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Screening of the selected formulations of a microbial consortium for their effectiveness on the growth of finger millet (*Eleusine coracana* L. Gaertn.)

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Abstract
A Greenhouse investigation was carried out to screen the effectiveness of selected four formulations (alginate based, fluid bed dryer based, lignite and liquid formulations) of Agriculturally Important Microorganisms (AIMs) *viz*., *Azotobacter chroococcum*., *Bacillus megaterium* and *Pseudomonas fluorescens* on growth parameters of finger millet (*Eleusine coracana* L. gaertn.). As a result, the plant growth parameters such as higher plant height (38.93 cm), maximum number of leaves (9.67), total chlorophyll content (2.54mg/g of leaf), total nitrogen uptake (103.56mg/ plant), total phosphorus uptake (63.11mg/plant) and total biomass content (12.87g/plant) were recorded in plants treated with triple inoculants in liquid formulation. The present study revealed that the triple inoculants in liquid formulation contributed more to the growth attributes and nutrient uptake compared to the other test formulations used in the present study.

Keywords: *Azotobacter chroococcum*, *bacillus megaterium*, *pseudomonas fluorescens*, formulations, consortium, finger millet

1. Introduction
Finger millet (*Eleusine coracana* L. Gaertn.) is native to the Ethiopian region of Africa and was introduced to India during the second millennium BC from Africa. It assumes the second most important millet among the millets grown in India. In recent decades, finger millet has assumed prime importance in diet especially for carrying women and the growth of children. Finger millet requires a considerable amount of zinc as well as calcium for its growth and grain development. Deficiency of secondary and micronutrients leads to a reduction in the number of effective tillers and improper grain filling which can be overcome by using supplements in the form of biofertilizers.

Swapna and Brahmaprakash (2013) [30] evaluated the effect of granular inoculant formulations of individual, dual inoculants and microbial consortium in eight selected substrates on survival, growth, and development of finger millet (*Eleusine coracana* L. Gaertn.). The results from the experiment revealed the maximum number of leaves, plant height, chlorophyll content, shoot and root nitrogen concentration, shoot and root phosphorus concentration, root dry weight, shoot dry weight and total biomass in seeds inoculated with a microbial consortium of *Azotobacter chroococcum* +*Bacillus megaterium* +*Pseudomonas fluorescens* followed by the dual inoculation.

Sahu (2012) [23] conducted an experiment on to evaluate the effectiveness of fluid bed dried consortia of agriculturally beneficial microorganisms; *Pseudomonas fluorescens*, *Acinetobacter* sp. and *Azotobacter chroococcum* on finger millet where the study revealed good results of plant growth parameters in triple inoculant formulation than single and dual inoculant formulation.

There are several studies which have been made on use of microbial inoculants in different combinations as consortium but in different formulation and their comparison on Finger millet (*Eleusine coracana* L. Gaertn.) crop was lacking. Hence, an attempt was made to delineate the effect of selected formulations of a microbial consortium on growth attributes of finger millet (*Eleusine coracana* L. Gaertn.).

2. Material and Methods

2.1 Screening the effectiveness of microbial consortia under greenhouse conditions

A greenhouse experiment was carried out to evaluate the effectiveness of four different formulations of a consortium consisting of *Azotobacter chroococcum*, *Bacillus megaterium* and *Pseudomonas fluorescens* for finger millet (*Eleusine coracana* L. Gaertn.) as test crop.

2.1.1 Seeds procurement and germination test

Seeds of finger millet variety MM-365 were procured from AICRP National Seed Project (crops), University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, and Bengaluru-560 065.

Germination test was conducted by blotting paper method and results was found 100 per cent germination for finger millet seeds.

2.2 Preparation of inoculant formulations for green house study

Two sets of microbial consortia of alginate based, fluid bed dryer based, lignite and liquid formulations were freshly prepared and allowed for stabilization for a week before use as for seed treatment and soil application.

2.3 Treatment details

The experiment consisting of 8 treatments (One was control and seven were different inoculant formulations).

T_1: Control
T_2: *Azotobacter chroococcum*
T_3: *Bacillus megaterium*
T_4: *Pseudomonas fluorescens*
T_5: *Azotobacter chroococcum +Bacillus megaterium*
T_6: *Azotobacter chroococcum +Pseudomonas fluorescens*
T_7: *Bacillus megaterium +Pseudomonas fluorescens*
T_8: *Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

2.4 Soil collection and processing

Soil used in the experiment was collected from uncultivated field at GKVK, Bengaluru, which was categorized as red sandy loam soil, classified as kandic paleustalfs soils. Soil was sieved through 4 mm sieve and 10 kg of soil was filled in to 12 kg capacity plastic pots. Soil sample subjected for three cycles of alternate wetting and drying was mixed well after each cycle. pH and field capacity of soil was determined by the method suggested by Jackson (1973).

2.5 Nutrients

The recommended dose of fertilizer for finger millet (*Eleusine coracana* L. Gaertn.) is 50: 50: 25 kg of NPK per acre. Appropriate dose of nitrogen was supplied through urea, phosphorus and potassium was supplied through single super phosphate and muriate of potash respectively.

2.6 Seed treatment

Seeds were treated with different formulations of single, dual and triple inoculants comprising *Azotobacter chroococcum*, *Bacillus megaterium* and *Pseudomonas fluorescens.*

Seeds were treated with different inoculant formulations at the rate of 20g/ml per kg seeds.

