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Efficacy of Different Fungicides for the Management of Downy Mildew of Pearl Millet

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Abstract

Pearl millet [*Pennisetum glaucum* (L.) R. Br.], commonly referred as bajra, is a crucial cereal food and fodder crop. It is the most extensively cultivated drought-tolerant, warm-season coarse grain crop. This crop is susceptible to numerous diseases, among them downy mildew caused by *Sclerospora graminicola* is the most prevalent and devastating. *Sclerospora graminicola*, a major soil-borne fungal pathogen, causes downy mildew and is challenging to control. This study assessed the effectiveness of eight different fungicides formulations in managing the pathogen in vivo (pot culture). The seeds were treated with standard fungicide Metalaxyl 35% SD @ 6.0 g kg^{-1} and sown in pots filled with sick soil of *Sclerospora graminicola*. Fungicides with recommended concentration were sprayed at 15 and 30 days after sowing. The observations on germination percentage, per cent disease incidence, per cent disease control were recorded. The highest per cent disease control (60.00%) were recorded for Metalaxyl 35 SD @ 6.0 g kg^{-1}, Bordeaux mixture @ 1% and Metalaxyl 8% + Mancozeb 64 % WP @ 0.4% followed by Azoxystrobin 18.2 % + Cyproconazole 7.3% w/w SC @ 0.05% (49.98%) over control. While Azoxystrobin 18.2 % + Difenoconazole 11.4 % SC @ 0.1% and Azoxystrobin 11% + Tebuconazole 18.3% ww SC were least effective compared to the rest of fungicides.

Key words : Pearl millet, *Sclerospora graminicola*, Metalaxyl, Fungicides.

Pearl millet, [*Pennisetum glaucum* (L.) R. Br.] is the most widely grown drought tolerant warm season coarse grain cereal and forage crop. It is critically important for food and nutritional security. Pearl millet ranks as the sixth most important cereal crop in the world, following rice (*Oryza sativa*), wheat (*Triticum aestivum*), maize (*Zea mays*), barley (*Hordeum vulgare*) and sorghum (*Sorghum bicolor*). It offers numerous benefits such as early maturation, resilience to drought, minimal input requirements and typically being resistant to both biotic and abiotic stresses. As a C4 plant, it has superior photosynthetic efficiency, greater capacity for dry matter production and resilience in unfavourable agro-climatic conditions, requiring fewer inputs while yielding higher economic returns (Nambiar *et al*., 2011). The "Kranz" anatomy in the leaves of C4 plants makes them more capable of fixing inorganic CO_2 and more efficient at utilising water compared to C_3 plants. Hence, along with other C_4 plants like maize and sorghum, pearl-millet can account for 30 % of the worldwide terrestrial carbon fixation (Choudhary *et al*., 2020). Its innate capacity to withstand temperatures as high as 42°C during the reproductive phase enables successful cultivation in extremely hot summers under irrigation in northern Gujarat and eastern Uttar Pradesh of India, thereby establishing it as a resilient crop in varying climatic conditions. Pearl millet is acknowledged in developing nations as a crucial crop, aiding in addressing food shortages and fulfilling nutritional needs of the growing population. It serves as a vital provider of dietary calories and protein in the daily intake of a substantial portion of the poor people. Nutritional value of pearl-millet per 100 grams is as: Energy 361 kcal, Protein 11.6 g, Carbohydrate 65.5 g, Crude fiber 1.2 g, Calcium 42 mg, Iron 8.0 mg. (*Source as per Nutritive value of Indian food,

NIN, ICMR, 2018). Pearl millet can be cultivated extensively, however, it is often susceptible to various diseases. Among them, downy mildew caused by Sclerospora graminicola is the most prevalent and devastating. Similar to other oomycetes, this pathogen also exhibits a complex disease cycle. Although the disease can be effectively controlled with the systemic fungicide metalaxyl, recent developments in metalaxyl tolerance highlight the necessity to explore new compounds that can manage downy mildew incidence equally well or even better. With this in mind, the present research work was undertaken during 2023.

Materials and methods

The pot culture experiment was conducted at Bajra Research Scheme, College of Agriculture, Dhule during *Kharif* 2023 to evaluate the efficacy of eight fungicides against Sclerospora graminicola. Pearl millet variety 'Dhule local-1' was sown in twenty-seven pots. Ten seedlings per pot were maintained. The details of the treatments are as follows:

Design : CRD

Variety : Dhule local-1

Replications : Three

Treatments : Nine

Pots of 25 cm diameter were taken and filled with sick soil of Sclerospora graminicola. Pearl millet seeds were treated with Metalaxyl 35% SD @ 6.0 g kg^{-1} and sown in sick soil pots. Seeds Fungicides with recommended concentration were sprayed at 15 and 30 days after sowing. The untreated treatment kept as a control. The observations on germination percentage, per cent disease incidence, per cent disease control were recorded. The downy mildew incidence per cent 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 formula.

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

Results and Discussion

During the *kharif* season of 2023, eight fungicides were evaluated in vivo using pot culture to assess their efficacy against downy mildew of pearl millet using the variety 'Dhule local-1'. The results are presented in Table 1 and depicted in Fig. 1.

The germination percentage found significantly superior in all treatments (83.33% to 91.11%) over untreated control (77.78%) due to seed treatment with Metalaxyl 35% SD @6.0 g kg^{-1} in all treatments before sowing.

