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Management of Pearl Millet Downy Mildew Disease by Organic Practices

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ABSTRACT: Three-year field experiments were conducted during kharif 2021, kharif 2022 and kharif 2023 at Pearl Millet Research Station, JAU, Jamnagar. Total five treatments [(*Trichoderma harzianum* (JAU @ 8 g/kg), PSB formulation (PSB 8g/kg), Neem oil (3%) and Metalaxyl (6g/kg)] including control was used as seed treatment. Seed treatment was carried out for management of pearl millet downy mildew. In 60 DAS observation shows that the Metalaxyl 35 SD (6 g/kg) recorded minimum downy mildew disease incidence (10.12%) and which was at par with seed treatment of *Trichoderma harzianum* (8 g/kg) (11.55%). The maximum downy mildew disease incidence recorded in control (18.58%). Maximum grain yield (2127 kg/ha) and fodder yield (38.02 q/ha) found in treatment Metalaxyl (6 g/kg) and which was at par seed treatment *Trichoderma harzianum* (8 g/kg) (2002 kg/ha grain yield and 36.86 q/ha fodder yield). Minimum grain yield (1418 kg/ha) and fodder yield (30.09 q/ha) recorded in control.

Keywords: Downy mildew, *Trichoderma harzianum,* Metalaxyl.

INTRODUCTION

Pearl millet is grown on 26 mha globally, of which 7.4 mha are in the most marginal arid and semiarid tropical regions of India, particularly in Maharashtra, Rajasthan, Gujarat, and Uttar Pradesh states (AICRP on Pearl Millet 2022). Pearl millet is mainly grown in *kharif* but in Gujarat it is also grown during summer season. In addition to this state have a large area where farmers grow pearl millet in the semi-*rabi* (Post rainy). This area actually unrecorded and lays along the west cost of bay of Cambay particularly Gir Somnath and other adjoining districts of Gujarat. In Gujarat it is grown in 26 out of 33 districts covering an area of 1.97 lakh ha in *kharif* with an average productivity of 1771 kg/ha (2023-24) and around 3.18 lakh ha area under summer with an average productivity of 2970 kg/ha (2022-23). The total area of pearl millet in the state is 5.08 lakh ha with an average productivity of 2545 kg/ha (2022-23).

Pearl millet suffer from different disease *i.e.* Downy mildew, Blast, Rust, Smut and Ergot but downy mildew disease show most impactful action in pearl millet crop. *Sclerospora graminicola* has the widest host range of the *Sclerospora* spp. with pearl millet and foxtail millet (*Setaria italica*) as its principal host originating in Africa (Harlan, 1975; Brunken *et al.*, 1977). It is believed that region of origin of the host is also the region of origin of the pathogen. Therefore, downy mildew pathogen has been associated with pearl millet since approximately 3500 BC.

The downy mildew (DM) disease of pearl millet [*Pennisetum glaucum* (L) R. Br.] sometimes referred to as 'green ear' disease is caused by *Sclerospora graminicola*, which isthe type species of the genus *Sclerospora*. It is the most widespread and destructive diseases of pearl millet in India and Western Africa (Rachie and Majmudar 1980). This disease, first reported in India (Butler, 1907), is present in more than 20 countries (Safeeulla, 1976) and is a major factor limiting the full exploitation of the high yield potential of hybrids in India (Singh *et al.*, 1993). Downy mildew disease causes reduction in the plant height, number of leaves and nodes in susceptible cultivars. As a result, grain and fodder yields are reduced. Symptoms often vary according to host, time of expression and ambient conditions (Kenneth, 1998). Both systemic and localized infection occurs. Infection is mainly systemic and symptoms appear on leaves and inflorescence. The downy mildew stage is prominent on the leaves (caused by sporangia) and the green ear stage affects the inflorescence/ear (caused by oospores).

