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Effect of Cyanobacteria on Various Vegetables Grown ln Antarctica

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Abstract

Mass culture of cyanobacteria available in Schirmacher Oasis of East Antartica, was prepared under artificial condition inside a glass ,house. Cyanobacterial culture was used as biofertilizer and its effect was studied on 31 species of 14 vegetables viz., capsicum, chilli, okra, pea, watermelon, muskmelon, cucumber bittergourd, bottlegourd, bean, lettuce, spin ach, beetroot and summer squash.

Introduction

Biological nitrogen fixation is restricted to a small group of bacteria, blue green algae or cyanobacteria and actinomycetes. About 26 genera or approxi mately 16 per cent of the known blue green algae are reported to fix nitrogen (Lie, 1984), out of which three types can be distinguished. These are unicellular filamentous non-heterocystous algae and filamentous algae with heterocyst Antarctic cyanobacteria are filamentous algae with heterocyst i.e. thick walled cells with reduced pigmentation present at irregular intervals on the filament. This group of cyanobacteria fixes nitrogen under aerobic conditions and Nostoc and Anabaena genera belong to this group. Komarek and Ruzicka (1966) were the first to report the occurrence of algae as a conspicuous part of the vegetation in Antarctica. Pankow et al.(1989) reported 220 species of algae from Schirmacher Oasis region in East Antarctica out of which 100 species belong to cyanophyceae.

De (1939) is presumably the first to suggest that cyanobacteria are respon sible for the maintenance of fertility of rice field under continuous cropping system. It is estimated that 175 million ton nitrogen is fixed annually by micro-organisms, roughly half occurring in agricultural soils. In absolute terms the contribution of fertilizer nitrogen (40 million tons) is smaller. However, it

is vital for the production of cereals and starchy root crops which comprise approximately 75% of the world food production (Hardy, 1976).

The cyanobacteria (blue green algae) are capable of fixing the atmospheric nitrogen and convert it into an available form of ammonia required for the plant growth. Cultivation of vegetables in open Antarctic conditions is prohibited which led to the contruction of glasshouse for conducting experiments. Literature reveals that cyanobacteria readily available in Schirmacher Oasis have so far not been used as bio-fertilizer in vegetable cultivation. In view of the above, the present study deals with the effect of cyanobacteria on vegetable cultivation in Antarctica.

Materials and Methods

Soil samples collected from different sites of lake Priyadarshini close to Indian station Maitri (70°45'52''S:11°44'03"E), in sterilized tubes.were examined under the microscope and Dizotrophic cyanobacterium *(Nostoc)* was isolated. The organism was inoculated on agar in petridishes. After the growth, the algae were inoculated in BG 11 medium (nitrogen free) in glass jar of 20 litre capacity for mass culture at 20 to 25°C temperature. Average humidity was maintained at 42.5% with a variation from 12 to 88% in variable glasshouse conditions. Different varieties of 11 vegetables viz. capsicum (two varieties), chilli (three varieties), okra, pea (three varieties), watermelon, muskmelon, cucumber (two varieties), bottlegourd (three varieties), summer squash (two varieties) and bean (seven varieties) were grown on different dates in three different media i.e.peat moss, Antarctic moss and Antarctic soil. The cyanobacterial culture was harvested on 14th day and 200 ml of cyanobacterial culture (600ug protein/ml) was applied to one group of vegetables and the other group of vegetables was kept controlled. Leaf area and plant height were recorded at ten days interval Digital planimeter was used for leaf area measurement.

Results and Discussion

The data recorded on capsicum, chilli, okra and pea are presented in Table I. Except two varieties i.e. capsicum (HC-202) and chilli (Pant C-1) all varieties had positive response to cyanobacteria. The data recorded on leaf area and plant height of cucurbits are presented in Table II. Watermelon grown in Antarctic moss did not survive in both conditions - treated (TR) and untreated (UT). Average and total leaf area and plant height of all cucurbits grown in peat moss were recorded maximum in treated condition. Similarly in Antarctic soil media watermelon, muskmelon, Pusa Sanyog variety of cucumber, PSPL variety of bottlegourd and summer squash had positive response in leaf area under treated

