Advances in Research

Volume 25, Issue 5, Page 223-235, 2024; Article no.AIR.123511
ISSN: 2348-0394, NLM ID: 101666096

Mitigating Pearl Millet Blast (*Pyricularia grisea*): Effective Fungicidal Treatments

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/air/2024/v25i51156

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/123511

Original Research Article

Received: 22/07/2024
Accepted: 24/09/2024
Published: 27/09/2024

ABSTRACT

Pearl millet is a staple cereal grown in India. It encounters number of diseases which attack the crop during its growth, cause low yield and economic loss to the peasant ad finally to the nation as a whole. The blast also referred as leaf spot caused by *Pyricularia grisea* has emerged as a serious disease affecting both forage and grain production in pearl millet. in view of this a field experiment was conducted over three consecutive *kharif* seasons (2021, 2022 and 2023) at the Pearl Millet Research Station, JAU, Jamnagar, to assess to evaluate the efficacy of different fungicides in reducing the incidence and severity of blast disease in pearl millet as well as Identify the most effective fungicide formulations and application rates for minimizing blast intensity. On the basis of

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Cite as: *Chaudhari, R. J., K. D. Mungra, G. M. Parmar, S. K. Parmar, and J. S. Sorathiya. 2024. "Mitigating Pearl Millet Blast (Pyricularia grisea): Effective Fungicidal Treatments". Advances in Research 25 (5):223-35. https://doi.org/10.9734/air/2024/v25i51156.*

field and based on the pooled data Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% recorded the lowest blast intensity at 30.20%, which was statistically at par with Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% (31.65%). The control treatment recorded the highest blast intensity at 54.96%. In context to grain and fodder yield, highest grain yield (2135 kg/ha) and fodder yield (44.38 q/ha) recorded in treatment Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% which was at par with Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% (2054 kg/ha), Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.625% (1940 kg/ha) and Tebuconazole 50% + Trifloxystrobin 25% WG, 0.0375% (1851 kg/ha). In summary**,** Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% was the most effective treatment for controlling blast and maximizing both grain and fodder yield. The performance of Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% was comparable in terms of blast intensity and yield parameters.

Keywords: Pearl millet blast; kharif; azoxystrobin; tebuconazole; disease intensity; yield.

ABBREVIATIONS

@	*:*	*At a Rate of*
a.i.	*:*	*Active Ingredient*
DAS	*:*	*Days After Sowing*
DMRT	*:*	*Duncan's Multiple Range Test*
EC	*:*	*Emulsifiable Concentrate*
ICBR	*:*	*Incremental Cost Venefit Ratio*
JAU	*:*	*Junagadh Agricultural University*
kg/ha	*:*	*Kilogram Per Hectare*
PDI	*:*	*Per cent Disease Intensity*
q/ha	*:*	*Quintal Per Hectare*
SC	*:*	*Suspension Concentrates*
WG	*:*	*Water Dispersible Granules*

1. INTRODUCTION

During 2023-24, pearl millet area in India was 7.36 million ha with an average production of 10.67 million tons and 1449 kg/ha productivity [1]. “The major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujrat and Haryana contributing to 90% of total production in the country. Rajasthan contributes nearly 45% followed by Uttar Pradesh (19%), Haryana (9%), Gujarat (9%), Maharashtra (6%) and Tamil Nadu (2%). Most of pearl millet in India is grown in rainy (kharif) season (June/July-September/October). Pearl millet is also cultivated during summer season (February-May) I parts of Gujarat, Rajasthan and Uttar Pradesh; and during the post-rainy (rabi) season (November-February) at a small scale in Maharashtra and Gujarat” [2]. In Gujarat it is grown in 26 out of 33 districts covering an area of 2.03 lakh ha in *kharif* with an average production 3.04 lakh tonnes and average yield 1787 kg/ha [1]. In 2023, Hon’ble prime minister of India rebranded millets as “Shree Anna” for their climate resilience and nutritional superiority and declared ICAR-IIMR, Hyderabad as “Global Centre of Excellence for Millets”. In order to mainstream and exploit nutritionally superiority of millets and promote their cultivation, Govt. of India declared Year 2018 as the “Year of Millets” and after declaration of FAO Committee on Agriculture (COAG) forum in 2021, Year 2023 was celebrated as “International Year of Millets” [2]. “Among the diseases of pearl millet, blast caused by *Pyricularia grisea* (Cooke) Sacc. [Teleomorph: Magnaporthe grisea (Herbert) Barr], a dis- ease of minor importance in past years, has gained status of major constraint to pearl millet production in India” [3]. Bajra blast also referred as leaf spot caused by *Pyricularia grisea (Cooke) Sacc.* [Teleomorph: *Magnaporthe grisea* (Herbert) Barr.] has emerged as a serious disease affecting both forage and grain production in pearl millet [4], resulting economic loss. Recently intensity of blast increased at alarming rate in commercial hybrids cultivation [5]. “In view of these, chemical control is taken to manage this disease. *Magnaporthe grisea* is externally seed borne and also survives as chlamydospores or as free saprophytic mycelium in the soil/leaf debris which serves as a source of primary inoculum” [6].

