Forage Res., **42** (1) : pp. 44-47 (2016) **http://forageresearch.in**

EVALUATION OF BIOAGENTS FOR MANAGEMENT OF DOWNY MILDEW OF PEARL MILLET CAUSED BY *SCLEROSPORA GRAMINICOLA* (SACC.) SCHROET

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(Received : 05 June 2016; Accepted : 27 June 2016)

SUMMARY

Downy mildew of pearl millet incited by *Sclerospora graminicola* (Sacc.) Schroet is the most widespread and destructive disease of pearl millet in India and other pearl millet growing area of the world. This disease is a major factor limiting full exploitation of high yield potential hybrids in India. The field trials were conducted in Department of Plant Pathology research area of CCS Haryana Agricultural University Hisar with the objective to evaluate different biological agents for the management of pearl millet downy mildew in an attempt to develop an ecofriendly management strategy. Pearl millet seeds of moderately susceptible hybrid B 2301 were treated with *Bacillus pumulis,* Chitosan, Chitosan + *Bacillus pumulis, Trichoderma viride, Trichoderma harzianum, Pseudomonas fluorescens* were sown under sick plot and observations on germination percentage, per cent disease incidence at 30 and 60 days after sowing and yield data on harvest were recorded. Among different agents tested to manage downy mildew, minimum disease incidence (9.3%) was observed in treatment of Chitosan + *Bacillus pumulis* with maximum germination percentage of 53.5% and grain yield (1091.7 kg/ha).

Key words : Pearl millet, downy mildew, bioagents, *Trichoderma,* Chitosan, *Bacillus pumulis*

Pearl millet [*Pennisetum glaucum* (L.) R.Br. Syn. *Pennisetum americanum* (L.) Leeke] is among the oldest cultivated crops of Asian and African countries. It is believed that it was domesticated for not less than 3000 years ago as a forage or cereal crop in Africa. Pearl millet is predominantly a rainfed crop able to thrive well in the rainfall as low as 250 mm on relatively poor soils. Being most tolerant to drought and salinity, the crop is by and large grown in different countries of the world. This coarse grain is considered as poor man's food especially for working class. Besides grain, the fodder of this crop is of excellent quality. Due to its adaptability under very wide range of agro-climatic conditions this crop is mostly grown in the states of Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, parts of Delhi, Punjab and Uttar Pradesh.

Pearl millet is attacked by many diseases however, economically important diseases include downy mildew, rust, ergot and smut (Raj *et al.,* 2014). Amongst various diseases affecting Pearl millet crop, Downy mildew [*Sclerospora graminicola* (Sacc.) Schroet] is a highly destructive and widespread disease in most pearl millet growing areas of Asia and Africa. Genetically uniform single-cross F1 hybrid cultivars generally become susceptible more rapidly than heterogeneous open-pollinated varieties (Thakur *et al*., 2006) leading to heavy production losses. Downy mildew severity reached epidemic levels in India during the mid 1970s to 1980s when only a few single-cross hybrids were cultivated on a large scale. *Sclerospora graminicola* (Sacc.) Schroet, incitant of downy mildew of pearl millet, is an obligate parasite, belonging to family Peronosporaceae, order Peronosporales. Downy mildew of pearl millet was first reported by Butler in India and described it the disease of ill-drained lands where it developed into epidemics of severity (Butler, 1907). In this disease two types of symptoms are produced - 'downy mildew' and 'green ear'. Symptoms often vary according to the host, time of their expression and ambient conditions. The variation in symptoms may occur due to systemic infection. Downy mildew infected

plants develop severe disease syndrome from the very beginning and succumb even before reaching maturity. Reduction in the plant height, number of leaves and nodes are commonly observed in susceptible cultivars resulting in reduced grain and fodder yields.

Pesticides are necessary at present but are not a long term solution for crop health. Besides their non-target effects, hazardous to nature and expensive, some of them are losing their effectiveness because of development of resistant strains. Breeding for resistance, as the most practical and feasible method to manage plant diseases, is not able to keep full pace with the development of more virulent pathogens. Use of biocontrol agents in integrated management of pearl millet downy mildew is the requirement of current era to avoid all inherent ill effects *viz*., environmental pollution, residual toxicity, development of resistance by the pathogen, cost ineffectiveness etc., caused by the continuous use of chemicals. The present study was carried out to evaluate different agents for management of downy mildew of pearl millet caused by *Sclerospora graminicola* (Sacc.) Schroet.

