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Enhancement of growth, yield and yield contributing traits with a particular reference by using *Trichoderma* and *Pseudomonas* through seed bio-priming technique and value added FYM in finger millet (*Eleusine coracana* L.) under field conditions

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Abstract
An attempt was made to apply putative fungal and bacterial bio-control agents possessing multifarious plant growth promoting (PGP) traits in view of enhancing growth parameters, grain as well as fodder yield of vital but underestimated crop viz., finger millet (*Eleusine coracana* L.). The experiment comprises a total of seven treatments including untreated control. A total of four bio-control isolates were investigated viz., *Trichoderma asperellum Th-14*, *Trichoderma harzianum Th-21*, *Pseudomonas fluorescens Psf-121* and *Pseudomonas fluorescens Psf-4*. These bioagents were used through seed bio-priming technique along with value added FYM. The remaining treatments of the present study were as seed hydro-priming along with FYM, only FYM and untreated control. The treatment T1 (Seed bio-priming with *Trichoderma asperellum Th-14*+ FYM pre-colonized by *Th*-14) was found significantly superior over all the treatments with respect to all the studied traits related to growth, yield and yield contributing attributes at the same time reducing foot rot disease caused by *Sclerotium rolfsii* followed by the treatment T4 (Seed bio-priming with *Pseudomonas fluorescens Psf-4* + FYM pre-colonized by *Psf-4*) and T2 (Seed bio-priming with *Trichoderma harzianum Th*-21+ FYM pre-colonized by *Th-21*) which were statistically at par. The study revealed that the bio-control strains showed significant potential when used along with FYM. However, the treatment T1 proved to be most effective in improving the growth, yield and yield contributing attributes and also helped in suppressing incidence of foot rot disease in finger millet under present materials and environmental conditions.

Keywords: Finger millet, seed bio-priming, FYM, *Trichoderma* and *Pseudomonas*

Introduction
Small millets represent a diverse group of small seeded annual cereal grasses used for food, feed and forage purpose. These crops can face wide range of temperatures, moisture-regimes and input conditions and are capable to supply food and feed to millions of dry-land farmers, particularly in the developing world (Bouis, 2000) [5] and (Kaur *et al*., 2012) [9].
Finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and it can thrive under a variety of harsh environmental conditions, but nowadays, varieties of factors viz., poor soil fertility, diseases and insect-pests attack have become major constraints in production and productivity of finger millet.
The rapid and uniform field emergences are known to be the two essential pre-requisites to increase yield, quality, and ultimately to gain profit in crop. Uniformity and percentage of seedling emergence of direct-seeded crops have a major impact on final yield and quality. However, slow emergence results in smaller plants and seedlings, which become more vulnerable to soil-borne diseases (Lliers *et al.*, 1994) [11]. The seed bio-priming is an effective seed treatment to increase the rate, rapid emergence, uniformity of emergence and crop establishment in most of the crops (Rawat *et al.*, 2011) [24]. It integrates the biological and physiological aspects of enhancing growth, disease control and increase in yield, which involves coating the seed with biological agents and incubating the seed under warm, moist conditions. Hydro-priming is one of the very important seed treatment technique for rapid germination and uniform stand establishment in various crops (Abebe *et. al*., 2009) [2]. Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre germination metabolic activity prior to emergence of the radicle and generally enhances rapid,

uniform emergence and plant performance to achieve better growth and yield (McDonald, 2000) [14].