2.7 Transplantation

2.7.1 Pre-harvest observations

Plant height, number of leaves was recorded at 30 days interval up to 50 per cent of flowering (74 DAS).

2.7.1.1 Determination of chlorophyll content

The chlorophyll content (Chlorophyll-a, Chlorophyll-b and total chlorophyll) of the leaves were estimated by the procedure of Dimethyl Sulfoxide (DMSO) method was suggested by Shoef and Lium (1976). Observations were made on 60 DAS.

2.7.2 Post-harvest observations

2.7.2.1 Dry weight of plant

After harvest, the dry matter of plant such as, shoot dry weight, root dry weight and total biomass were recorded by drying the samples till attaining a constant weight in oven at 60 ^{o}C.

2.7.2.2 Estimation of nitrogen concentration in plant samples

Nitrogen concentration in the root and shoot of finger millet plants were estimated by Micro Kjeldhal method as given by Subbiah and Asija (1956) [28].

The total nitrogen content of plant was estimated by summating the nitrogen content of root and shoot.

2.7.2.3 Estimation of phosphorus concentration in plant samples

The procedure used for estimation of phosphorus concentration in plant sample as given by the Black (1965) [3].

The total phosphorus content of plant was estimated by summating the phosphorus content of root and shoot.

2.9 Statistical analysis

Statistical data analysis for green house experiment was done by using factorial CRD was used for and means were compared by the Duncan's Multiple Range Test.

3. Results and discussion

Microbial inoculants in alginate based, fluid bed dryer based, lignite and liquid formulation were developed and a greenhouse experiment was carried out to test the effectiveness of inoculants in different formulations on finger millet. The effect of consortium formulations on plant growth parameters, nitrogen uptake and phosphorus uptake, biomass production are described below.

3.1 Plant growth parameters

3.1.1 Plant height

Data pertaining to the effect of different formulations on plant height of finger millet is presented in Table 1. General view of greenhouse experiment of finger millet (*Eleusine coracana* L. Gaertn.).

Among different treatments, the maximum plant height was recorded in plants treated with triple inoculants in all the four formulations. Triple inoculants play many activities when they applied as consortium and they have enormous positive effect when compared to dual or single inoculants (Table 1).

Several studies were made and reported earlier by many researchers regarding response of plant height to different formulations such as solid, liquid or granular based bio inoculant formulations and the liquid inoculants have influenced on the survival of microbial inoculants and plant growth parameters (Datta *et al.*, 2011; Gandhi and Sivakumar, 2010) [4, 9]. Secretion of growth promoting substances by inoculated microorganisms might have helped in better nutrient uptake and plant growth (Sachin and Mishra, 2009) [21]. These results are in conformity with the findings of many research workers who reported increased plant height was due

to biofertilizer application in crops like finger millet (Lavanya, 2014 and Patel *et al*., 2014) [14, 18].

3.1.2 Number of leaves

The effect of different formulations on number of leaves after 30 and 60 days are shown in Table 2.

Number of leaves per plant influences the rate of photosynthesis activity and ultimately photosynthesis process enhances the growth of plants. Plants treated with PGPRs are known to enhance number of leaves (Niranjan *et al*., 2004). The plants treated with triple microbial inoculants have shown maximum number of leaves which attributed for better availability of nutrients in the rhizosphere and congenial environmental prevailed in the vicinity of root zone for the persistence and perpetuation of allochthonous beneficial microbial inoculants to perform better mobilization of nutrients (Bhatt, 2014; Rather *et al*., 2010) [2, 15].

3.1.3 Chlorophyll content

Variation in the chlorophyll-a, chlorophyll-b content of finger millet in different formulations and in different treatments are shown in Table 3.

3.1.3.1 Chlorophyll -a

Among all the inoculant formulations, triple inoculants in liquid formulation recorded highest chl -a content followed by lignite formulation, alginate based formulation and in fluid bed dryer based formulation (Table 3).

3.1.3.2 Chlorophyll -b

Among all the inoculant formulations, triple inoculants in liquid formulation recorded highest chl -b content followed by lignite formulation, alginate based formulation and in fluid bed dryer based formulation (Table 3).

3.1.3.3 Total chlorophyll

Treatment (T_8) receiving triple inoculants of liquid formulation was recorded highest total chlorophyll content 2.54mg/g of leaf (Fig. 1) followed by treatment T_8 receiving triple inoculants in alginate based formulation (2.46mg/g of leaf), lignite based formulation (2.45mg/g of leaf).

Overall, the treatment receiving triple inoculants (T_8) of each formulation have performed better when compared to other treatments inoculated dual and single. Among all formulations, inoculants in liquid formulation were outstanding followed by alginate formulation, lignite formulation and fluid bed dryer formulation (Vijaykumar and Brahmaprakash 2018; Sahu *et al*., 2016) [34, 22]. Chlorophyll content directly influences on the efficiency of net primary production of carbohydrates through photosynthetic activity and indirectly influences the growth (Deepti *et al*., 2016; Kumar e*t al*., 2018) [7, 34].

3.1.4 Effect of different selected formulations on nitrogen content of finger millet

3.1.4.1 Shoot Nitrogen

The data pertaining to shoot nitrogen uptake (mg/ plant) and shoot nitrogen content of finger millet root shown in Table 4.

