides against *P. grisea*

Note: 1- Azoxystrobin 11% + Tebuconazole18.3% SC, 2- Tricyclazole 18% + Mancozeb 62% WP, 3- Carbendazim 12% + Mancozeb 63% WP and 4- Zineb 68% WP+ Hexaconazole 4%

Plate 4. *In vitro* evaluation of bioagents against *P. grisea* by dual culture technique

Note: 1- *Trichoderma viride* (Tri-4),, 2- *Trichoderma harzianum* (Tri-5), 3- *Pseudomonas fluorescens* (EP-5), 4- *Pseudomonas fluorescens* (Rp64) 5- *Bacillus subtilis* (Bs-16) and 6-Bacillus *subtilis* (Bs-30)

In vitro evaluation of combi fungicides by using poisoned food technique

Four combination molecules (fungicides) were evaluated to know their efficiency against *P. grisea* through poison food techniques (Table 3 and Plate 3) at 0.1, 0.2 and 0.3 per cent concentrations. Among the four combi products, carbendazim (12%) + mancozeb (63%) WP was found highly effective with 100 per cent inhibition at all the three concentrations tested, followed by tricyclazole (18%) + mancozeb (62%) WP with 95.92, 100 and 100 per cent and hexaconazole (4%) + zineb (68%) WP with 92.22, 100 and 100 per cent at 0.1, 0.2 and 0.3 per cent concentrations respectively, as compare to control.

However, azoxystrobin (11%) + tebuconazole (18.3%) SC was found comparatively less effective with 79.62, 86.47 and 96.66 per cent inhibition at 0.1, 0.2 and 0.3 per cent concentrations, respectively. Irrespective of fungicidal concentrations, carbendazim (12%) + mancozeb (63%) WP resulted cent per cent inhibition and found to be best and significantly superior over other fungicides tested.

In vitro evaluation of bioagents by using dual culture technique

The antagonistic actions of selected six biocontrol agents against *P. grisea* were carried out through dual culture technique. Based on the observation of radial growth of the bioagent and fungus, per cent inhibition was calculated. The results are presented in Table 4 and Plate 4. Among the fungal bioagents tested, *T. harzianum* (Tri 5) was found more effective and statistically significant over other bio-control agents in inhibiting the mycelial growth of 77.03 per cent followed by *T. viride* (Tri 4) with 66.66 per cent. Among the bacterial bioagents, *P. fluoresces* (RP-46) was very effective with mycelial inhibition of 67.77 per cent. However, the least mycelial inhibition was recorded in *B. subtilis* (BS-16) with 38.51 per cent. The rest of the biocontrol agents were found least effective and found in the range of 41.84 to 44.07 per cent inhibition of pathogen.

Among the different fungicides evaluated, systemic and combi fungicides were found effective except azoxystrobin in inhibiting the growth of fungus. Among systemic fungicides, tricyclazole was found effective in inhibiting the fungal growth of *P. grisea* with cent per cent inhibition at all concentration tested (0.05, 0.1 and 0.2%) followed by carbendazim (Table 1). This may be due to inhibition of sterol bio synthesis. Similar results were reported by Joshi and Gohel (2015). Among the contact fungicides tested, mancozeb was found effective in inhibiting the growth of *P. grisea* at all concentrations tested (0.1, 0.2 and 0.3%) followed by copper oxychloride with mycelial inhibition of 83.58 per cent (Table 2). Similar results were reported by Roopadevi and Patil (2017). Among four combi fungicides tested, carbendazim (12%) + mancozeb (63%) WP was found highly effective with cent per cent inhibition at all three concentrations tested (Table 3). Similar results were reported by Roopadevi and Patil (2017). Among the bioagents tested, *T. harzianum* (Tri 5) and *P. fluorescens* (RP-46) were found effective with 77.03 and 67.77 per cent inhibition respectively (Table 4). The inhibitory effect of these bioagents was probably due to competition or antibiosis. Similar results were reported by Kishan Lal *et al.*, (2015).

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