The lowest downy mildew incidence (10.00%) and highest per cent disease control (66.67%) was recorded in treatments T_1 (Seed treatment with Metalaxyl 35 SD @ 6.0 g kg^{-1}) and T_6 (Bordeaux mixture @ 1%) at 30 DAS. These were followed by treatments T_2 (Azoxystrobin 18.2 % + Cyproconazole 7.3 % w/w SC @ 0.05%) and T_8 (Metalaxyl 8 % + Mancozeb 64% WP @ 0.4%), with per cent disease incidence of 13.33% and per cent disease control of 55.56% and were at par to each other over control (30.00 %). The results revealed minimum downy mildew incidence (13.33%) and highest per cent disease control (60.00%) with the treatments T_1 (Seed treatment with Metalaxyl 35 SD @ 6.0 g kg^{-1}), T_6 (Bordeaux mixture @ 1%) and T_8 (Metalaxyl 8 % + Mancozeb 64 % WP @ 0.4%) over control (PDI 33.33%) at 60 DAS. The next

Table 1. Management of downy mildew of pearl millet by different fungicides *in vivo* (Pot culture)

Treatments	Germination (%)	PDI (%) 30 DAS	PDC (%)	PDI (%) 60 DAS	PDC (%)
T_1 : Metalaxyl 35 SD @ 6.0 g kg^{-1}	90.00 (71.57)*	10.00 (18.43)	66.67	13.33 (21.14)	60.00
T_2 : Azoxystrobin 18.2% + Cyproconazole 7.3 % w/w SC @ 0.05%	85.56 (67.79)	13.33 (21.14)	55.56	16.67 (23.85)	49.98
T_3 : Carbendazim 12% + Mancozeb 63% WP @ 0.2%	83.33 (66.14)	16.67 (23.85)	44.43	16.67 (23.85)	49.98
T_4 : Azoxystrobin 18.2% + Difenoconazole 11.4 % w/w SC @ 0.1%	85.56 (67.79)	16.67 (23.85)	44.43	23.33 (28.78)	30.00
T_5 : Azoxystrobin 11% + Tebuconazole 18.3% ww SC @ 0.05%	84.45 (66.97)	20.00 (26.57)	33.33	23.33 (28.78)	30.00
T_6 : Bordeaux mixture @ %	90.00 (71.57)	10.00 (18.43)	66.67	13.33 (21.14)	60.00
T_7 : Copper Hydroxide 53.8% w/w DF @ 0.2%	91.11 (72.88)	16.67 (23.85)	44.43	16.67 (23.85)	49.98
T_8 : Metalaxyl 8% + Mancozeb 64 % WP @ 0.4%	86.67 (68.85)	13.33 (21.14)	55.56	13.33 (21.14)	60.00
T_9 : Control	77.78 (61.89)	30.00 (33.21)	-	33.33 (35.21)	-
SE ±	1.91	2.02	-	2.53	-
CD at 5%	5.72	6.05	-	7.60	-

*Arc sine values

effective treatments were T_2 (Azoxystrobin 18.2% + Cyproconazole 7.3% w/w SC @ 0.05%), T_3 (Carbendazim 12% + Mancozeb 63% WP @ 0.2%) and T_7 (Copper Hydroxide 53.8% w/w DF @ 0.2%) which had a per cent disease incidence of 16.67% and per cent disease control 49.98% each. The results are in confirmity with many earlier workers. Champagnol (1973) reported that Bordeaux mixture was the most effective fungicide for controlling downy mildew of grapes. Litvinov *et al*. (1984), concluded that Ridomil @ 0.2% gave best disease control (89.3-99.9%) against downy mildew pathogen. Pandya *et al*. (1999) reported that seed tratment with Apron 6.0 g kg^{-1} combined with spray of Ridomil @ 4.0 g L^{-1} resulted in the lowest downy mildew incidence with 1.83% observed 30 DAS and 6.73% at the dough stage. Pandya *et al*. (2000), reported that seed treatment with metalaxyl (Apron 35 % WS) @ 2 g ai kg^{-1} seed controlled pearl millet downy mildew up to 20-22 days after sowing (DAS). Seed treatment with Apron 35% WS @ 2 g ai/kg, followed by one spray of Ridomil MZ 72 WP (metalaxyl + mancozeb) @ 4 g L^{-1}, at 20 DAS gave the best result, with the disease incidence 4.63 and 41.59% as compared to

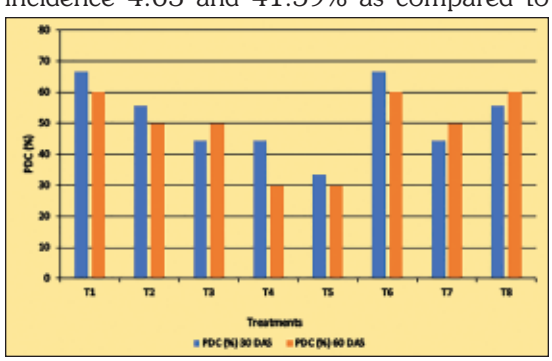

Fig. 1. *In vivo* evaluation of different fungicides against downy mildew of pearl millet (pot culture).

39.10 and 69.92% in control at 30 and 60 DAS, respectively.

Conclusion

From the present research study, it was concluded that Metalaxyl 35 SD @ 6.0 g kg^{-1}, Bordeaux mixture @ 1%, Metalaxyl 8% + Mancozeb 64% WP @ 0.4% found significantly superior over rest of treatments in controlling the downy mildew of pearl millet.

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