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Influence of inorganic nutrients levels and microbial consortia on growth, yield and fibre quality parameters of *Bt* cotton (*Gossypium hirsutum*)

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Abstract

Field experiments was conducted during *kharif* 2018 and 2019 at Agriculture Research Station, Dharwad, Karnataka, India to study the effect of inorganic nutrient levels and liquid biofertilizer consortia on growth, yield and fibre quality parameters of Bt cotton. Experiment was laid out with three main plots comprising nutrient levels and five sub plots comprising biofertilizer consortia in split plot design + one check and replicated thrice. Application of 100% recommended nutrients recorded significantly higher ginning out turn (33.86%) and dry matter accumulation in leaf (40.82 g plant^{-1}), stem (120.4 g plant^{-1}) and reproductive parts (110.4 g plant^{-1}) compared to 80 and 60% recommended nutrients. Among liquid biofertilizer consortia application of rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS recorded higher seed cotton yield (2040 kg ha^{-1}) and harvest index (0.33). Among interactions, significantly higher seed cotton yield per plant, seed cotton yield per hectare and boll weight was recorded with application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS (156.1 g, 2388 kg and 4.89 g, respectively).

Keywords: Consortia, nutrient, phyllosphere, rhizosphere, seed cotton

Introduction

Cotton (*Gossypium hirsutum* L.) is an important fibre crop which is extensively grown in India and Karnataka and it is backbone of textile industries mainly because of its lint. In India cotton has an area of 122.38 lakh ha with a production of 361 lakh bales of seed cotton. Average productivity of cotton in India is 501 kg lint per ha, which is low when compared to the world average of 725 kg lint per ha. Maharashtra, Gujarat, Andhra Pradesh, Madhya Pradesh, Punjab, Haryana, Karnataka, Rajasthan and Tamil Nadu are the important cotton growing states in India. In Karnataka, cotton occupies an area of 5.75 lakh ha with a production of 18.80 lakh bales of seed cotton with a productivity of 532 kg lint per ha (Anon., 2019) [3].

Supply of nutrients is the major limiting factor in cotton production. It is well established fact that sufficient quantity of nutrients at proper time are needed for achieving high yield. Cotton plant being a heavy feeder require adequate supply of nutrients to optimize the seed cotton yield, quality and net profit in cotton production (Aladakatti *et al.*, 2011) [1]. Inoculation of beneficial microorganism through biofertilizers enhances crop production through improving the nutrient supply and their availability which helps to improve growth and yield of crops. Microbial consortium are the association of organisms, which perform the basic biochemical functions *viz.*, toxic substance detoxification, organic matter decomposition and nutrient transformations (solubilizing and mobilizing) in turn improving the soil properties and crop performance (Pindi and Satyanarayana, 2012) [9]. To improve supply and availability of nutrients to plants experiment was carried out with following objectives. 1. Effect inorganic nutrient levels and consortia on growth and yield of cotton 2. Effect inorganic nutrient levels and consortia on fibre quality parameters.

Material and Methods

Experimental site: Field experiment was conducted at Agricultural Research Station, Dharwad during 2018 and 2019. Experimental site consisted medium black soil and available

N, P_2O_5 and K_2O were 224.09, 26.67 and 374.55 kg ha^{-1}, respectively during 2018 and 235.30, 28.90 and 379.85 kg ha^{-1}, respectively during 2019.

Treatment details: Experiment was laid out in split plot design with one recommended check. Main plot comprising nutrient levels *viz.*, M_1-100% recommended nutrients (100:50:50 kg N P_2O_5 K_2O ha^{-1}), M_2- 80% recommended nutrients (80:40:40 kg N P_2O_5 K_2O ha^{-1}) and M_3- 60% recommended nutrients (60:30:30 kg N P_2O_5 K_2O ha^{-1}) and sub plot comprising liquid biofertilizer consortia *viz.*, S_1- Rhizosphere biofertilizer consortia-I, S_2- Rhizosphere biofertilizer consortia-II, S_3- Phyllosphere consortia at 50, 70 and 90 DAS, S_4- Rhizosphere biofertilizer consortia-I + phyllosphere consortia at 50, 70 and 90 DAS and S_5- Rhizosphere biofertilizer consortia-II + phyllosphere consortia at 50, 70 and 90 DAS. Recommended package of practice taken as check (Seed treatment with *Azospirillum* and PSB each @ 200 g kg^{-1} seed + 100:50:50 kg NPK ha^{-1}).