Significantly higher shoot nitrogen uptake was recorded in finger millet treated with triple inoculants in liquid formulation, followed by lignite, alginate based formulations and fluid bed dryer based formulations respectively. The higher shoot nitrogen content was recorded in plants treated with single inoculant of *A. chroococcum* in liquid formulation followed by lignite formulation, alginate based formulation and fluid bed dryer based formulation. The higher nitrogen content was recorded in *A. chroococcum* treated alone due to ratio between amounts of nitrogen fixed and shoot biomass content. This might be due to more milligrams of fixed nitrogen per gram of plant shoot biomass (Lavanya, 2014 [14]; Thilakarathna and Raizada. 2015; Virpal and Rajesh, 2017) [32, 35].

3.1.4.2 Root Nitrogen

Data pertaining to nitrogen uptake (mg/ plant) and nitrogen content of finger millet root is shown in Table 5.

The higher nitrogen uptake and content of root was recorded in finger millet treated with triple inoculants in liquid formulation, followed by lignite, alginate based formulations and fluid bed dryer based formulations respectively. The increase in nitrogen content might be due to *A. chroococcum* ability of atmospheric nitrogen fixation. Similar results were reported by Lavanya, 2014 [14]; (Ramakrishnan and Bhuvaneshwari, 2014; Thanuja and Ambika, 2010) [19, 31].

3.1.5 Effect of different selected formulations on phosphorus content of finger millet

3.1.5.1 Shoot Phosphorus

Data pertaining to shoot phosphorus uptake (mg/ plant) and per cent phosphorus content in shoot of finger millet is shown in Table 6.

The higher shoot phosphorus uptake and content of finger millet is observed in plants treated with triple inoculants in liquid formulation. *B. megaterium*, a phosphate solubilizer with various mechanisms it solubilizes the unavailable form phosphorus to available form. One of the main mechanisms include, by the release of organic acids and metabolites (Vassilev *et al*., 2006) [33]. These were similar findings to that of Fan *et al*., 2011 [8]; Shilpa and Brahmaprakash (2016) [22].

3.1.5.2 Root Phosphorus

Data pertaining to phosphorus uptake (mg/plant) and phosphorus content (per cent) in root of finger millet is shown in Table 7.

The higher root Phosphorus uptake of finger millet is observed in plants treated with triple inoculants in liquid formulation whereas, phosphorus content (%) recorded in almost all the treatments were on par with each other. This might be due to co-inoculation with *B. megaterium*, a potential phosphate solubilizer with various mechanisms it solubilizes the unavailable form phosphorus to available form (Vassilev *et al*., 2006) [33]. These are similar findings to that of Dayamani (2010) [5], Fan *et al*. (2011) [8].

3.1.6 Total Nitrogen and Total Phosphorus

Data pertaining to total nitrogen uptake and total phosphorus uptake is described in Table 8.

3.1.6.1 Total Nitrogen

Th higher total nitrogen uptake was recorded in treatment receiving triple inoculants of liquid formulation followed by lignite, alginate based and fluid bed dryer based formulation (Table 8).

3.1.6.2 Total Phosphorus

The higher total phosphorus uptake was recorded in treatment receiving triple inoculants of liquid formulation followed by lignite, alginate based and fluid bed dryer based formulation.

Total nitrogen and total phosphorus uptake in finger millet was significantly higher in triple inoculants followed by dual

inoculants and single inoculants (Table 8). The increased nitrogen uptake might be due to the increased availability of fixed atmospheric dinitrogen by N-fixing *A. chroococcum* (Abbasi *et al*., 2011; Mahdi *et al*., 2010) [1, 15] whereas, co-inoculation of *B. megaterium* increases the phosphorus availability by solubilizing unavailable form P to available form (Lavanya, 2014; Swain *et al*., 2012) [14, 29].

3.1.7 Effect of different selected formulations on biomass content of finger millet

The data pertaining to shoot and root biomass is presented in Table 9.

3.1.7.1 Shoot Biomass

In alginate based formulation, maximum shoot biomass (8.54 g/plant) was recorded in treatment T_8 receiving triple inoculants followed by T_5 treatment receiving dual inoculants of *A. chroococcum +B. megaterium* (7.88g/plant) and lower (4.04 g/plant) was recorded in treatment T_1 un-inoculated control (Table 9).

In fluid bed dryer based formulation, maximum shoot biomass (8.18 g/plant) was recorded in triple inoculants followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (7.68 g/plant) and lower (4.14 g/plant) was recorded in un-inoculated control (T_1). In Lignite formulation, maximum shoot biomass (8.88 g/plant) was recorded in triple inoculants followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (8.07 g) and lower shoot biomass of 4.18 g/plant was recorded in un-inoculated control (T_1).

In liquid formulation, maximum shoot biomass (9.05 g/plant) was recorded in triple inoculants followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (8.29 g/plant) and lower shoot biomass of 4.17 g/plant was recorded in un-inoculated control (T_1).

3.1.7.2 Root Biomass

In alginate based microbial formulation maximum root biomass of finger millet plants was recorded of 3.67 g/plant in treatment T_8 receiving triple inoculants followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (3.02 g/plant), treatment T_7 (*B. megaterium +P. fluorescens*) recorded 2.94 g/plant and was found on par with T_6 (*A. chroococcum +P. fluorescens*) recorded 2.91 g/plant whereas, lower root biomass of 1.71 g/plant was recorded in un-inoculated control (T_1).

