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Effect of Coir Pith Based Cyanobacterial Biofertilizer on Morphological and Yield Characters of *Aloe Barbadensis* Miller in Pot Experiment

S. Krishna Moorthy, V. Subramaniyan and Malliga, P

Department of Marine Biotechnology, National Facility for Marine Cyanobacteria, Bharathidasan University, Tiruchirapalli-620024, Tamilnadu, India.

Abstract

The cultivation of *Aloe Vera* (*Aloe barbadensis* Miller) has achieved economic importance due to the products which are obtained from its leaves. However, there is a scarcity of information about its agronomic management and the effect of nutrition availability in inorganic form for its establishment and production. A pot experiment was conducted at Bharathidasan University, Tiruchirappalli, Tamilnadu, India to evaluate the effect of different amount of coir pith based cyanobacterial biofertilizers named cyanopith and cyanospray on the morphological and yield characters of *Aloe barbadensis* Miller (*Aloe vera).* There were 36 different treatments of cyanopith (solid form) with cyanospray (liquid form) fertilizer and the plant without any treatment was considered as control. The results indicated that the plant attained maximum height, highest number of leaves and maximum leaf weight, leaf length, leaf breadth, highest number of offsets and significant improvement in gel and latex yield found to be improved with T_{22} treatment (100g cyanopith with 0.4% cyanospray) over other treatments and control (without biofertilizer application). It was revealed that 100g of cyanopith with 0.4% of cyanospray fertilizer were the optimum concentration for maximum improvement of the agronomic characters of *A. barbadensis* Miller.

Key words: Cyanobacterial biofertilizer, *Aloe vera*, Cyanopith, Cyanospray

Introduction

Cyanobacteria play a spectrum of remarkable roles in the field of energy production, biofertilizer, human food, animal feed, polysaccharides, biochemical and pharmaceuticals and in cleaning up of the environment, etc. Cyanobacteria are capable of abating various kinds of pollutants and have advantages as potential biodegrading organisms (Malliga and Viswajith, 2005).

Coconut (*Coccus nucifera* Linn.) is one of the most useful and extensively cultivated palms in tropical countries. The coir dust and coir pith are waste products of coir yarn industries. At present coir pith is being utilized for commercial applications. As coir pith has high content of lignin and it takes decades to decompose. It causes environmental hazards because of its disposal problems. Thus, this study aims at converting coir pith into biofertilizer by cyanobacteria and utilizing the degraded coir pith for crop production.

Aloe vera is a stemless, perennial, drought resisting, succulent plant and has reportedly been used since ancient times for medicinal purposes (Klein and Penneys, 1988; Shelton, 1991; Kent, 1979). It belongs to the lily (Liliaceae) family, and has stiff grey to bright green lance-shaped leaves containing clear gel in a central mucilaginous pulp. More than 360 species are known worldwide. Species of *Aloe* which have been used as folk medicine include: Curacao *Aloe* (*Aloe barbadensis* or *Aloe vera*), Cape *Aloe* (*Aloe ferox*), and Socotra *Aloe* (*Aloe perryi*). Biomass of *Aloe vera* is represented mainly by leaves; growth occurs in a rosette around a small portion of stem no greater than 5 cm. The leaves are simple, triangular, succulent, thick, with narrow lanceolate mucro tip, 30–60cm long, and 5–12cm wide at the base and 0.8 – 3cm thick (A˜nez and Vásquez, 2005). *Aloe Vera* is an important industrially cultivated species, exhibiting proven pharmacological and medicinal value (Yagi and Takeo, 2003; Hamman, 2008). Yepez *et. al.,*. (1993) showed that the yield of gel improved with a low frequency of watering and a high dose of fertilizer. The gel is found in a clear internal zone located between the abaxial and adaxial mesophyll. This central zone has been called by various names, including pulp, mucilaginous tissue, mucilaginous gel and parenchyma tissue. It is composed of cell walls, degenerate organelles and the viscous liquid contained in the cells. The gel has a complex chemical composition, composed primarily of soluble sugars, anthraquinones, polysaccharides, amino acids, vitamins and proteins, many of which are enzymes (Chow *et. al.,*. 2005; Chun-hui *et. al.,*. 2007)**.** The best-known uses of the *Aloe Vera* gel are in cosmetology and medicine; in the latter it has been used to treat bites, scars, burns and in some cases as a cofactor in the treatment of cancer and even AIDS (Hamman, 2008; Ramachandra and Srinivasa, 2008). Most of the extensive bibliographic references to this plant are oriented to the promotion and marketing of products which include the gel. There is only a small amount of agronomic and physiological information (Rodríguez-Garcia *et. al.,*. 2000; Zhao-Pu *et. al.,*. 2006), since most countries which have its germplasm consider it to be a strategic crop. Cultivation of *Aloe vera* is expanding day by day in the area as it provides quick and regular income to the farmers. Farmers are not using any recommended farming practices for *Aloe vera* cultivation which resulted poor yield. Fertility management in *Aloe vera* field may be one of the strategies for boosting up the yield of *Aloe vera*. *Aloe vera* being a succulent plant is more responsive to nutrient. However, the excess doses of chemical nutrient as well as improper sources can show negative effect of quality. Organic manures are more effective in *Aloe vera* growth and yield which is comparable to chemical fertilizer (Saha et. al.,. 2005). In addition organic manures enhance a good leaf quality. So, it is necessary to find out a suitable recommendation for manuring in *Aloe vera* farm. The present study was carried out to determine the effect of coir pith based cyanobacterial biofertilizer levels on Morphological, Metabolic and Yield characters of *Aloe barbadensis* Miller under pot experiment.

