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Research Article

BIOLOGICAL MANAGEMENT OF FINGER MILLET (*Eleusine coracana* (L.) Gaertan) FOOT ROT CAUSED BY *Sclerotium rolfsii* Sacc.

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Abstract: Finger millet [*Eleusine coracana* (L.) Gaertn] is one of the important millet crops of India. In Gujarat, finger millet is the staple food of the tribal people of the Dangs district of south Gujarat and is grown as rainfed crop in *kharif* season on least fertile hilly soils. Finger millet is a rich source of protein, dietary fiber, minerals and amino acids. This crop is grown on an average area of about 12128 ha per year in the Dangs district of Gujarat. In *kharif* season due to continuous, heavy rainfall, high humidity and warm temperature, the crop is heavily infested by a soil borne foot rot disease incidence (up to 47%) and found to be a major constraint in the production of finger millet, resulting in direct crop losses mainly in The Dang district of south Gujarat. Since recent past, the Dangs district of south Gujarat was declared as organic district and thus, a field experiment on biological management of finger millet foot rot was formulated and conducted for three years. Two bio agents *viz., T. viride* 1.5% WP (2 x 10^6 cfu/g) (IIHR strain) and *P. fluorescence* 1.5% liquid form (1 x 10^8 cfu / ml) (NAU strain) were used as seed treatment and soil application. Among all the treatments, maximum disease control and grain production was reported in the seed treatment of *P. fluorescence* @ 10 ml / kg of seeds + two soil applications of *P. fluorescence* @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering with the minimum foot rot incidence of (9.63%) and highest grain (3415 kg/ ha) and fodder yield (7091 kg/ ha) which was found at par with the seed treatment of *T. viride* @ 10g/kg of seeds + two soil applications of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering with the foot rot incidence of (12.59 %) and highest grain (3226 kg/ha) and fodder yield (6173 kg/ ha) followed by all the other treatment and control with positive effect on average plant height (cm), average number of productive tillers per plant, average number of fingers, average finger length and bio agent cfu /gm soil at harvest with high cost benefit ratio.

Keywords: *Finger millet, Foot rot, Sclerotium rolfsii, Biological management*

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Introduction

Finger millet [*Eleusine coracana* (L.) Gaertn] is one of the most important highly nutritive millet crops belongs to family Poaceae and subfamily Chloridoidae of India. It is a staple food for millions of poor people and widely grown in the semi-arid areas of Eastern, Southern Africa and South Asia. The global annual planting area of finger millet is estimated at around 4.0-4.5 million hectares, with a total production of 5 million tons of grains, of which India alone produces 3.0 million tons (2.6 million hectares) and Africa about 2 million tons. The higher fiber content of finger millet helps in many ways as it prevents constipation, high cholesterol formation and intestinal cancer. People suffering from diabetes are advised to eat finger millet and other small millets instead of rice [1]. Finger millet is cultivated in more than 25 countries in Africa and Asia, because of its adaptability to different agro climatic conditions. In India major finger millet growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Maharashtra, Uttar Pradesh, Bihar and Gujrat accounting for more than 95.00 per cent of the total finger millet production [2]. This crop is grown on an average area of about 12128 ha per year in Dang District of Gujarat [3]. Being one of the major and important millet crops of Dang district there is a need to resolve the constraint of higher production of this crop in the Dang. In *kharif*, due to continuous, heavy rainfall, high humidity and warm temperature, the crop is heavily infested by a soil borne foot rot disease and found to be a major constraint in the production of finger millet, resulting in direct crop losses mainly in The Dang district of south Gujarat.

The incidence of finger millet foot rot (*Sclerotium rolfsi* Sacc.) was estimated up to 47% in The Dangs and leads to cause 20-40% yield loss [4]. Increased cost of production due to higher cost of chemical pesticides to control the disease leads to lower the cost benefit ratio of finger millet. Finger millet is known as "nutri-cereals" and very important crop of tribal area and foot rot reported as very serious constraint and as The Dang district was declared as organic district of south Gujarat there is a need of using bio control strategy. Thus, an experiment on biological control of foot rot in finger millet has been formulated to find out effective bioagent and its application method for the biological management of foot rot in finger millet. It was conducted at Hill Millet Research Station, N.A.U., Waghai, Dang, south Gujarat heavy rainfall zone – I and situation – I.