In fluid bed dryer based formulation, maximum biomass of 3.57 g/plant was recorded in triple inoculants of *A. chroococcum +B. megaterium +P. fluorescens* followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (2.89 g/plant) and lower was recorded of 1.73 g/plant in un-inoculated control (T_1). Maximum root biomass 3.72 g/plant was recorded in treatment T_8 receiving triple inoculants of *A. chroococcum +B. megaterium +P. fluorescens* followed by treatment T_5 receiving dual inoculants of *A. chroococcum +B. megaterium* (3.37 g) and un-inoculated control recorded lower root biomass (1.72 g/plant) in lignite formulations (Table 9).

In liquid formulation, maximum root biomass (3.82 g) was recorded in treatment T_8 receiving triple inoculants of *A. chroococcum +B. megaterium +P. fluorescens* followed by treatment T_5 received dual inoculants of *A. chroococcum +B. megaterium* (3.42 g) and un-inoculated control recorded lower root biomass (1.71 g/plant) in liquid formulations (Table 9).

3.1.7.3 Total Biomass

Maximum total biomass of finger millet plants was recorded 12.87 g/plant in treatment (T_8) receiving triple inoculants in liquid based formulation followed by lignite formulation (12.60 g/plant), alginate based formulation (12.20 g/plant) and fluid bed dryer based (11.74 g/plant) inoculants (Fig. 2). Increased accumulation of biomass indicates the increased growth of plant. Treatment T_8 with triple inoculants in liquid formulations might have elucidated plant growth promotion activity by performing many functions by colonizing the rhizosphere by performing direct or indirect mechanisms for plant growth promotion (Subba Rao, 1982) [27]. By inoculating with plant growth promoting rhizobacteria at early stages of crop growth, shoot as well as root biomass can be enhanced and with help of synergistic interaction among inoculants, causes higher accumulation of biomass (Hussain *et al*., 2013; Kumar *et al*., 2012; Mohammadi and Sohrabi, 2012) [10, 12, 16]

Table 1: Effect of different inoculant formulations on plant height of finger millet

Treatments	Plant height (cm) 30 DAT					Plant height (cm) 60 DAT				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	17.53^{o}	17.60^{o}	17.49^{o}	17.50^{o}	17.53^{h}	27.49^{r}	27.54^{r}	27.46^{sr}	27.44^{sr}	27.48^{h}
T_2	18.73^{k}	17.94^{n}	18.96^{ij}	19.0^{1}	18.66^{f}	29.60^{o}	28.00^{q}	31.31^{l}	30.93^{m}	29.96^{e}
T_3	18.36^{l}	18.38^{l}	18.47^{l}	18.7^{k}	18.48^{g}	29.07^{p}	26.67^{t}	30.40^{n}	29.07^{p}	28.80^{g}
T_4	18.80^{jk}	18.16^{m}	19.0^{1i}	19.84^{ed}	18.95^{e}	29.07^{p}	27.15^{s}	31.20^{lm}	32.00^{k}	29.86^{f}
T_5	19.49^{f}	18.97^{ij}	19.85^{ed}	19.98^{d}	19.57^{b}	32.94^{ij}	30.19^{n}	33.25^{i}	34.33^{f}	32.68^{d}
T_6	19.48^{f}	18.47^{l}	19.83^{ed}	20.19^{c}	19.49^{bc}	32.71^{j}	32.09^{k}	35.69^{d}	36.13^{c}	34.16^{b}
T_7	19.22^{h}	18.93^{ij}	19.30^{gh}	19.73^{e}	19.29^{d}	32.99^{ij}	33.61^{h}	33.89^{gh}	34.07^{fg}	33.64^{c}
T_8	21.04^{b}	19.34^{fgh}	21.06^{b}	21.68^{a}	20.78^{a}	38.07^{b}	34.97^{e}	37.85^{b}	38.93^{a}	37.46^{a}
Main effect of formulations (F)	19.08^{c}	18.47^{d}	19.25^{b}	19.58^{a}		31.49^{c}	30.03^{d}	32.63^{b}	32.86^{a}	
	LSD at 1%					LSD at 1%				
T	0.10					0.16				
F	0.07					0.12				
T x F	0.19					0.33				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 2: Effect of different inoculant formulations on number of leaves in finger millet

Treatments	Number of leaves									
	30 DAT					60 DAT				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	5.33^{efg}	5.33^{efg}	5.33^{efg}	5.33^{efg}	5.33^{g}	7.67^{fgh}	7.33^{ghi}	7.67^{fgh}	7.67^{fgh}	7.59^{efg}
T_2	5.67^{def}	5.67^{def}	6.00^{cde}	6.00^{cde}	5.83^{e}	7.67^{fgh}	7.33^{fgh}	7.67^{fgh}	8.00^{efg}	7.67^{def}
T_3	5.67^{def}	5.67^{def}	5.67^{def}	6.00^{cde}	5.75^{f}	7.67^{fgh}	8.00^{efg}	7.67^{fgh}	8.00^{efg}	7.84^{de}
T_4	6.33^{bcd}	5.67^{cde}	6.00^{cde}	6.67^{abc}	6.17^{d}	8.33^{def}	7.67^{fgh}	8.00^{efg}	8.67^{bcd}	8.17^{cde}
T_5	6.00^{cde}	6.00^{bcd}	6.67^{abc}	6.67^{abc}	6.33^{c}	8.67^{bcd}	8.33^{efg}	8.67^{bcd}	8.67^{bcd}	8.59^{b}
T_6	6.67^{abc}	6.33^{bcd}	6.00^{cde}	6.33^{bcd}	6.33^{c}	8.67^{bcd}	8.00^{def}	8.00^{efg}	8.33^{def}	8.25^{cd}
T_7	6.67^{abc}	6.00^{cde}	6.33^{bcd}	6.67^{abc}	6.42^{b}	8.67^{bcd}	8.33^{fgh}	8.33^{def}	8.67^{bcd}	8.50^{bc}
T_8	7.00^{ab}	6.67^{abc}	7.00^{ab}	7.33^{a}	7.00^{a}	9.33^{ab}	9.00^{abc}	9.33^{ab}	9.67^{a}	9.33^{a}
Main effect of formulations (F)	6.17^{b}	5.92^{d}	6.13^{bc}	6.38^{a}		8.33^{c}	7.99^{d}	8.04^{b}	8.46^{a}	
	LSD at 1%					LSD at 1%				
T	0.54					0.56				
F	0.38					0.40				
T x F	1.08					1.13				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 3: Effect of different inoculant formulations on chlorophyll content in finger millet