Materials and methods

Organism and culture conditions

A fresh water cyanobacterium belonging to *Oscillatoria annae* was obtained from the germplasm of National Facility for Marine Cyanobacteria, Bharathidasan University, Tiruchirappalli, Tamilnadu, India. The culture was maintained in BG11 medium **(**Rippka et. *al*.,. 1979**),** at 1500 lux. at 25 ± 2^0 C with 10/12 hrs light /dark cycle.

Lignocellulosic material

Coir pith was collected from coir industry, near Srirangam, Tiruchirappalli, Tamilnadu, India.

Biofertilizer production

Mass cultivation of cyanopith and cyanospray was carried out in which cyanobacteria (*Oscillatoria annae*) and coir pith was inoculated in 1:10 ratio (wet weight: dry weight). After 20-25 days of incubation the degraded pellet and supernatant were separated and used as biofertilizers. Thus, pellet was used as solid fertilizer (cyanopith) and supernatant was used as liquid fertilizer (cyanospray) for the plant growth promotion.

Experimental design

In this experiment the medicinal plant *A. barbadensis* was cultivated using cyanopith and cyanospray fertilizers at various combinations. There were 36 different treatments of cyanopith with cyanospray fertilizer and a plant without biofertilizer application was used as control, each experiment was carried out in triplicates. Seedlings of around 2 weeks old were collected from Virudhunagar District, Tamilnadu, India. Single seedling was planted in pot and pots were irrigated whenever necessary. In this experiment fertilizers were applied three times before harvesting. Table 1 shows detailed experimental design of this present investigation.

Table 1 Experimental Design

S.no.	Treatments		S. no.	Treatments
	Experimental set up – I			
1.	C – Control			
Experimental set up - II			Experimental set up - V	
1.	T_1- Cyp 25 g + C.Sp. 0.1%		1.	T_{19} - Cyp 25 g + C.Sp 0.4%
2.	T_2 - Cyp 50 g + C.Sp 0.1%		2.	T_{20} - Cyp 50 g + C.Sp 0.4%
3.	T_3 - Cyp 75 g + C.Sp 0.1%		3.	T_{21} - Cyp 75 g + C.Sp 0.4%
4.	T_4 - Cyp 100 g + C.Sp 0.1%		4.	T_{22} - Cyp 100 g + C.Sp 0.4%
5.	T_5 - Cyp 125 g + C.Sp 0.1%		5.	T_{23} - Cyp 125 g + C.Sp 0.4%
6.	T_6 - Cyp 150 g + C.Sp 0.1%		6.	T_{24} - Cyp 150 g + C.Sp 0.4%
Experimental set up - III			Experimental set up - VI	
1.	T_7 - Cyp 25 g + C.Sp 0.2%		1.	T_{25} - Cyp 25 g + C.Sp 0.5%
2.	T_8 - Cyp 50 g + C.Sp 0.2%		2.	T_{26} - Cyp 50 g + C.Sp 0.5%
3.	T_9 - Cyp 75 g + C.Sp 0.2%		3.	T_{27} - Cyp 75 g + C.Sp 0.5%
4.	T_{10} - Cyp 100 g + C.Sp 0.2%		4.	T_{28} - Cyp 100 g + C.Sp 05%
5	T_{11} - Cyp 125 g + C.Sp 0.2%		5.	T_{29} - Cyp 125 g + C.Sp 0.5%
6.	T_{12} - Cyp 150 g + C.Sp 0.2%		6.	T_{30} - Cyp 150 g + C.Sp 0.5%
Experimental set up - IV			Experimental set up - VII	
1.	T_{13} - Cyp 25 g + C.Sp 0.3%		1.	T_{31} - Cyp 25 g + C.Sp 0.6%
2.	T_{14} - Cyp 50 g + C.Sp 0.3%		2.	T_{32} - Cyp 50 g + C.Sp 0.6%
3.	T_{15} - Cyp 75 g + C.Sp 0.3%		3.	T_{33} - Cyp 75 g + C.Sp 0.6%
4.	T_{16} - Cyp 100 g + C.Sp 0.3%		4.	T_{34} - Cyp 100 g + C.Sp 06%
5.	T_{17} - Cyp 125 g + C.Sp 0.3%		5.	T_{35} - Cyp 125 g + C.Sp 0.6%
6.	T_{18} - Cyp 150 g + C.Sp 0.3%		6.	T_{36} - Cyp 150 g + C.Sp 0.6%