Material and Methods

For conducting present experiment, the variety of finger millet used was GN-4. The treatment given was T_1: *T. viride* ST @ 10g/kg of seeds, T_2: *T. viride* ST @ 10g/kg of seeds + SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting, T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering, T_4: *P. fluorescens* ST @ 10ml/kg of seeds, T_5: *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting, T_6: *P. fluorescens* ST @ 10ml/kg of seeds + two time SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering, T_7: Control.

Table-1 Efficacy of bio agents as seed treatment as well as soil application for the management of finger millet foot rot

Treatment	30DAT				60 DAT (at flowering)				90DAT (at Maturity)				At Harvesting			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	pooled
T_1	12.80* (5.00)**	11.32* (3.89)**	8.45 *(2.22)**	10.86* (13.70)**	17.27* (8.89)**	16.78* (8.33)**	14.96* (6.67)**	16.34** (7.96)**	23.18* (15.56)**	22.31* (14.44)**	21.35* (13.33)**	22.28** (14.44)**	26.16** (19.44)**	25.34* (18.33)**	24.08* (16.67)**	25.19* (18.15)**
T_2	11.32 (3.89)	8.45 (2.22)	8.45 (2.22)	9.41 (2.78)	14.88 (6.67)	13.60 (5.56)	12.12 (4.44)	13.54 (5.56)	21.39 (13.33)	20.40 (12.22)	19.43 (11.11)	20.41 (12.22)	23.62 (16.11)	23.64 (16.11)	22.77 (15.00)	23.34 (15.74)
T_3	11.32 (3.89)	8.45 (2.22)	7.42 (1.67)	9.06 (2.59)	13.60 (5.56)	12.80 (5.00)	12.12 (4.44)	12.84 (5.00)	19.94 (11.67)	19.39 (11.11)	18.40 (10.00)	19.24 (10.93)	20.42 (12.22)	21.39 (13.33)	20.45 (12.22)	20.76 (12.59)
T_4	12.12 (4.44)	11.32 (3.89)	9.49 (2.78)	10.98 (3.70)	14.88 (6.67)	15.57 (7.22)	14.89 (6.67)	15.11 (6.85)	22.76 (15.00)	23.18 (15.56)	22.31 (14.44)	22.75 (15.00)	24.04 (16.67)	23.62 (16.11)	22.77 (15.00)	23.48 (15.93)
T_5	11.32 (3.89)	8.45 (2.22)	9.25 (2.78)	9.67 (2.96)	13.60 (5.56)	12.12 (4.44)	12.80 (5.00)	12.84 (5.00)	19.38 (11.11)	19.39 (11.11)	18.40 (10.00)	19.07 (10.74)	21.85 (13.89)	21.39 (13.33)	20.45 (12.22)	21.23 (13.15)
T_6	11.32(3.89)	8.45 (2.22)	7.42 (1.67)	9.06 (2.59)	13.60 (5.56)	12.12 (4.44)	11.32 (3.89)	12.35 (4.63)	15.56 (7.22)	16.17 (7.78)	14.89 (6.67)	15.54 (7.22)	17.88 (9.44)	18.40 (10.00)	17.84 (9.44)	18.04 (9.63)
T_7	18.39 (10.00)	16.73 (8.33)	14.64 (6.67)	16.59 (8.33)	22.70 (15.00)	21.83 (13.89)	21.39 (13.33)	21.97 (14.07)	29.96 (25.00)	28.85 (23.33)	27.73 (21.67)	28.85 (23.33)	34.89 (32.78)	34.56 (32.22)	31.43 (27.22)	33.63 (30.74)
S.Em±	0.7	0.66	0.6	0.38	1.02	0.84	0.74	0.48	0.96	0.87	0.9	0.52	1.14	0.91	0.67	0.54
CD@5%	2.14	2.05	1.87	1.09	3.13	2.58	2.29	1.37	2.96	2.68	2.78	1.51	3.51	2.81	2.05	1.54
CV%	9.52	11	11.13	10.48	11.15	9.69	9.08	9.53	7.66	7.05	7.67	7.46	8.2	6.57	5.06	6.79
YxT				NS				NS				NS				NS