Experimental details: Farm yard manure of 5 t was applied three prior to sowing to avoid immobilization of nutrients. Ajeet- 199 (BG-II) Bt hybrid was sown on flat bed with recommended spacing of 90 cm × 60 cm. Rhizosphere consortia-I and II applied @ 6.25 lit ha^{-1} was mixed with 400 kg well decomposed FYM and the mixture was spot applied at the time of sowing. The Phyllosphere Consortium @ 4 ml per lit of water was foliar sprayed with the present recommendation of foliar spray of 1% $MgSO_4$ and 1% water soluble all 19 fertilizer (19:19:19). Rhizosphere biofertilizer consortia-I consists of *Gluconoacetobacter,* P- Solubilising Bacteria (PSB), K- Solubilising Bacteria (KSB), Zn- Solubilising Bacteria (Zn SB), JK-16, Pink Pigmented Facultative Microorganism (PPFM-33) and *Lactobacillus* (LAB 75). Rhizosphere biofertilizer consortia-II consists of *Azospirillum*, P- Solubilising Bacteria (PSB), K- Solubilising Bacteria (KSB), Zn- Solubilising Bacteria (ZnSB), Silicon Solubilising Bacteria (Si SB), JK-16, Pink Pigmented Facultative Microorganism (PPFM-33) and *Lactobacillus* (LAB 75). Phyllosphere biofertilizer consortia consists of *Actinomycetes* strains 502, 248, A-34, PSA-5, PSA-7 and UPM-3, PPFM strains PPFM-33 and PPFM-58, *Lactobacillus* strains LAB-75, LABLS-36 and LAB-82. Nitrogen, phosphorus and potassium were supplied through urea, diammonium phosphate and muriate of potash fertilizers. Entire dose of phosphorus and 50% nitrogen and potassium were applied as basal and remaining 50% of nitrogen and potassium applied into 3 equal splits at 30, 60 and 90 DAS. Gap filling and thinning was done 10 and 15 DAS, respectively. Dry matter accumulation was computed for only above ground portions of the plant. Various conventional instruments are integrated into a single compact operating system by using the state of the art technology in optics, mechanics and electronics. HVI system provides measurement of Fibre span length (mm), Fibre fineness (µg $inch^{-1}$) and Fibre strength (g tex^{-1}). Cotton samples were sent for analysis of fibre quality parameters to CIRCOT, Mumbai and Plus enterprises, Dharwad with Compact HVI instrument (in ICC mode) by the method adopted from ASTM D-5867 procedure (Sundaram, 2002) [11]. Ginnig out turn was worked out by seed cotton obtained from all the pickings from each net plot was mixed thoroughly and 300 g sample was drawn. This seed cotton was ginned with mechanical ginner and the ginning out turn was calculated by the following formula.

$$\text{Ginning out turn (\%)} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

Statistical analysis: The data collected from the experiment was subjected to statistical analysis as described by Gomez and Gomez (1984) [6]. The level of significance used in 'F' and't' test was P = 0.05. Critical difference (CD) values were calculated wherever the 'F' test was found significant.