T – Treatments (Triplicates); Cyp – Cyanopith (Fertilizer in Solid form); C.Sp – Cyanospray (Fertilizer in liquid form)

Analysis on morphological parameters

Morphological characters based on plant growth such as height of the plant, number of leaves, leaf length, breadth, weight and numbers of offsets, number of leaves in offsets were analyzed after 210 days of growth.

Analysis on yield

The yield characters such as *Aloe* leaf gel and latex yield were estimated in all treatments.

Statistical analysis

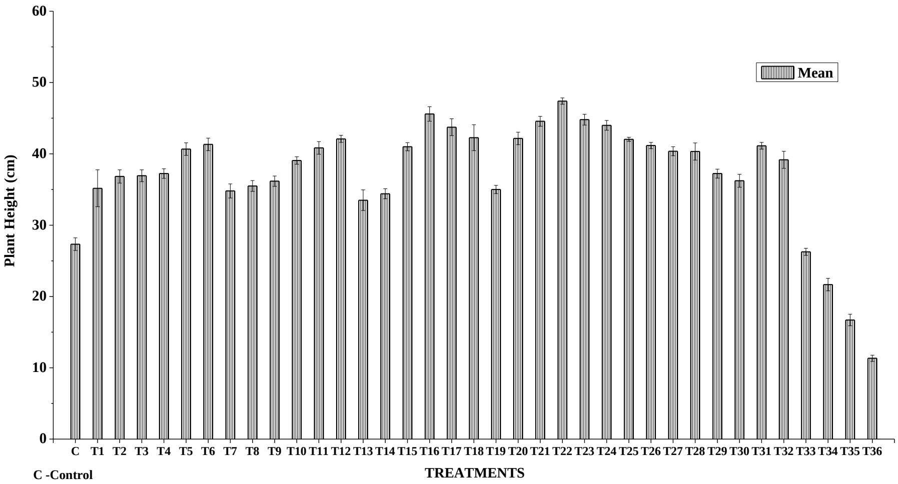
The measurements of growth parameters and metabolic aspects were subjected to one-way analysis of variance (ANOVA) technique and mean separations were adjusted by the Multiple Comparison test. Means were compared by using Fisher's test at $p<0.05$ level of significance.

Results

The pot experiment was begun in October 2009 with planting age of 2 weeks plantlets of *Aloe vera* with triplicates. The first fertilization was given to the plants 15 DAP (Days after planting). The second and third fertilizations were given 75DAP and 135DAP respectively. The plant morphological and yield characters studies were carried out 210 days after planting.

Growth analysis

The results of morphological parameters obtained based on the growth of *Aloe vera* subjected to different combinations of cyanopith and cyanospray treatments via. T1 – T36 are given in Fig. 1-7. All the treatments exhibited significant differences in plant height, when compared to control (Fig. 1). The plants height of T17, T21 and T23 was 43.73cm, 44.56cm and 44.8cm respectively, significantly greater than ($p<0.05$) T5, T6 and T12 plants which was 40.66cm, 41.33cm and 40.83cm respectively. The maximum plant height was in T22 plants followed by T16 plants, 47.4cm and 45.6cm respectively, when compared to control and all other treatments (Fig. 1). Different combinations of cyanopith and cyanospray treatments significantly ($p<0.05$) affected the leaf characteristics of *Aloe vera* in this experiment. Plants of T16 and T22 produced 36.66 and 45.66 leaves/plant/pot respectively, which was significantly greater than control and all other treatments (Fig. 2). The superior result in leaf length was found in T22 followed by T23 and T16, when compared with control and all other treatments. The maximum leaf length (46.16cm) was recorded in T22, but T16 also produced leaves with 45.00cm in length (Fig. 3), which was significantly higher than control and all other treatments.