2. MATERIALS AND METHODS

Three-year field experiments were conducted during *kharif* 2021, *kharif* 2022 and *kharif* 2023 at Pearl Millet Research Station, JAU, Jamnagar to find out the bio efficacy of different fungicidal compounds against the minimized blast disease intensity at natural condition.

Experiment conducted with randomized block design (RBD), each having three replications. The plot size was 4.2 m × 2.4 m and distance between row to row and plant to plant was 60 cm and 10 cm, respectively. Four row were maintained in each treatment (plot) during all experimental season. Total ten fungicide and fungicidal combination (Table 1) including control was used as treatment for management of pearl millet blast disease intensity.

Foliar application of different fungicides was carried out management of pearl millet blast [7]. The first spray was given just after appearance of the disease and subsequent spray given after 15 days of first spray. For observation, ten plants were selected randomly and labeled from each plot for scoring the disease intensity. These labeled plants were observed for disease intensity from upper, middle and lower leaves using disease rating scale of 0-9. Observations on disease intensity was recorded at 30, 45 and 60 DAS.

Table 1. Treatments details

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	a. i g/ha	Quantity of formulation kg or l/ha
1.	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	375	0.800 l
2.	Iprobenphos 48 EC	0.1	20.83 ml	500	1.000 l
3.	Iprobenphos 48 EC	0.125	26.04 ml	625	1.302 l
4.	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	188	0.250 kg
5.	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	250	0.333 kg
6.	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	313	0.417 kg
7.	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	188	0.640 l
8.	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	250	0.853 l
9.	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	313	1.000 l
10.	Untreated (Control)	-	-	-	-

Per cent disease intensity (PDI) will be calculated by using the following formula [8].

$$\text{Disease intensity (\%)} = \frac{\text{Sum of total rating} \times 100}{\text{Total number of leaves observed} \times \text{Maximum disease rating}}$$

Blast disease rating scale (0-9)

Scale		Description	Scale		Description
0	:	No lesions	5	:	Typical blast lesions infecting 2-10% of the leaf area
1	:	Small brown specks of pinhead size without sporulating center	6	:	Blast lesions infecting 11-25% leaf area
2	:	Small roundish to slightly elongated, necrotic grey spots, about 1-2 mm in 8diameter with a distinct brown margin, lesions are mostly found on the lower leaves	7	:	Blast lesions infecting 26-50% leaf area
3	:	Lesion type is the same as in scale 2, but significant number lesions are on the upper leaves	8	:	Blast lesions infecting 51-75% leaf area
4	:	Typical sporulating blast lesions, 3 mm or longer, infecting less than 2% of the leaf area	9	:	More than 75% leaf area affected

Grain and fodder yield will be recorded from net plot area at harvest and data obtained was analyzed statistically.

3. RESULTS AND DISCUSSION

A field experiments was conducted with different ten treatments including control during *kharif* 2021, 2022 and 2023. The three year pooled result of all parameters presented in Tables 1 to 5. All the treatment found effective to suppress blast disease intensity significantly.

Based on the three-year pooled observations (2021-2023) for 30 Days After Sowing (DAS) (Table 1), Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% was found to be the most effective treatment, minimizing blast disease intensity to 10.81%**.** This treatment, Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% which recorded a blast intensity of 11.85%**,** Tebuconazole 50% + Trifloxystrobin 25% WG, 0.0375%**,** with a blast intensity of 12.11%**,** Iprobenphos 48% EC, 0.075%**,** with a blast intensity of 13.29% and Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.0625%**,** with a blast intensity of 13.88% was statistically at par with Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05%.

