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Effect of Biopriming with Plant Growth Promoting Bacteria (PGPB) on Growth, Yield and Biochemical Traits of Finger Millet

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ABSTRACT

A field experiment was undertaken at Department of seed science and Technology, HNB Garhwal university, Srinagar Garhwal (Uttarakhand) during kharif season to study the effect of PGPR on growth, seed yield and biochemical parameters of finger millet (*Eleusine coracana* (L.). Three bacterial strains (BS-58, BS-27, and Y-19) were finally selected to assess their effects on the plant growth, yield and biochemical parameters of finger millet under field experiment in randomized block design with three replications. Among the different treatments, T-1(BS-27) exhibited a maximum plant height, shoot length, shoot fresh and dry weight (17.80%, 22.47%, 138.39%, 115.51%) respectively and T-2 (BS-58) exhibited a maximum increase in seed yield (35.96%) closely followed by T-5 (BS-58+Y-19; 34.45%). A significant increase was recorded (91.04%, 311.43%, 105.62% and 117.84%) in chlorophyll 'a', chlorophyll 'b', total chlorophyll and protein content respectively over control. The study revealed that the Biopriming of finger millet seeds with PGPB alone and in combination found as potential agents to enhance the physiological traits of finger millet for obtaining higher yield and quality.

Key words**:** *Bacillus* spp., *Pseudomonas fluorescens*, PGPBs, Finger millet, Plant growth, Chlorophyll, Protein

Finger millet (*Eleusine coracana* L.) an annual herbaceous plant and a widely grown cereal crop in the arid and semiarid tropics area in Asia and Africa belongs to family poaceae and has been a vital component of dry land farming systems [1-3]. It is good source of minerals especially calcium (0.38%) and also rich in fiber. Total carbohydrate content of finger millet has been reported to be in the range of 72-79.5%. The second major component of finger millet is protein which is nearly 7% but protein content had been reported to vary from 5.6 to 12.70 per cent due to biotic abiotic and varietal differences [4-5]. Besides protein it also contains 1.29% fat, 2.24% minerals and 3.90% ash. It also contains Vitamin A, Vitamin B complex, folic acid, and niacin in smaller quantities [6]. It has been reported to beneficial in diabetes, during pregnancy and during early-stage development of infants [7]. Finger millet straw is an important nutritious fodder for animal and a good supplement for a dairy cow to get higher milk yield [8]. Organic farming is a method of cultivating crop which focuses on the increasing crop yield and quality without affecting the natural agro-ecosystem. It is an alternative method for conventional farming system it includes sustainable utilization of land and farm resources with proper farm waste management system. It largely excludes the use of inorganic fertilizers and chemical based herbicides, fungicides and pesticides [9]. Biofertilizers aims at efficient and judicious use of the major sources of plant nutrients in an integrated approach so as to get maximum economic yield without any deleterious effect on Physico-chemical and biological properties of the soil [10]. Hence, the major advantages of biofertilizers are increases in yield, nutrient use efficiency, quality and sustainability [11].

Biofertilizers are those soil amendments which are of biological origin. Biofertilizers, a type of organic fertilizers, are emerging as an ecologically safe means of fertilization. It is defined as a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of major nutrients to the host plant [12].

Pseudomonas and *Bacillus* are the most extensively studied [13]. The genus *Pseudomonas* encompasses arguably the most diverse and ecologically significant group of bacteria on the planet. Fluorescent pseudomonades are well recognized as phosphate solubilizes and as biocontrol agents against soil borne plant pathogens [14]. Bacilli rhizobacteria can be external or internal rhizobacteria with respect to plant roots [15]. The Bacilli rhizobacteria are known for many unique functions and properties in plant rhizosphere including phytostimulation, biofertilization and bioprotection. Bacilli rhizobacteria as phytostimulators Production of phytohormones such as Gibberellic acid (GA) and indole-3-

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acetic acid (IAA) is one of the direct PGPR mechanisms exhibited by Bacilli rhizobacteria [16].

Uttarakhand is a leading state in production of finger millet in Himalayan states, but the poor production is not able to offer economic revenue to the farmers. Use of inorganic fertilizer to increase production is not safe for environment as well as for human beings. So, the use of biofertilizers is one of the eco-friendly approaches to increase productivity. In view of the above multipurpose usage of finger millet as both animal feed and human food, there is a need to improve the production and productivity of finger millet to make it as an economic crop. Hence, PGPR treatment was taken up in this study to improve the yield and quality of finger millet crop.