C -Control

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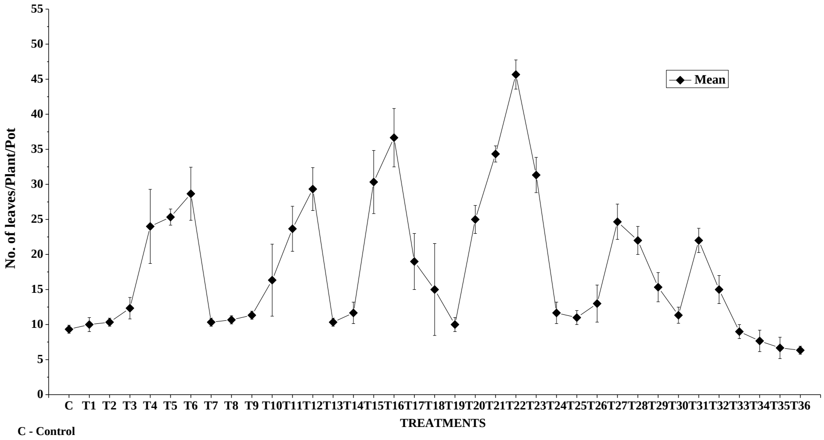
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.1. Effect of cyanopith with cyanospray fertilizer on plant height of *Aloe barbadensis* Mill.



C - Control
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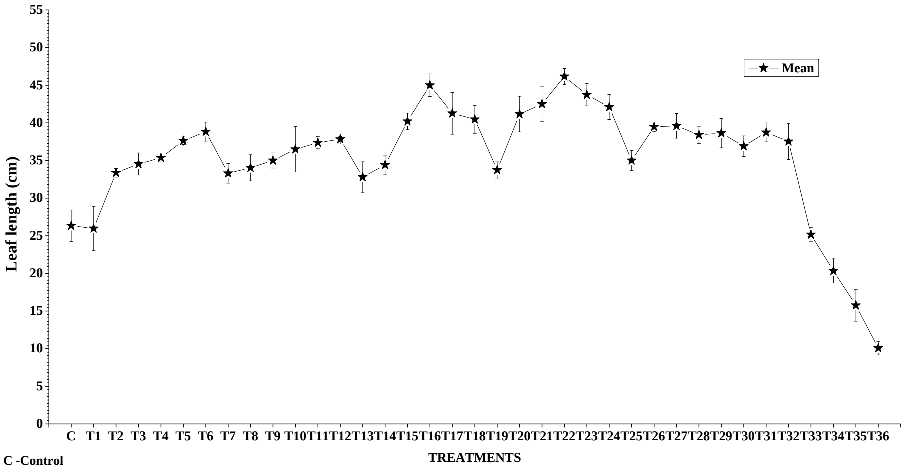
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9- Cyp75g+C.Sp0.2%; T10- Cyp100g+C.Sp0.2%; T11- Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15- Cyp75g+C.Sp0.3%; T16- Cyp100g+C.Sp0.3%; T17- Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21- Cyp75g+C.Sp0.4%; T22- Cyp100g+C.Sp0.4%; T23- Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27- Cyp75g+C.Sp0.5%; T28- Cyp100g+C.Sp0.5%; T29- Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33- Cyp75g+C.Sp0.6%; T34- Cyp100g+C.Sp0.6%; T35- Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.2. Effect of cyanopith with cyanospray fertilizer on number of leaves of *Aloe barbadensis* Mill.

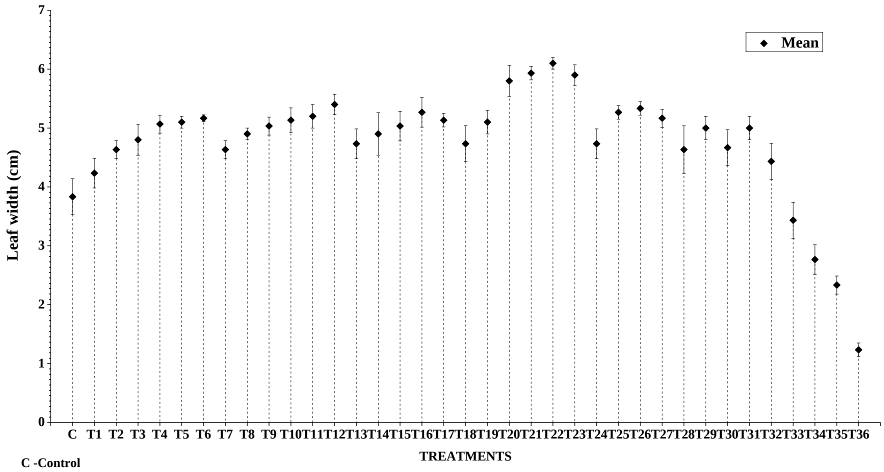


C -Control
T1-Cyp25g+ C.Sp0.1%; T2- Cyp 50g+C.Sp0.1%; T3-Cyp75g+C.Sp0.1%; T4-Cyp100g+C.Sp0.1%; T5-Cyp125g+C.Sp0.1%; T 6-Cyp150g+C.Sp 0.1%
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.3. Effect of cyanopith with cyanospray fertilizer on leaf length of *Aloe barbadensis* Mill.