Results and Discussion

Effect of inorganic nutrient levels and consortia on growth parameters

Application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) recorded significantly higher monopodial branches during 2018, 2019 and for pooled (2.85, 2.92 and 2.88 $plant^{-1}$, respectively), dry matter accumulation in leaf (39.54, 42.09 and 40.82 g $plant^{-1}$, respectively), stem (118.2, 122.7 and 120.4 g $plant^{-1}$, respectively) and reproductive parts (108.9, 111.8 and 110.4 g $plant^{-1}$, respectively). Significantly lower monopodial branches (2.18, 2.13 and 2.15 $plant^{-1}$, respectively), dry matter accumulation in leaf (28.06, 30.77 and 29.42 g $plant^{-1}$, respectively), stem (88.90, 96.90 and 92.90 g $plant^{-1}$, respectively) and reproductive parts (83.80, 86.50 and 85.10 g $plant^{-1}$, respectively) was recorded with 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) (Table 1). Adequate supply of nutrients helped the normal metabolic activities in plant which resulted higher growth parameters. Similar trend of data was reported by Vinayak Hosamani (2012) [12] who recorded higher dry matter accumulation in leaf, stem and reproductive parts with higher level of nutrients.

Among liquid biofertilizer consortia, application of rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS recorded higher dry matter accumulation in leaf (37.35 g $plant^{-1}$), stem (111.3 g $plant^{-1}$) and reproductive parts (102.1 g $plant^{-1}$) for pooled and it was on par with rhizosphere consortia-I + phyllosphere consortia at 50, 70 and 90 DAS for dry matter accumulation in leaf (36.22 g $plant^{-1}$) and stem (108.9 g $plant^{-1}$). Application of phyllosphere consortia at 50, 70 and 90 DAS recorded significantly lower dry matter accumulation in leaf (33.15 g $plant^{-1}$), stem (102.8 g $plant^{-1}$) and reproductive parts (93.30 g $plant^{-1}$) (Table 1). These results are in accordance with the findings of Madhaiyan *et al.* (2006) [13] who found that application of 30% methanol and 30% PPFMs recorded higher dry matter over control.

Interactions of inorganic nutrient levels and liquid biofertilizer consortia influenced non significantly on monopodials, dry matter accumulation in leaf and stem but significantly influenced on dry matter accumulation in reproductive parts. Significantly higher dry matter accumulation in reproductive parts was recorded with 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS (114.4 g $plant^{-1}$) and which was on par with the 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-I + phyllosphere consortia at 50, 70 and 90 DAS (111.8 g $plant^{-1}$) and 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-I (109.4 g $plant^{-1}$) (Table 1). Higher dry matter might be due to supply of adequate nutrients and enhanced microbial activities in soil increases the nutrients availability and supply to the plants. These results are in line with findings of Anup *et al.* (2006) [4] who reported that integrated application of nitrogen + FYM + *Azospirillum* recorded significantly higher plant height, leaf area index and dry matter production over control.

Effect of inorganic nutrient levels and consortia on yield and yield parameters

Soil application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) resulted into significantly higher boll weight (4.69 g), seed cotton yield per plant (148.7 g), seed cotton yield per hectare (2241 kg) and harvest index (0.35) for pooled. Application of 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) resulted into significantly lower boll weight (3.56 g), seed cotton yield per plant (87.90 g), seed cotton yield per hectare (1523 kg) and harvest index (0.29) (Table 2). Similar results was obtain with experiments of Basavanneppa *et al.* (2015) [5] and Ambika *et al.* (2017) who reported higher yield parameters with increased level of nutrients.

Yield parameters *viz.,* boll weight (4.35 g), seed cotton yield per plant (131.8 g), seed cotton yield per hectare (2040 kg) and harvest index (0.33) were significantly higher with application of rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS for pooled and which was on par with rhizosphere consortia-I + phyllosphere consortia at 50, 70 and 90 DAS for seed cotton yield per plant (127.1 g), seed cotton yield per hectare (1966 kg) and harvest index (0.33). Foliar application of phyllosphere consortia recorded significantly lower boll weight (4.23 g), seed cotton yield per plant (107.0 g), seed cotton yield per hectare (1719 kg) and harvest index (0.31) (Table 2). These results are complimentary with Munirathnam and Sawadhkar (2008) [8] who reported bio-inoculants with *Azospirillum* + Phosphorus Solubilizing Bacteria + Pink Pigmented Facultative Methylotrophic Bacterium recorded significantly higher dry matter production over control in sandy loam soil at Nadyal.