Table I: Plant Height (cm) of Capsicum, Chlli, Okra and Pea in Treated (TR) with Cyanobacteria and in Untreated (UT) at 10 Days Interval. (Sowing Date: 1.1.92) (TR-Treated, UT-Untreated, PM-Peat Moss, AM-Antarctic Moss, AS-Antarctic Soil, PH-Plant Height and NG-Not Germinated)

S.No Variety		14 Jan. 92 Plant Height			24 Jan. 92 Plant Height			4 Feb. 92 Plant Height			14 Feb. 92 Plant Height		
		PM	AS	AM	PM	AS	AM	PM	AS	AM	PM	AS	AM
1. Capsicum (California Wonder)	TR	2.0	NG	2.5	6.0	NG	5.0	11.5	NG	7.5	15.5	NG	9.5
	UT	2.0	NG	3.0	5.0	NG	4.5	10.5	NG	6.0	12.5	NG	7.0
2. Capsicum (HC-202)	TR	2.5	NG	2.0	4.8	-	3.5	9.5	-	4.5	10.5	-	6.0
	UT	2.5	-	2.0	5.0	-	4.0	9.0	-	5.0	9.5	-	6.5
3. Chilli (Green long Jwala)	TR	2.3	-	3.0	3.5	-	4.5	5.0	-	5.5	-	-	8.5
	UT	2.48	-	2.5	3.6	-	4.0	4.5	-	5.0	-	-	7.0
4. Chilli (Pant C-1)	TR	2.0	-	2.0	3.7	-	2.5	5.0	-	4.0	-	-	6.0
	UT	2.4	-	2.5	3.6	-	3.0	5.0	-	4.0	-	-	6.0
5. Chilli (Pusa Jwala)	TR	2.2	-	2.0	3.5	-	3.5	4.5	-	5.6	-	-	8.8
	UT	2.3	-	2.4	3.4	-	3.5	4.6	-	4.5	-	-	7.0

Contd

Table I- *Contd.*

6. Okra (Gumbo)	**TR**	**3.0**	**-**	**3.0**	**6.5**	**-**	**8.5**	**8.5**	**-**	**10.5**	**11.5**	**-**	**9.5**
	UT	**4.6**	**-**	**3.0**	**5.5**	**-**	**6.0**	**6.7**	**-**	**8.5**	**9.5**	**-**	**8.5**
7. Pea (Bonneville)	**TR**	**2.0**	**-**	**2.0**	**5.0**	**-**	**Dried**	**11.0**	**-**	**-**	**13.5**	**-**	**-**
	UT	**2.0**	**-**	**2.0**	**4.5**	**-**	**Dried**	**11.0**	**-**	**-**	**14.0**	**-**	
8. Pea (Arkel)	**TR**	**2.5**	**-**	**2.0**	**6.0**	**-**	**Dried**	**16.0**	**-**	**-**	**18.0**	**-**	**-**
	UT	**2.5**	**-**	**2.5**	**5.0**	**-**	**Dried**	**13.0**	**-**	**-**	**16.0**	**-**	**-**
9. Pea(Azad-l)	**TR**	**2.0**	**-**	**2.5**	**6.5**	**-**	**Dried**	**13.0**	**-**	**-**	**15.0**	**-**	**-**
	UT	**2.5**	**-**	**2.0**	**6.0**	**-**	**Dried**	**10.0**	**-**	**-**	**14.0**	**-**	**-**