MATERIALS AND METHODS

Finger millet accession was collected from Silkakhal (Tehri Garhwal) for field experiments. Three superior bacterial strains (Two Bacillus BS-27, BS-58 and one PseudomonasY-19) were procured from the Department of Microbiology, College of Forestry, (VCSGUUHF Bharsar), Ranichauri Tehri Garhwal, Uttarakhand. The previous studies confirmed plant growth activity of the selected *Bacillus* and *Pseudomonas* strains [17-18]. The experiment was carried out at Seed Research Centre (SRC), Department of Seed Science and Technology, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand (India), during Jun to October in the years 2019 and 2020. The three PGPB strains (BS-58, BS-27 and Y-19) were used alone and in combination. A total seven different treatments of these strains alone and in combination in triplicate were assessed with control. Talc formulation of the selected bacterial strains was used for seed treatment @ 10g kg^{-1} of seed.

Physiological characteristics, yield attributes and biomass dry matter

Data on different physiological parameters of finger millet crops were recorded from 10 plants randomly selected from each experimental plot at different growth stages (60 Days after sowing and at harvesting). Plant growth and yield parameters such as Dry matter accumulation, number of panicles, finger length, weight of panicle, seed weight per panicle, number of seed per panicle, seed yield per plant, seed yield per plot, straw yield per plot, biological yield and harvest index were recorded.

Biochemical analysis of plants

Chlorophyll content of leaves

Chlorophyll contents were measured following the method of [19]. 100 mg Fresh leaves of finger millet were homogenized in 5ml of 80% acetone and incubated in the water bath at 90°C for 5 min. The extracts were centrifuged at 3000 rpm for 10 min. The OD of supernatant was recorded for chlorophyll 'a' and 'b' contents at 663 and 645 nm against 80% acetone blank, respectively.

Chlorophyll 'a' (mg/g) = 12.7 x A663 – 2.69 x A645

Chlorophyll 'b' (mg/g) = 22.9 x A645 – 4.68 x A663

Total chlorophyll (mg/g) = (12.7 x A663) + (22.9 x A645)

Protein content

The protein content of fresh leaves was determined following the method of [20]. 0.1 g of Fresh leaves was grinded with the help of mortar and pestle in 5 ml of phosphate buffer and centrifuged for 10 min at 3000 rpm. The supernatant (0.1 ml) was poured in a test tube and total volume of 1 ml was made by distilled water. One ml Reagent C was added. After shaking for 10 minutes, 0.1 ml of reagent D was added. The absorbance of each sample was recorded at 650 nm after 30 minutes incubation. The concentration of protein was determined by the following formula:

Protein content mg/g = K value × Dilution Factor × Absorbance/Weight of sample

K value = 19.6

Statistical analysis

The generated data was analyzed through OPSTAT software [21]. Data for plant growth, yield, and biochemical parameters subjected to analysis of variance (ANOVA). Tukey-Kramer multiple comparison tests (Tukey's honestly significant difference) were used to quantify and evaluate the source of variation between mean. Principal component analysis (PCA) was carried out to determine the statistical correlation among different treatments, growth, seed yield, plant protein and chlorophyll content in finger millet leaves using XLSTAT 2020 version 22.5.1040.0 add-in software in Microsoft Excel 2007 [22].

RESULTS AND DISCUSSION

Plant growth promotion

The data recorded for different growth parameters is presented in (Table 1), which clearly indicates that the application of biofertilizers significantly influenced the plant growth of Finger millet. Plant growth parameters were recorded in term of plant height, shoot length, shoots fresh weight, shoot dry weight, dry matter accumulation. PGPR inoculation stimulated the growth of plant. The co-inoculation of 3-PGPR strains alone or in combination with PGR had significantly enhanced plant height, shoot length, shoot fresh and dry weights. Maximum plant height was recorded in T_1 (115.53 cm) followed by T_5 (114.80) and minimum plant height was recorded in control (98.07 cm) [23-25]. Similarly, [26] reported that inoculation of rice with PGPR, increased plant height by 26.23%.