**Figures inside the parenthesis are original values while those outside are arc sine transformed values.*

Treatment details- T_1: T. viride ST @ 10g/kg of seeds, T_2: T. viride ST @ 10g/kg of seeds + SA of T. viride @ 2.5 kg /ha in 250 kg FYM at transplanting, T_3: T. viride ST @ 10g/kg of seeds + two times SA of T. viride @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering, T_4: P. fluorescens ST @ 10ml/kg of seeds, T_5: P. fluorescens ST @ 10ml/kg of seeds + SA of P. fluorescens @ 2.5 l /ha in 250 kg FYM at transplanting, T_6: P. fluorescens ST @ 10ml/kg of seeds + two time SA of P. fluorescens @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering, T_7: Control

Table-2 Efficacy of bio agents as seed treatment as well as soil application on morphological characters of finger millet and bioagent cfu over three years 2017-19

Treatment detail	Average plant height (cm)	Average numbers of productive tillers/plant	Average numbers of fingers	Average finger length (cm)	Bio agent cfu / gm soil at harvest
T_1: *T. viride* ST @ 10g/kg of seeds	119.04	1.73	8.76	10.27	2 X 10^{3*}
T_2: *T. viride* ST @ 10g/kg of seeds + SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting	122.73	1.91	10.09	10.96	2 x 10^{7*}
T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering	123.87	2.16	10.51	11.4	2 x 10^{10*}
T_4: *P. fluorescens* ST @ 10ml/kg of seeds	125.41	1.82	9.98	10.69	2 x 10^{5**}
T_5: *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting	127.23	1.92	10.52	11.09	5 x 10^{9**}
T_6: *P. fluorescens* ST @ 10ml/kg of seeds + two time SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering	128.68	2.2	11.14	11.93	>300 x 10^{10**}
T_7: Control	102.32	1.47	8.59	9.09	Tv = 2 x 10^{1*} PsF = 2 x 10^{2**}
S.Em±	2.86	0.07	0.31	0.31	
CD at 5%	8.22	0.19	0.88	0.88	
CV%	7.08	10.48	9.26	8.58	
YxT	NS	NS	NS	NS	

**PDA supplemented with rose bengal and streptocycline ** Pseudomonas agar (fluorescent base)*

Table-3 Efficacy of bio agents as seed treatment as well as soil application on finger millet grain yield and fodder yield

Treatment	Grain yield (kg/ha)				Fodder yield (kg/ha)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1: *T. viride* ST @ 10g/kg of seeds	2469	2668	3126	2754	4806	5057	5926	5263
T_2: *T. viride* ST @ 10g/kg of seeds + SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting	2728	2954	3214	2966	5432	5666	6649	5916
T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering	2962	3131	3585	3226	5794	6010	6715	6173
T_4: *P. fluorescens* ST @ 10ml/kg of seeds	2592	2734	3351	2892	4971	5137	6675	5594
T_5: *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting	2810	3056	3439	3102	5629	5869	6698	6065
T_6: *P. fluorescens* ST @ 10ml/kg of seeds + two time SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering	3230	3417	3598	3415	6189	6349	8735	7091
T_7: Control	2222	2315	2485	2341	4279	4471	5608	4786
S.Em±	178.91	173.29	188.36	104.09	303.31	286.67	405.87	194.05
CD at 5%	551.29	533.96	580.44	298.81	934.6	883.31	1250.73	557.04
CV%	11.41	10.36	10.02	10.56	9.91	9.01	10.47	9.97
YxT				NS				NS

