

ESTIMATION OF GROWTH IN SOME BLUE-GREEN ALGAE

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DOI: 10.47750/pnr.2022.13.S06.123

Abstract

Physiological characterization show that all the strains have more growth in nitrogen enriched medium compared to nitrogen deficient medium. The growth measurement in terms of dry weight indicated that genus *Westiellopsis* has produced the maximum biomass. Therefore it has more growth rate and minimum generation time.

Keywords: Biomass, Dry weight, Growth rate, Generation time.

INTRODUCTION

The Blue-green algae are of ubiquitous distribution in soils but reach their greatest abundance in tropical regions. Therefore, the importance of the blue-green algae to enrich the tropical soils, particularly rice fields have been emphasized by De, 1939; Stewart et al. 1969; Tiwari 1972; 1975; 1979; Venkataraman 1979 and Singh P.K. 1985 and 1988. Blue-green algae are also known to improve the physico-chemical properties of the soils. Improvement in soil aggregation due to algal growth was reported by Sankaram 1971; Kaushik and Subhashini 1985. Blue-green algae are like that of the other algae but their certain biochemical attributes are like those of Bacteria. Blue-green algae are only organism known to have simultaneously both the photosystem (Photosystem-I and Photosystem –II) and nitrogen fixing capability in the same organism. Photosynthetic and diazotrophic nature of Blue-green algae makes them perfect autotrophic and versatile organisms. Blue-green algae are found in different ecosystem and make substantial contribution to the nitrogen economy of their immediate environment (Singh 1961, Roger and Kulasoorya 1980, Venkataraman 1981) it is well known that certain bacteria can fix nitrogen in free living as well as in symbiotic conditions. The free living dizotrophic. Blue-green algae are the largest contributors to the process of “ Biological Nitrogen Fixation “ the second most important process on this planets (Singh et al. 1986).

Most of the previous work done on Blue –green algae was related with their floristic accounts, isolation and identification. The strains of Blue-green algae from rice fields were isolated and reported by Banergy 1935; Singh 1939; De 1939; Gonzalves and Gangla 1949; Mitra 1951; Khan 1957; Verma 1963; Pandey 1964 a & b; Gupta 1969; Laloraya and Mitra 1973 a & b; Verma 1963; Pandey 1964 a & b ; Gupta 1969; Laloraya and Mitra 1973 a & b ; Tiwari 1972, 1975 , 1979; Subsequently the workers after isolation of different strains of BGA as unialgal cultures, they assessed the contribution of these strains by their Biomass production and total fixed nitrogen in a particular period individually. There are only few reports Roy Choudhary et al. 1986; Roy Choudhary and Kaushik 1989; Tripathi et al. 1990; Dixit and Tiwari G.L. 1990 who have studied biomass and Nitrogen fixation potentiality of isolated strains of heterocystous Blue-green algae.

The morphological and Physiological characterization of blue green algae have been studied by numerous workers, most of the works have been reviewed by different workers Geitler 1932; Tiffany and Britton 1952; Starmach 1966; Bourrelly 1970; Drout 1978, 1981; Fogg et al. 1973, Fay & Van Baalan 1987; Staley et al. 1989; Komarck and Anagnostidis 1989; Bryant 1994; Singh Vivek 2002, 2009, 2010, 2019, 2020. The growth and development of plants depends upon nitrogen. Therefore nitrogen is one of the most important elements in plants. The productivity of plant is determined mainly by the availability of nitrogen.

MATERIAL AND METHODS

The present work incorporate the survey of rice field for the selection of most common and dominant strains of blue-green algae, their isolation in axenic culture, study of their physiological characterization of certain parameters under standard laboratory condition.

In the present study attempts observes study the physiological characterization of 24 strains of blue-green algae collected from different localities of rice fields. Cultural studies of selected strains have been done at standard laboratory conditions in sterilized glassware and media.

GROWTH MEASUREMENT

The assessment of growth of algae were based on their estimation of chlorophyll-a, nitrogenise activity, dry weight and calculation of specific growth rate and generation time.

Specific Growth Rate and Generation Time

The time interval required for the cells to divide or for the population to double is known as generation time, which is a determining factor in rate of growth of an organism. Specific growth rate and generation time was calculated after Guillard (1973). Specific growth rate was calculated by using the following formula-

$$K = 3.3[\text{Log}N_2 - N_1] \ t$$

Where

K= Specific growth rate

N1 = initial optical density

N2= final optical density

T = time interval

Generation time was calculated by using the following formula –

$$G = t \ 3.3[\text{Log}N_2 - N_1]$$

Where –

G = generation time

K = specific growth rate.