Maximum shoot length was recorded in T_1 (60.83 cm) followed by T_5 (58.63 cm). Minimum shoot length was recorded in control (49.67 cm). Maximum shoot fresh weight (61.41g) and shoot dry weight (11.81g) was recorded in T_1. While minimum shoot fresh weight (25.76g) and dry weight (5.48g) was recorded in control. For shoot fresh weight and dry weight between T_2 and T_5 was non-significant to each other (Table 1). These results were confirmed by [27] who reported enhanced shoot fresh and dry weights in *Brassica* plants inoculated with PGPR. Similarly, [28] reported that finger millet seed treated with pseudomonas sp. (MSSRFD41) strain increased shoot length, shoot fresh weight and shoot dry weight.

Photosynthetic activity of the plant is well reflected in their dry matter production. Maximum dry matter accumulation (48.02g/m^2) was recorded in T_5 which is at par with T_2 (46.71g/m^2). Minimum dry matter accumulation (33.23 g/m^2) was recorded in control (Table 1). The results conformed to the findings of [29-30]. Further, [31] observed positive effects of combined inoculation of *Azotobacter* and *Azospirillum* on dry matter of maize and sorghum. Similarly, [32] reported that inoculation of maize and sorghum with *Bacillus subtilis* increased plant dry weight compared to the non-fertilized control treatment. Potential of PGPBs to enhance yield and other growth parameters in various agricultural crops have been reported [33-34].

Table 1 Effect of PGPR on different growth and yield component parameters of finger millet

Treatments	Shoot length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Plant height (cm)	Dry matter accumulation (g/m^2)	No. of panicles $plant^{-1}$	Finger length (cm)	Weight of $panicle^{-1}$ (g)	Seed weight $panicle^{-1}$ (g)	No. of seed $panicle^{-1}$
Control	49.67^{e}	25.76^{e}	5.48^{e}	98.07^{d}	33.23^{h}	1.90^{f}	5.85^{g}	7.32^{e}	4.79^{e}	2206.27^{d}
BS-27	60.83^{a}	61.41^{a}	11.81^{a}	115.53^{a}	46.71^{ab}	2.14^{e}	6.92^{c}	8.97^{b}	5.77^{cd}	2529.96^{c}
BS-58	$51.13d^{e}$	42.03^{c}	8.07^{d}	107.67^{b}	45.08^{b}	2.67^{ab}	7.35^{a}	9.63^{a}	6.99^{a}	2867.82^{a}
Y-19	54.07^{c}	50.80^{b}	10.04^{bc}	114.27^{a}	42.89^{c}	2.54^{bc}	6.12^{f}	8.13^{cd}	5.74^{cd}	2570.81^{c}
BS-27+BS-58	54.57^{c}	56.73^{a}	10.49^{ab}	107.87^{b}	43.40^{bc}	2.50^{cd}	6.37^{e}	7.89^{d}	6.23^{bc}	2684.28^{b}
BS-58+Y-19	58.63^{b}	60.47^{a}	11.45^{ab}	114.80^{a}	48.02^{a}	2.74^{a}	6.99^{b}	9.11^{ab}	6.33^{b}	2769.57^{ab}
BS-27+Y-19	52.83^{cd}	55.82^{ab}	10.49^{ab}	113.50^{a}	40.55^{cd}	2.40^{d}	6.67^{d}	8.35^{c}	5.99^{bcd}	2705.76^{b}
BS-58+BS-27 + Y-19	50.87^{e}	41.81^{c}	9.30^{cd}	101.13^{c}	41.91^{c}	2.37^{d}	6.66^{d}	8.79^{b}	5.64^{d}	2546.08^{c}
C.D. (at 5%)	1.88	6.77	1.7	4.274	2.74	0.142	0.024	0.427	0.570	112.775
SE(m)	0.64	2.31	1.2	1.396	0.94	0.046	0.008	0.140	0.186	36.824
SE(d)	0.91	3.27	1.7	1.974	1.33	0.066	0.011	0.197	0.263	52.077
C.V.	2.05	8.12	21.57	2.216	3.80	3.344	0.205	2.835	5.429	2.444

The data presented is the average of two successive cropping seasons (2019 and 2020)
Values in the table represented with different letters are significantly different ($P < 0.05$)