Application of cyanopith with cyanospray fertilizer at different combinations significantly enhanced the leaf width (Fig. 4). The coir pith based cyanobacterial biofertilizer cyanopith and cyanospray applications have significantly increased the leaf width in all the treatments when compared to control, but the minimum leaf width was observed in the plants of T33, T34, T35 and T36. The maximum leaf width improvement was found in plants of T23, T21 and T22, which was 5.9cm 5.93cm and 6.1cm respectively and followed by plants of T12 and T20, which was 5.4cm and 5.8cm respectively (Fig. 4). The reported data in Fig. 5 clearly indicated that fresh leaf weight of *Aloe* considerably ($p<0.05$) increased as result of various treatments and reached maximum values of 266.24gm/leaf in the plants of T22, which was significantly greater than control and all other treatments. The lowest leaf weight was obtained from the plants of control, T33, T34, T35 and T36, which produced 99.60gm, 94.99gm, 74.29 gm, 50.35 gm and 38.15 gm/leaf respectively (Fig. 5). The number of offsets (Plantlets) produced by the plants were not similar in all the treatments. Plants of T22 inoculated with 100g of cyanopith with 0.4% cyanospray produced increased number of offsets per pot, differing significantly ($p<0.05$) from number of offsets of all other treatments and control (Fig. 6). The number of offsets was lowest in the control plants, T1, T6, T7 and T24, which produced mean value of 0.33, 0.33, 0.33 and 0.66 respectively. The interesting fact is the number of offsets was zero in the plants of T29, T30, T33, T34, T35 and T36, all of which were inoculated with high amount of cyanopith and higher concentration of cyanospray (Fig. 6). The Fig. 7 showed that the maximum improvement in number of leaves (27.33) in offsets were in the treatments of 100g of cyanopith with 0.4% of cyanospray (T22).



C -Control
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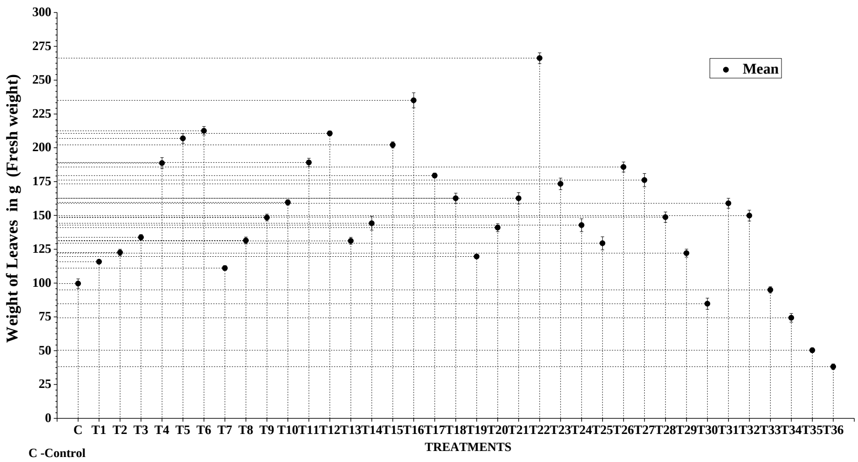
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%
T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.4. Effect of cyanopith with cyanospray fertilizer on leaf width of *Aloe barbadensis* Mill.



C -Control
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T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
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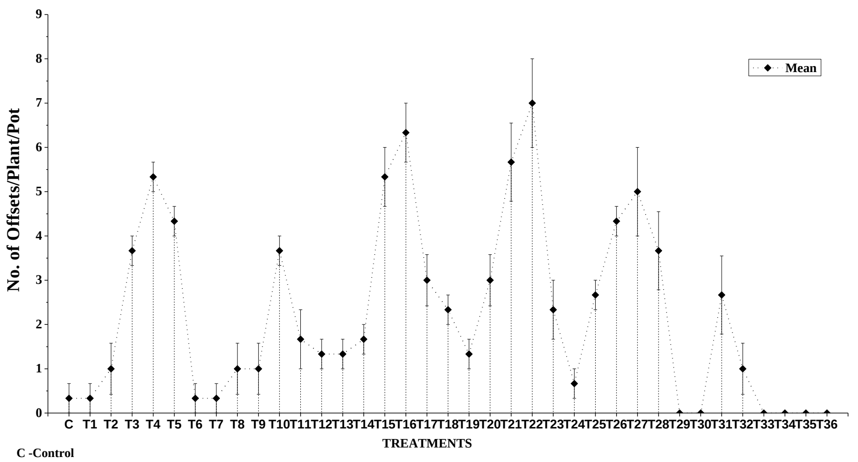
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%
T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.5. Effect of cyanopith with cyanospray fertilizer on leaf weight of *Aloe barbadensis* Mill.