Finger millet, being a hardy crop, is known to be least affected by biotic and abiotic stresses (Dwivedi *et al.*, 2012) [7]. However, now a day it seems to be affected by several diseases also viz., blast, banded blight, smut, rust, foot rot and viral diseases (Rossman *et al.*, 1990) [26]. Among them, foot rot caused by *Sclerotium rolfsii* has been an increasing problem in heavy rainfall areas (Nagaraja and Reddy, 2009) [18]. The disease has been reported to cause more than 50% yield loss under conducive environmental conditions (Basta and Tamang, 1983) [4]. To prevent losses by diseases, farmers resort to indiscriminate and mostly irreverent crop protection measures. The use of chemicals in crops like finger millet is not only impractical but also uneconomical. In recent years there has been a worldwide swing to the use of ecofriendly methods for increasing fertility and protecting the crops from pests and diseases. Use of bioagents having antagonist and PGP activities may be a viable alternative to minimize the use of synthetic chemicals and their hazardous effects and to provide protection to the plants against the resident pathogen population (Lugtenberg *et al*., 2001) [12].

Hence, an attempt has been made to assess the influence of seed bio-priming technique and value added FYM on enhancement of growth parameters, yield, yield contributing traits as well as suppression of important endemic disease viz., foot rot caused by *Sclerotium rolfsii* in finger millet.

Materials and Methods

Details of the experimental site

This experiment was conducted at Plant Pathology Division, B-Block, College of Forestry, Ranichauri during *Kharif* season 2018, each in three replications by using randomized block design having plot size 2 X 2 m^2 with plant to plant distance 10 cm and row to row distance 22.5 cm, assessing the ability of fungal and bacterial bio- control strains under field conditions on plant growth, yield and yield contributing attributes of finger millet crop. The experiment consists of seven treatments including untreated control. The treatments comprises bio-control agents (*Trichoderma asperellum Th-14*, *Trichoderma harzianum Th-21* and *Pseudomonas fluorescens Psf-121* and *Pseudomonas fluorescens Psf-4*), used through seed bio-priming along with value added FYM and the remaining three treatments used were as seed hydro-priming along with FYM, only FYM and untreated control. The list of different treatments used in the study is presented in Table 1.

Table 1: The details of different treatments used in the study.

Symbol	Treatment
T1	Seed bio-priming with *Trichoderma asperellum Th*-14 @ 10g/kg seed +FYM colonized by *Th*-14 @ 8 kg FYM/plot
T2	Seed bio-priming with *Trichoderma harzianum Th*-21 @ 10g/kg seed +FYM colonized by *Th*-21 @ 8 kg FYM/plot
T3	Seed bio-priming with *Pseudomonas fluorescens Psf*-171 @ 10g/kg seed +FYM colonized by *Psf*-171 @ 8 kg FYM/plot
T4	Seed bio-priming with *Pseudomonas fluorescens Psf*-4 @ 10g/kg seed +FYM colonized by *Psf*-4 @ 8 kg FYM/plot
T5	Seed hydropriming+ Farmyard Manure (FYM) @ 8 kg FYM/plot
T6	Farmyard Manure (FYM) @ 8 kg FYM/plot
T7	Untreated Control

Collection of seed material and bio-agents

The seed material of finger millet (*Eleusine coracana* L.) for the experiment comprised one variety *viz.*, PRM-1. The bio-agents used in this study viz., *Trichoderma* and *Pseudomonas* strains were obtained from Plant Pathology Division, College of Forestry, Ranichauri, Tehri Garhwal, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Uttarakhand, India.

Seed bio-priming

Seeds were separately treated with bio-control isolates @ 10 g/kg of seeds. Seeds were then kept under warm and moist conditions for 24 h just prior to radical emergence to facilitate *Trichoderma* and *Pseudomonas* colonization on spermosphere during incubation. For seed hydro priming treatment, seeds were soaked in water only and then incubated for 24 h. Seeds without any treatment were used as untreated control.

Preparation of value added FYM (Colonization of FYM by bio-control agents)

FYM before use was supplemented with fresh bio-agents @ 250g/q. All bio-control strains were mixed separately with 100 kg compost. Mixture was spread as approximately 6-10 inch layer under the shade and covered with leaves or rice straw. The supplemented FYM was left for 2 to 3 weeks. Water was sprinkled regularly just to maintain the moisture in the FYM heap. After 2 to 3 weeks the FYM colonized by bio-agent and was ready for use as it contained very high population of bio-agents. This process increased the nutritive value of the FYM as well as provided opportunity to the bio-agents to grow faster on the FYM (Singh *et al.*, 2003) [27].