condition. In Antarctic moss media watermelon, muskmelon, long green variety of cucumber, Pusa Sanyog variety of cucumber, Pusa Navin and PSPL variety of bottlegourd, Pusa Domausami variety of bittergourd, Pusa Alankar and Australian Green variety of summer squash collapsed between 20 to 30 days. However, in Antarctic soil media only long green variety of cucumber collapsed on the 20th day in both conditions. The maximum average leaf area recorded was 147.4 2 cm^2 with a variation of 28.4 to 245.7 cm2 in Pusa Navin variety of bottlegourd, and average minimum leaf area recorded was 44.2 cm^2 with a variation of 15.7 to 71.7 cm^2 in Pusa Domausami variety of bittergourd, grown in peat moss media in treated conditions (Table II). In controlled group of plants, the average leaf area was recorded - maximum 118.25 cm^2 (variation 19.0 to 140.0 -cm^2) in watermelon and minimum 32.0 cm^2 (variation 14.0 to 68.0 cm^2) in Pusa Domausami variety of bittergourd. The total leaf area was recorded maximum 3270.0 cm and 2084.0 cm^2 in Pusa Domausami variety of bittergourd in treated and controlled plants respectively.This is followed by Pusa Alankar variety of summer squash i.e. 2364.87 in treated and 1932.80 cm^2 in controlled plants. Minimum total leaf area was recorded in watermelon 828.7 8 and 709.50 cm in treated and controlle d plants, respectively .

Maximum plant height recorded was 160.0 cm In Pusa Navin variety followed by PSPL variety of bottlegourd which recorded 148.0 cm in treated plants grown in peat moss. In untreated plants grown In peat moss media, maximum plant height recorded was 101.2 cm in Pusa Navin variety of bottlegourd followed by PSPL variety of bottlegourd and muskmelon which recorded 98 cm. The maximum difference in plant height in treated and controlled plants was recorded as 58.8 cm in Pust Navin variety of bottlegourd closely followed by 56.0 cm in Pusa Domausami variety of bittergourd in peat moss media on the 30th day.

The results of seven varieties of bean are presented in Table III The maximum average APL was recorded as 52.78 cm^2 with a variation from 13.3 to 100.3 cm^2 in Master Piece variety of Dwarf bean in treated plants grown in peat moss media. This was followed by 51.25 cm^2 (variation 24.0 to 98.2 cm^2) in treated plants of same variety grown in Antarctic moss media. Asparagus and VL - Bauni varieties of bean had best response in leaf area under treated conditions in Antarctic moss media i.e.21.2 5 cm^2 (variation 4.0 to 38.5 cm^2) and 20.2 3 cm^2 (variation 11.6 to 78.5 cm2), respectively . The total leaf area and plant height recorded were - maximum 1830.4 cm^2 and 140.0 cm, respectively in high altitude variety of creeper bean in treated plants. However, the differ ence in TLA and PH in treated and controlled plants was recorded as 656.36 cm^2 and 60 cm, respectively.

Table II: Growth of Leaf Area (can^2) and Plant Height (cm) in Treated (TR) with Cyanobacteria and in Untreated (UT) Condition at 10 Days Interval in Cucurbits Grown in Peat Moss (PM), Antarctic Soil (AS) and Antarctic Moss (AM) Sowing pate : 31 Dec.1991

S.No.	Variety		14 Jan. 92		24 Ja n.92		4 Feb. 92			14 Feb. 92		
			Av.APL	TLA	Av.APL	TLA	Av.APL	TLA	PH	Av.APL	TLA	PH
1	2	3	4	5	6	7	8	9	10	11	12	13
1. Watermelon	(AY)	TR(PM)	1.5	3.0	14.5	43.5	33.4	200.4	12.0	138.6 (20.5-152.6)	828.78	19.0
		UT(PM)	1.7	3.4	13.2	39.6	29.5	177.0	11.0	118.25 (19.0-140.0)	709.50	17.5
		TR(AS)	1.6	3.2	1.8	5.4	5.3	21.2	4.5	11.6 (1.5-18.6)	46.4	4.0
		UT(AS)	1.5	3.8	1.7	5.1	4.2	16.8	4.0	9.86 (1.6-16.5)	39.44	4.0
		TR(AM)	2.2	4.2	3.3	13.2	7.8	31.2	8.0	Dried		
		UT(AM)	1.4	2.9	3.5	14.0	5.3	21.2	7.0	Dried		
2. Muskmelon	(Pusa Madhuras)	TR(PM)	6.4	12.8	25.2	55.2	48.66	372.0	76.C	87.81 (18.8-108.0)	1580.58	139.57
		UT(PM)	8.75	17.5	16.6	39.84	35.42	243.52	66.0	68.2 (12.5-108.0)	1023.0	98.0

Contd.