C -Control
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T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
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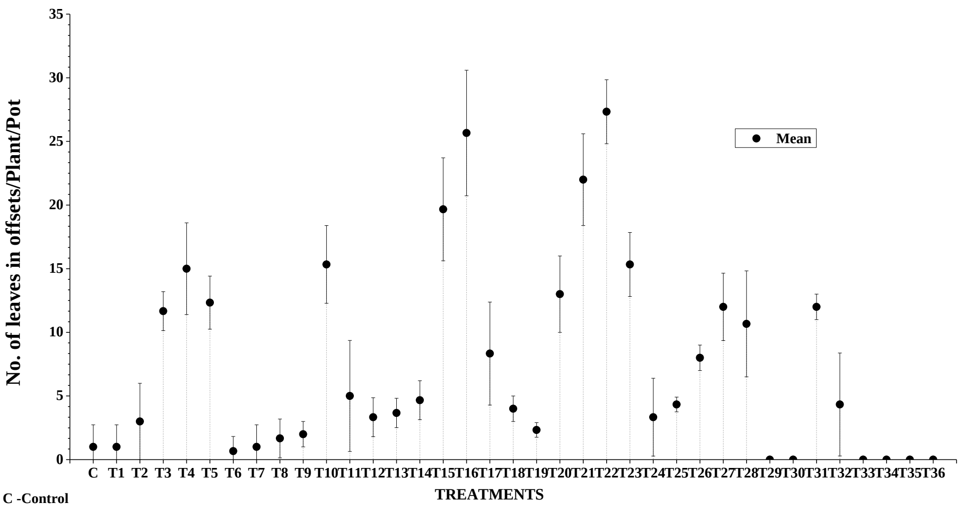
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp- Cyanopith fertilizer; C.Sp- Cyano Spray

Fig.6. Effect of cyanopith with cyanospray fertilizer on number of offsets



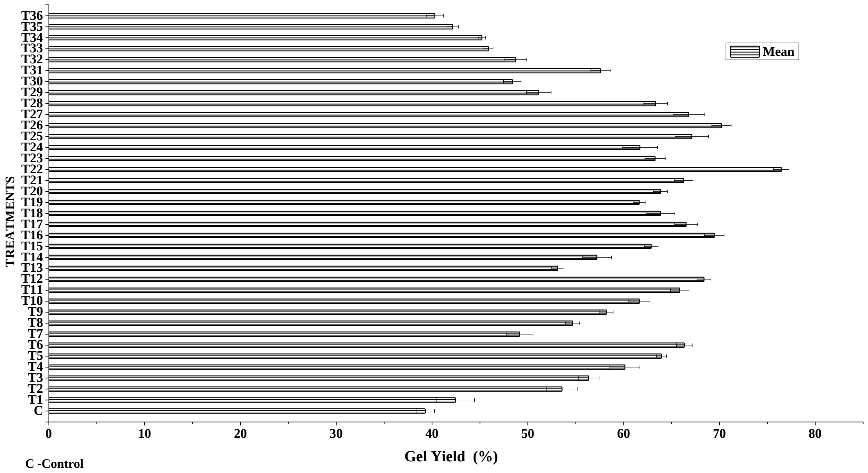
C -Control
T1-Cyp25g+ C.Sp0.1%; T2- Cyp 50g+C.Sp0.1%; T3-Cyp75g+C.Sp0.1%; T4-Cyp100g+C.Sp0.1%; T5-Cyp125g+C.Sp0.1%; T 6-Cyp150g+C.Sp 0.1%
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.7. Effect of cyanopith with cyanospray fertilizer on number of leaves in offsets