Treatments	Chl –a Content (mg/g leaf)					Chl –b Content (mg/g leaf)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	1.02^{op}	1.03^{op}	1.01^{p}	1.02^{op}	1.02^{h}	0.39^{l}	0.38^{l}	0.41^{klj}	0.39^{l}	0.39^{h}
T_2	1.12^{on}	1.14^{nm}	1.27^{kghij}	1.26^{khij}	1.20^{e}	0.43^{kilj}	0.40^{kl}	0.47^{i}	0.45^{kij}	0.44^{e}
T_3	1.15^{lnm}	1.15^{nm}	1.23^{klmj}	1.19^{klnm}	1.18^{g}	0.43^{kilj}	0.38^{l}	0.44^{klj}	0.43^{kilj}	0.42^{g}
T_4	1.10^{onp}	1.10^{onp}	1.26^{khij}	1.30^{ghij}	1.19^{f}	0.42^{kilj}	0.39^{l}	0.47^{i}	0.45^{ij}	0.43^{f}
T_5	1.37^{fge}	1.25^{klij}	1.34^{fghi}	1.42^{fde}	1.34^{d}	0.78^{fhg}	0.77^{hg}	0.81^{fdge}	0.84^{cde}	0.80^{d}
T_6	1.36^{fghe}	1.32^{fghij}	1.45^{cde}	1.50^{cdb}	1.41^{b}	0.76^{h}	0.80^{fhge}	0.86^{cd}	0.87^{cdb}	0.82^{b}
T_7	1.37^{fge}	1.37^{fge}	1.37^{fge}	1.41^{fde}	1.38^{c}	0.81^{fhge}	0.78^{fhge}	0.81^{fdge}	0.83^{fd}	0.81^{c}
T_8	1.54^{cab}	1.46^{cde}	1.56^{ab}	1.61^{a}	1.54^{a}	0.92^{ab}	0.82^{fde}	0.89^{cab}	0.94^{a}	0.89^{a}
Main effect of formulations (F)	1.25^{c}	1.23^{d}	1.31^{b}	1.34^{a}		0.62^{b}	0.59^{c}	0.65^{a}	0.65^{a}	
	LSD at 1%					LSD at 1%				
T	0.05					0.03				
F	0.04					0.02				
T x F	0.10					0.05				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 4: Effect of different inoculant formulations on shoot nitrogen content in finger millet

Treatments	Shoot N Uptake (mg/plant)					Shoot N Content (per cent)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	22.32^{x}	22.64^{x}	22.39^{x}	22.36^{x}	22.43^{h}	0.54^{p}	0.56^{p}	0.54^{p}	0.54^{p}	0.54^{h}
T_2	47.68^{q}	44.42^{r}	50.28^{p}	53.60^{o}	49.00^{e}	1.04^{cb}	1.01^{cd}	1.06^{ab}	1.10^{a}	1.05^{a}
T_3	42.63^{s}	39.80^{t}	44.88^{r}	47.31^{q}	43.65^{f}	0.76^{lkm}	0.73^{nm}	0.771^{kmj}	0.78^{lkj}	0.76^{f}
T_4	35.93^{v}	33.62^{w}	37.74^{u}	40.58^{t}	36.97^{g}	0.69^{o}	0.68^{o}	0.71^{no}	0.74^{lnm}	0.71^{g}
T_5	71.78^{g}	68.51^{i}	76.22^{f}	79.55^{d}	74.02^{b}	0.91^{gh}	0.89^{h}	0.94^{gf}	0.96^{ef}	0.93^{d}
T_6	63.34^{k}	60.30^{l}	66.70^{j}	70.12^{h}	65.11^{c}	0.97^{ef}	0.96^{ef}	1.02^{cd}	1.04^{cb}	1.00^{b}
T_7	56.53^{n}	53.70^{o}	58.11^{m}	62.53^{k}	57.72^{d}	0.80^{ij}	0.78^{lkj}	0.79^{kj}	0.83^{i}	0.80^{e}
T_8	81.50^{c}	77.51^{e}	85.77^{b}	90.32^{a}	83.78^{a}	0.95^{f}	0.95^{gf}	0.97^{ef}	1.00^{ed}	0.97^{c}
Main effect of formulations (F)	52.71^{c}	50.06^{d}	55.26^{b}	58.30^{a}		0.83^{bc}	0.82^{cd}	0.85^{ab}	0.87^{a}	
	LSD at 1%					LSD at 1%				
T	0.54					0.02				
F	0.38					0.01				
T x F	1.07					0.04				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*