According to the results for 45 Days After Sowing (DAS) (Table 2), the treatments for managing blast disease in pearl millet showed the following effectiveness. Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% was the most effective treatment, minimizing blast disease intensity to 19.05%.

This treatment was statistically at par with Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05%, which recorded a blast intensity of 20.47%. Iprobenphos 48% EC, 0.075%, which resulted in a blast intensity of 23.07%. Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.0625%, with a blast intensity of 23.31%. These findings suggest that Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% is highly effective at 45 DAS for reducing blast disease intensity, with similar results from the other listed treatments.

The three-year pooled data for 60 Days After Sowing (DAS) (Table 3, Fig. 1) confirmed the previous observations for managing blast disease in pearl millet. Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% recorded the minimum blast intensity of 30.20%. This treatment was statistically at par with, Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05%, which recorded a blast intensity of 31.65%. The maximum blast intensity of 54.96% was observed in the control treatment, indicating the lack of protection in untreated plots. This data highlights the consistent effectiveness of Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% and Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% in minimizing blast intensity

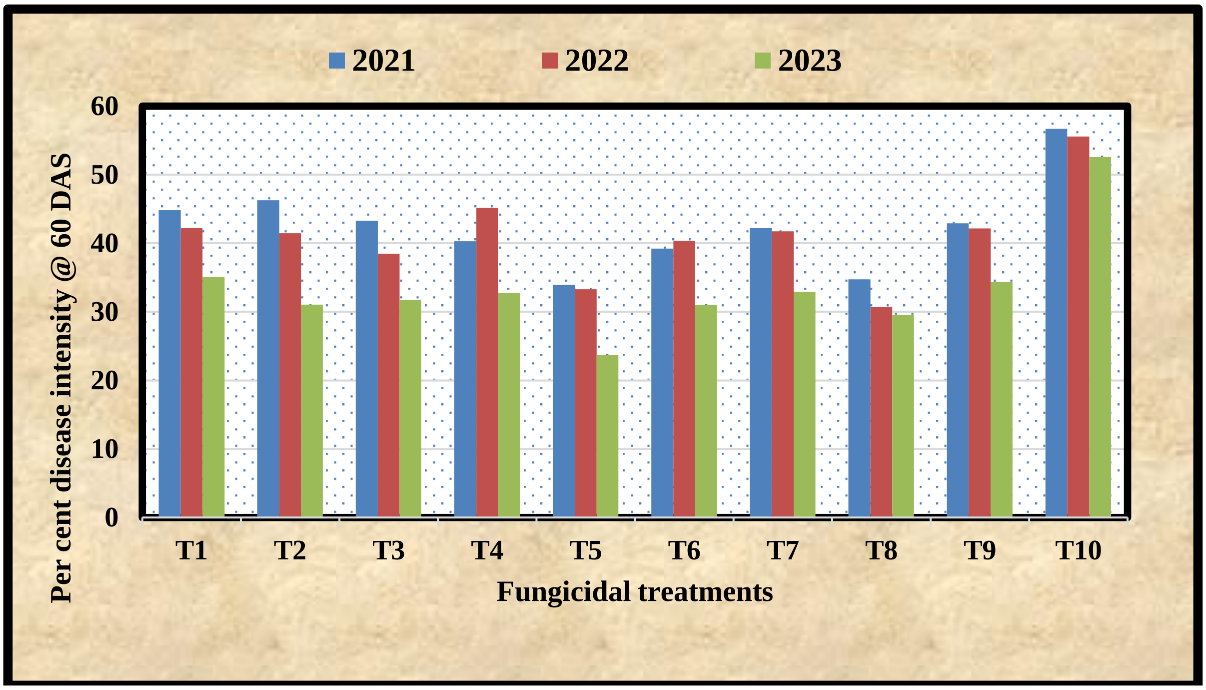

Fig. 1. Efficacy of different fungicides on blast disease intensity at 60 DAS

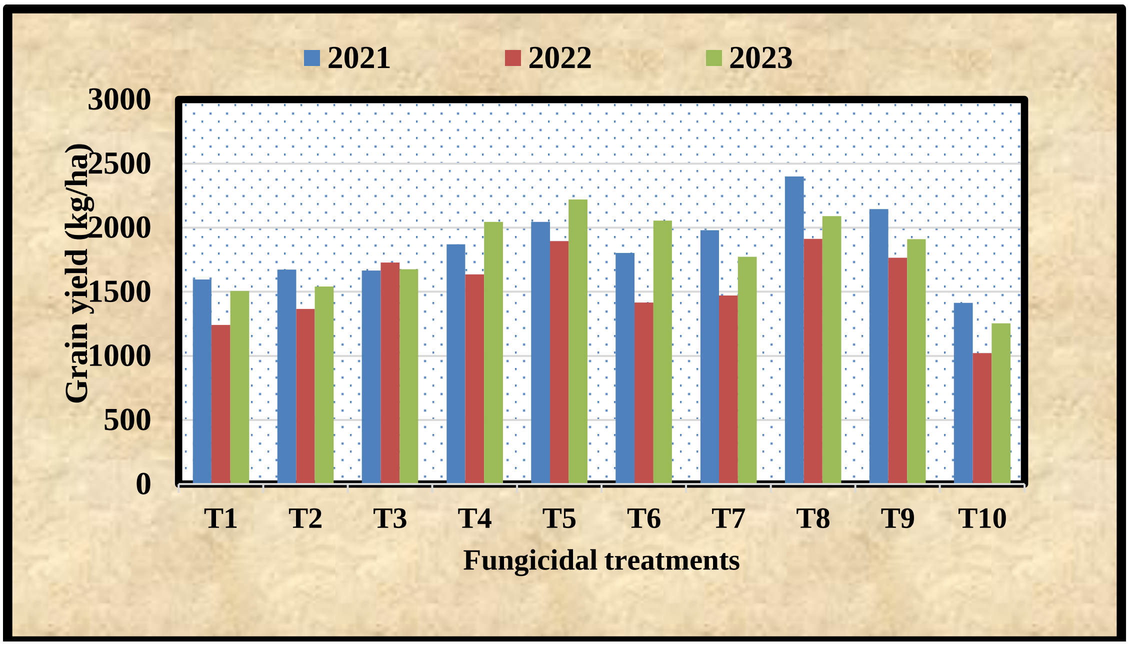

Fig. 2. Efficacy of different fungicides on grain yield

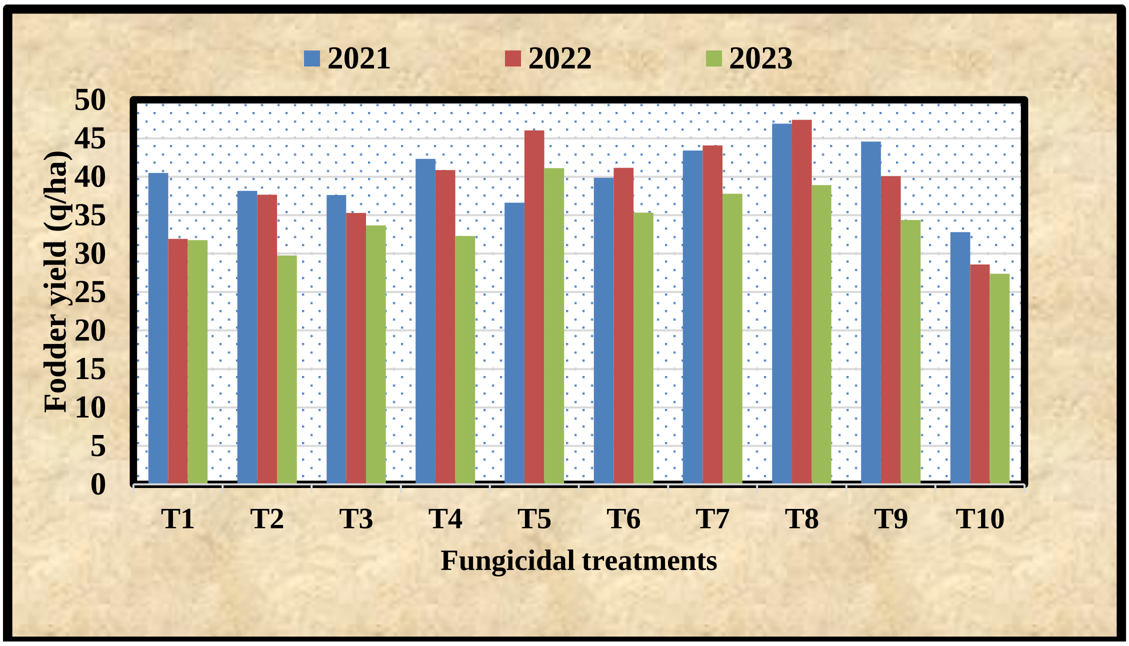

Fig. 3. Efficacy of different fungicides on fodde yield

over the three-year period at 60 DAS. Sharma et al. [9] reported that, the disease can be effectively managed in pearl millet with two to three sprays of propiconazole or tebuconazole + trifloxystrobin at 15 day intervals with the first spray at 20–25 days after sowing. Patro et al. [10] mentioned that initial spray of *Pseudomonas fluorescens* and Trifloxystrobin + Tebuconazole as second spray was found superior in managing the blast disease. Gouramanis [11] reported the fungicide Derosal (Carbendazim) @ 1.5 lb/100 gallons and Beam (Tricyclazole) @ 0.75 kg/ha effectively decreased rice neck blast followed by Fongoren (Pyroquilon) @ 2 kg/ha while, Kitazin (Iprobenfos) @ 750 g/ha and bla-s (Blasticidin) @ 100 µg/ml reduced leaf blast but not neck blast infection. Effectiveness of iprobenfos (kitazin) (3.75 kg a.i./ha) in controlling rice blast and increasing grain yield has also been reported by Sharma and Kumar [12].

Table 2. Efficacy of different fungicides on blast disease intensity at 30 DAS

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	Blast intensity (30 DAS)			
				2021	2022	2023	Pooled
T_1	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	22.33^{bc} (14.43)	23.81^{bcd} (16.29)	18.00^{e} (9.55)	21.38^{bcd} (13.29)