Application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS recorded higher boll weight (4.89 g), seed cotton yield per plant (156.1 g), seed cotton yield per hectare (2388 kg) and harvest index (0.36) for pooled and which was on par with 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-I + phyllosphere consortia at 50, 70 and 90 DAS (4.76 g, 151.3 g, 2271 kg and 0.36, respectively) (Table 2). Significantly lower yield parameters were recorded with application of 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) along with phyllosphere consortia at 50, 70 and 90 DAS (3.45 g, 71.00 g, 1334 kg and 0.26, respectively). Increase in yield parameters with nutrients and biofertilizer was reported by Raju (2013) [10] and Jagdish Kumar *et al.* (2019) [7].

Effect of inorganic nutrient levels and consortia on fibre quality parameters

Fibre quality parameters *viz.,* span length, micronaire value and fibre strength were non significantly influenced by inorganic nutrients levels, however significant effect was noticed on ginning out turn. Significantly higher ginning out turn was recorded with application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) during 2018, 2019 and for pooled (33.84, 33.88 and 33.86%, respectively). Significantly lower ginning out turn was recorded with application of 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) (31.28, 31.17 and 31.22) (Table 3). Vinayak Hosamani (2012) [12] from Raichur reported similar pattern of results on ginning out turn. Non-significant effect was recorded by liquid biofertilizer consortia and their interaction with inorganic nutrient levels for fibre quality parameters (Table 3).

Table 1: Growth of cotton as influenced by nutrient levels and liquid biofertilizer consortia

	Number of monopodial branches per plant			Dry matter accumulation in leaf (g plant^{-1})			Dry matter accumulation in stem (g plant^{-1})			Dry matter accumulation in reproductive parts (g plant^{-1})		
Treatments	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
M_1	2.85	2.92	2.88	39.54	42.09	40.82	118.2	122.7	120.4	108.9	111.8	110.4
M_2	2.42	2.39	2.40	33.87	37.01	35.44	104.9	110.5	107.7	97.40	100.4	98.90
M_3	2.18	2.13	2.15	28.06	30.77	29.42	88.90	96.90	92.90	83.80	86.50	85.10
S.Em.±	0.12	0.15	0.05	0.36	0.28	0.15	0.50	0.40	0.30	1.70	2.70	1.80
C.D. (P=0.05)	0.46	0.59	0.19	1.41	1.08	0.59	1.90	1.70	1.10	6.80	10.50	7.00
S_1	2.45	2.45	2.45	32.86	35.52	34.19	102.0	107.6	104.8	95.60	97.70	96.60
S_2	2.50	2.42	2.46	33.88	36.54	35.21	104.0	110.6	107.3	96.90	99.50	98.20
S_3	2.45	2.37	2.41	32.00	34.30	33.15	100.7	105.0	102.8	91.40	95.20	93.30
S_4	2.42	2.55	2.49	34.90	37.55	36.22	105.6	112.1	108.9	98.80	102.1	100.4
S_5	2.59	2.58	2.59	35.49	39.21	37.35	107.7	114.9	111.3	100.8	103.4	102.1
S.Em.±	0.12	0.11	0.06	0.57	0.71	0.43	0.60	1.90	0.90	0.7	0.6	0.4
C.D. (P=0.05)	NS	NS	NS	1.67	2.06	1.26	1.80	5.40	2.70	1.9	1.7	1.2
M_1S_1	2.82	2.85	2.84	37.97	40.01	38.99	115.0	117.3	116.2	107.2	110.6	108.9
M_1S_2	2.83	2.89	2.86	38.80	41.00	39.90	117.9	123.3	120.6	108.1	110.8	109.4
M_1S_3	2.87	2.71	2.79	37.98	39.91	38.95	113.6	117.2	115.4	105.3	109.1	107.2
M_1S_4	2.82	3.01	2.91	41.18	42.80	41.99	120.9	125.3	123.1	110.7	112.9	111.8
M_1S_5	2.91	3.11	3.01	41.77	46.75	44.26	123.8	130.2	127.0	113.1	115.8	114.4
M_2S_1	2.43	2.35	2.39	33.80	36.51	35.16	104.0	109.7	106.9	95.70	97.50	96.60
M_2S_2	2.43	2.41	2.42	34.04	37.83	35.93	105.7	110.9	108.3	96.80	99.30	98.00
M_2S_3	2.26	2.29	2.28	32.03	33.00	32.52	101.6	105.5	103.6	93.90	96.90	95.40
M_2S_4	2.28	2.43	2.35	34.61	38.80	36.70	105.8	112.3	109.1	99.20	104.0	101.6
M_2S_5	2.67	2.45	2.56	34.89	38.89	36.89	107.5	114.1	110.8	101.6	104.4	103.0
M_3S_1	2.10	2.15	2.13	26.80	30.03	28.42	87.10	95.60	91.40	83.90	84.90	84.40
M_3S_2	2.24	1.96	2.10	28.80	30.80	29.80	88.30	97.70	93.00	85.90	88.50	87.20
M_3S_3	2.21	2.10	2.16	25.98	30.00	27.99	86.90	92.10	89.50	75.10	79.60	77.40
M_3S_4	2.17	2.23	2.20	28.90	31.04	29.97	90.30	98.60	94.40	86.50	89.30	87.90
M_3S_5	2.19	2.18	2.19	29.80	32.00	30.90	91.80	100.3	96.00	87.60	90.10	88.80
S.Em.±	0.22	0.23	0.11	0.96	1.13	0.69	1.10	2.90	1.50	2.00	2.80	1.90