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 effective organic compounds for minimize downy mildew disease incidence. Experiment conducted in sick plot (continuous three-year selection plot) with randomized block design (RBD) each having four 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). Total five treatments [(*Trichoderma harzianum* (*JAU* @ 8 g/kg), PSB formulation (PSB 8g/kg), Neem oil (3%) and Metalaxyl (6g/kg)] including control was used as seed treatment for management of pearl millet downy mildew. Seed

treatment was given at the time of sowing. The observations on total number of plants and plants infected with downy mildew were recorded at 60 DAS. Percent disease incidence (PDI) will be calculated by using the following formula (Wheeler, 1969).

$$\text{Disease incidence} = \frac{\text{No.of diseased plants}}{\text{Total number of plants}}$$

RESULTS AND DISCUSSION

For this studies, five ecofriendly inputs where used to know the minimize downy mildew disease incidence an importantly 30 and 60 days after sowing (DAS) in relation to disease incidence, seedling emergence, obtained grain and fodder yield at harvest.

Three year pooled data indicated (Table 1 and Fig. 1) that none of the treatment found significantly superior. Its shows that all the treatment application was not statistically effective on seed germination. Same result (Table 2 and Fig. 2) found 30 DAS, none of the treatment found statistically effective against downy mildew disease incidence.

For three year pooled result (Table 3 and Fig. 3) of 60 DAS downy mildew incidence, data revealed that treatment metalaxyl 35 SD (6 g/kg) recorded minimum downy mildew disease incidence (10.12%) and which was at par with seed treatment of *Trichoderma harzianum* (8 g/kg) (11.55%). The maximum downy mildew disease incidence recorded in control (18.58%). The results supported and related evident observed by Singh *et al.* (2018) that the management of downy mildew mancozeb was significantly superior over all the tested bio agent, seed dressing with Amectoctradin + Dimethomorph @0.4 ml/ 500 ml water, whiles it was statistically at par with metalaxyl. Another research of Mani and Hepziba (2009) suggested that seed treatment with *Pseudomonas fluorescens* 10 g/kg (ST) ranks next (10.47%) followed by ST with *Trichoderma viride* at 4 g/kg (17.15%) and FS with the culture filtrate of *Fusarium longipes* (10^3 conidia/ml) 20 DAS (29.76%) he also mentioned that the grain yield recorded 910 kg/ha in ST with *T. viride*, and *Pseudomonas fluorescens* (880 kg/ha).

Grain and fodder yield: Three year pooled result (Table 4 and Fig. 4) for grain yield indicated that the highest grain yield (2127 kg/ha) found in treatment Metalaxyl (6 g/kg) and which was at par seed treatment *Trichoderma harzianum* (8 g/kg) (2002 kg/ha).

For fodder yield data shows that (Table 5 and Fig. 5) revealed that maximum fodder yield (38.02 q/ha) same as grain yield in treatment Metalaxyl (6 g/kg) and which was at par with *Trichoderma harzianum* (8 g/kg) (36.86 q/ha). Minimum grain (1418 kg/ha) and fodder yield (30.09 q/ha) recorded in control.

Economics: Looking to the economics of different seed treatments of bio agents, the highest additional income ₹ 15954/ha, highest net realization of ₹ 15452/ha and maximum ICBR 1:32 was obtained in the treatment *Trichoderma harzianum* (8 g/kg).

Table 1: Effect of chemical and bio-agents treatments on seedling emergence (%).