Dry Weight

The growth measurement in term of dry weight of the algal material was done after harvesting the alga form liquid nutrient medium. The algal mass was filtrated and washed twice with distilled water. The algal material was filtrated by previously weighed Whatman No.1 filter paper and these filter papers with algal materials were dried at 50c in oven.The dry weight of algal material was determined after 24 hours up to their constant weight. Observation:

Physiological processes directly or indirectly leave impact on external morphology as well as internal structure. High rate of anabolic process results production of more building blocks for a cell which increases vigorously and affect the shape and size

of cell and ultimately of individuals. This incensement in shape and size of individuals results a change in their gross morphology.

Measurement and Growth:

Expansion of thallus through multiplication in vegetative cell is known as growth, which increases total biomass of an organism. It can be calculated in terms of dry weight, specific growth rate and generation time. In present study, the result indicates that appreciable growth in Nitrogen deficient BG-11 medium.

Determination of Dry Weight:

Biomass production was measured in terms of dry weight (ug/ml) after 15 day of growth period. Result indicate that after growth of 15 days all the strain have more dry weight in nitrogen enriched medium as compared to nitrogen deficient medium.

All the strains showed dry weight production between 69ug/ml to 306ug/ml dry weight of strains. Maximum dry weight was produced by Westiellopsis-33(306ug/ml) while minimum dry weight was produced by Scytonema-12(69ug/ml). It was observed that Nostoc-42(231ug/ml), Nostoc-51(274ug/ml), Nostoc-35(210ug/ml), Nostoc-15(216ug/ml), Anabaena-32(161ug/ml), Aulosira-52(295ug/ml), Microchaete-11(203ug/ml), Calothrix-25(253ug/ml), Calothrix-31(190ug/ml), Chlorogloeopsis-40(234ug/ml) were found better dry weight producing strains. (Table 1 & fig. 1-3)

In Terms of Dry Weight of all Strains, the Following Trend was Observed:

Westiellopsis-33 > Aulosira-52 > Nostoc-51 > Calothrix-25 > Chlorogloeopsis-40 > Nostoc-42 > Nostoc-15 > Nostoc-35 > Microchaete-11 > Nostoc-28 > Calothrix-31 > Hapalosiphon-19 > Calothrix-50 > Anabaena-32 > Cyndrospermum-21 > Calothrix-44 > Anabaena-24 > Gloeotrichia-47 > Camptylonemopsis-39 > Anabaena-49 > Anabaena-7 > Tolypothrix-46 > Scytonema-43 > Scytonema -12.

Determination of Specific Growth Rate (K):

Specific growth rate (K) of all the strains had been measured after 10 days of interval. All the strains showed specific growth rate. Results indicate that all the strains showed better growth rate in nitrogen enriched medium as compared to nitrogen deficient medium.

All the strains showed specific growth rate between 0.25 to 0.64. Maximum growth rate constant was calculated for Westiellopsis-33, however minimum growth rate in Microchaete-11.

The Following Trend was Observed:

Westiellopsis-33 > Aulosira-52 > Calothrix-25 > Camptylonemopsis-39 > Tolypothrix-46 > Anabaena-24 > Nostoc-15 > Anabaena-49 > Anabaena-32 > Calothrix-50 > Calothrix-44 > Nostoc-51 > Nostoc-28 > Chlorogloeopsis-40 > Cyndrospermum-21 > Nostoc-35 > Gloeotrichia-47 > Anabaena-7 > Nostoc-42 > Hapalosiphon-19 > Calothrix-31 > Scytonema-43 > Scytonema-12 > Microchaete-11 (Table 1 & fig. 4).

Determination of Generation Time (G):

Generation time (G) of all the strain by calculated in hours (h) after 10 days growth period. Results indicate that all the strains showed more generation time in nitrogen deficient medium as compared to nitrogen enriched medium.

All the strains showed generation time between 48 to 152 hours. Maximum generation time was observed in Scytonema-12 (152h) while minimum in Westtiellopsis-33 (48h). The generation time of remaining 22 strains ranges between 56 to 139 hours.