Table-4 Economics of Biological seed treatment and soil application to control finger millet foot rot

Treatment	Bioagent quantity for Seed treatment/ha	Bioagent quantity for Soil application/ha	FYM quantitity soil application Kg/ha	Seed treatment cost (Rs./ha)	Bioagent cost Soil application (Rs./ha)	FYM cost /ha	Labour cost Seed treatment (Rs./ha)	Labour cost soil application (Rs./ha)	Total cost Of cultivation (Rs./ha)	Yield (Kg/ha)		Income(Rs./ha)		Gross income (Rs./ha)	Net Income (Rs./ha)	Increase over control	CBR
										Grain	Fodder	Grain	Fodder				
T_1	60g	-	-	10	-	-	89	-	39040	2754	5263	55080	10526	65606	26566	9115	01:01.7
T_2	60g	2.5kg/ha	250	10	300	312.5	89	178	39830.5	2966	5916	59320	11832	71152	31322	13871	01:01.8
T_3	60g	5kg/ha	500	10	600	625	89	356	40621	3226	6173	64520	12346	76866	36245	18794	01:01.9
T_4	60ml	-	-	10	-	-	89	-	39040	2892	5594	57840	11188	69028	29988	12537	01:01.8
T_5	60ml	2.5L/ha	250	10	175	312.5	89	178	39705.5	3102	6065	62040	12130	74170	34465	17014	01:01.9
T_6	60ml	5L/ha	500	10	350	625	89	356	40371	3415	7091	68300	14182	82482	42111	24660	01:02.0
T_7	-	-	-	-	-	-	-	-	38941	2341	4786	46820	9572	56392	17451		01:01.3

Treatment details- T_1: T. viride ST @ 10g/kg of seeds, T_2: T. viride ST @ 10g/kg of seeds + SA of T. viride @ 2.5 kg /ha in 250 kg FYM at transplanting, T_3: T. viride ST @ 10g/kg of seeds + two times SA of T. viride @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering, T_4: P. fluorescens ST @ 10ml/kg of seeds, T_5: P. fluorescens ST @ 10ml/kg of seeds + SA of P. fluorescens @ 2.5 l /ha in 250 kg FYM at transplanting, T_6: P. fluorescens ST @ 10ml/kg of seeds + two time SA of P. fluorescens @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering, T_7: Control, Cost per item - 1. T. viride: Rs 120/kg, 2. P. fluorescens : Rs70/Lit, 3. Labour cost : Rs 178 /each, 4. FYM : Rs 1.25/ kg, 5. Grain cost : Rs 20/ kg, 6. Fodder cost: Rs. 2/ kg*

The bioagents *viz*., *T. viride*1% WP (Powder formulation) and *P. fluorescens* 1.5% (liquid formulation) used here obtained from Dept. of Plant Pathology, NAU, Navsari containing minimum (1x10^8 cfu/gm or per ml). Plot size: Gross: 4.5 x 2.25 m60 dibbles * 7.5 = 4.5) x (10 rows * 22.5 = 2.25) Net: 4.2 x 1.80 m (56 dibbles * 7.5 = 4.2) x (8 rows * 22.5 = 1.80 Spacing: 22.5 cm x 7.5 cm. Three replication of each treatment was maintained with application of recommended dose of NPK-40:20:00 kg/ha. Observations on Per cent foot rot incidence at regular interval 30 DAT, at flowering, at maturity and at harvest were recorded. The foot rot incidence was calculated by following formula, foot rot incidence = (numbers of foot rot infected plant in a plot / number of total plants in a plot) x100.

Agronomic characters such as plant height, numbers of productive tillers per plant, finger length, number of fingers per plant were also recorded. CFU count of *T. viride* and *Pseudomonas fluorescens* in treatment T_2, T_3, T_5 and T_6 was also calculated by following serial dilution method. Grain yield (kg /ha) and fodder yield (kg/ha) was also recorded in all the three replications. Data thus obtained was analyzed by RBD design.