C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.30	10.80	7.20
Check	2.70	2.66	2.68	34.94	39.05	36.99	112.5	116.3	114.4	102.9	106.7	104.8
S.Em.±	0.21	0.23	0.11	0.93	1.16	0.70	1.00	3.00	1.50	2.00	2.40	1.70
C.D. (P=0.05)	NS	0.70	0.34	2.82	3.49	2.12	3.10	9.10	4.60	5.90	7.30	5.10

M_1: 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) M_2: 80% recommended nutrients (80:40:40 kg NPK ha^{-1}) M_3: 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) S_1: Rhizosphere biofertilzer consortium-I S_2: Rhizosphere biofertilzer consortium-II S_3: Foliar application of Phyllosphere consortium @ 50, 70 and 90 DAS S_4: S_1+S_3 S_5: S_2+S_3

Table 2: Yield and yield parameters of cotton as influenced by nutrient levels and liquid biofertilizer consortia

	Boll weight (g)			**Seed cotton yield (g plant^{-1})**			**Seed cotton yield (kg ha^{-1})**			**Harvest index**		
Treatments	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
M_1	4.48	4.90	4.69	142.9	154.5	148.7	1886	2597	2241	0.30	0.40	0.35
M_2	4.06	4.47	4.26	111.4	125.7	118.6	1605	2154	1880	0.28	0.37	0.32
M_3	3.34	3.78	3.56	81.80	94.10	87.90	1331	1714	1523	0.27	0.30	0.29
S.Em.±	0.04	0.05	0.05	2.70	3.20	2.60	43	58	31	0.01	0.01	0.01
C.D. (P=0.05)	0.17	0.21	0.18	10.50	12.40	10.10	167	227	121	0.02	0.04	0.03
S_1	3.89	4.32	4.11	106.1	117.6	111.8	1564	2064	1814	0.28	0.34	0.31
S_2	3.94	4.36	4.15	107.6	120.8	114.2	1630	2104	1867	0.29	0.35	0.32
S_3	3.80	4.23	4.01	101.1	112.9	107.0	1462	1975	1719	0.28	0.34	0.31
S_4	4.01	4.44	4.23	120.7	133.5	127.1	1668	2264	1966	0.28	0.38	0.33
S_5	4.15	4.56	4.35	124.6	139.0	131.8	1713	2367	2040	0.28	0.38	0.33
S.Em.±	0.01	0.01	0.01	2.70	2.70	2.60	28	44	27	0.01	0.01	0.01
C.D. (P=0.05)	0.03	0.04	0.03	7.80	8.00	7.70	81	128	79	NS	0.02	0.02
M_1S_1	4.39	4.82	4.60	143.1	150.9	147.0	1856	2593	2224	0.28	0.37	0.33