MATERIALS AND METHODS

The field trials were conducted in Department of Plant Pathology research area of CCS Haryana Agricultural University Hisar during *kharif* season of 2014 with the objective to evaluate different biological agents for the management of pearl millet downy mildew in an attempt to develop an ecofriendly management strategy. Pearl millet seeds of moderately susceptible hybrid B 2301 were treated with *Bacillus pumulis* INR 7 (@10 g/Kg), Chitosan @ 2.5 g/Kg seed, Chitosan + *Bacillus pumulis* @ 10 g/Kg, *Trichoderma viride* @ 4g/ Kg, *Trichoderma harzianum* @ 4g/Kg, *Pseudomonas fluorescens* Pf1 (@ 10g/Kg). The treated seeds were sown in a sick plot, in a randomized block design having plot size of 5×3 meter and the distance between row to row and plant to plant was maintained 50 cm and 10 cm respectively. Four set of replications for each treatment were planted. Observations on germination percentage, disease incidence at 30, 60 DAS and grain yield at maturity were recorded. Per cent disease incidence was calculated by the formula

$$\text{Downy mildew incidence (\%)} = \frac{\text{Downy mildew infected plants}}{\text{Total number of plants}} \times 100$$

RESULTS AND DISCUSSION

Different bioagents viz., *Bacillus pumulis* INR7, Chitosan, Chitosan+*Bacillus pumulis* INR7, *Trichoderma viride*, *Trichoderma harzianum* and *Pseudomonas fluorescens* Pf1 were evaluated and data on germination %, downy mildew incidence at 30 and 60 Days after sowing and grain yield was recorded.

The results presented in Table 1 revealed that there were maximum average number of plants in seed treatment with Chitosan (@2.5g/kg seed)+ *Bacillus pumulis* INR7 (@ 10 g/kg seed) (160.5) followed by seed treatment with *Pseudomonas fluorescens* Pf1 (@ 10 g/kg seed) (157.5), seed treatment with *Bacillus pumulis INR7* (@ 10 g/kg seed) (150) and seed treatment with *Trichoderma viride* (148.5) where as minimum average number of plants were observed when seed treated with Chitosan (@ 2.5 g/kg seed) alone. Similarly, maximum germination percentage was observed in seed treatment with Chitosan (@ 2.5 g/kg seed) + *Bacillus pumulis* INR7 (@ 10 g/kg seed) (53.5%) followed by seed treatment with *Pseudomonas fluorescens* Pf1 (@ 10 g/kg seed) (52.5%), seed treatment with *Bacillus pumulis* (50%) and seed treatment with *Trichoderma viride* (49.5%). Minimum germination (%) was recorded when seed treated with Chitosan (@ 2.5 g/kg seed) alone. Simultaneously, none of the plant exhibited downy mildew at 30 and 60 DAS. Results are in consistent with the finding of (Begum *et al*., 2010) who reported that application of *T. harzianum* suppressed *Alternaria* fruit rot disease and improved seed germination, vigour index, growth and yield in chilli.

Maximum grain yield of (1091.7 kg/ha) was recorded in seed treatment with Chitosan (@ 2.5 g/kg seed) + *Bacillus pumulis* INR7 (@10 g/kg seed) followed by seed treatment with *Bacillus pumulis* INR7 (@10 g/ kg seed) (1000 kg/ha) in comparison to control (850 kg/ ha).

Downy mildew incidence at 30 days after sowing was recorded as minimum in seed treatment with Chitosan (@ 2.5 g/kg seed)+ *Bacillus pumulis* INR7 (@ 10 g/kg seed) (0.9%) in comparison to control 21.5%. Seed treatment with *Pseudomonas fluorescens* ranked next (4.7%) in management of downy mildew of pearl millet followed by seed treatment with *Trichoderma viride* (5.0%), seed treatment with *Trichoderma harzianum* (5.1%) and seed treatment with *Bacillus pumulis* INR7 (@ 10 g/kg seed) (6.1%). Our results are in corroboration to the studies of different authors, Mani

TABLE 1
Effect of different bioagents against germination percentage and grain yied at maturity

Treatment	Average no. of plants	Germination (%)	Grain yield at maturity (kg/ha)
Seed treatment with *Bacillus pumulis* INR7 (@ 10g/ kg seed)	150	50 (45)*	1000.0
Seed treatment with Chitosan (@2.5g/kg seed)	24	8 (16.4)	166.7
Seed treatment with Chitosan (@2.5g/kg seed) + *Bacillus pumulis INR7* (@10g/kg seed)	160.5	53.5 (47.0)	1091.7
Seed treatment with *Trichoderma viride* (@4g/kg seed)	148.5	49.5 (44.7)	983.3
Seed treatment with *Trichoderma harzianum* (@ 4g/ kg seed)	145.5	48.5 (44.1)	975.0
Seed treatment with *Pseudomonas fluorescens* Pf1 (@10g/kg seed)	157.5	52.5 (46.4)	991.7
Control	133.5	44.5 (41.8)	850.0
C. D. (P=0.05	14.6	(2.9)	81.8

*Figures in the parenthesis are angular transformed values.

