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Finger millet commonly known as '*Ragi*' is an important food crop of millions both in Africa and Aisa. It is known for high calcium and is valued for its methionine content; its forage is a valuable fodder to the cattle. In India the crop is grown from Kanyakumari in the South to Uttrakhand hills in the North and Odisha in the East to Gujarat in the West. Though extensively, it is grown in less fertile soils, under poor management, in rainfed situations and mostly by resource poor farmers. Of the several diseases of ragi, foot rot caused by *Sclerotium rolfsii*Sacc. though sporadic, at times can be devastating especially in irrigated and heavy rainfall situations. Chemicals are effective in the management of the disease, but the health and environmental hazards besides low returns limit their use in this crop. Field studies conducted at the Zonal Agricultural Research Station, Visveshwarayya Canal farm, Mandya, Karnataka during the rainy seasons of 2011, 2012 and 2013 revealed that soil application of value added bio-agent prepared by mixing the talc formulation of bio-agents *P.f.+T.v.* (500 g each) or *T.v.* alone (1000 g) in compost, incubated for a week and applied at first weeding or Intercultivation (30-35 days) not only minimized foot rot incidence in ragi, but also resulted in higher returns.

Key words: Finger millet, Foot rot, Biocontrol, *Trichoderma viride, Pseudomonas fluorescens*, Soil application

INTRODUCTION

Eleusine coracana (L.) Gaertn. is commonly known as finger millet, African finger millet, caracan millet, koracan, ragi; and is native to the Ethiopian Highlands. It is an annual plant widely grown as a cereal in the arid areas of Africa and Asia. Finger millet has been cultivated in India from as far back as 4000 years ago. Presently grown over an area of 1134 ('000 ha) with a production of 1878 ('000 t) and productivity of 1656 (kg ha^{-1}). Important states are Karnataka, Maharashtra, Uttarakhand, Tamil Nadu, Odisha and Andhra Pradesh. It remains one of the main ingredients of the staple diet in Karnataka which is the top producer of Ragi having 58 per cent share in India's export of this crop. The area, production and productivity for the state under ragi is 632 ('000 ha), 1112 ('000 t) and 1759 (kg ha^{-1}) during the year 2013-14 (Source: dmd.dacnet.nic.in) Foot rot by *Sclerotium rolfsii* Sacc. [Perf. State: *Athelia rolfsii* (Curzi) C.C. Tu & Kimbr.] is one of the important production constraints especially in heavy rainfall and irrigated conditions (Nagaraja and

Anjaneya Reddy, 2009). Though it was first reported in 1928 from Anakapalli in Andhra Pradesh, but later found to be prevalent in Coimbatore, Tamil Nadu as well. The pathogen is very widely distributed and may infect ragi extensively in areas where the crop is grown, but according to Rachie and Peters (1977), damage does not appear to be extensive but rather sporadic in nature. Since its severe incidence in the Peth tehsil of Nasik dist. Mahrashtra during *Kharif* 2010, it has been on the rise and is reported to occur in many other states *viz*., Gujarat, Madhya Pradesh, Uttarakhand hills and Karnataka.

Channamma *et al*, (1980) found duter, a tin compound and vitavax to be effective than brassicol in controlling the foot rot, as the returns realized from are low, advocating chemicals may not be economically viable in the management of ragi diseases. This is more so in soil borne pathogens like *Sclerotium* that produce enormous sclerotia inter-alia parasitizing almost 500 host species (Aycock, 1966). However, under *in vitro* tests bioagents more so the isolates of *Trichoderma harzianum* have been reported to be highly efficient in suppressing *Sclerotium rolfsii* (Manu *et al*., 2012; Patro and Madhuri, 2013). In this background, field trials were conducted at the Zonal Agricultural Research Station (ZARS), VC farm, Mandya, Karnataka during the consecutive rainy seasons of 2011, 2012 and 2013 to evolve eco-friendly management of foot rot of ragi.

MATERIALS AND METHODS

Ramakrishnan (1971) found that the infected plants were often pale green and stunted. The infection most commonly occurs at the base of the plants, on the leaf sheath and culm. These often turn brown at the place of infection (Fig. 1a); and the plants eventually wilt, lodge and dry up. Mycelial growth occurs prominently between the sheaths or on the stem at the basal region as a white fan-shaped growth. The sclerotia are formed on the surface of the mycelial growth as small mustard seed-like and tan colored bodies (Fig. 1b).Requisite quantity of seeds of foot rot susceptible cultivar Indaf 5 were treated with the talc formulations of bioagents (T1 to T3) and fungicide (T4) as shown in table 1. Untreated seeds were used for treatments at T5 to T8. Seedlings were raised and transplanted at 20 days to the Sclerotium sick soil in plots. Six rows of each treatment in three replications were kept in RBD with a spacing of 30 cm x 9 cm. The crop was raised by following standard agronomic practices (Ashok *et al*., 2011). In the meantime value added bio agent formulations were prepared by adding either 500+500 or 1000 g of bioagent *Pseudomonas fluorescens* (*P.f.*) or *Trichoderma viride* (*T. v.*) or both (as the case) in 25 kg compost and incubating for a week allowing its thorough multiplication. At the first inter-cultivation value added bio agent formulation (T5 to T7) was incorporated into the soil. Plants exhibiting typical foot rot symptoms were counted and expressed in percentage. Crop was harvested at maturity and grain yield was recorded and per ha yield was computed. From the data so obtained Avoidable Yield Loss (AYL) was estimated by employing the following formula (Singh and Singh, 2005):AYL= [(Yp-Yu)/Yp] x 100Where, Yp= Yield under protected condition and Yu = Yield under unprotected condition.