Yield enhancement

By the application of biofertilizers various yield parameter were significantly increased over control. The yield of finger millet seeds was determined by variations in yield components such as the number of panicles per plant, finger length, weight of panicle, seed weight of per panicle, number of seed per panicles, seed yield and straw yield. Results showed that the maximum numbers of panicle per plant (2.74) was recorded in T_5 followed by T_2 (2.67) while minimum numbers of panicle per plant (1.90) was recorded in control. Maximum finger length (7.35cm) was recorded in T_2 followed by T_5 (6.99cm). Similar results were reported by [35] who observed significantly increase finger length of *Amaranthus hypochondriacus* by combination two *Bacillus* strains (BS- 27 + BS-58). Highest value of panicle weight (9.63g) was recorded in T_2 followed by T_5 (9.11g) and minimum panicle weight was recorded in control (9.32cm). The significantly enhanced seed weight per panicle was recorded in T_2 (6.99g) followed by T_5 (6.33g) over control (4.79g). The highest number of seeds per panicle was recorded in T_2 (2867.82) followed by T_5 (2769.57) over control (2206.27). For number of seed per panicle T_2 and T_5 were non-significant to each other (Table 1). The significant increase in seed yield per plant was recorded in T_5 (17.87g) followed by T_2 (16.21g) over control (9.39g) [36-37]. Similarly, these research outcomes are in promise with [38] which improved plant growth and yield per plant by treatment of *P. putida*, *P. fluorescence*, *S. marcescens*, *B. amyloliquefaciens*, *B. subtilis*, and *B. cereus* in tomato.

Maximum seed yield per plot was recorded in T_5 (2.46kg) followed by T_2 (2.27kg) and minimum seed yield per plot was recorded in control (1.31kg). The highest straw yield per plot was recorded in T_3 (2.67kg) followed by T_5 (2.62kg) [39-40]. Similar findings were reported by [41] who reported an increase in yield (76%) in chick pea plant by co-inoculated with 3-PGPR namely, *Bacillus subtilis*, *Bacillus thuringiensis* and *Bacillus megaterium*.

The maximum biological yield was recorded in T_5 (5.08kg) followed by T_3 (4.73 kg), minimum biological yield was recorded in control (3.22kg). The maximum harvest index was recorded in T_2 (53.66) followed by T_7 (52.27) while minimum harvest index was recorded in control (40.75). Similar results were reported by [42] who reported a 37% increase in seed yield and 46% in biological yield of *Amaranthus hypochondriacus* by Bacillus strains (BS-27 + BS-58) in combination. During present investigations, enhancement in planting value parameters and yield was mainly due to the growth-promoting abilities of *Bacillus amyloliquefaciens* (BS-58) and *Pseudomonas fluorescens* (Y-19).

Table 2 Effect of PGPR on different seed yield parameters of finger millet

Treatment	Seed yield $plant^{-1}$ (g)	Seed yield $plot^{1}$ (kg)	Straw yield $plot^{-1}$ (kg)	Biological Yield (Kg)	Harvest index
Control	9.39^{e}	1.31^{h}	1.91^{c}	3.22^{f}	40.75^{d}
BS-27	14.27^{c}	2.00^{f}	2.45^{b}	4.45^{c}	44.97^{c}
BS-58	16.21^{b}	2.27^{b}	1.96^{c}	4.23^{d}	53.66^{a}
Y-19	14.66^{c}	2.06^{e}	2.67^{a}	4.73^{b}	43.46^{c}
BS-27+BS-58	15.97^{b}	2.20^{c}	2.02^{c}	4.23^{d}	52.13^{a}
BS-58+Y-19	17.87^{a}	2.46^{a}	2.62^{a}	5.08^{a}	48.41^{b}
BS-27+Y-19	14.48^{c}	2.08^{d}	2.29^{b}	4.37^{cd}	47.49^{b}
BS-58+BS-27+Y- 19	13.59^{d}	1.91^{g}	1.74^{d}	3.64^{e}	52.27^{a}
C.D. (at 5%)	0.599	0.017	0.161	0.158	1.733
SE(m)	0.196	0.006	0.053	0.051	0.566
SE(d)	0.277	0.008	0.074	0.073	0.8
C.V.	2.329	0.484	4.171	2.112	2.033

The data presented is the average of two successive cropping seasons (2019 and 2020)
Values in the table represented with different letters are significantly different ($P < 0.05$)