Results and discussion

Total foot rot disease incidence (%)

The pooled data presented in [Table-1] revealed that all the treatments significantly reduced the foot rot disease incidence at 30 DAT, at flowering, at maturity and at harvest as compared to the control. The treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA *of P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering was found significantly superior with minimum total foot rot incidence at 30 DAT (2.59 %) and at flowering (4.63%) which was found at par with treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering at 30 DAT (2.59%) and at flowering (5.00 %) , treatment T_2: *T. viride* ST @ 10g/kg of seeds + SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting at 30 DAT (2.78%) and at flowering (5.56 %) and treatment T_5 : *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting at 30 DAT (2.96%) and at flowering (5.00 %).

Moreover, treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering was also found significantly superior with minimum total foot rot incidence at maturity (7.22 %) and at harvest (9.63%) followed by the treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering at maturity (10.93%) and at harvest (12.59 %), treatment T_5 : *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting at maturity (10.74%) and at harvest (13.15 %) and treatment T_2: *T. viride* ST @ 10g/kg of seeds + SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting at maturity (12.22%) and at harvest (15.74 %).The year effect was found non-significant.

Morphological characters

The pooled data on morphological characters presented in [Table-2] revealed that all the treatments significantly increased the average plant height, average numbers of productive tillers per plant, average numbers of fingers and average finger length at 30 DAT, at flowering, at maturity and at harvest as compared to the control. Among all the treatments, significantly higher plant height (128.68 cm) higher numbers of productive tiller per plant (2.20), higher numbers of fingers per plant (11.14) and higher finger length (11.93 cm) was recorded in treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering which was found at par with the treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering with recording higher numbers of productive tiller per plant (2.16), average numbers of fingers per plant (10.51) and average finger length (11.40cm) respectively. The treatment T_6 was also found at par with the treatment T_5: *P. fluorescens* ST @ 10ml/kg of seeds + SA of *P. fluorescens* @ 2.5 l /ha in 250 kg FYM at transplanting in case of plant height (127.23 cm), average numbers of fingers per plant (11.09) and average finger length (11.09 cm) followed by all the other treatments.

Bioagent cfu/g soil

The results obtained on cfu by using serial dilution technique in [Table-2] revealed that highest cfu of *P. fluorescens* (>300 x 10^{10}) was recorded in treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering followed by treatment T_5 and T_4 at harvest. Whereas highest cfuof *T. viride* (2 x 10^{10}) was obtained in Treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering followed by T_2 and T_1 at harvest.

Grain yield (Kg /ha)

The results of grain yield presented in [Table-3] revealed that the effect of different treatments was found to be significant during all the individual years as well as in pooled also. All the treatments recorded significantly higher yield as compared to the control. Among all the treatments, significantly higher grain yield was recorded in treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l/ha in 250 kg FYM at transplanting and at 50% flowering (3415 kg/ha) which was found at par with the treatmentT_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering (3226 kg/ha).

Fodder yield (Kg/ha)

In case of fodder yield [Table-3], higher fodder yield was recorded in treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering (7091 kg/ha) followed by treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering (6173 kg/ha).

Economics

The economics was calculated by considering the profit increase over control of different treatments [Table-4]. The treatment *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering (T_6) recorded higher net return (Rs. 42111/ha) with CBR (1:2.04) followed by *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering (T_3) with net return (Rs. 36245/ha) and CBR (1:1.89). Therefore, considering the yield and economics of the treatment T_6: *P. fluorescens* ST@ 10ml/kg of seeds + two time SA of *P. fluorescens*@ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering or treatment T_3: *T. viride* ST @ 10g/kg of seeds + two times SA of *T. viride* @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering are recommended for the management of finger millet foot rot and to obtain higher yield.