Observations

Growth, yield and yield contributing traits

The observations on growth and yield parameters were recorded during the vegetative and reproductive growth period of the crop. Five plants were selected randomly in each replication. Plant height (cm), Number of tillers/plant, Stem diameter (mm), Number of leaves/plant, Ear length (cm) Ear diameter (mm), Days to 50% flowering, Number of fingers/ear, Days to maturity, Biological yield/plant (gm), Grain yield/plant (gm) and 1000 seed weight were recorded.

Harvest index

Harvest index was calculated by using following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Foot rot incidence

The incidence of foot rot was counted in each treatment and replication based on their PDI as suggested by (Nagaraja, 2010) [17].

$$\text{Per cent Disease Incidence} = \frac{\text{Number of foot rot infected plants}}{\text{Total number of plants observed}} \text{X } 100$$

Per cent disease incidence (PDI) Category/ Response

Sr. No.	Per cent disease incidence (PDI)	Category/ Response
1	0 per cent (no disease)	Immune (I)
2	Up to 1 per cent	Highly Resistant (HR)
3	2-10 per cent	Resistant (R)
4	11-20 per cent	Moderately Resistant (MR)
5	21-50 per cent	Susceptible (S)
6	>50 per cent	Highly Susceptible (HS)

Statistical Analysis

Data was statistically analyzed by using standards statistical procedure described by (Cochran and Cox, 1992) [6]. The interpretation of results was based on F-test at 0.05and 0.01 level of significance, standard error (SEm), and coefficient of variance (CV) to find out the superiority.

Results and Discussion

During *Kharif* 2018, the effect of seed bio priming technique and value added FYM with bio control strains on different growth and yield parameters of finger millet and reducing the incidence of foot rot disease are depicted in Table 2 and Table 3.

The effect of seed bio-priming and value added FYM with bio-control agents on plant height was found significant which ranged from 90.17 cm to 110.58 cm with an overall mean of 102.70 cm. Statistically the maximum plant height (110.58 cm) was found in plants pretreated with the treatment T1 (Seed bio-priming with *Trichoderma asperellum Th*-14 @ 10g/kg seed +FYM colonized by *Th*-14 @ 8 kg FYM/plot) which was at par with T4 (108.81cm), T2 (106.87 cm) and T3 (104.79 cm) while, the minimum plant height (90.17 cm) was observed under T7 (Control) treatment (Table 2). The pattern of development during vegetative growth is influenced by various fixed and non-fixed factors like genetic, nutritional and status of growth hormones (Noggle and Fritz, 1986) [20]. The plant height is a good index of plant vigor, which may contribute towards increased productivity due to high photosynthetic efficiency. Similar results in enhancement of plant height in plants raised from seeds with prior bio-control treatment were reported previously by (Niranjan Raj *et al.* 2004) [19] in pearl millet, (Hassan, 2014) [8] in rice and (Rawat *et al.* 2018) [25] in barnyard millet.

The highest value (2.33) for number of tillers per plant was recorded under the treatment T1 which was almost at par with T4 (2.00) whereas, the minimum number of tillers (0.33) per plant was observed under T7 (untreated control) treatment. (Patra and Haque, 2011) [21] reported that productive tillers are very important because the final yield is mainly a function of the number of panicles bearing tillers per unit area.Similar results were reported by (Rawat *et al.*, 2018) [25] in barnyard millet.

The maximum stem diameter (11.41 mm) was recorded under T1 treatment followed by T4 (10.68 mm) and T2 (9.97 mm). The minimum stem diameter (8.02 mm) was measured under T7 (untreated control) treatment. These results are in accordance with (Rawat *et al.*, 2018) [25] in barnyard millet. The increase in stem diameter might be due to plant growth promotion activities created by used microbial inoculants. Similar results were also observed by (Prasad *et al.*, 2009) [22] and (Hassan, 2014) [8] in rice.