T_2	Iprobenphos 48 EC	0.1	20.83 ml	23.52^{b} (15.92)	24.07^{bc} (16.64)	18.42^{de} (9.98)	22.00^{bcd} (14.04)
T_3	Iprobenphos 48 EC	0.125	26.04 ml	21.60^{bcd} (13.55)	26.30^{ab} (19.63)	22.33^{ab} (14.44)	23.41^{b} (15.78)
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	19.60^{cd} (11.25)	21.41^{de} (13.32)	20.10^{c} (11.81)	20.37^{bcd} (12.11)
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	18.44^{d} (10.00)	24.31^{bc} (16.94)	17.67^{e} (9.21)	20.14^{cd} (11.85)
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	20.78^{bcd} (12.59)	25.20^{bc} (18.13)	20.71^{c} (12.50)	22.23^{bcd} (14.31)
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	21.68^{bcd} (13.65)	25.21^{bc} (18.14)	21.05^{bc} (12.91)	22.65^{bc} (14.83)
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	19.09^{cd} (10.70)	20.41^{e} (12.16)	18.07^{e} (9.62)	19.19^{d} (10.81)
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	23.22^{b} (15.54)	22.63^{cde} (14.81)	19.77^{cd} (11.44)	21.88^{bcd} (13.88)
T_{10}	Untreated (Control)	-	-	29.87^{a} (24.80)	28.36^{a} (22.56)	23.20^{a} (15.51)	27.14^{a} (20.81)
	S. Em. ±			**1.06**	**0.82**	**0.51**	**0.92**
	C. D. at 5%			**3.16**	**2.44**	**1.50**	**2.74**
	C. V. %			**8.36**	**5.88**	**4.39**	**6.51**
	Y						
	S. Em. ±						**0.26**
	C. D. at 5%						**0.74**
	Y×T						
	S. Em. ±						**0.83**
	C. D. at 5%						**2.35**

Figures in parenthesis are retransformed arc sine values. Data were transformed (angular transformed) before analysis.
Treatment means with letters(s) in common are at par as per DMRT at 5% level of significance