Table II — *Contd.*

	TR(AS)	1.5	3.0	1.8	5.4	5.3	21.2	4.0	11.6 (1.5- 18.6)	46.4	4.5
	UT(AS)	1.6	3.2	7.6	22.8	5.5	16.5	5.0	9.12 (2.8-15.0)	45.6	6.5
	TR(AM)	3.15	6.3	5.3	15.9	7.4	22.2	6.0	Dried		
	UT(AM)	3.85	7.7	4.6	13.8	5.4	16.2	5.0	Dried		
3. Cucumber (long green)	TR(PM)	12.5	25.0	23.5	70.5	80.4	221.6	26.0	86.0 (26.3-168.2)	1548.0	72.0
	UT(PM)	13.4	26.8	20.0	60.0	71.5	286.0	25.5	75.9 (15.1442.7)	1290.3	44.0
	TR(AS)	2.3	4.6	2.8	5.6	Dried					
	UT(AS)	2.6	5.2	6.4	19.2	Dried					
	TR(AM)	10.21	20.42	12.73	38.19	Dried					
	UT(AM)	10.18	20.36	11.19	33.57	Dried					
4. Cucumber (Pusa Sanyog)	TR(PM)	13.9	27.8	30.43	91.29	100.88	378.3	30.0	108.55 (32.3-187.7)	2072.4	90.0

Contd

Table II — *Contd.*

	UT(PM)	14.76	29.4	28.7	57.4	89.2	267.6	28.5	89.64 (18.5-192.5)	1792.0	54.0
	TR(AS)	3.0	6.0	12.8	25.6	14.0	42.0	12.0	81.48 (43.7-124.07)	248.88	28.0
	UT(AS)	3.5	7.0	13.3	26.6	19.5	43.5	10.5	78.5 (40.5-111.13)	235.5	26.5
	TR(AM)	9.5	19.0	11.23	33.69	17.48	69.92	Dried			
	UT(AM)	9.0	18.0	10.13	30.39	15.72	62.88	Dried			
5. Bottlegourd (Pusa Navin)	TR(PM)	12.48	24.96	20.2	60.6	92.7	461.5	90.0	147.42 (28.4-245.7)	2358.72	160.0
	UT(PM)	11.80	23.60	17.8	53.4	70.3	351.5	76.0	113.6 (21.4-198.0)	1590.4	101.2
T.D. 4 Jan. 92	TR(AS)	3.6	7.2	6.4	19.2	11.0	33.0	62.5	108.5 (18.5-120.0)	1200.00	87.0
	UT(AS)	3.4	6.8	5.7	17.1	6.85	20.53	8.5	Dried		
	TR(AM)	3.7	7.4	10.2	30.63	12.5	62.5	10.5	Dried		
	UT(AM)	3.6	7.2	10.0	30.0	12.0	60.0	10.0	Dried		

Contd.

Table II— *Contd* .

6. Bottlegourd (Pusa summer prolific long)	TR(PM)	13.2	26.4	20.9	62.7	81.3	406.5	85.0	132.36 (24.6-202.8)	1853.4	148.0
	UT(PM)	12.5	25.0	19.0	57.0	61.2	306.6	71.0	102.4 (20.5-198.76)	1331.2	98.0
	TR(AS)	7.1	14.2	16.8	33.6	17.65	70.60	18.5	107.21 (24.3-178.2)	428.84	22.0
	UT(AS)	7.3	14.6	19.5	29.0	15.2	60.8	18.0	91.92 (22.0-161.13)	366.04	22.5
	TR(AM)	7.1	14.2	8.7	26.1	14.3	71.5	9.5	Dried		
	UT(AM)	7.4	14.8	11.0	33.0	13.5	67.5	8.5	Dried		
7. Bittergourd (Pusa Domousami)	TR(PM)	16.88	182.2	44.7	759.9	48.8	1916.56	108.0	44.2 (15.1-71.1)	3270.8	140.0
	UT(PM)	15.66	172.26	41.6	553.2	48.24	916.56	68.0	32.0 (14.0-68.0)	2084.0	84.0
	TR(AS)	11.52	23.94	14.36	43.08	15.13	60.52	-	22.3 (7.2-26.3)	267.6	14.9

Contd.