The maximum number of leaves (12.00) per plant was recorded under T1 treatment followed by T4 (11.00), T2 (8.33) and T3 (8.00) while the minimum number of leaves (7.00) per plant was recorded under T7 (untreated control) treatment. The results are in accordance with the work of (Miranda, 2012) [15] in wheat and (Rawat *et al.*, 2018) [25] in barnyard millet crop who reported similar findings.

The mean value for ear length and ear diameter showed significant variation among different treatments given to finger millet. The maximum ear length (12.66 cm) was measured under T1 treatment followed by treatment T4 (10.75 cm) and T2 (10.10 cm), as compared to control (8.19 cm) treatment. Similarly the mean value for ear diameter ranged from 38.72 mm to 49.41 mm. The maximum ear diameter (49.41 mm) was recorded for T1 treatment which was followed by T4 (47.06 mm) and T2 (45.94 mm) while the minimum ear diameter (38.72 mm) was recorded for T7 (untreated control) treatment. Similar results were earlier reported by (Rawat *et al.*, 2018) [25] in barnyard millet.

The mean value of per cent incidence of foot rot disease varied significantly among the given treatments. It ranged from 1.33 to 26.67 per cent among all the treatments. The lowest incidence (1.33%, Highly Resistant response) of foot rot disease was recorded in the T1 treatment followed by T4 treatment (1.67%, Highly Resistant response) and T2 (3.00%, Resistant response), while the highest per cent incidence of foot rot was recorded in untreated control (26.67%, Susceptible response). (Patro and Madhuri, 2013) [23] have reported that *Trichoderma harzianum*-2 isolate showed maximum inhibition of *Sclerotium rolfsii* under *in vitro* conditions. The least per cent disease incidence has also been reported by (Madhukarrao, 2013) [13] by seed treatment with *P. fluorescence* and *Trichoderma harzianum*.

The significant influence of treatments was observed for days to 50 per cent flowering which ranged from 63.67 days to 70.33 days with and overall mean of 67.24 days (Table 3). Minimum number of days (63.67 days) for 50 per cent flowering was taken up by T1 (Seed bio-priming with *Trichoderma asperellum Th*-14 @ 10g/kg seed +FYM colonized by *Th*-14 @ 8 kg FYM/plot) treatment followed by T4 (65.67 days) while significantly maximum days (70.67 days) taken to 50% flowering for T7 (untreated control). (Niranjan Raj *et al.*, 2004) [19] also reported significant difference for days to 50 per cent flowering in pearl millet, (Anitha *et al.* 2015) [1] in soybean and (Rawat *et al*., 2018) [25] in barnyard millet.

The maximum number of fingers per ear (10.67) was found under T1 treatment followed by T4 (9.67) and T2 (9.00). The minimum number of fingers per ear (6.67) was recorded under T7 (untreated control) treatment. The increase in the number of fingers may be attributed due to the synthesis of amino acid and chlorophyll and better carbohydrates transformation which resulted in better growth and a higher number of fingers which ultimately produced more number of grains per finger. Similar results were also reported by (Niranjan Raj *et al.*, 2004) [19] in finger millet and (Rawat *et al.*, 2018) [25] in barnyard millet crop when given prior *Trichoderma* and *Pseudomonas* treatments.

Days to maturity ranged from 106.67 days to 114.67 days. The minimum days to maturity (106.67 days) was again recorded in T1 treatment followed by T4 (107.67 days) and T2 (109.67 days) which was found significantly superior over other treatments while, maximum days (114.67 day) were taken to maturity was observed in T7 (untreated control) treatment. Similar finding was also reported by (Kumar, 2013) [10] and (Rawat *et al.*, 2018) [25] in barnyard millet.