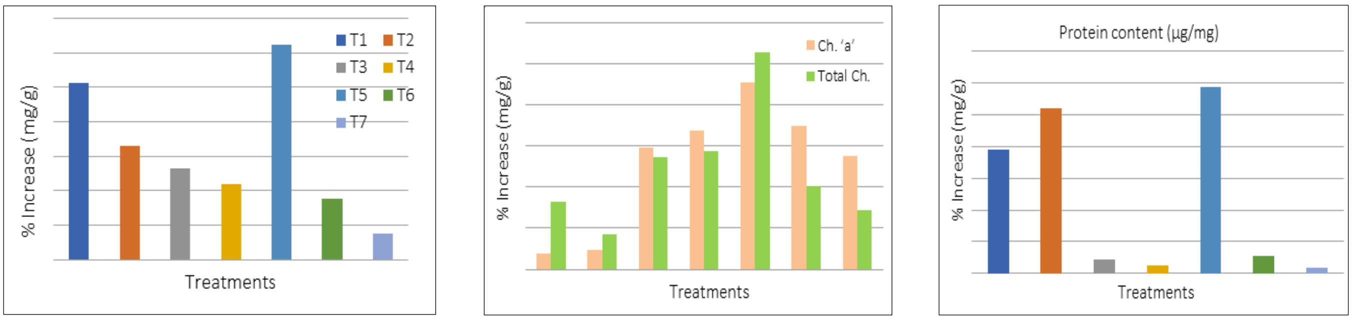
Among all the treatments, *Bacillus subtillis* (BS-58) alone and in combination with *Pseudomonas fluorescens* (Y-19) were found most effective to increase plant growth, seed yield, chlorophylls content and protein content in finger millet plants. Several studies have currently exposed that inoculation with PGPR, increased leaf area, growth and yield in many plants [43-44]. PGPR can enhance plant growth and yield either by increasing leaf area, nitrogen uptake, phytohormone production, minerals solubilization or by chelation of iron [45]. Beside this, PGPR induced increase in yield had been studied in many other plants including sweet potato, apple, tomato, maize and peanut [46-47]. An increase in yield and yield attributing characters with the application of biofertilizers may be attributed to the build-up of humus, organic carbon which increased availability of nutrients and improved the soil properties hence leading to better root growth. This, in turn, increased absorption and translocation of nutrients by crop leading to increased production of photosynthetic by the crop resulting in increased biomass accumulation.

Biochemical parameters of plant leaves

Seed treatment with PGPR significantly increased all biochemical parameters studied in finger millet as compared to control.

Chlorophyll content

Increased chlorophyll content and, subsequently, enhanced photosynthesis, enhanced plant growth and yield, is a known plant response to inoculation with several PGPBs [48-49]. It was encouraging to note significant increase in chlorophyll content ‘a’ (8 to 91%) and chlorophyll ‘b’ (37 to 311%) and total chlorophyll (17 to 106%) in finger millet leaves as showed by shown by percent increase in different treatments over control in the current study (Fig 1a-b). Maximum increase in chlorophyll ‘a’ was recorded in treatment T_5, which was 91% more over control, followed by T_6 (70%). Maximum increase in chlorophyll ‘b’ (311%) in T_5 followed by T_1 (256%) and maximum increase in total chlorophyll content was recorded in T_5 (106%) followed by T_4 (58%). Minimum chlorophylls content was recorded in control (Fig 1a-b). Chlorophyll content is a benchmark of plant growth related to crop production. The higher chlorophyll contents of a plant, the higher the yield potential [50]. Our results observed increases in chlorophylls in finger millet plants by Plant growth-promoting rhizobacteria (PGPR) inoculation. Significant enhancement in chlorophylls was observed in finger millet leaves (Fig 1a-b). These increases were due to the soil supplementation with the tested PGPR. Thereby, suggesting that combined treatment of *bacillus* and *pseudomonas* can effectively increase chlorophylls content in finger millet plant. It had been reported previously that PGPR induce chlorophyll content in many plants [51-56]. Similarly, [57] evaluated Effects of PGPR (*Pseudomonas sp.*) and Ag-nanoparticles on Enzymatic Activity and Physiology of Cucumber. They found Increased chlorophyll ‘a’ 31%, chlorophyll ‘b’, 33% and total chlorophyll content 35% by pseudomonas sp. as compared to control and other treatments in cucumber. Enhanced chlorophylls content in the PGPR inoculated plant also led to increased synthesis of photo-assimilates [58], as well as changes in nitrogen, phosphorous, and potassium uptake [59].