Table II — *Contd.*

	UT(AS)	11.6	23.2	12.87	38.61	14.82	59.28	-	23.25 (8.2-22.7)	225.27	14.0
	TR(AM)	10.5	21.0	11.5	23.0	Dried					
	UT(AM)	11.0	22.0	11.5	23.0	Dried					
8. Summer Squash (Pusa Alankar)	TR(PM)	13.5	27.0	69.55	243.42	137.9	799.37	6.0	139.11 (36.5-242.5)	2364.87	-
	UT(PM)	14.66	28.32	51.20	204.8	84.77	614.61	5.0	128.92 (37.0-216.0)	1932.80	-
	TR(AS)	12.8	25.6	26.75	53.50	30.3	90.9	3.8	49.34 (17.2-61.34)	197.36	-
9. Summer Squash (Australian Green)	UT(AS)	12.6	25.2	24.10	48.2	26.1	78.3	3.4	45.32 (15.68-60.32)	181.28	-
	TR(AM)	8.1	16.2	32.32	66.96	33.5	134.0	Dried			
	UT(AM)	8.7	17.4	20.12	66.36	29.25	118.0	Dried			
	TR(PM)	17.1	34.2	62.45	241.80	89.8	538.8	4.0	126.54 (38.2-197.6)	1898.1	-
	UT(PM)	21.55	43.1	54.43	190.51	68.2	272.8	4.0	102.75 (39.2-194.5)	1335.75	-

Contd.

Table II — Contd.

TR(AS)	9.5	19.0	33.07	297.45	43.6	305.2	4.0	41.86 (16.4-52.7)	209.30	-
UT(AS)	9.6	19.2	21.3	149.1	28.2	197.4	3.5	38.3 (15.68-48.43)	153.2	-
TR(AM)	8.5	17.0	24.5	73.5	60.93	304.65	5.0	Dried		
UT(AM)	6.1	12.2	23.1	57.75	48.06	192.24				

Av. APL - Average Area per leaf; TLA - Total Leaf Area per plant; PH - Plant Height

Table III: Growth of Leaf Area (cm^2) and Plant Height (cm) at 10 Days Interval in Cyanobacteria Treated and Untreated Leguminous Vegetables Grown in Peat Moss (PM), Antarctic Soil (AS) and Antarctic Moss (AM)

S.NO	Variety		14 Jan. 92		24 Jan. 92		4 Feb. 92			14 Feb. 92		
			Av.APL	TLA	Av.APL	TLA	Av.APL	TLA	PH	Av.APL	TLA	PH
1	2		3	4	5	6	7	8	9	10	11	12
1.	Bean creeper (High Alt.Sel)	TR(PM)	32.2	122.36	46.5	344.1	55.24	1104.08	72.5	41.60 (14.7-71.1)	1830.4	140.0
	S.D.31.12.91	UT(PM)	22.3	44.6	35.63	178.16	40.7	569.8	63.8	37.48 (5.4-60.3)	1173.0	80.0
		TR(AS)	Germinated and dried after two leaves formation									
		UT(AS)			-do-							
		TR(AM)	16.36	49.08	23.5	188.0	36.5	547.5	80.0	38.33 (12.2-48.46)	689.94	87.0
		UT(AM)	16.00	48.00	18.25	127.75	29.5	554.0	76.0	36.57 (12.5-45.5)	658.26	72.0
2.	Dwarf Bean (Master Piece)	TR(PM)	24.10	120.5	43.33	377.11	51.12	644.56	37.0	52.78 (13.3-100.3)	1266.72	54.0
	S.D. 31.12.91	UT(PM)	24.46	122.3	42.86	282.9	36.90	480.38	23.0	44.83 (14.5-80.5)	1031.09	45.0

Contd.