Table 5: Effect of different inoculant formulations on root nitrogen content in finger millet

Treatments	Root N Uptake (mg/plant)					Root N Content (per cent)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	5.64^{n}	5.72^{n}	5.78^{n}	5.63^{n}	5.69^{h}	0.33^{i}	0.33^{hi}	0.34^{ig}	0.33^{i}	0.33^{g}
T_2	12.81^{jmk}	12.01^{jmki}	13.57^{jgki}	14.58^{jgki}	13.24^{e}	0.60^{cab}	0.59^{cadb}	0.62^{ab}	0.64^{a}	0.69^{a}
T_3	9.65^{mnl}	9.07^{mn}	10.25^{ml}	11.01^{mkl}	10.00^{fg}	0.41^{heig}	0.40^{hfig}	0.42^{hfig}	0.43^{hfig}	0.42^{ef}
T_4	11.60^{jmk}	10.77^{mkl}	12.18^{jmki}	12.81^{jmk}	11.84^{ef}	0.54^{cfdb}	0.53^{cfdb}	0.50^{fdge}	0.51^{cfde}	0.52^{cde}
T_5	19.63^{cedb}	18.50^{cedf}	20.49^{cadb}	21.55^{cab}	20.04^{b}	0.65^{cadb}	0.64^{cadb}	0.61^{cadb}	0.63^{cadb}	0.63^{abc}
T_6	17.22^{gedf}	16.95^{gedf}	18.05^{cedf}	18.99^{cedb}	17.80^{c}	0.59^{cadb}	0.65^{cadb}	0.67^{cab}	0.67^{cab}	0.64^{ab}
T_7	15.43^{jgei}	14.53^{jgki}	16.09^{geif}	16.92^{gedf}	15.74^{cd}	0.52^{cfde}	0.50^{cfde}	0.53^{cfde}	0.54^{cfd}	0.52^{cde}
T_8	22.05^{cab}	20.99^{cadb}	23.24^{ab}	24.45^{a}	22.68^{a}	0.67^{cadb}	0.66^{cadb}	0.70^{cadb}	0.73^{a}	0.61^{bcd}
Main effect of formulations (F)	14.25^{bc}	13.57^{cd}	14.96^{ab}	15.74^{a}		0.54^{bc}	0.54^{bc}	0.55^{ab}	0.56^{a}	
	LSD at 1%					LSD at 1%				
T	2.13					0.08				
F	1.51					0.06				
T x F	4.26					0.16				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 6: Effect of different inoculant formulations on shoot phosphorus content in finger millet

Treatments	Shoot P Uptake (mg/plant)					Shoot P Content (per cent)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	13.83^{r}	13.98^{r}	14.20^{r}	14.03^{r}	14.01^{h}	0.33^{f}	0.35^{f}	0.34^{f}	0.34^{f}	0.34^{fg}
T_2	21.89^{pq}	20.39^{q}	23.05^{opq}	24.60^{opq}	22.48^{g}	0.48^{de}	0.46^{e}	0.49^{cde}	0.50^{cdb}	0.48^{ef}
T_3	29.00^{olm}	28.53^{olm}	30.52^{klm}	32.80^{klm}	30.21^{e}	0.52^{cad}	0.53^{cadb}	0.52^{cadb}	0.54^{cad}	0.53^{cde}
T_4	26.01^{opq}	24.22^{opq}	27.38^{opm}	28.72^{olm}	26.58^{f}	0.50^{cdb}	0.49^{cde}	0.52^{cadb}	0.53^{cad}	0.51^{de}
T_5	43.77^{cde}	41.94^{hief}	46.08^{cde}	48.60^{cdb}	45.10^{b}	0.56^{cadb}	0.55^{cadb}	0.57^{cab}	0.59^{ab}	0.56^{ab}
T_6	34.36^{klj}	32.67^{klm}	36.17^{kij}	38.15^{hij}	35.34^{d}	0.53^{cadb}	0.52^{cde}	0.55^{cadb}	0.56^{cad}	0.54^{cd}
T_7	38.56^{hij}	37.66^{hij}	40.59^{hif}	42.74^{hde}	39.89^{c}	0.55^{cadb}	0.54^{cadb}	0.55^{cadb}	0.57^{cad}	0.55^{bc}
T_8	49.65^{cab}	47.20^{cde}	52.26^{ab}	54.92^{a}	51.01^{a}	0.58^{cab}	0.58^{cab}	0.59^{ab}	0.61^{a}	0.59^{a}
Main effect of formulations (F)	32.13^{bc}	30.82^{cd}	33.78^{ab}	35.57^{a}		0.51^{bc}	0.50^{cd}	0.52^{ab}	0.53^{a}	
	LSD at 1%					LSD at 1%				
T	3.00					0.05				
F	2.12					0.03				
T x F	6.01					0.09				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 7: Effect of different inoculant formulations on root phosphorus content in finger millet