The maximum biological yield per plant (49.35 g) and maximum 1000 grain weight (3.40 g) were recorded in T1 treatment followed by T4 (46.29 g of biological yield per plant and 3.12 g of 1000 grain weight) and T2 (44.85 g of

biological yield per plant and 2.65 g of 1000 grain weight). The minimum biological yield per plant (36.86 g) and 1000 grain weight (1.25 g) was recorded under T7 (untreated control) treatment. This finding is in close conformity with the finding of (Mishra *et al.* 2014) [16]. (Hassan, 2014) [8] also reported 4.12 q/ha to 7.54 q/ha biological yield in wheat with biological treatments. (Rawat *et al.* 2018) [25] has previously mentioned the maximum biological yield per plant (57.65 g) in *Th*-14 + FYM colonized by *Th*-14 treatment in barnyard millet crop. The response of bio-control agents on seed weight is well known and the response of biopriming on seed weight has previously been reported by (Niranjan Raj *et al.*, 2004) [19] in pearl millet that ranged from 5.6 g to 6.8 g. (Rawat *et al*., 2018) [25] also reported 1000 seed weight (g) ranged from 4.12 g to 4.91 g with an overall mean of 4.47 g in barnyard millet crop with a particular reference by using *Trichoderma* and *Pseudomonas*.

Significant differences were observed for grain yield which ranged from 26.01 q/ha to 33.52 q/ha with an overall general mean of 30.27q/ha. The maximum grain yield (33.52 q/ha) was recorded under the treatment T1 followed by T4 (32.82 q/ha) and T2 (31.88 q/ha) which were significantly at par with each other. The minimum grain yield (26.01 q/ha) was observed under T7 treatment (untreated control). The increase in grain yield might be due to positive influence of bio-agent in initiation and growth of roots that in turn speed up and increased the uptake of essential elements and moisture from the soil. Similar results were also reported by (Niranjan Raj *et al*., 2004) [19] in pearl millet, (Prasad *et al.*, 2009) [22] in wheat, (Kumar, 2013) [10] and (Rawat *et al*., 2018) [25] in barnyard millet. Harvest index was found in the range of 14.22% to 15.34% (Table 3). The overall mean for harvest index was 14.77%. Out of different treatments used in the present investigation the maximum harvest index (15.34%) was found under T2 (seed bio-priming with *Trichoderma harzianum* Th-21 + FYM colonized by Th-21+ FYM colonized by Th-21) treatment followed by T4 (15.09%) while, the minimum harvest index (14.22%) was observed under T7 (control) treatment.

Conclusion

On the basis of overall performance, it can be concluded that the treatment T1 i.e. Seed bio-priming with *Trichoderma asperellum Th*-14 @ 10g/kg seed +FYM colonized by *Th*-14 @ 8 kg FYM/plot followed by T4 treatment i.e. Seed bio-priming with *Pseudomonas fluorescens Psf*-4 @ 10g/kg seed +FYM colonized by *Psf*-4 @ 8 kg FYM/plot was found giving the most consistent effect under the present materials and conditions with respect to enhancement of growth, yield and yield contributing traits and also in suppressing the incidence of foot rot disease in finger millet.

Table 2: Effect of seed bio-priming and value added FYM with bio-control agents on growth characteristics and foot rot disease in finger millet (*Eleusine coracana* L.) under field conditions