M_1S_2	4.45	4.87	4.66	142.5	155.3	148.9	1848	2618	2233	0.29	0.40	0.35
M_1S_3	4.33	4.75	4.54	134.5	145.7	140.1	1774	2482	2128	0.29	0.40	0.35
M_1S_4	4.55	4.97	4.76	145.4	157.2	151.3	1880	2662	2271	0.31	0.40	0.36
M_1S_5	4.69	5.08	4.89	148.7	163.5	156.1	2070	2706	2388	0.31	0.42	0.36
M_2S_1	4.05	4.45	4.25	106.5	120.7	113.6	1623	2065	1844	0.29	0.36	0.32
M_2S_2	4.07	4.48	4.27	109.5	123.7	116.6	1619	2122	1870	0.28	0.36	0.32
M_2S_3	3.83	4.26	4.04	102.8	117.0	109.9	1378	2010	1694	0.27	0.35	0.31
M_2S_4	4.13	4.54	4.33	117.5	131.7	124.6	1719	2261	1990	0.28	0.38	0.33
M_2S_5	4.22	4.61	4.42	120.9	135.4	128.1	1687	2312	2000	0.28	0.38	0.33
M_3S_1	3.25	3.69	3.47	68.60	81.30	74.90	1213	1534	1373	0.27	0.27	0.27
M_3S_2	3.31	3.74	3.52	70.80	83.50	77.10	1422	1573	1497	0.29	0.28	0.29
M_3S_3	3.23	3.67	3.45	66.00	76.00	71.00	1234	1435	1334	0.27	0.26	0.26
M_3S_4	3.36	3.81	3.59	99.30	111.6	105.4	1405	1947	1676	0.25	0.35	0.30
M_3S_5	3.52	3.97	3.75	104.1	118.1	111.1	1383	2082	1733	0.25	0.36	0.30
S.Em.±	0.05	0.06	0.05	4.90	5.30	4.80	61	89	52	0.01	0.01	0.01
C.D. (P=0.05)	0.18	0.22	0.19	15.80	17.30	15.50	207	298	170	NS	0.04	NS
Check	4.20	4.62	4.41	122.8	138.5	130.7	1705	2394	2050	0.28	0.40	0.34
S.Em.±	0.05	0.05	0.05	4.80	5.10	4.70	56	85	51	0.01	0.01	0.01
C.D. (P=0.05)	0.14	0.17	0.14	14.50	15.20	14.20	168	257	153	0.04	0.04	0.03

M_1: 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) M_2: 80% recommended nutrients (80:40:40 kg NPK ha^{-1}) M_3: 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) S_1: Rhizosphere biofertilzer consortium-I S_2: Rhizosphere biofertilzer consortium-II S_3: Foliar application of Phyllosphere consortium @ 50, 70 and 90 DAS S_4: S_1+S_3 S_5: S_2+S_3

Table 3: Fibre quality parameters of cotton as influenced by nutrient levels and liquid biofertilizer consortia