Table 3. Efficacy of different fungicides on blast disease intensity at 45 DAS

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	Blast intensity (45 DAS)			
				2021	**2022**	**2023**	**Pooled**
T_1	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	32.03^{b} (28.13)	28.63^{cs} (22.96)	25.45^{def} (18.52)	28.70^{bc} (23.07)
T_2	Iprobenphos 48 EC	0.1	20.83 ml	32.46^{b} (28.80)	29.36^{bcd} (24.04)	26.56^{bcde} (20.00)	29.46^{b} (24.19)
T_3	Iprobenphos 48 EC	0.125	26.04 ml	31.79^{b} (27.74)	33.18^{ab} (29.95)	25.20^{def} (18.15)	30.05^{b} (25.08)
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	29.62^{bcd} (24.43)	30.58^{bc} (25.88)	27.34^{bcd} (21.11)	29.18^{bc} (23.77)
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	26.82^{d} (20.36)	31.00^{bc} (26.52)	22.88^{f} (15.19)	26.90^{bc} (20.47)
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	29.85^{bc} (24.78)	32.00^{abc} (28.09)	28.29^{bc} (22.59)	30.05^{b} (25.08)
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	31.80^{b} (27.76)	30.59^{bc} (25.90)	28.58^{ab} (22.96)	30.32^{b} (25.49)
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	28.12^{cd} (22.22)	25.47^{d} (18.50)	24.04^{ef} (16.67)	25.88^{c} (19.05)
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	32.03^{b} (28.13)	28.83^{cd} (23.25)	$25.74c^{def}$ (18.89)	28.87^{bc} (23.31)
T_{10}	Untreated (Control)	-	-	39.87^{a} (41.10)	35.69^{a} (34.04)	31.07^{a} (26.67)	35.54^{a} (33.80)
	S. Em. ±			**0.85**	**1.19**	**0.84**	**1.02**
	C. D. at 5%			**2.52**	**3.52**	**2.50**	**3.02**
	C. V. %			**4.68**	**6.73**	**5.49**	**5.71**
	Y						
	S. Em. ±						**0.31**
	C. D. at 5%						**0.87**
	Y×T						
	S. Em. ±						**0.97**
	C. D. at 5%						**NS**

Figures in parenthesis are retransformed arc sine values. Data were transformed (angular transformed) before analysis.
Treatment means with letters(s) in common are at par as per DMRT at 5% level of significance

Table 4. Efficacy of different fungicides on blast disease intensity at 60 DAS

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	Blast intensity (60 DAS)			
				2021	**2022**	**2023**	**Pooled**
T_1	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	42.02^{b} (44.81)	40.51^{b} (42.20)	36.32^{b} (35.09)	39.62^{b} (40.66)
T_2	Iprobenphos 48 EC	0.1	20.83 ml	42.87^{b} (46.29)	40.09^{b} (41.47)	33.85^{bc} (31.03)	38.94^{b} (39.50)
T_3	Iprobenphos 48 EC	0.125	26.04 ml	41.14^{bc} (43.29)	$38.34b^{cd}$ (38.48)	34.30^{b} (31.76)	37.93^{b} (37.78)
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	39.40^{c} (40.28)	42.22^{b} (45.16)	34.94^{b} (32.80)	38.85^{b} (39.35)
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	35.65^{d} (33.96)	35.24^{cd} (33.29)	29.12^{c} (23.68)	34.23^{c} (31.65)
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	38.79^{c} (39.24)	39.44^{bc} (40.35)	$33.83b^{c}$ (30.99)	37.35^{b} (36.81)
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	40.51^{bc} (42.20)	40.25^{b} (41.76)	35.01^{b} (32.92)	38.59^{b} (38.91)
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	36.12^{d} (34.75)	33.66^{d} (30.72)	32.93^{bc} (29.55)	33.33^{c} (30.20)
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	40.93^{bc} (42.92)	40.50^{b} (42.18)	35.90^{b} (34.39)	39.11^{b} (39.80)
T_{10}	Untreated (Control)	-	-	48.85^{a} (56.70)	48.19^{a} (55.56)	46.49^{a} (52.60)	47.85^{a} (54.96)
	S. Em. ±			**0.75**	**1.48**	**1.52**	**0.75**
	C. D. at 5%			**2.22**	**4.40**	**4.51**	**2.13**
	C. V. %			**3.19**	**6.44**	**7.46**	**5.83**
	Y						
	S. Em. ±						**0.41**
	C. D. at 5%						**1.17**
	Y×T						
	S. Em. ±						**1.30**
	C. D. at 5%						**NS**

Figures in parenthesis are retransformed arc sine values. Data were transformed (angular transformed) before analysis.
Treatment means with letters(s) in common are at par as per DMRT at 5% level of significance