The data so generated was analyzed statistically and inferences were drawn at 5 per cent level of significance. The B: C (benefit:cost) ratio was also worked out for each treatment taking into account the prevailing market rate of bio-agents, chemicals (check), labour, fodder and grain etc.

RESULTS AND DISCUSSION

The results of the present study revealed that all the treatments were effective in reducing the foot rot during all the three years of experimentation (Table 1). However treatments involving soil application of value added *Trichoderma viride (T.v.)* + *Pseudomonas fluorescens (P.f.)* or *T.v.* alone resulted in least foot rot incidence of 2.1, 3.6, 4.0 and 3.2, 2.9, 5.1 per cent as against 20.6, 26.2 and 30.8 per cent in untreated check plots during 2011, 2012 and 2013 respectively. Consequently, these treatments resulted in least mean foot rot incidence of 3.2% and 3.7% as against 25.8% in check plots.The grain yields were also highest in treatment where value added *P.f. + T.v.* were applied to the soil with 3795, 4073 and 3908 kg ha^{-1} during 2011, 2012 and 2013. The yields obtained in the soil application of *T.v.* alone were also comparable with corresponding values of 3452, 3958 and 4156 kg ha^{-1}. The mean grain yield was highest in these treatments recording 3925 and 3855 kg ha^{-1} respectively as against 3017 kg ha^{-1} in untreated check. This would suggest that use of *Trichoderma* can provide protection

Table 1 : Efficacy of bio-agent treatments on foot rot incidence and grain yield of ragi

Treatment details/ Year	Foot rot (%)				Grain yield (kg ha^{-1})			
	2011	2012	2013	Mean	2011	2012	2013	Mean
Seed treatment with *P. fluorescens* @10gkg^{-1} of seeds	6.4	8.9	14.0	9.8	3250	3507	3308	3355
Seed treatment with *T. viride* @10gkg^{-1} of seeds	4.5	5.9	11.4	7.3	3395	3514	3320	3410
Seed treatment with P.f + T.v each @ 5gkg^{-1} of seeds	4.1	6.4	9.0	6.5	3343	3629	3433	3468
Seed treatment with Vitavax (Carboxin+Thiram) @ 2gkg^{-1} of seeds	4.0	7.9	14.6	8.8	3366	3497	3291	3385
Soil application of P.f (1 kg) talc formulation mixed with 25 kg compost incubate d for a week and apply over an acre	4.5	5.4	11.9	7.3	3321	3794	3587	3567
Soil application of T.v (1 kg) talc formulation mixed with 25 kg compost incubated for 15 days and applied over an acre	3.2	2.9	5.1	3.7	3452	3958	4156	3855
Soil application of P.f + T.v (each 500 g) talc formulation mixed with 25 kg compost incubated for 15 days and applied over an acre	2.1	3.6	4.0	3.2	3795	4073	3908	3925
Control plot (Untreated check)	20.6	26.2	30.8	25.8	3044	3374	2632	3017
S.Em+	1.2	0.95	0.87		117	255	229	
CD (P 0.05)	3.6	2.89	2.64		356	775	697	

against *S. rolfsii* infection resulting in increased productivity. According to Ganesan *et al*, (2007) competition for space and nutrient, parasitism, production of enzymes, volatile and non-volatile metabolites or combined action of these mechanisms of

Fig. 1 : 1a) infected plant; **1b)** mycelia and mustard seed like brown sclerotia

