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Evaluation of Microbial Consortia for the Management of Downy Mildew of Pearl Millet

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Abstract

Downy mildew caused by *Sclerospora graminicola* poses the greatest threat to pearl millet in India and other pearl millet growing regions. The present research was conducted to evaluate the MPKV microbial consortia for the management of downy mildew of pearl millet. The MPKV microbial consortia were assessed as seed treatment and soil application. The pearl millet seeds were treated with MPKV microbial consortia @8.0 g kg^{-1} and standard fungicide Metalaxyl 35 SD @ 6.0 g kg^{-1}. The soil application of MPKV microbial consortia @8.0 g L^{-1} were done immediately after sowing. These seeds were sown in downy mildew sick plot and observations were recorded as germination percentage, per cent disease incidence, per cent disease control, grain yield and fodder yield. Seed treatment @8.0 g kg^{-1} + soil application @8.0 g L^{-1} of combined microbial consortia showed significantly maximum germination (95.28%) over all other treatments and control (78.05%). The highest downy mildew disease control (82.86%) was observed for seed treatment with Metalaxyl 35 SD @ 6.0 g kg^{-1} followed by seed treatment @ 8.0 g kg^{-1} + soil application @ 8.0 g L^{-1} of MPKV fungal consortia (62.76%) and soil application of MPKV bacterial consortia @ 8.0 g L^{-1} (62.76%). While grain and fodder yield were not significantly influenced by these treatments.

Key words : Pearl millet, *Sclerospora graminicola*, MPKV microbial consortia.

Pearl millet, [Pennisetum glaucum (L.) R. Br.] holds significance as both a cereal and forage crop in arid and subtropical areas of the Indian subcontinent and various parts of Africa. It is believed to have been domesticated in Africa as a cereal or forage crop at least 3000 years ago. India is recognized as a secondary hub of biodiversity for pearl millet (Appa Rao and de Wet, 1999). The crop serves as a staple food of 90 million impoverished people and extensively grown on 30 mha area in the arid and semi-arid tropical parts of Asia and Africa. It is also utilized for feed and fodder, contributing to nearly half of the total global millet production (Srivastava *et al*., 2020). Bajra outperforms other cereals like wheat, maize, rice, sorghum and barley due to its unique qualities. Besides rice, wheat and maize, bajra is the fourth most extensively grown food crop in India, encompassing 6.93 mha with 8.61 mt and average productivity of 1,243 kg/ha (Reddy *et al*., 2021). Among the various diseases affecting pearl millet, downy mildew poses the greatest threat to pearl millet, especially on susceptible hybrid varieties. Downy mildew, a globally distributed disease, is one of the most significant threats to grain yield, causing losses of up to 60% (Nene and Singh, 1976). Sclerospora graminicola, a major soil-borne fungal pathogen, causes downy mildew and is challenging to control. Exploring microbial consortium could give alternative for disease control. With this in mind, the present study has been proposed during 2023.

Materials and methods

The field experiment was conducted during *Kharif*-2023 at Bajra Research Scheme, College of Agriculture, Dhule. The MPKV microbial consortia (fungal, bacterial and combined) were assessed as seed treatment and soil application for the management of downy

mildew of pearl millet. The seeds of variety 'Dhule local-1' were treated with with MPKV microbial consortia @8.0 g kg^{-1} and standard fungicide Metalaxyl 35 SD @6.0 g kg^{-1} and shade dried. Then, the seeds were sown in row to row 50 cm and plant to plant 10 cm apart in plot size 4.0 x 3.0 m. The soil application of MPKV microbial consortia @8.0 g L^{-1} was done immediately after sowing. The untreated treatment served as control and observations were recorded as germination percentage (%), downy mildew incidence at 30 and 60 DAS, per cent disease control (%), grain and fodder yield (q ha^{-1}) were recorded. The per cent downy mildew incidence was calculated with the help of following formula:

$$\text{Downy mildew incidence (\%)} = \frac{\text{Downy mildew infected plants}}{\text{Total no. of plants}} \times 100$$

The downy mildew incidence was recorded and percent disease control (PDC) was worked out by using following formula:

$$\text{Per cent Disease Control (PDC)} = \frac{\text{PDI in control} - \text{PDI in treatment}}{\text{PDI in control}} \times 100$$

Results and Discussion

The impact of MPKV microbial consortia on downy mildew of pearl millet was assessed through in vivo (field) experiments. The results including germination percentage, per cent disease incidence, per cent disease control, grain and fodder yield are presented in Table 1 and depicted in Figure 1.