A: Enhancement in Chlorophyll ‘a’ by the application of different treatments over control

B: Enhancement in Chlorophyll ‘b’ and total chlorophyll by the application of different treatments over control

C: Enhancement in protein content by the application of different treatments over control

Fig 1 Effects of PGPR on biochemical parameters of finger millet plants

The co-inoculation of PGPR namely, *Bacillus* and *Pseudomonas* had significantly enhanced the leaf protein content in finger millet plant. The maximum increase in protein content was recorded in T_5 (118%) followed by T_2 (104%). Minimum protein content was recorded in control (Fig 1c). Noteworthy, the PGPR (T_5) significantly enhanced the protein content (Fig 1c) [60-62]. These results are in close conformity with the result of Zimmer *et al* (2016); Zaki *et al.* (2012); Nawaz and Bano, (2020). Similarly, [63] reported an increase in leaf protein (37%) in chick pea plant by co-inoculated with 3-PGPR namely, *Bacillus subtilis*, *Bacillus thuringiensis* and *Bacillus megaterium.* Our findings are in agreement with the results of several studies that proved the application of PGPRs in nutrient management strategies aimed at decreasing chemical fertilizer consumption and consequently, promoting environmental-friendly crop production [64-66].

The increment of protein content was signifying the activity of plant growth promoting bacteria especially due to the nitrogen fixing bacteria as they rapidly mobilization the nitrogen contentment of organic matter which is readily available to the plant. They also enhance the production of endogenous phytohormones (IAA and GA) which played an important role in forming vigorous active root system. Thus, enhances the nutrients assimilation, photosynthesis rate and translocation of solutes as well as accumulation of N within seed.

Principal component analysis

The principal component analysis of plant growth, yield, chlorophyll content and protein content in different treatments was performed to evaluate the statistical correlation between different treatments and variables (Fig 2). The four principal components explained 94.33% of total variation among variables. The principal component analysis for different treatments, plant growth, yield, chlorophylls content and protein content are explained with component-1 (F_1: 62.80%) and component-2 (F_2: 16.17%) (Fig 2). Analysis revealed the potential impact of treatments on different variables such as plant growth, yield, chlorophylls content and protein content. The results also revealed that application of biofertilizers alone was less effective than combined effect of biofertilizers. Among the different treatments T_5, T_6, T_1, T_2 and T_4 showed their best impact on growth, yield and biochemical parameters. Among these, T_5 and T_4 were most effective in increasing shoot length, shoot fresh and dry weight, straw yield per plot, chlorophyll 'a' and total chlorophyll content, number of panicles per plant, seed yield per plant, seed yield per plot however, T_2 and T_1 were most effective in increasing chlorophyll 'b' number of seed per panicle, seed weight per panicle, panicle weight, finger length, protein content and dry matter accumulation. A positive correlation was observed between plant growth and seed yield and biochemical parameters.