	Ginning out turn (%)			**Span length (mm)**			**Micronaire value (µg/inch)**			**Fibre strength (g/ tex)**		
Treatments	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
M_1	33.84	33.88	33.86	28.17	27.69	27.93	3.99	3.83	3.91	25.33	27.81	26.57
M_2	32.72	31.99	32.35	27.99	27.72	27.86	3.91	3.80	3.86	25.62	27.47	26.55
M_3	31.28	31.17	31.22	28.23	27.93	28.08	3.98	3.79	3.89	25.50	27.22	26.36
S.Em.±	0.47	0.53	0.18	0.18	0.13	0.12	0.08	0.04	0.05	0.17	0.13	0.09
C.D. (P=0.05)	1.86	2.06	0.70	NS	NS	NS	NS	NS	NS	NS	NS	NS
S_1	32.48	32.49	32.48	28.07	28.09	28.08	3.98	3.76	3.87	25.53	27.23	26.38
S_2	32.73	32.54	32.64	28.32	27.90	28.11	3.92	3.83	3.88	25.27	27.54	26.41
S_3	32.14	32.14	32.14	27.84	27.91	27.88	3.96	3.84	3.90	25.38	27.31	26.34
S_4	32.99	32.35	32.67	28.27	27.64	27.96	3.98	3.83	3.90	25.32	27.76	26.54
S_5	32.72	32.21	32.46	28.16	27.36	27.76	3.97	3.79	3.88	25.92	27.66	26.79
S.Em.±	0.50	0.48	0.35	0.13	0.21	0.15	0.03	0.04	0.03	0.28	0.23	0.15
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M_1S_1	33.28	34.62	33.95	28.00	27.70	27.85	3.93	3.75	3.84	25.20	27.57	26.38
M_1S_2	34.04	34.21	34.12	28.13	27.77	27.95	3.93	3.83	3.88	24.77	28.03	26.40
M_1S_3	33.91	33.58	33.74	28.13	27.57	27.85	4.03	3.86	3.95	25.20	27.37	26.28
M_1S_4	33.96	33.51	33.73	28.53	27.77	28.15	4.00	3.87	3.94	24.97	27.87	26.42
M_1S_5	34.03	33.47	33.75	28.03	27.67	27.85	4.03	3.85	3.94	26.53	28.20	27.37
M_2S_1	33.52	32.81	33.17	27.77	28.00	27.88	4.00	3.72	3.86	25.97	26.90	26.43

M_2S_2	32.41	32.42	32.42	28.30	28.30	28.30	3.87	3.86	3.87	25.40	27.67	26.53
M_2S_3	32.51	31.42	31.97	27.77	27.77	27.77	3.87	3.84	3.85	25.57	27.80	26.68
M_2S_4	32.53	32.06	32.30	28.07	27.60	27.83	3.93	3.76	3.85	25.83	27.67	26.75
M_2S_5	32.61	31.22	31.91	28.07	26.93	27.50	3.90	3.83	3.87	25.33	27.33	26.33
M_3S_1	30.63	30.02	30.33	28.43	28.57	28.50	4.00	3.80	3.90	25.43	27.23	26.33
M_3S_2	31.76	30.98	31.37	28.53	27.63	28.08	3.97	3.79	3.88	25.63	26.93	26.28
M_3S_3	30.01	31.41	30.71	27.63	28.40	28.02	3.97	3.82	3.90	25.37	26.77	26.07
M_3S_4	32.48	31.48	31.98	28.20	27.57	27.88	4.00	3.84	3.92	25.17	27.73	26.45
M_3S_5	31.52	31.94	31.73	28.37	27.47	27.92	3.97	3.69	3.83	25.90	27.43	26.67
S.Em.±	0.91	0.91	0.57	0.27	0.35	0.26	0.09	0.07	0.06	0.47	0.38	0.25
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Check	33.62	32.44	33.03	28.00	28.03	28.02	4.03	3.66	3.85	25.13	27.40	26.27
S.Em.±	0.86	0.92	0.58	0.28	0.35	0.27	0.08	0.07	0.06	0.46	0.40	0.26
C.D. (P=0.05)	NS	NS	1.74	NS	NS	NS	NS	NS	NS	NS	NS	NS

M_1: 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) M_2: 80% recommended nutrients (80:40:40 kg NPK ha^{-1}) M_3: 60% recommended nutrients (60:30:30 kg NPK ha^{-1}) S_1: Rhizosphere biofertilzer consortium-I S_2: Rhizosphere biofertilzer consortium-II S_3: Foliar application of Phyllosphere consortium @ 50, 70 and 90 DAS S_4: S_1+S_3 S_5: S_2+S_3

Conclusion

Application of 100% recommended nutrients (100:50:50 kg NPK ha^{-1}) along with rhizosphere consortia-II + phyllosphere consortia at 50, 70 and 90 DAS resultzzed higher growth and yield parameters compared to other treatments and recommended check.

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