Seed Germination (%) : From the results (Table 1), it was revealed that the treatments imposed significantly superior effect on seed germination which was maximum (95.28%) with the treatment T_9 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} MPKV combined microbial (Fungal+Bacterial) consortia, followed by T_7 : Seed treatment @ 8.0 g kg^{-1} with MPKV combined microbial consortia (92.78 %) and T8 : Soil application @ 8.0 g L^{-1} with MPKV combined microbial (Fungal +Bacterial) consortia (91.67%) over untreated control (78.05%). Rest of the treatments recorded seed germination from 88.89% to 82.36%.

Downy mildew incidence (%) :

At 30 DAS : Downy mildew incidence was recorded lowest (1.29 %) with the treatment T3 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} with MPKV fungal consortia, with maximum per cent disease control (79.78%), followed by T10 : Seed Treatment @ 6.0 g kg^{-1} with Metalaxyl 35% SD with per cent disease incidence (1.91%) and per cent disease control (70.06%). These treatments were on par with treatment T_9 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} MPKV combined microbial consortia (PDI 2.04 %), T7 : Seed treatment @ 8.0 g kg^{-1} of combined microbial consortia (PDI 2.53%) and T_8 : Soil application @ 8.0 g L^{-1} MPKV combined microbial consortia (PDI 3.19%), over unreated control (PDI 6.38%). Rest of the treatments were recorded DM incidence in the range of 3.43 to 5.43%, with per cent disease control from 46.23 to 14.89%.

At 60 DAS : Significantly lowest downy mildew incidence (2.02 %) was recorded with the T_{10} : Seed Treatment of Metalaxyl 35% SD @ 6.0 g kg^{-1} with disease control 82.86 per cent, followed by the treatments T_3 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} MPKV fungal consortia, T_5 : Soil application @ 8.0 g L^{-1} MPKV bacterial consortia (PDI 4.39 % each), T_9 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} MPKV combined microbial consortia (PDI 4.84%) and these treatments were on par to each other, over untreated control (PDI 11.79%). Rest of the treatments recorded DM

incidence from 5.68 to 9.64% and disease control ranged from 51.82 to 18.23 per cent. Suryadi (2013) and Zhou *et al*. (2015) recorded that by using a combination of several antagonistic bacteria as a consortium can increase the ability of bacteria as biological controllers and plant growth promoters. The high enhanced disease control activity occurs due to the bacterial metabolic activity of the consortium complementing each other.

Grain yield (q ha^{-1}) : The results revealed that all the treatments alone and combined application of seed treatment and soil application were found non-significant in grain yield. Maximum grain yield (20.0 q ha^{-1}) was recorded with the treatment T_9 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} MPKV combined microbial consortia, compared to untreated control (15.69 q ha^{-1}). The next best treatments for grain yield were T_7 : Seed treatment @ 8.0 g kg^{-1} with combined MPKV microbial consortia (18.47 q ha^{-1}), T_{10} : Seed treatment @ 6.0 g kg^{-1} with Metalaxyl 35% SD

Table 1. Evaluation of microbial consortia (MPKV) against downy mildew of pearl millet