Table III — *Contd.*

		TR(AS)	7.62	15.24	9.0	27.0	10.9	54.5	5.5	7.43 (2.8-10.8)	52.01	6.0
		UT(AS)	7.81	15.62	8.12	24.36	8.0	40.0	5.5	7.21 (2.5-10.8)	50.47	5.5
		TR(AM)	18.22	54.66	26.85	214.80	31.5	504.0	26.0	51.25 (24.0-98.2)	1076.26	31.0
		UT(AM)	18.5	55.5	20.4	163.2	22.42	313.88	21.0	29.8 (18.0-40.4)	596.0	25.0
3.	Bean (Pant Anupama)	TR(PM)	23.85	47.7	34.75	165.06	48.92	684.88	20.0	32.2 (12.5-68.3)	676.2	28.0
	S.D.31.12.91	UT(PM)	22.35	44.7	28.25	141.25	31.00	372.12	18.0	27.5 (11.4-52.06)	495.0	23.5
		TR(AS)	6.82	13.64	12.5	37.5	14.8	78.0	3.5	10.9 (11.4-18.0)	80.72	7.0
		UT(AS)	6.92	13.34	11.0	33.0	12.62	63.10	3.0	9.5 (5.0 - 16.5)	76.00	7.0
		TR(AM)	7.0	14.0	14.85	118.80	51.56	1082.76	13.0	9.5 (5.0-16.5)	941.16	20.0

Contd.

Table III — *Contd*

		UT(AM)	3.65	7.30	12.60	100.80	51.82	725.48	11.5	26.26 (15.0-58.2)	630.00	19.0
4.	French Bean (Pusa Cheese Contender)	TR(PM)	39.7	79.4	41.06	228.72	57.66	720.78	18.0	30.0 (12.0-61.03)	630.0	20.0
		UT(PM)	53.5	107.0	24.56	171.92	48.13	529.43	16.0.	24.5 (11.2-56.04)	441.0	l8.5
	S.D.31.12.91	TR(AS)	9.15	18.3	14.6	43.8	15.2	80.0	8.8	9.03 (1.5-20.9)	135.45	10.0
		UT(AS)	9.13	18.30	12.81	37.43	14.13	56.52	8.5	15.93 (10.4-21.8)	150.3	9.0
		TR(AM)	28.2	56.4	35.5	177.5	42.5	595.0	17.0	32.0 (13.0-58.0)	672.0	20.5
		UT(AM)	28.5	57.0	32.0	150.0	40.5	526.5	17.0	28,5 (13.5-55.0)	627.0	20.0
5.	French bean (Pusa Parvati)	TR(PM)	31.10	62.2	40.76	232.9	46.8	374.4	15.33	31.04 (12.7-52.2)	620.8	24.0
		UT(PM)	35.70	71.4	24.8	89.6	27.66	221.28	13.8	27.02 (12.0-48.4)	486.36	20.5

Contd.

Table III — *Contd.*

S.D.31.12.91	TR(AS)	13.5	27.0	13.62	40.86	14.4	72.0	3.5	11.23 (6.2-19.5)	56.15	6.5
	UT(AS)	13.46	26.90	13.72	41.16	14.23	56.92	3.5	8.57 (5.8-18.27)	42.85	6.0
	TR(AM)	19.0	38.0	15.75	94.50	18.4	144.0	11.0	18.1 (8.2-29.0)	362.0	20.0
	UT(AM)	16.8	33.6	15.43	77.15	15.23	121.84	9.5	16.5 (7.5-26.25)	297.0	18.25
6. Bea (Asparagusn)	TR(PM)	13.8	27.6	16.25	68.67	37.1	296.8	13.33	20.12 (10.6-29.2)	400.24	20.0
S.D.31.12.91	UT(PM)	22.6	45.2	11.15	66.90	22.96	183.68	10.00	16.05 (4.9-24.2)	321.00	15.0
	TR(AS)	7.62	15.24	9.27	27.81	13.1	65.5	3.7	9.5 (5.0-14.5)	76.0	7.0
	UT(AS)	7.63	15.26	9.15	27.45	12.32	49.28	3.5	11.6 (4.5-16.9)	81.2	8.3
	TH(AM)	8.3	16.6	12.5	50.0	14.10	112.80	27.0	21.25 (40-38.5)	212.5	21.0

Contd.

Table III — Contd.