bio-control organisms against the pathogen are the possible reasons for effective disease management.Avoidable yield loss were highest at 19.8, 17.2 and 32.7 in the treatments receiving value added *P.f. + T.v.* and were closely followed by 11.8, 14.8 and 36.7 in sole application of*T.v.* during the three years 2011, 2012 and 2013 respectively. Consequently mean avoidable yield loss was the highest at 21.1 and 23.2 respectively in treatments involving soil application of *T.v.+P.f* or sole application of *T. v.* (Table 2). As a result, B:C ratio was highest of 1.45 in the treatment receiving soil application of *T.v+P.f*, closely followed with 1.41 in soil application of *T.v.* alone. The ability of these bio-control agents to persist in soil can provide protection in the next crop as well. Application of organic compost or products fortified with *T. harzianum* in agricultural soils will not only reduce many soil-borne disease pathogens but will also enhance seedling growth and plant health (Nahar *et al*, 2012). Similarly, of the various methods used, the use of microorganism as bio-control agents has provided a very promising alternative and less hazardous method for plant disease control (Papavizas and Lumsden, 1980). Jadon (2009) also reported that the soil and seedling dip treatment with *T. viride* significantly reduced the incidence of collar rot disease of brinjal. In conclusion it can be said that soil application of value added bio-agent *P.f.+T.v.* (500g each) or *T.v.* alone (1000 g) mixed in compost and incubated for a week and applied at first weeding or Intercultivation (30-35 days) not only minimized foot rot incidence in ragi, but also resulted in higher grain yield and consequently high returns. This would be ideal in crops like ragi where use of chemicals is not economical (remunerative), but also may be hazardous to human and animal health and would be unsafe to the environment.

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Table 2 : Efficacy of bio-agent treatments on avoidable yield loss, returns and B:C ratio of ragi

Treatment details/	Avoidable yield loss				Straw yield	Gross returns	Cost of cultivation	Net returns	B:C ratio
Year	2011	2012	2013	Mean	tha^{-1}	(Rs)	(Rs)	(Rs)	
Seed treatment with *P. fluorescens* @10g kg^{-1} of seeds	6.4	4.0	20.4	10.3	5.23	63528	30013	33515	1:1.11
Seed treatment with *T.viride* @10g kg^{-1} of seeds	10.3	4.0	20.7	11.7	5.31	64560	30013	34547	1:1.15
Seed treatment with P.f + T.v each @ 5 gkg^{-1} of seeds	8.9	7.0	23.3	13.1	5.41	65676	30013	35663	1:1.18
Seed treatment with Vitavax (Carboxin+Thiram) @ 2g kg^{-1} of seeds	9.6	3.5	20.0	11.0	5.28	64092	30020	34072	1:1.13
Soil application of P.f (1 kg) talc formulation mixed with 25 kg compost incubated for a week and apply over an acre	8.3	11.1	26.6	15.3	5.56	67548	30250	37298	1:1.23
Soil application of T.v (1 kg) talc formulation mixed with 25 kg compost incubated for 15 days and applied over an acre	11.8	14.8	36.7	21.1	6.01	73002	30250	42752	1:1.41
Soil application of P.f + T.v (each 500 g) talc formulation mixed with 25 kg compost incubated for 15 days and applied over an acre	19.8	17.2	32.7	23.2	6.12	74328	30250	44078	1:1.45
Control plot (Untreated check)					4.70	57120	30000	27120	1:0.90

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REFERENCES

Aycock, R. 1966. Stem rot and other diseases caused by *Sclerotium rolfsii*. *North Carolina Agril. Expt. Sta. Bull. No.* 174.

Channamma, K.A.L., Hiremath, P.C. and Viswanath, S. 1980. Efficacy of some fungicides in controlling foot rot of ragi caused by *Sclerotium rolfsii*. *Curr. Res.* **9**: 142-143.

Manu, T.G, Nagaraja, A, Chetan, S. Janawad and Vinayaka Hosamani. 2012. Efficacy of fungicides and biocontrol agents against *Sclerotium rolfsii* causing foot rot disease of finger millet, under *in vitro*conditions *G.J. B.A.H.S.,* **1**: 46-50.

Nagaraja, A and Anjaneya Reddy, B. 2009. Foot rot of finger millet- an increasing disease problem in Karnataka. *Crop Res*. **38**: 224-225.

Nahar, M. S., Rahman, M. A. Kibria, M. G., Rezaul Karim A. N. M. and Miller. S. A. 2012. Use of Tricho-Compost and Tricho-Leachate for Management of Soil-Borne Pathogens and Production of Healthy Cabbage Seedlings. *Bangladesh J. Agril. Res.* **37**: 653-664.

Papavizas, G.C. and Lumsden, R.D. 1980. Biological control of soilborne fungal propagules. *Ann. Rev. Phyropathol.*, **18**: 389-413.

Patro T.S.S.K. and Madhuri J. 2013. Evaluation of biocontrol agents against foot rot of finger millet caused by *Sclerotium rolfsii*, under *in vitro* conditions *International Journal of Food, Agriculture and Veterinary Sciences.* **3**:30-32.

Rachie, K.O. and Peters, L. V. 1977. The Eleusines: A review of the world literature, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, CAB, pp179.

Ramakrishnan, T.S. 1971. *Diseases of millets.* Indian council of Agricultural Research, New Delhi. Pp 83-100.

Singh, R.B. and Singh, R.N. 2005. Fungicidal management of foliar diseases of mustard in mid-eastern India. *Indian Phytopath.* **58**: 51-56.