Yield analysis

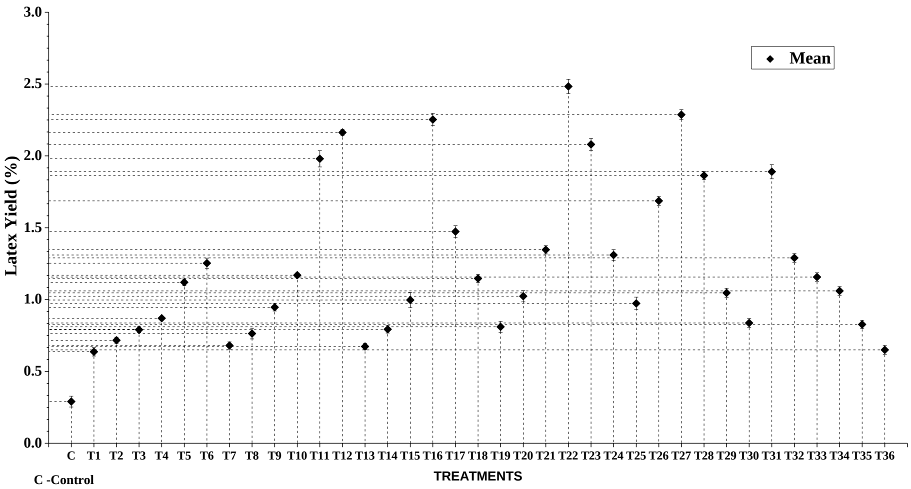
The leaf gel yield of fertilized *Aloe vera* plants with cyanopith and cyanospray in various combinations were significantly ($p<0.05$) higher than those of unfertilized control plants **(**Fig. 8**).** The maximum % of aloe leaf gel yield per plant was 76.45% (T22), 70.21% (T26), 69.45% (T16) and 68.38% (T12)**.** Nutritive availability of cyanopith and cyanospray fertilizer enhanced the latex production of the experimental plant of *Aloe vera.* Plants of T16, T22 and T27 produced 2.16%, 2.48 and 2.28 % of latex yield respectively, significantly **($p<0.05$)** greater than control and all other treatments **(**Fig. 9**).**



C -Control
T1-Cyp25g+ C.Sp0.1%; T2- Cyp 50g+C.Sp0.1%; T3-Cyp75g+C.Sp0.1%; T4-Cyp100g+C.Sp0.1%; T5-Cyp125g+C.Sp0.1%; T 6-Cyp150g+C.Sp 0.1%
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.8. Effect of cyanopith with cyanospray fertilizer on gel yield



C -Control
T1-Cyp25g+ C.Sp0.1%; T2- Cyp 50g+C.Sp0.1%; T3-Cyp75g+C.Sp0.1%; T4-Cyp100g+C.Sp0.1%; T5-Cyp125g+C.Sp0.1%; T 6-Cyp150g+C.Sp 0.1%
T7-Cyp25g+C.Sp 0.2%; T8 -Cyp50g+C.Sp0.2%; T9-Cyp75g+C.Sp0.2%; T10-Cyp100g+C.Sp0.2%; T11-Cyp125g+C.Sp0.2%; T12-Cyp150g+C.Sp 0.2%
T13-Cyp25g+C.Sp 0.3%; T14-Cyp50g+C.Sp0.3%; T15-Cyp75g+C.Sp0.3%; T16-Cyp100g+C.Sp0.3%; T17-Cyp125g+C.Sp0.3%; T18-Cyp150g+C.Sp 0.3%
T19-Cyp25g+C.Sp 0.4%; T20-Cyp50g+C.Sp0.4%; T21-Cyp75g+C.Sp0.4%; T22-Cyp100g+C.Sp0.4%; T23-Cyp125g+C.Sp0.4%; T24 -Cyp150g+C.Sp0.4%
T25-Cyp25g+C.Sp 0.5%; T26-Cyp50g+C.Sp0.5%; T27-Cyp75g+C.Sp0.5%; T28-Cyp100g+C.Sp0.5%; T29-Cyp125g+C.Sp0.5%; T30-Cyp150g+C.Sp 0.5%
T31-Cyp25g+C.Sp 0.6%; T32-Cyp50g+C.Sp0.6%; T33-Cyp75g+C.Sp0.6%; T34-Cyp100g+C.Sp0.6%; T35-Cyp125g+C.Sp0.6%; T36-Cyp150g+C.Sp 0.6%

T-Treatments; Cyp-Cyanopith fertilizer; C.Sp-Cyano Spray

Fig.9. Effect of cyanopith with cyanospray fertilizer on latex yield

Disscussion

Cyanobacteria are one of the potential organisms, which are useful to mankind in various ways, and are potential resource in varied applications such as mariculture, food, feed, fuel, fertilizer, medicine, industry and in combating pollution (Mitsui *et. al.*,. 1983; Subramaniyan and Uma, 1996**)**. Degraded coir pith with cyanobacteria [*Oscillatoria annae* (BDU6)] was used to promote the plant growth and was found to enhance the crop yield and especially soil productivity. The coir pith based cyanobacterial biofertilizer, plays a spectrum of remarkable role in agriculture, especially in sustainable integrated agro-ecosystems. Also, they add nutrients to soil, release of growth promoting substances, increase the soil organic content, improve the soil structure and water holding capacity, reduce soil crusting problems, erosion from wind and water and improve the buffering capacity against fluctuations in pH levels of soil. The release of micro and macro nutrients from the cyanobacteria supports the plant growth and improves the quality of the crop yield.