Sr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water or 1 kg seed	Seedling emergence (%)			
				2021	2022	2023	Pooled
1.	*Trichoderma harzianum*	2×10^6cfu/g	8 g/kg	48.69^b	58.39^b	64.75^c	57.27^a
2.	PSB formulation	1×10^8cfu/g	8 g/kg	50.89^a	66.38^a	65.28^c	60.85^a
3.	Neem oil	3%	30 ml/kg	46.79^c	56.58^b	68.45^b	57.27^a
4.	Metalaxyl 35 SD	0.021	6 g/kg	47.55^{bc}	64.01^a	71.3^a	60.95^a
5.	Control (Untreated)	-	-	51.95^a	66.68^a	67.54^{bc}	62.06^a
	S. Em. ±			**0.54**	**0.86**	**0.87**	**1.74**
	C. D. @ 5 %			**1.66**	**2.65**	**2.70**	**NS**
	C. V. %			**2.19**	**2.75**	**2.59**	**2.59**
	Y						
	S. Em. ±						**0.35**
	C. D. @ 5 %						**0.99**
	Y × T						
	S. Em. ±						**0.77**
	C. D. @ 5 %						**2.22**

Data were transformed (angular transformed) before analysis. Treatment means with letters(s) in common are at par as per DNMRT at 5% level of significance.

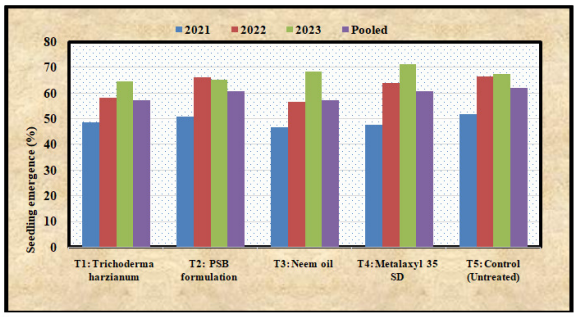

Fig. 1. Effect of chemical and bio-agents treatments on seedling emergence (%).

Table 2: Effect of chemical and bio-agents on downy mildew disease incidence @ 30 DAS.

Sr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water or 1 kg seed	DM incidence (30 DAS)			
				2021	2022	2023	Pooled
1.	*Trichoderma harzianum*	2×10^6cfu/g	8 g/kg	19.49^{ab} (10.68)	18.01^{b} (9.56)	13.39^{c} (5.76)	16.97^{ab} (8.66)
2.	PSB formulation	1×10^8cfu/g	8 g/kg	15.30^{c} (6.60)	19.62^{ab} (11.28)	18.03^{ab} (9.58)	17.65^{ab} (9.15)
3.	Neem oil	3%	30 ml/kg	16.31^{bc} (7.52)	21.93^{ab} (13.94)	16.65^{b} (8.21)	18.29^{ab} (9.89)
4.	Metalaxyl 35 SD	0.021	6 g/kg	19.22^{abc} (10.55)	17.97^{b} (9.52)	11.74^{c} (4.14)	16.15^{b} (8.07)
5.	Control (Untreated)	-	-	21.11^{a} (12.50)	23.51^{a} (15.92)	20.27^{a} (12.01)	21.25^{a} (13.48)
	S. Em. ±			**1.22**	**1.18**	**0.80**	**1.35**
	C. D. @ 5 %			**3.77**	**3.6514**	**2.47**	**NS**
	C. V. %			**13.39**	**11.73**	**9.93**	**11.68**
	Y						
	S. Em. ±						**0.50**
	C. D. @ 5 %						**1.44**
	Y × T						
	S. Em. ±						**1.12**
	C. D. @ 5 %						**3.22**

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 DNMRT at 5% level of significance.

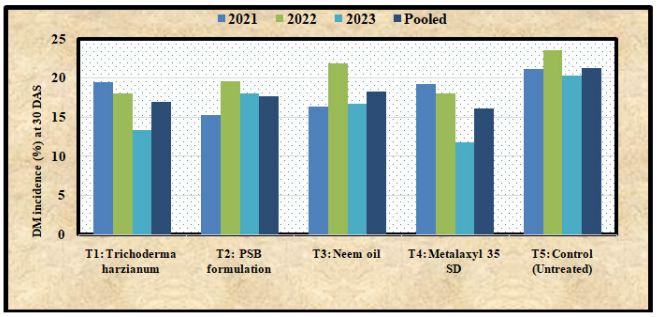

Fig. 2. Effect of chemical and bio-agents on downy mildew disease incidence at @ 30 DAS.