TABLE 2
Effect of different bioagents against downy mildew of pearl millet caused by *Sclerospora graminicola*

Treatment	Downy mildew incidence (%) at 30 DAS	Downy mildew incidence (%) at 60 DAS
Seed treatment with *Bacillus pumulis* INR7 (@ 10g/ kg seed)	6.1 (14.0)*	14.0 (21.9)
Seed treatment with Chitosan (@2.5g/kg seed)	0.0 (0.0)	0.0 (0.0)
Seed treatment with Chitosan (@2.5g/kg seed) + *Bacillus pumulis INR7* (@10g/kg seed)	0.9 (2.8)	9.3 (17.7)
Seed treatment with *Trichoderma viride* (@4g/kg seed)	5.0 (12.8)	13.3 (21.3)
Seed treatment with *Trichoderma harzianum* (@ 4g/ kg seed)	5.1 (12.9)	12.4 (20.6)
Seed treatment with *Pseudomonas fluorescens* Pf1 (@10g/kg seed)	4.7 (12.4)	11.2 (19.4)
Control	21.5 (27.5)	27.0 (31.3)
C. D. (P=0.05)	(4.5)	(2.2)

*Figures in the parenthesis are angular transformed values.

and Hepziba (2009) who reported that seed treatment with antagonists *viz., Pseudomonas fluorescens* pf1 (@ 10g/kg seed), *P. fluorescens* pf2 (@ 10g/kg seed) and *Trichoderma viride* (@ 4g/kg seed) significantly reduced the incidence of downy mildew at 30, 45 and 65 DAS. Similarly, Nandini *et al.,* (2013) observed significantly higher disease resistance in seedlings raised from seed treated with oligosaccharides along with mannitol under greenhouse conditions. Oligosaccharides from *Trichoderma virens* (4 mg/ml) showed significant protection against downy mildew of pearl millet in comparison with *T. hamatum* and *T. harzianum*. Mannitol treatment enhanced the ability of oligosaccharides in inducing resistance in all the treatments. Among the three

oligosaccharides tested, minimum disease incidence of 13.7% was recorded in *T. virens* oligosaccharide+ 1% mannitol treatment whereas, metalaxyl treatment showed a significantly lower disease incidence (8.1%).

Downy mildew incidence at 60 days after sowing was recorded as minimum in seed treatment with Chitosan (@ 2.5 g/kg seed) + *Bacillus pumulis* INR7 (@10g/kg seed*)* (9.3%) in comparison to control (27.0%). Seed treatment with *Pseudomonas fluorescens* ranked next (11.2%) in management of downy mildew of pearl millet followed by seed treatment with *Trichoderma harzianum* (12.4%), seed treatment with *Trichoderma viride* (13.3%) and seed treatment with *Bacillus pumulis* INR7 (@ 10 g/kg seed) (14.0%). Our results are in line with Machenahalli *et al.,* (2013) who studied the efficacy of fungicides, botanicals and bioagents against spoarangial germination of *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow causing downy mildew in gherkin or pickling cucumber (*Cucumis sativus L.*) at Dharwad, Karnataka during 2010 and found that *Pseudomonas fluorescens* was most effective in inhibiting sporangial germination followed by *Trichoderma harzianum*. Similar results were reported against Fusarium wilt incited by *Fusarium oxysporum* in faba bean (*Vicia faba L.*) by Mahmoud (2016) who reported that *Trichoderma viride* and *T. harzianum* were the most effective species, inhibiting the growth of the pathogen in vitro. In greenhouse, *T. viride* and *T. harzianum* reduced the severity of Fusarium wilt by 70.52% and 65.23%, respectively.

REFERENCES

Begum, M. F., M. A. Rahman, and M. F. Alam. 2010 : Biological control of *Alternaria* fruit rot of chilli by *Trichoderma* species under field conditions. *Mycobiol.* **38** : 113-117.

Butler, E. J. 1907 : Some diseases of cereals caused by *Sclerospora graminicola*. *Mem. Dept. Agric. India. Bot. Res.* **2** : 1-24.

Machenahalli, S. R., M. S. L. Rao, and V. B. Nargun, 2013 : Effect of fungicides, botanicals, bioagents and organics on inhibition of sporangial germination of *Pseudoperonospora cubensis* (Berk and Curt.) Rostow. *Bioinfolet*. **10** (2 B): 588-592.

Mahmoud, A. F. 2016 : Evaluation of certain antagonistic fungal species for biological control of faba bean wilt disease incited by *Fusarium oxysporum*. *J. Phytopathol. Pest Mgmt.* **3** : 1-14.

Mani, M. T. and S. J. Hepziba. 2009 : Biological management of pearl millet downy mildew caused by *Sclerospora graminicola. Archives Phytopathol. Pl. Protec.* **42** : 129 -135.

Nandini, B., P. Hariprasad, S. R. Niranjana, H. S. Shetty and N. P. Geetha. 2013 : Elicitation of resistance in pearl millet by oligosaccharides of *Trichoderma spp.* against downy mildew disease. *J. Pl. Int.* **8** : 45-55.

Raj, K., R. K. Arya and R. Kumar. 2014 : Pearl millet improvement for disease resistance, *Forage Res.* **40** : 133-146.

Thakur, R. P., H. S. Shetty, and I. S. Khairwal. 2006 : Pearl millet downy mildew research in India : progress and perspectives. *Int. Sorghum and Millets Newsl.* **47** : 125-130.