Treatments	Root P Uptake (mg/plant)					Root P Content (per cent)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	3.24^{q}	3.48^{q}	3.66^{q}	3.93^{q}	3.58^{h}	0.19^{e}	0.20^{ed}	0.21^{ced}	0.23^{ced}	0.21^{g}
T_2	5.94^{npq}	5.53^{npq}	6.25^{npm}	6.71^{nml}	6.11^{fg}	0.31^{cab}	0.30^{cad}	0.32^{ab}	0.33^{a}	0.32^{ef}
T_3	7.86^{njm}	7.32^{nmk}	8.28^{njm}	8.89^{jhm}	8.09^{e}	0.34^{a}	0.33^{ab}	0.34^{a}	0.34^{a}	0.34^{de}
T_4	7.05^{nml}	6.57^{mol}	7.43^{nmk}	7.81^{njm}	7.22^{ef}	0.33^{ab}	0.32^{ab}	0.31^{cab}	0.31^{cab}	0.32^{ef}
T_5	11.87^{fcg}	11.28^{fch}	12.49^{fca}	13.14^{cad}	12.20^{b}	0.39^{a}	0.39^{a}	0.37^{a}	0.38^{a}	0.38^{a}
T_6	9.32^{jhg}	8.86^{jhm}	9.81^{fjh}	10.32^{fjh}	9.58^{cd}	0.32^{ab}	0.34^{a}	0.36^{a}	0.36^{a}	0.35^{bd}
T_7	10.46^{ejh}	9.94^{fjh}	11.01^{fch}	11.58^{fch}	10.75^{c}	0.36^{a}	0.34^{a}	0.36^{a}	0.37^{a}	0.36^{bc}
T_8	13.46^{cab}	12.80^{cad}	14.17^{ab}	14.91^{a}	13.84^{a}	0.37^{a}	0.36^{a}	0.38^{a}	0.39^{a}	0.37^{ab}
Main effect of formulations (F)	8.65^{c}	8.22^{cd}	9.14^{b}	9.66^{a}		0.33^{a}	0.32^{a}	0.33^{a}	0.34^{a}	
	LSD at 1%					LSD at 1%				
T	1.38					0.05				

F	0.97	0.04
T x F	2.75	0.10

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 8: Effect of different inoculant formulations on total nitrogen and phosphorus uptake by finger millet

Treatments	Total N Uptake (mg/plant)					Total P Uptake (mg/plant)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	27.96^{u}	28.36^{u}	28.17^{u}	27.99^{u}	28.12^{h}	17.31^{t}	17.22^{t}	17.86^{t}	17.96^{t}	17.59^{h}
T_2	45.58^{mn}	42.69^{pon}	47.99^{ml}	51.59^{kl}	46.96^{g}	27.83^{sr}	25.92^{s}	29.30^{qsr}	31.31^{oqp}	28.59^{g}
T_3	60.49^{pqr}	56.43^{sr}	63.85^{po}	68.18^{on}	62.24^{e}	36.86^{omn}	35.85^{omp}	38.80^{lmn}	41.69^{lmk}	38.30^{f}
T_4	54.23^{t}	50.57^{t}	57.06^{sqr}	60.12^{pq}	55.49^{f}	33.06^{oqp}	30.79^{qps}	34.81^{oqp}	36.53^{pmp}	33.80^{e}
T_5	91.41^{e}	87.01^{ef}	96.71^{d}	101.10^{cd}	94.06^{b}	55.64^{efd}	53.22^{efg}	58.57^{ecd}	61.74^{cb}	57.29^{b}
T_6	71.95^{gh}	68.23^{ih}	84.75^{gf}	79.45^{ef}	73.46^{d}	43.68^{ljk}	41.53^{lmk}	45.98^{ijk}	48.47^{ijg}	44.91^{d}
T_7	80.56^{kj}	77.25^{kl}	74.20^{ij}	89.11^{h}	82.92^{c}	49.02^{ijg}	47.60^{uh}	51.60^{ifg}	54.32^{efg}	50.63^{c}
T_8	103.56^{c}	98.50^{d}	109.01^{b}	114.77^{a}	106.46^{a}	63.11^{cb}	60.00^{cd}	66.43^{ab}	69.83^{a}	64.84^{a}
Main effect of formulations (F)	66.97^{c}	63.63^{d}	70.22^{b}	74.04^{a}		40.81^{c}	39.01^{d}	42.92^{b}	45.23^{a}	
	LSD at 1%					LSD at 1%				
T	1.94					2.21				
F	1.37					1.56				
T x F	3.88					4.41				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

Table 9: Effect of different inoculant formulations on biomass content of finger millet

Treatments	Shoot Biomass (g/plant)					Root Biomass (g/plant)				
	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)	ABF	FBD BF	LGF	LQF	Main effect of treatments (T)
T_1	4.04^{v}	4.14^{v}	4.18^{uv}	4.17^{v}	4.13^{h}	1.71^{s}	1.73^{s}	1.72^{s}	1.71^{s}	1.72^{h}
T_2	4.58^{st}	4.40^{ut}	4.72^{sr}	4.89^{qr}	4.65^{g}	1.92^{qr}	1.83^{sr}	1.94^{qr}	2.03^{qp}	1.93^{g}
T_3	5.61^{m}	5.43^{mn}	5.87^{l}	6.04^{kl}	5.74^{f}	2.34^{mn}	2.24^{on}	2.45^{lm}	2.58^{ljk}	2.40^{e}
T_4	5.18^{op}	4.97^{qp}	5.32^{on}	5.45^{mn}	5.23^{e}	2.14^{op}	2.05^{qp}	2.44^{lm}	2.53^{lk}	2.29^{f}
T_5	7.88^{ed}	7.68^{ef}	8.07^{cd}	8.29^{c}	7.98^{b}	3.02^{hfg}	2.89^{hi}	3.37^{e}	3.42^{ed}	3.18^{b}
T_6	6.53^{j}	6.25^{k}	6.55^{j}	6.75^{ji}	6.52^{d}	2.91^{hig}	2.60^{jk}	2.72^{j}	2.87^{i}	2.77^{d}
T_7	7.07^{h}	6.93^{hi}	7.34^{g}	7.50^{gh}	7.21^{c}	2.94^{hig}	2.91^{hig}	3.04^{fg}	3.12^{f}	3.00^{c}
T_8	8.54^{b}	8.18^{c}	8.88^{a}	9.05^{a}	8.66^{a}	3.67^{cb}	3.57^{cd}	3.72^{ab}	3.82^{a}	3.69^{a}
Main effect of formulations (F)	6.18^{c}	6.00^{d}	6.37^{b}	6.52^{a}		2.58^{c}	2.48^{d}	2.67^{b}	2.76^{a}	
	LSD at 1%					LSD at 1%				
T	0.12					0.07				
F	0.08					0.05				
T x F	0.24					0.15				