Table 3: Effect of chemical and bio-agents on downy mildew disease incidence @ 60 DAS.

Sr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water or 1 kg seed	DM incidence (60 DAS)			
				2021	2022	2023	Pooled
1.	*Trichoderma harzianum*	2×10^6cfu/g	8 g/kg	21.41^{ab} (12.87)	20.55^{b} (12.32)	17.82^{cd} (9.47)	19.92^{bc} (11.55)
2.	PSB formulation	1×10^8cfu/g	8 g/kg	19.90^{b} (11.18)	22.91^{ab} (15.16)	21.39^{b} (13.34)	21.40^{b} (13.22)
3.	Neem oil	3%	30 ml/kg	21.96^{ab} (13.59)	24.17^{ab} (16.76)	19.42^{bc} (11.17)	21.85^{b} (13.84)
4.	Metalaxyl 35 SD	0.021	6 g/kg	19.74^{b} (11.02)	20.85^{b} (12.67)	14.97^{d} (6.69)	18.52^{c} (10.12)
5.	Control (Untreated)	-	-	24.05^{a} (16.12)	27.63^{a} (21.51)	25.17^{a} (18.13)	25.61^{a} (18.58)
	S. Em. ±			**0.97**	**1.24**	**1.04**	**0.61**
	C. D. @ 5 %			**NS**	**3.8196**	**3.22**	**1.74**
	C. V. %			**9.10**	**10.67**	**10.57**	**10.11**
	Y						
	S. Em. ±						**0.47**
	C. D. @ 5 %						**1.35**
	Y × T						
	S. Em. ±						**1.05**
	C. D. @ 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 DNMRT at 5% level of significance.

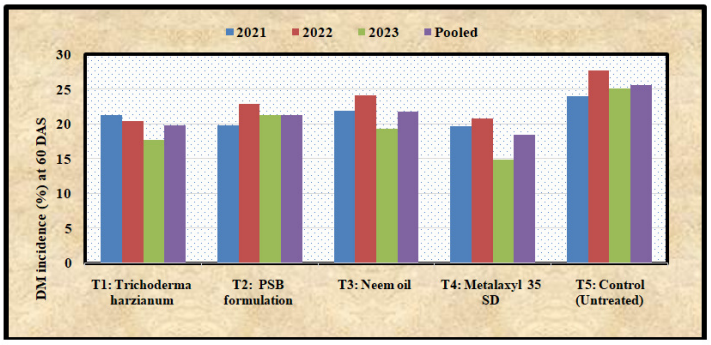

Fig. 3. Effect of chemical and bio-agents on downy mildew disease incidence @ 60 DAS.

Table 4: Effect of chemical and bio-agents on grain yield.

Sr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water or 1 kg seed	Grain yield (kg/ha)			
				2021	2022	2023	Pooled
1.	*Trichoderma harzianum*	2×10^6cfu/g	8 g/kg	1995^{a}	1937^{a}	2076^{ab}	2002^{ab}
2.	PSB formulation	1×10^8cfu/g	8 g/kg	1981^{a}	1901^{a}	1858^{bc}	1913^{bc}
3.	Neem oil	3%	30 ml/kg	1540^{b}	1812^{a}	1912^{b}	1755^{c}
4.	Metalaxyl 35 SD	0.021	6 g/kg	2177^{a}	1925^{a}	2280^{a}	2127^{a}
5.	Control (Untreated)	-	-	1361^{b}	1274^{b}	1620^{c}	1418^{d}
	S. Em. ±			**68.36**	**108.67**	**81.69**	**50.72**
	C. D. @ 5 %			**210.67**	**334.88**	**251.73**	**145.60**
	C. V. %			**7.55**	**12.28**	**8.38**	**9.53**
	Y						
	S. Em. ±						**39.29**
	C. D. @ 5 %						**112.79**
	Y × T						
	S. Em. ±						**87.86**
	C. D. @ 5 %						**NS**