Table 5. Efficacy of different fungicides on grain yield

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	Grain yield (kg/ha)			
				2021	**2022**	**2023**	**Pooled**
T_1	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	1596^{de}	1242^{de}	1505^{cd}	1448^{de}
T_2	Iprobenphos 48 EC	0.1	20.83 ml	1674^{cde}	1367^{cd}	1540^{cd}	1527^{cde}
T_3	Iprobenphos 48 EC	0.125	26.04 ml	1667^{cde}	1729^{ab}	1675^{bcd}	1690^{bcd}
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	1871^{bcd}	1637^{abc}	2046^{ab}	1851^{abc}
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	$2045a^{bc}$	1895^{a}	2221^{a}	2054^{ab}
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	1804^{bcde}	1415^{cd}	2055^{ab}	1758^{bcd}
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	1980^{bc}	1471^{bcd}	1773^{abc}	1742^{bcd}
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	2401^{a}	1913^{a}	2090^{ab}	2135^{a}
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	2144^{ab}	1766^{ab}	1911^{abc}	1940^{ab}
T_{10}	Untreated (Control)	-	-	1413^{e}	1021^{e}	1254^{d}	1229^{e}
	S. Em. ±			**114.95**	**93.03**	**137.87**	**114.74**
	C. D. at 5%			**341.51**	**276.41**	**409.64**	**340.92**
	C. V. %			**10.71**	**10.42**	**13.21**	**11.64**
	Y						
	S. Em. ±						**36.91**
	C. D. at 5%						**104.72**
	Y×T						
	S. Em. ±						**116.73**
	C. D. at 5%						**NS**

Treatment means with letters(s) in common are at par as per DMRT at 5% level of significance

Table 6. Efficacy of different fungicides on fodder yield

Tr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water	Fodder yield (q/ha)			
				2021	2022	2023	Pooled
T_1	Iprobenphos (Kitazin) 48 EC	0.075	15.63 ml	40.50^{ab}	31.90^{de}	31.75^{bcd}	34.72^{cd}
T_2	Iprobenphos 48 EC	0.1	20.83 ml	38.15^{ab}	37.65^{bcde}	29.76^{cd}	35.19^{cd}
T_3	Iprobenphos 48 EC	0.125	26.04 ml	37.60^{ab}	35.27^{cde}	33.65^{abcd}	35.51^{c}
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0375	5.0 g	42.30^{ab}	40.85^{abcd}	32.30^{bcd}	38.49^{bc}
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	0.05	6.67 g	36.61^{ab}	46.03^{ab}	41.11^{a}	41.25^{ab}
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	0.0625	8.33 g	39.86^{ab}	41.14^{abcd}	35.32^{abcd}	38.77^{bc}
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0375	12.80 ml	43.39^{ab}	44.06^{abc}	37.78^{abc}	41.74^{ab}
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.05	17.06 ml	46.88^{a}	47.38^{a}	38.89^{ab}	44.38^{a}
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	0.0625	21.33 ml	44.57^{a}	40.06^{abcd}	34.36^{abcd}	39.66^{abc}
T_{10}	Untreated (Control)	-	-	32.79^{b}	28.57^{e}	27.381^{d}	29.58^{d}
	S. Em. ±			**3.17**	**2.90**	**2.61**	**1.68**
	C. D. at 5%			**NS**	**8.62**	**7.77**	**4.76**
	C. V. %			**13.64**	**12.80**	**13.22**	**13.26**
	Y						
	S. Em. ±						**0.92**
	C. D. at 5%						**2.61**
	Y×T						
	S. Em. ±						**2.90**
	C. D. at 5%						**NS**

Treatment means with letters(s) in common are at par as per DMRT at 5% level of significance