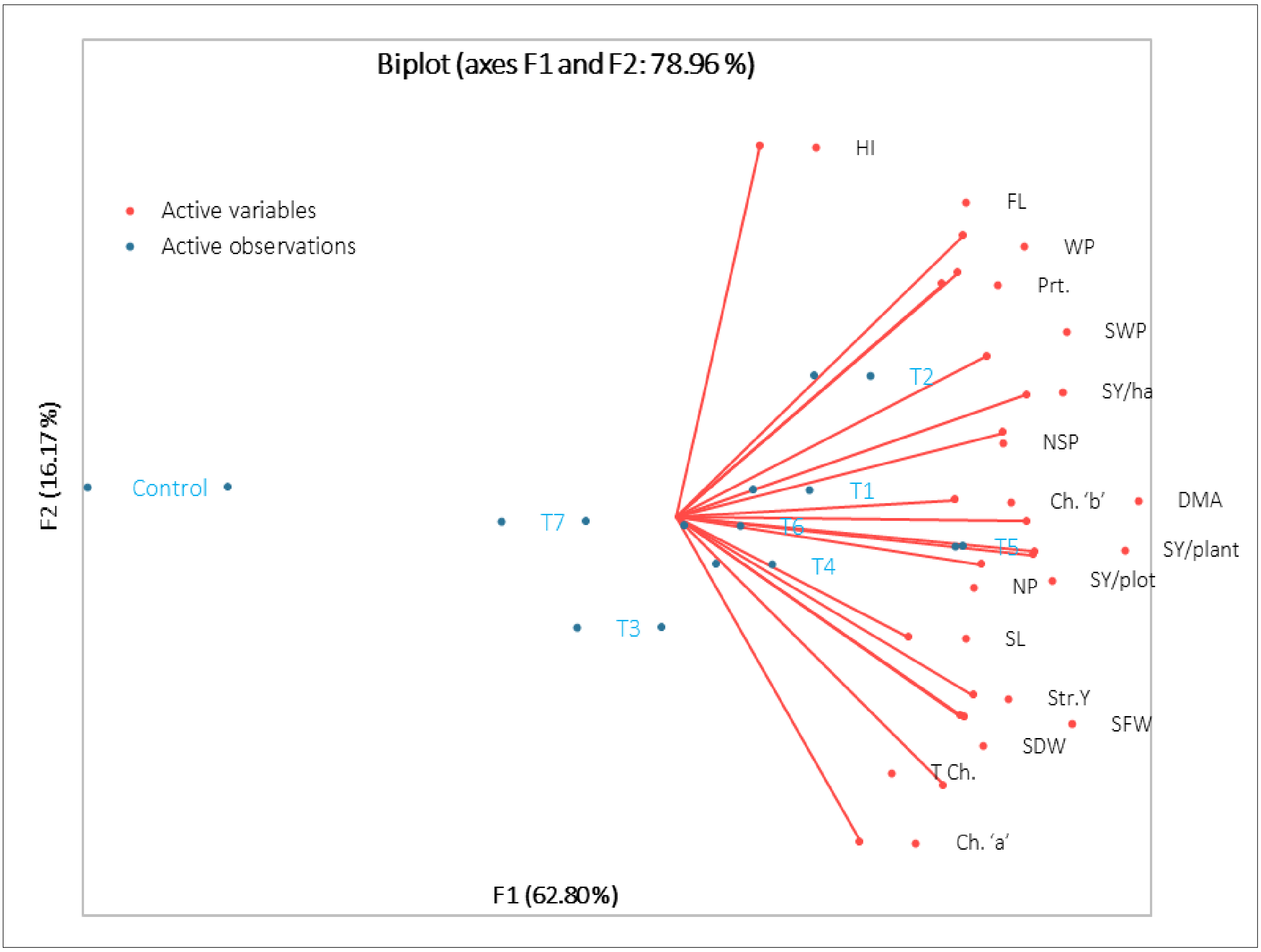


Fig 2 Principal component analysis showing correlation between different treatments and variables. Principal component analysis of different treatments, Dry matter accumulation (DMA), Shoot length (SL), shoot fresh weight (SFW), shoot dry weight (SDW), Number of panicle (NP), Finger length (FL), weight of panicle (WP), seed weight per panicle (SWP), number of seeds per panicle (NSP), Seed yield per plant (SY/plant), seed yield per plot (SY/plot), seed yield per hectare (SY/ha), straw yield (Str. Y), Harvest index (HI), Chlorophyll 'a', chlorophyll 'b', total chlorophyll, protein content (Prt.)

A positive correlation was observed between growth and chlorophyll content of finger millet. The data illustrate that chlorophyll content of Finger millet has been increased with different treatments. Dry matter accumulation is an important index indicating the photosynthetic efficiency of the crop, which ultimately influences the crop yield. Dry matter accumulation increased progressively with advancement in crop age. The higher dry matter under T_5 might be due to more plant population (number of panicle) (Table 1). The maximum dry matter accumulation was recorded in treatment T_5, which also showed the maximum chlorophyll content (Ch 'a', Ch 'b' and total chlorophyll) and protein content also. Increase in plant dry matter accumulation was due to increase in nitrogen levels which might have increased the amount and efficiency of chlorophyll that influenced the photosynthetic efficiency and formation of the other nitrogenous compounds like amino acids, proteins and protoplasm [67].

CONCLUSION

It may be concluded that *Bacillus subtilis* (BS-58) alone and in combination with *Pseudomonas flourescence* (Y-19) efficiently improved the plant growth, seed yield, photosynthesis pigment (Chlorophylls) and protein in Finger millet. This practice is convenient and be cost-effective as well as eco-friendly. Plant growth-promoting rhizobacteria (PGPR) improve soil productivity by phosphate solubilization and nitrogen fixation and make these nutrients available to the plants for plant growth. They also promote plant growth by producing plant growth regulators such as auxins, gibberellins and cytokinin's; by inducing root metabolic activities. By the use of PGPB, crop-microbial-soil ecosystem can be invigorated in sustainable agriculture with substantial ecological stability with environmental compatibility. Furthermore, the results of this study lead to the conclusion that use of BS-58 and BS-58+Y-19 should be promoted among farmers growing finger millet for better crop productivity and nutrient quality under organic farming.

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