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

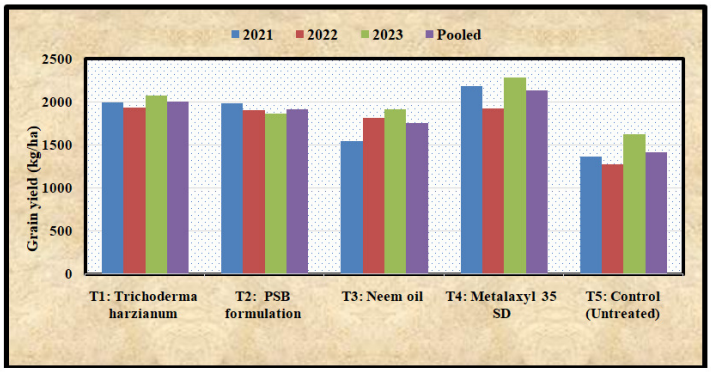

Fig. 4. Effect of chemical and bio-agents on grain yield.

Table 5: Effect of chemical and bio-agents on fodder yield.

Sr. No.	Treatment	Con. (a. i.)	Quantity in g or ml in 10 liter of water or 1 kg seed	Fodder yield (q/ha)			
				2021	2022	2023	Pooled
1.	*Trichoderma harzianum*	2×10^6cfu/g	8 g/kg	34.19^{ab}	43.31^{a}	33.07^{ab}	36.86^{ab}
2.	PSB formulation	1×10^8cfu/g	8 g/kg	34.96^{ab}	36.72^{a}	31.43^{abc}	34.37^{ab}
3.	Neem oil	3%	30 ml/kg	32.01^{b}	37.27^{a}	30.03^{bc}	33.10^{bc}
4.	Metalaxyl 35 SD	0.021	6 g/kg	37.69^{a}	40.34^{a}	36.04^{a}	38.02^{a}
5.	Control (Untreated)	-	-	26.98^{c}	36.22^{a}	27.06^{c}	30.09^{c}
	S. Em. ±			**1.40**	**2.89**	**1.60**	**1.20**
	C. D. @ 5 %			**4.31**	**NS**	**4.93**	**3.43**
	C. V. %			**8.4300**	**14.93**	**10.14**	**12.02**
	Y						
	S. Em. ±						**0.93**
	C. D. @ 5 %						**2.66**
	Y × T						
	S. Em. ±						**2.07**
	C. D. @ 5 %						**NS**

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

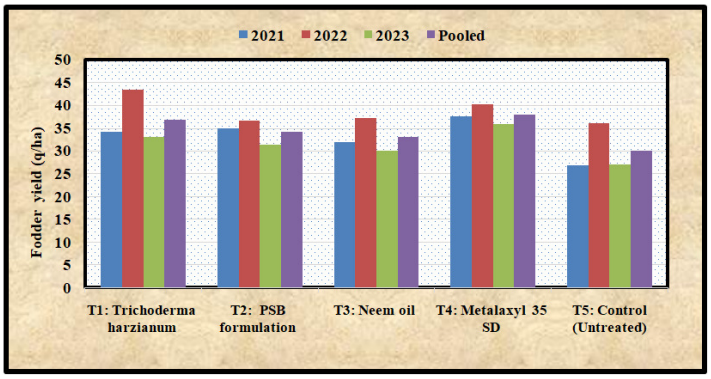

Fig. 5. Effect of chemical and bio-agents on fodder yield**.**

CONCLUSIONS

It can be concluded from the above results that the seed treatment of *Trichoderma harzianum* (8 g/kg) in pearl millet against downy mildew disease were found effective to minimize blast intensity, higher grain and fodder yield and additional income also.

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Conflict of Interest. None.

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