Table 7. Economics of various treatments for the management pearl millet blast

Tr. No.	Treatment	Yield (kg/ha) Pooled		Yield increase over control (kg/ha)		Income (₹)		Additional income (₹)	Cost of treatment (fungicides, labour charge, etc.) (₹/ha)	Net realization (₹)	ICBR
		Grain	Fodder	Grain	Fodder	Grain*	Fodder**				
1	2	3	4	5	6	7	8	9	10	11 (9-10)	12 (9/10)
T_1	Iprobenphos (Kitazin) 48 EC	1448	3472	219	514	5475	1028	6503	1800	4703	1: 3.61
T_2	Iprobenphos 48 EC	1527	3519	298	561	7450	1122	8572	2000	6572	1 :4.29
T_3	Iprobenphos 48 EC	1690	3551	461	593	11525	1186	12711	2302	10409	1 :5.52
T_4	Tebuconazole 50 + Trifloxystrobin 25 WG	1851	3849	622	891	15550	1782	17332	3000	14332	1 :5.78
T_5	Tebuconazole 50 + Trifloxystrobin 25 WG	2054	4125	825	1167	20625	2334	22959	3664	19295	1 :6.27
T_6	Tebuconazole 50 + Trifloxystrobin 25 WG	1758	3877	529	919	13225	1838	15063	4336	10727	1 :3.47
T_7	Azoxystrobin 11 + Tebuconazole 18.30 SC	1742	4174	513	1216	12825	2432	15257	2152	13105	1 :7.09
T_8	Azoxystrobin 11 + Tebuconazole 18.30 SC	2135	4438	906	1480	22650	2960	25610	2535	23075	1 :10.10
T_9	Azoxystrobin 11 + Tebuconazole 18.30 SC	1940	3966	711	1008	17775	2016	19791	2800	16991	1 :7.07
T_{10}	Untreated (Control)	1229	2958	-	-	-	-	-	-	-	-

** Price of bajra grain: ₹25/kg, ** Price of bajra fodder: ₹2/kg*

3.1 Grain and Fodder Yield

The three-year pooled results for grain yield (Table 4, Fig. 2) demonstrated that the highest grain yield of 2135 kg/ha was recorded in the treatment Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05%. The treatment Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05%**,** which produced a grain yield of 2054 kg/ha and the treatment Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.625% recorded a grain yield of 1940 kg/ha and the treatment Tebuconazole 50% + Trifloxystrobin 25% WG, 0.0375% recorded a grain yield of 1851 kg/ha found at par in the three-year pooled results. While this yield was lower than other treatments like Azoxystrobin + Tebuconazole (2135 kg/ha) combinations, it still contributed to significant improvement in grain yield compared to untreated controls. Trifloxystrobin + Tebuconazole was found to be effective in managing the blast disease in pearl millet with higher yield [13]. Field experiment results of Sharma et al. [9] revealed that three sprays of Tebuconazole + Trifloxystrobin or propiconazole was superior in reducing blast incidence with higher yields in pearl millet. Pramesh et al. [14] reported that rice blast was effectively controlled with Tebuconazole + Trifloxystrobin and resulted in higher yield.

For fodder yield data presented in Table 5 and Fig. 3 revealed that maximum fodder yield (44.38 q/ha) same as grain yield in treatment Azoxystrobin 11 + Tebuconazole 18.30 SC, 0.05% and which was at par with Azoxystrobin 11 + Tebuconazole 18.30 SC, 0.0375% (41.74 q/ha), Tebuconazole 50 + Trifloxystrobin 25 WG, 0.05% (41.25 q/ha) and treatment Azoxystrobin 11 + Tebuconazole 18.30 SC, 0.0625% (39.66 q/ha). Minimum grain yield (1229 kg/ha) and fodder yield (29.58 q/ha) recorded in control.

3.2 Economics

Based on the economics of different fungicidal treatments presented in Table 6. The highest additional income of ₹25,610/ha was obtained with the treatment Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05%. This treatment also achieved the highest net realization of ₹23,075/ha. The maximum Incremental Benefit-Cost Ratio (ICBR) of 1:10.10 was associated with the same treatment. These economic indicators highlight that Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% is not only the most effective fungicide for controlling blast disease but also provides the best financial return on investment.

4. CONCLUSION

From the results, it can be concluded that spraying Azoxystrobin 11% + Tebuconazole 18.30% SC, 0.05% (17.06 ml/10 l of water) or Tebuconazole 50% + Trifloxystrobin 25% WG, 0.05% (6.67 g/10 l of water) in pearl millet effectively manages blast disease. Both treatments were successful in minimizing blast intensity, achieving higher grain and fodder yields and also providing additional income. These treatments offer a practical solution for managing blast disease while also enhancing the overall productivity and profitability of pearl millet cultivation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENT

The assistance, help and co-operation received during the experimental period from the teaching and nonteaching staff members attached with Pearl Millet Research Station, JAU, Jamnagar are gratefully acknowledged.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/123511