Note: ABF; Alginate Based Formulation, FBDBF; Fluid Bed Dryer Based Formulation, LGF; Lignite Formulation, LQF; Liquid Formulation

T_1	Control	T_5	*Azotobacter chroococcum +Bacillus megaterium*
T_2	*Azotobacter chroococcum*	T_6	*Azotobacter chroococcum +Pseudomonas fluorescens*
T_3	*Bacillus megaterium*	T_7	*Bacillus megaterium +Pseudomonas fluorescens*
T_4	*Pseudomonas fluorescens*	T_8	*Azotobacter chroococcum +Bacillus megaterium +Pseudomonas fluorescens*

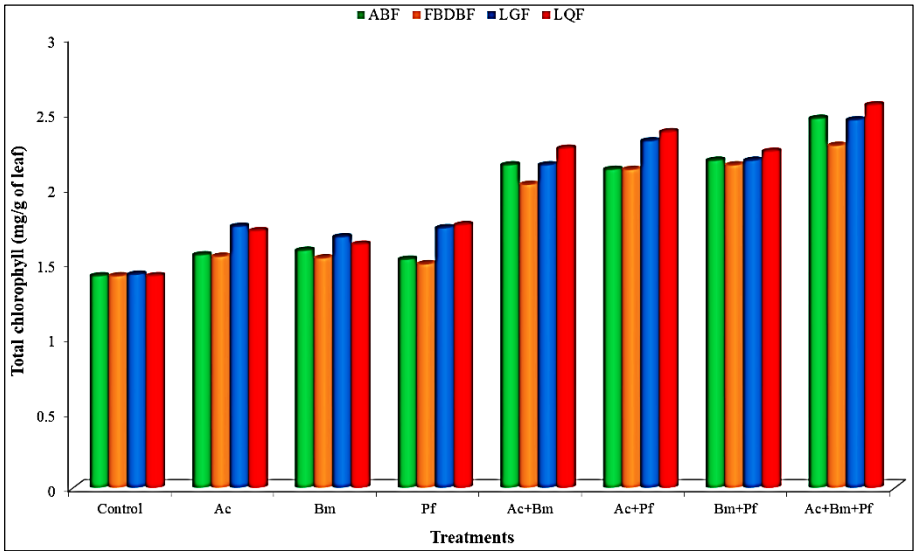

Fig 1: Total chlorophyll content of finger millet as influenced by different inoculant formulations A; *Azotobacter chroococcum*, B; *Bacillus megaterium* P; *Pseudomonas fluorescen*

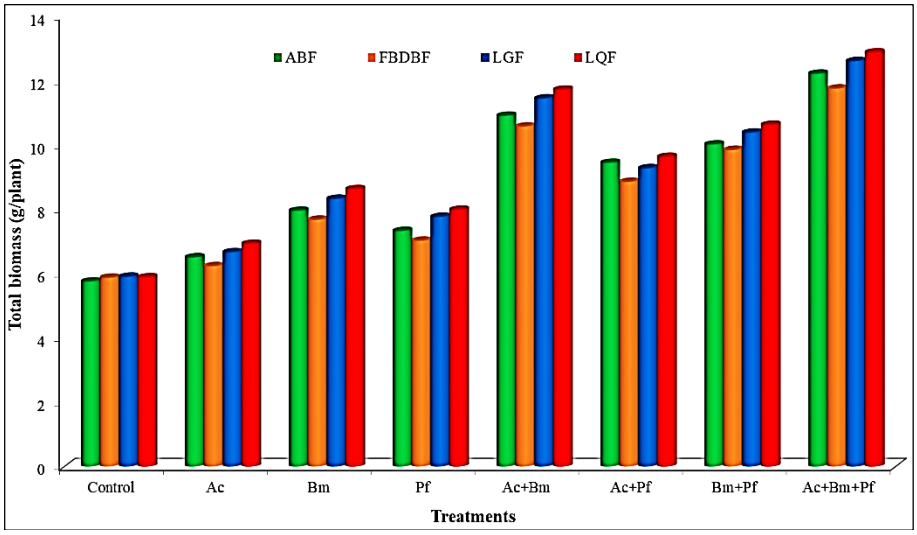

Fig 2: Total biomass of finger millet as influenced by different inoculant formulations A; *Azotobacter chroococcum*, B; *Bacillus megaterium* P; *Pseudomonas fluorescens*

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