Treatments	Plant height (cm)	Number of tillers/plant	Stem diameter (mm)	Number of leaves/plant	Ear length (cm)	Ear diameter (mm)	Incidence of foot rot (%)
T1	110.58	2.33	11.41	12.00	12.66	49.41	1.33 (HR)
T2	106.87	1.67	9.97	8.33	10.10	45.94	3.00 (R)
T3	104.79	1.33	9.08	8.00	9.47	43.99	7.33 (R)
T4	108.81	2.00	10.68	11.00	10.75	47.06	1.67 (HR)
T5	102.17	1.00	8.97	6.67	9.12	42.00	12.67 (MR)
T6	95.49	0.67	8.32	7.67	8.67	40.25	17.33 (MR)
T_7	90.17	0.33	8.02	7.00	8.19	38.72	26.67 (S)
S.Em.	1.18	0.43	0.43	0.35	0.39	0.59	0.79
CD at 1%	5.11	1.86	1.84	1.52	1.68	2.55	3.42
CD at 5%	3.65	1.33	1.32	1.09	1.20	1.82	2.44
CV	2.00	55.90	7.80	7.05	6.85	2.33	13.71

HR= Highly Resistant; R= Resistant; MR=Moderately Resistant; S= Susceptible

Table 3: Effect of seed bio-priming and value added FYM with bio-control agents on yield and yield contributing characteristics in finger millet (*Eleusine coracana* L.) under field conditions

Treatments	Days to 50% flowering	Number of fingers/ear	Days to maturity	Biological yield/plant (g)	1000 grain weight (g)	Grain yield/plant (g)	Grain yield/ha (q/ha)	Harvest index (%)
T1	63.67	10.67	106.67	49.35	3.40	7.24	33.52	14.66
T2	66.67	9.00	109.67	44.85	2.65	6.86	31.88	15.34
T3	67.00	8.67	110.67	42.91	2.45	6.23	30.96	14.61
T4	65.67	9.67	107.67	46.29	3.12	7.00	32.82	15.09
T5	68.33	8.00	112.00	40.87	1.93	6.00	28.87	14.74
T6	69.00	7.67	113.00	38.94	1.77	5.70	27.86	14.70
T7	70.33	6.67	114.67	36.86	1.25	5.25	26.01	14.22
S.Em.	0.67	0.40	0.73	0.82	0.27	0.42	0.60	1.050
CD at 1%	2.91	1.73	3.13	3.53	1.16	1.80	2.58	N/A
CD at 5%	2.08	1.24	2.24	2.52	0.83	1.28	1.84	N/A
CV	1.74	8.07	1.14	3.30	19.70	11.41	3.43	12.32

References

1. Anitha, Mummigatti UV, Jahangirdar S. Influence of seed priming agents on yield, yield parameters and purple seed stain disease in soybean. J Agril. Sci. 2015; 28(1):20-23.
2. Abebe AT, Modi AT. Hydro-priming in dry bean (*Phaseouls vulgris* L.). Res. J Seed Sci. 2009; 2(2):23-31.
3. Baalbaki R, Zurayk R, Bleik M, Talhouk S. "Germination and seedling development of drought