The research work carried out on biological management of finger millet foot rot caused by *Sclerotium rolfsii* was also more or less similar with the work done carried out by earlier workers. Least per cent foot rot disease incidence was recorded in seed treatment with *P. fluorescens* and *T. viride* each @ 5 g/kg showed (12.38%) [4]. An experiment was conducted on integrated management of foot rot disease of finger millet in field condition with 9 different treatments. Among these, Seed treatment with *T. harzianum* @5g /kg of seed + Seedling root dipping in solution of *T. harzianum* + Application of Neem cake @ 50 g/ hill at transplanting recorded least per cent disease incidence (3.69%) with the highest (72.46 %) reduction in disease incidence and with the highest increasing in yield of about (37.42%) over control, Sawant, *et al*., [5]. Mundhe, (2005) [6] tested ten antagonists against *S. rolfsii,* the causal agent of finger millet foot rot. They found that maximum inhibition of *S. rolfsii* was accomplished due to *T. harzianum* (strain P) (73.77%) followed by *T. harzianum* (strain JCR) (73.00%), *T. viride* (JCR) (72.66%) and *P. fluorescens* (71.55%). Soil application of *Trichoderma* at the time of transplanting or application of farmyard manure with *T. harzianum* resulted in minimum disease incidence and increased dry mass of roots, shoots and yield. Results of using different *Trichoderma* antagonists for complete growth inhibition of *S. rolfsii* causing stem rot of groundnut. Sahu and Senapati (2003) [7], Rao and Kulkarni, (2003) [8] also justified the present findings. Soil incorporation of organic compost enriched with *T. harzianum* reduces many soil-borne diseases and enhances seedling growth and plant health [9]. Soil application of value added bioagent prepared by mixing the talc formulation of bio-agents *Pseudomonas fluorescence+Trichoderma viride* (500 g each) or *T. viride* 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 finger millet crop but also resulted in higher returns [10]. Soil application of enriched *P. fluorescens* + *T. viride* (500 g each of talc formulations mixed in 25 kg FYM incubated for 15 days and applied for one ha) resulted in least foot rot disease incidence and maximum yield followed by soil application of enriched *T. viride* (one kg talc formulation mixed in 25 kg FYM, incubated for 15 days and applied for one ha) in finger millet crop [11].

Raveendra and Nagaraja (2018) [12] revealed that seedling root dip with *Trichoderma* (Chandagalu isolate) 5 g L-1 + *Pseudomonas* (Kannahatty isolate) 5 g L-1of water followed by soil application of *Trichoderma* (Chandagalu isolate)+ *Pseudomonas* (Kannahatty isolate)Each 5 g kg-1 of soil along with 300-500 g enriched compost incubated for 15 days showed least foot rot incidence (0.00, 2.20 %) in comparison to untreated check (11.67, 36.67%) both at tillering as well as maturity stages respectively. Seed bio-priming of *P. fluorescence*, *T. viride* and *T. harzianum* in numbers of crops not only enhances crop seedling and plant growth but also induces disease resistance against numbers of major and minor diseases in variety of field, horticultural and forest crops [13].

Conclusion

Finger millet growing farmers are recommended to give seed treatment with *P. fluorescens* 1.5% (1x10^8 cfu/ml) @ 10ml/kg of seeds + two soil applications of *P. fluorescens* 1.5% @ 2.5 l /ha in 250 kg FYM at transplanting and at 50% flowering or to give seed treatment with *T. viride* 1% WP (1x10^8 cfu/ml) @ 10g/kg of seeds + two soil applications of *T. viride*1%WP @ 2.5 kg /ha in 250 kg FYM at transplanting and at 50% flowering for effective management of finger millet foot rot and to get maximum yield and maximum net return.

Application of research: Study of biological management of Finger millet (*Eleusine coracana* (L.) Gaertan) foot rot

Research Category: Plant Pathology, Disease management

Abbreviations: cfu- colony forming unit, T_1-Treatment 1 ST-seed treatment, SA-soil application, WP-Wettable powder, ha-hectare, FYM- Farm yard manure, CBR-Cost benefit ratio

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Study area / Sample Collection: Rajendrapur farm, Hill Millet Research Station, Waghai, 394730

Cultivar / Variety / Breed name: Finger millet GN-4

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