The effect of coir pith based cyanobacterial biofertilizers named cyanopith and cyanospray in different combinations promoted the growth of *A. barbadensis.* Cyanopith with cyanospray at lower concentrations (T22-cyanopith100g+0.4% cyanospray) showed higher rate of plant height, number of leaves, leaf length and leaf width, while as higher concentrations of cyanopith and cyanospray reduced the growth of the experimental plant (T30-cyanopith150g+0.5%cyanospray, T35-cyanopith125g+0.6%cyanospray and T36-cyanopith150g+0.6% cyanospray). The increased growth rate in lower concentrations may be due to presence of cyanobacteria and its capacity to synthesize and liberate bioactive substances such as auxins, gibberellins, cytokinins, vitamins, polypeptides, amino acids, which promote plant growth and development (Caire *et. al*.,. 1979). The unfertilized plants (control) showed lower growth rate. These results are in agreement with Marino *et. al*.,. (2009) who reported unfertilized plants were significantly shorter than fertilized plants, N addition increasing plant height and the propensity of plants to lodging, though values were generally low. Indeed, no lodging was noticed in the case of unfertilized plants.

Lignin, a key component of the stem and seed heads of the plant material, which is the main source of phenolic acids and quinones. These chemicals are released during the rotting process. Many research peoples (Martin and Ridge, 1999; Pillinger *et. al*.,. 1992; Everall and Lees, 1997) stated that the lignin degradation and the chemical release associated with this degradation, is the key component of inhibitory effects of barley on algae. The results are similar to the results, which obtained by Moyin-Jesu and Adekayode (2010). They reported that the increase in growth parameters such as plant height, leaf area, stem girth, leaf number, root length and fresh shoot weight of African cherry nut seedlings could be attributed to the nutrient contents of the organic fertilizers used which encouraged better seedlings growth. The culture filtrate of degraded lignocellulosic waste by *O. annae* was tested for its plant growth promoting ability as foliar spray on *Tagetes erecta*. The results showed that *Tagetes erecta* treated with only lignocellulosics (Coir pith, *P. juliflora* and *L. camara*) showed more height compared to control. However, *O. annae* with lignocellulosics (*O. annae* + coir pith; *O. annae* + *P. juliflora*; *O. annae* + *L. camara*) treated plants showed better growth and flowering compared to control and only lignocellulosic waste treated plants (Viswajith, 2008).

The effect of basal (cyanopith) with foliar (cyanospray) application of coir pith based cyanobacterial biofertilizer was observed that plants treated by cyanopith100g with 0.4% cyanospray (T22) combination produced maximum number of offsets with more leaves when compared to control and other treatments. This could be due to the presence of enough amount of growth promoting substances present in coir pith based cyanobacterial biofertilizer for maximum growth of *A. babadensis*. But higher concentration showed reduction in offsets production and the same results obtained by the number of studies (Fatima and Venkatraman, 1999; Nalinidevi, 2003). Morphological observation in test plant of *B. rubra* L. demonstrated increase in stem circumference, branching, number of flowers, number of leaves and plant height over control (Christopher *et. al*.,. 2007).

The leaf gel and latex yield of *A. barbadensis* increased significantly with all combinations of cyanopith and cyanospray over control. The maximum percentage was obtained from the plants of T22 (cyanopith 100g with 0.4% cyanospray) when compared to control and overall treatments. This dose of cyanopith and cyanospray fertilizers improving the growth *of A. barbadensis* by providing essential nutrients which resulted the maximum cell growth and turgidity which influenced the growth of plant and these results were confirmed by other studies (Tawfik, 1984; Chatterjee *et. al*.,. 1979; Yepez *et. al*.,. 1993). The unfertilized *Aloe vera* plants resulted lower in leaf and leaf gel yield. These results are in agreement with Ercoli *et. al*.,. (2008) and Yunchen *et. al*.,. (2009) who reported that plants supplied with nitrogen fertilizer had a higher grain yield compared to unfertilized ones, as nitrogen deficiency reduced plant size and consequently plant storage capacity.

Conclusions

The application of coir pith based cyanobacterial biofertilizers cyanopith and cyanospray (T22- 100g cyanopith + 0.4% cyanospray) increased significantly the morphological and yield characters of *Aloe barbadensis* Miller. It is recommended that coir pith based cyanobacterial biofertilizer applied at 100g of cyanopith with 0.4% cyanospray per plant was the most effective fertilizer for improving the nutrient availability and ensuring sustainable cultivation of *Aloe barbadensis* Miller on a commercial basis.

This recommendation corroborates with the fact that inorganic fertilizers are becoming too expensive to purchase by small scale farmers of *Aloe vera*. Besides, this coir pith based cyanobacterial biofertilizer appear to have a strong beneficial secondary effect on the soil properties and could be environmental friendly.

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