Treatments	Rate of apllication	Seed germination (%)*	PDI (%)* 30 DAS	PDC (%)*	PDI (%)* 60 DAS	PDC (%)*	Grain yield (q ha^{-1})*	Fodder yield (q ha^{-1})*
T_1 - Seed treatment of MPKV fungal consortia	8.0 g kg^{-1}	85.00 (67.23)	4.98 (12.80)	21.94	8.35 (16.70)	29.17	16.81	51.11
T_2 - Soil application of MPKV fungal consortia	8.0 g L^{-1}	82.36 (65.29)	5.43 (13.34)	14.89	9.64 (17.80)	18.23	16.53	49.17
T_3 - T_1 (Seed treatment) + T_2 (Soil application) MPKV fungal consortia	8.0 g kg^{-1} + 8.0 g L^{-1}	86.25 (68.34)	1.29 (6.24)	79.78	4.39 (11.73)	62.76	17.36	54.45
T_4 - Seed treatment of MPKV bacterial consortia	8.0 g kg^{-1}	86.53 (68.90)	4.67 (12.39)	26.80	5.68 (13.59)	51.82	17.09	52.78
T_5 - Soil application of MPKV bacterial consortia	8.0 g L^{-1}	85.55 (67.80)	3.43 (10.59)	46.23	4.39 (12.04)	62.76	16.94	49.50
T_6 - T_4 (Seed treatment) + T_5 (Soil application) MPKV bacterial consortia	8.0 g kg^{-1} + 8.0 g L^{-1}	88.47 (70.52)	4.27 (11.84)	33.07	6.89 (15.12)	41.56	17.92	54.72
T_7 - Seed treatment of combined microbial consortia	8.0 g kg^{-1}	92.78 (74.60)	2.53 (8.99)	60.34	7.14 (15.11)	39.44	18.47	55.55
T_8 - Soil application of combined microbial consortia	8.0 g L^{-1}	91.67 (73.37)	3.19 (10.14)	50.00	8.90 (17.18)	24.51	18.20	54.45
T_9 - T_7 (Seed treatment) + T8 (Soil application) combined microbial consortia	8.0 g kg^{-1} + 8.0 g L^{-1}	95.28 (77.54)	2.04 (8.06)	68.02	4.84 (12.15)	58.94	20.00	58.06
T_{10} - Seed treatment with Metalaxyl 35% SD	6.0 g kg^{-1}	88.89 (71.02)	1.91 (7.79)	70.06	2.02 (8.03)	82.86	18.20	57.22
T_{11} - Control	-	78.05 (62.13)	6.38	- (14.50)	11.79	- (20.02)	15.69	46.67
SE ±	-	2.46	0.83	-	1.31	-	2.49	6.27
CD at 5%	-	7.26	2.45	-	3.87	-	N.S	N.S

* : Mean of three replications. Figures in parentheses are Arc sine values.

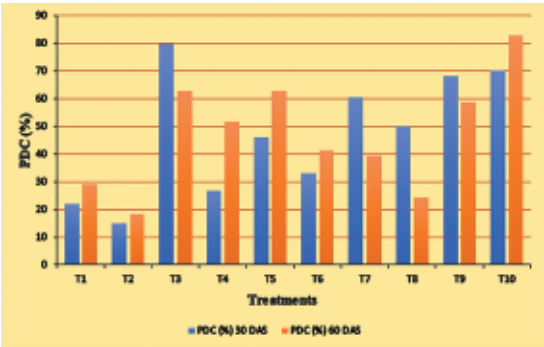

Fig. 1. Evaluation of MPKV microbial consortia against downy mildew of pearl millet

and T_8 : Soil application @ 8.0 g L^{-1} with MPKV combined microbial consortia (18.20 q ha^{-1}).

Fodder yield (q ha^{-1}) : The results (Table 1) revealed that, fodder yield was not influenced by different treatments. However, maximum fodder yield was found with the treatment T_9 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} of MPKV combined microbial consortia (58.06 q ha^{-1}) compared to untreated control (46.67 q ha^{-1}). The next best treatments were T_{10} : Seed treatment @ 6.0 g kg^{-1} with Metalaxyl 35 SD (57.22 q ha^{-1}), T_7 : Seed treatment @ 8.0 g kg^{-1} with combined MPKV microbial consortia (55.55 q ha^{-1}) and T_6 : Seed treatment @ 8.0 g kg^{-1} + Soil application @ 8.0 g L^{-1} of MPKV bacterial consortia (54.72 q ha^{-1}). Rest of the treatments recorded fodder yield in the range of 54.45 to 49.17 q ha^{-1}.

Conclusion

From the present research work, it was concluded that Metalaxyl 35 SD @ 6.0 g kg^{-1} found effective against downy mildew of pearl millet and among the microbial consortia treatments, seed treatment @ 8.0 g kg^{-1} + soil application @ 8.0 g L^{-1} MPKV combined microbial consortia found most effective over all other remaining treatments and untreated control.

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