In Regards to Generation Time Following Trend was Observed:

Scytonema-12 (152h) > Scytonema-43 (139h) > Anabaena-7 (127h) > Tolypothrix-46 (93h) > Calothrix-50 (89) > Camptylonemopsis-39 (81h) > Calothrix-44 (79h) > Calothrix-31 (78h) > Microchaete-11 (76h) > Nostoc-42 (75h) > Chlorogloeopsis-40 (72h) > Calothrix-25 (71h) > Gloeotrichia-47 (68h) > Hapalosiphon-19 (65h) > Anabaena-24 (63h) > Anabaena-32 (60h) > Anabaena-49 (59h) > Nostoc-15 (58h) > Nostoc-28 (57h) > Cylandrospermum-21 (56h) > Nostoc-51 (55h) > Nostoc-35 (54h) > Aulosira-52 (52h) > Westiellopsis-33 (48h)

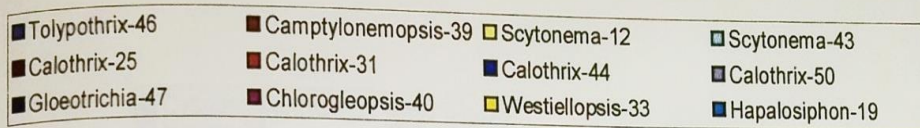
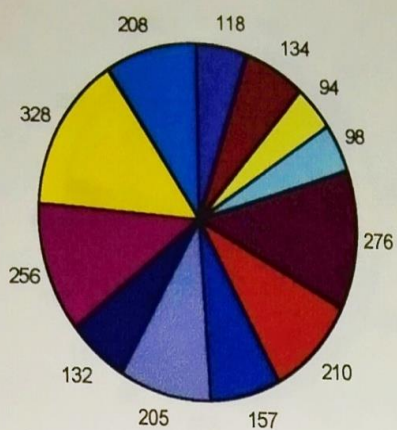
RESULT & DISCUSSION

The growth measurement in term of dry weight (Table 1 & fig. 1-3) indicated that Westiellopsis prolifica has produced that maximum biomass and that is why it has more growth rate and minimum generation time (Table 1 & fig. 4,5). The results are quite comparable with other workers (Adhikary 1997).

Table- 1 Analysis of dry weight, specific growth rate and generation time of different strains (in Nitrogen deficient and Nitrogen enriched medium)

STRAINS	DRY WEIGHT (ug/ml)		SPECIFIC GROWTH RATE		GENERATION TIME (hrs)	
	Nitrogen deficient	Nitrogen enriched	Nitrogen deficient	Nitrogen enriched	Nitrogen deficient	Nitrogen enriched
Cylandrospermum-21	154	178	0.49	0.56	56	42
Nostoc-35	210	242	0.48	0.54	54	46
Nostoc-51	274	306	0.52	0.61	55	45
Nostoc-28	195	224	0.51	0.62	57	46
Nostoc-42	231	252	0.43	0.51	75	61
Nostoc-15	216	246	0.57	0.63	58	92
Anabaena-7	98	125	0.45	0.55	127	102
Anabaena-24	115	146	0.58	0.64	63	51
Anabaena-49	107	132	0.55	0.63	59	48
Anabaena-32	161	186	0.54	0.59	60	49
Aulosira-52	295	315	0.64	0.68	52	44
Microchaete-11	203	227	0.25	0.32	76	58
Tolypothrix-46	94	118	0.59	0.63	93	79
Camptylonemopsis-39	110	134	0.62	0.67	81	66
Scytonema-12	69	94	0.28	0.36	152	134
Scytonema-12	76	98	0.32	0.44	139	112
Calothrix-25	253	276	0.63	0.69	71	59
Calothrix-31	190	210	0.38	0.46	78	63
Calothrix-44	131	157	0.52	0.57	79	61
Calothrix-50	177	205	0.55	0.59	89	64
Gloeotrichia-47	112	132	0.46	0.52	68	49
Chlorogloeopsis-40	234	256	0.50	0.63	72	58
Westiellopsis-33	306	328	0.66	0.70	48	43
Hapalosiphon-19	182	208	0.42	0.49	65	54