tolerant and susceptible wheat under moisture stress". Seed Sci. and Tech. 1999; 27:291-302.
4. Batsa BK, Tamang DB. Preliminary report on the study of millet diseases in Nepal. In: Maize and Finger millet, 10th summer workshop 23-28 Jan, Rampur, Chitwan, Mysore, 1983.
5. Bouis HE. Enrichment of food staples through plant breeding: a new strategy for fighting micronutrient malnutrition. J Nutr. 2000; 16:701-704.
6. Cochran WG, Cox. Experimental designs. 2nd ed. Wiley Interscience Publication, U.S.A, 1992.
7. Dwivedi S, Upadhyaya H, Senthilvel S, Hash C, Fukunaga K, Diao X. Millets: genetics and genomic resources. Pln. Breed. Rev. 2012; 35:247-375.
8. Hasssan MDM. Effect of Trichoderma and fungicide on seedling establishment and yield performance of dry direct seeded rice. Thesis, M.Sc. Agronomy, Bangladesh Agricultural University, 2014, 63.
9. Kaur KD, Jha A, Sabikhi L, Singh AK. Significance of coarse cereals in health and nutrition: a review. J Food Sci. and Tech. 2012; 24:011-061.
10. Kumar B. Management of grain smut disease of barnyard millet (*Echinochola frumentaceae*). Ind. Phytopatho. 2013; 66(4):403-405.
11. Lliers DV, Van Rooyen MW, Theron GK, Van DJ. "Germination of three Namaqualand pioneer species, as influenced by salinity, temperature and light". Seed Sci. and Tech. 1994; 22:427-433.
12. Lugtenberg BJJ, Dekkers L, Bloemberg GV. Molecular determinants of rhizosphere colonization by *Pseduomonas*. Ann. Rev. of Phytopatho. 2001; 39:461-490.
13. Madhukarrao PD. Management of foot rot (*Sclerotium rolfsii* Sacc.) of finger millet (*Eleusine coracana* L. Gaertn). Thesis, M.Sc. Agriculture, Navsari Agriculture University. 2013, 154.
14. McDonald MB. Seed Priming. In: Seed Technology and its Biological Basis, Black, M. and Bewley, J. D. (Eds.). Shefield Academic Press, Shefield, UK, 2000, 287-325.
15. Miranda MVC. Effects of microbial inoculants on bio-control and plant growth promotion. Thesis M.Sc., Ohio State University. 2012, 90.
16. Mishra G, Kumar N, Giri K, Pandey S, Kumar R. Effect of fungicides and bio-agents on number of microorganisms in soil and yield of soybean (*Glycine max*). Nusan. Bioscie. 2014; 6(1):45-48.
17. Nagaraja A. All India Co-ordinated Research Small Millets Improvement Project, G.K.V.K., Bangalore, (Personal Communication), 2010.
18. Nagaraja A, Anjaneya Reddy B. Foot rot of finger millet – an increasing disease problem in Karnataka. Crop Resea. 2009; 38(1, 2 & 3):224-225.
19. Niranjanraj S, Shetty NP, Shetty HS. Seed bio-priming with *Pseudomonas fluorescens* isolates enhance growth of pearl millet plants and induces resistance against downy mildew. Int. J Pest Manage. 2004; 50(1):41-48.
20. Noggle GR, Fritz GJ. Introduction to plant physiology. 2nded. Indian Prentice Hall Pvt. Ltd., New Delhi. 1986, 526.
21. Patra PS, Haque S. Effect of seedling age on tillering pattern and yield of rice (*Oryza sativa* L.) under system of rice intensification. J Agril. and bio. Sci. 2011; 6(11):33-35.
22. Prasad B, Prasad R, Singh A, Prasad S. Presowing seed inoculation of wheat (*Triticum aestivum* L. cv. VL 832) for seed yield and quality enhancement in North-West Himalayan agriculture system. J Crop and Weed. 2009; 5(2):80-86.
23. Patro TSSK, Madhuri J. Evaluation of biocontrol agents against foot rot of finger millet caused by *Sclerotium rolfsii*, under *in-vitro* conditions. Int. J Food Agril. Veter. Sci. 2013; 3(3):30-32.
24. Rawat L, Singh Y, Shukla N, Kumar J. Alleviation of the adverse effect of salinity stress in wheat (*Triticum aestivum* L.) by seed biopriming with salinity tolerant isolates of *Trichoderma harzianum*. J Pl. soil. 2011; 34(1):387-400.
25. Rawat L, Tiwari A, Bisht TS, Prasad S, Yadav V. Effect of bio-priming and colonized FYM with bio-control agents on quantitative and qualitative traits and disease management in barnyard millet (*Echinochloa crusgalli* L.). Int. J Agril. Sci. 2018; 14(2):335-343.
26. Rossman AY, Howard RJ, Valent B. *Pyricularia grisea*, the correct name of the rice blast disease fungus. Mycolo. 1990; 82:509-512.
27. Singh BB, Ajeigbe HA, Tarawali SA, Fernandez-Rivera S, Abubakar Musa. Improving the production and utilization of cowpea as food and fodder. Field Cr. Res. 2003; 84(1-2):169-177.