	UT(AM)	6.35	12.7	12.0	48.0	9.0	72.0	14.0	14.83 (2.0-16.1)	133.47	18.0
7. Bean (VL Bauni) S.D.31.12.91	TR(PM)	10.2	20.4	12.65	37.95	28.5	228.0	9.0	20.12 (10.6-29.2)	221.32	20.0
	UT(PM)	10.5	21.0	11.87	35.61	18.5	148.0	8.0	16.5 (4.9-24.2)	128.40	15.0
	TR(AS)	6.65	13.30	7.35	21.05	8.01	64.08	7.0	10.9 (4.5-18.0)	80.72	7.5
	UT(AS)	6.32	12.64	6.81	20.43	7.83	54.81	7.0	9.5 (5.0-16.5)	76.0	7.0
	TR(AM)	13.25	26.50	12.25	61.25	18.6	120.2	10.0	20.23 (11.6-78.5)	424.83	*21.5*
	UT(AM)	13.00	26.00	10.37	51.85	16.25	113.75	8.5	18.5 (10.0-68.33)	388.5	19.0

Av.APL - Average area per leaf; TLA - Total leaf area; PH - Plant Height
TR - Treated; UT - Untreated

Table IV : Leaf Area (cm2) of Beet Root, Spinach and Lettuce (Treated with Cyanobacteria) at 10 Days Interval (Sowing Date: 1.1.92)(TLA - Total Leaf area, UT -Untreated, TR-Treated, PH- Plant Height, Av.APL-Average Area Per Leaf)

S.No.	Variety		14 Jan. 92		24 Jan. 92		4 Feb. 92		14 Feb 92	
			Av.APL	TLA	Av.APL	TLA	Av.APL	TLA	Av.APL	TLA
1.	Beet Root (Red Ball)	TR	5.8	11.6	13.4	40.2	29.6	21.2	31.4 (6.0-60.5)	157.0
		UT	4.9	9.8	11.8	35.4	118.4	84.4	32.68 (6.8-67.05)	163.4
2.	Beet Root (Detroit Dark Red)	TR	6.7	13.4	18.4	55.2	33.12	132.48	36.42 (6.4-68.2)	200.3
		UT	6.8	13.6	14.6	43.8	26.5	10.20	35.2 (5.8-71.2)	176.0
3.	Spinach (Pusa Hari)	TR	2.3	9.2	11.06	55.3	19.0	76.0	30.2 (10.0-56.7)	180.12
		UT	2.4	7.2	10.3	41.2	16.5	66.0	28.22 (11.0- 50.5)	169.32
4.	Spinach (Pusa Banarasi)	TR	2.25	9.0	6.7	20.1	10.12	40.48	26.5 (10.0-50.0)	159.0
		UT	2.8	11.2	6.1	18.3	9.8	39.2	24.0 (9.0-42.5)	144.0

Contd.

Table IV — *Contd*

5.	Lettuce (Chinese yellow)	TR	6.8	*27.2*	16.5	49.5	42.3	169.2	48.0 (20.0-66.0)	240.0
		UT	6.5	26.0	14.2	42.6	31.4	125.6	40.0 (16.0-49.0)	200.0
6.	Lettuce (Great Lake)	TR	2.2	8.8	11.2	33.6	35.74	142.96	44.26 (21.6-77.0)	354.08
		UT	*2.3*	9.2	9.8	29.4	27.2	108.8	42.25 (20.5-75.84)	336.0

Among dwarf beans, TLA was recorded maximum 1266.72 cm^2 and 1076.26 cm^2 in Master Piece variety grown in peat moss and Antarctic moss media, respectively. The difference in TLA in treated Mid controlled plants was recorded remarkably higher in Antarctic moss media (480.26 cm^2) than the plants grown in peat moss media (235.63 cm^2). On the 30th day of the application of cyanobacteria the plant height was recorded is 140.0 cm in comparison to same plant in controlled conditions measuring 80.0 cm in peat moss media. The difference in plant height in treated and controlled plants was recorded as 15 cm in Antarctic moss media. Table IV represents date on beet root, spinach and lettuce. Beet root had no response of cyanobacteria. Increased average APL and TLA were recorded in two varieties of spinach and lettuce in treated conditions.

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