Value of Dry weight in +N medium



Value of Dry Weight in -N medium

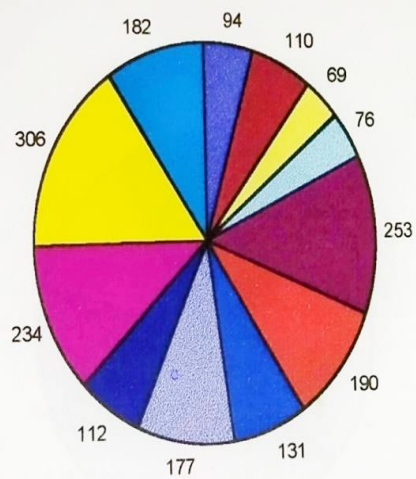
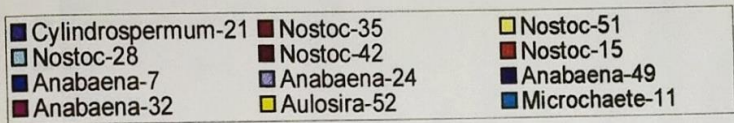
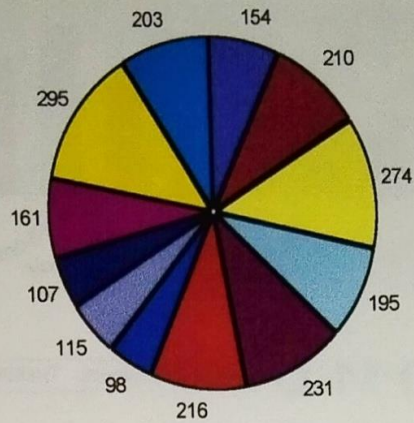


Fig.-1

DRY-WEIGHT in -N medium



Dry Weight in +N medium

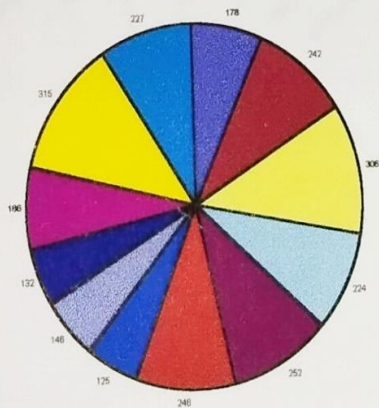


Fig.-2

Comparison of Dry Weight(in -N & + N medium) of different Strains

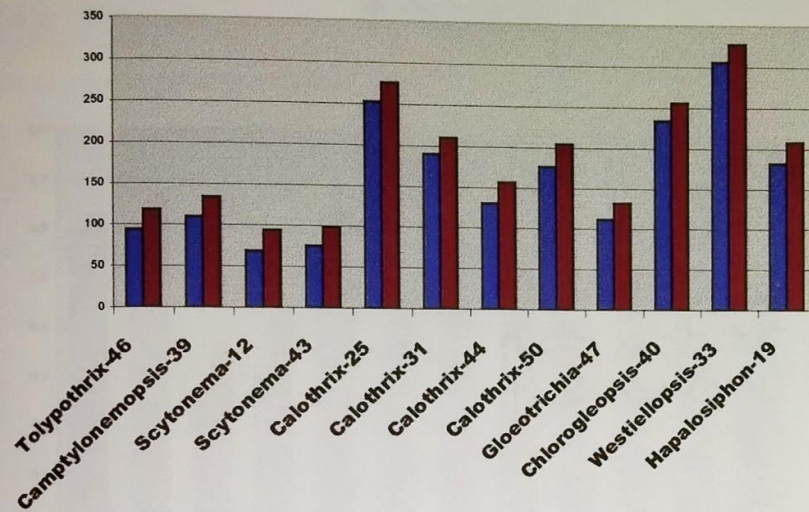
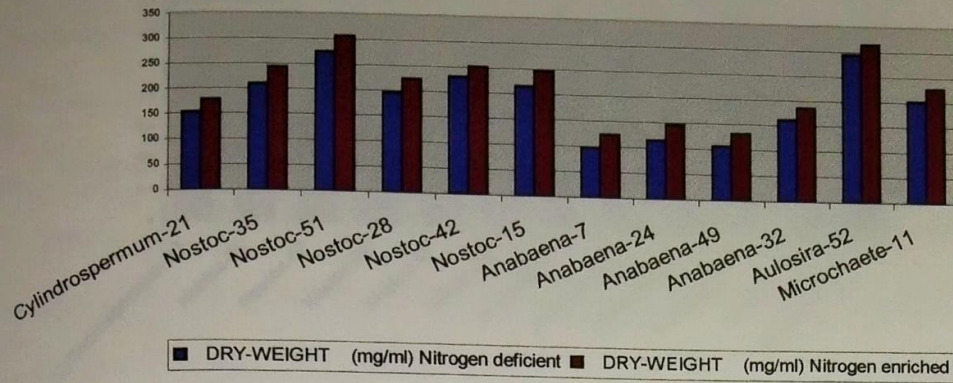


Fig.3

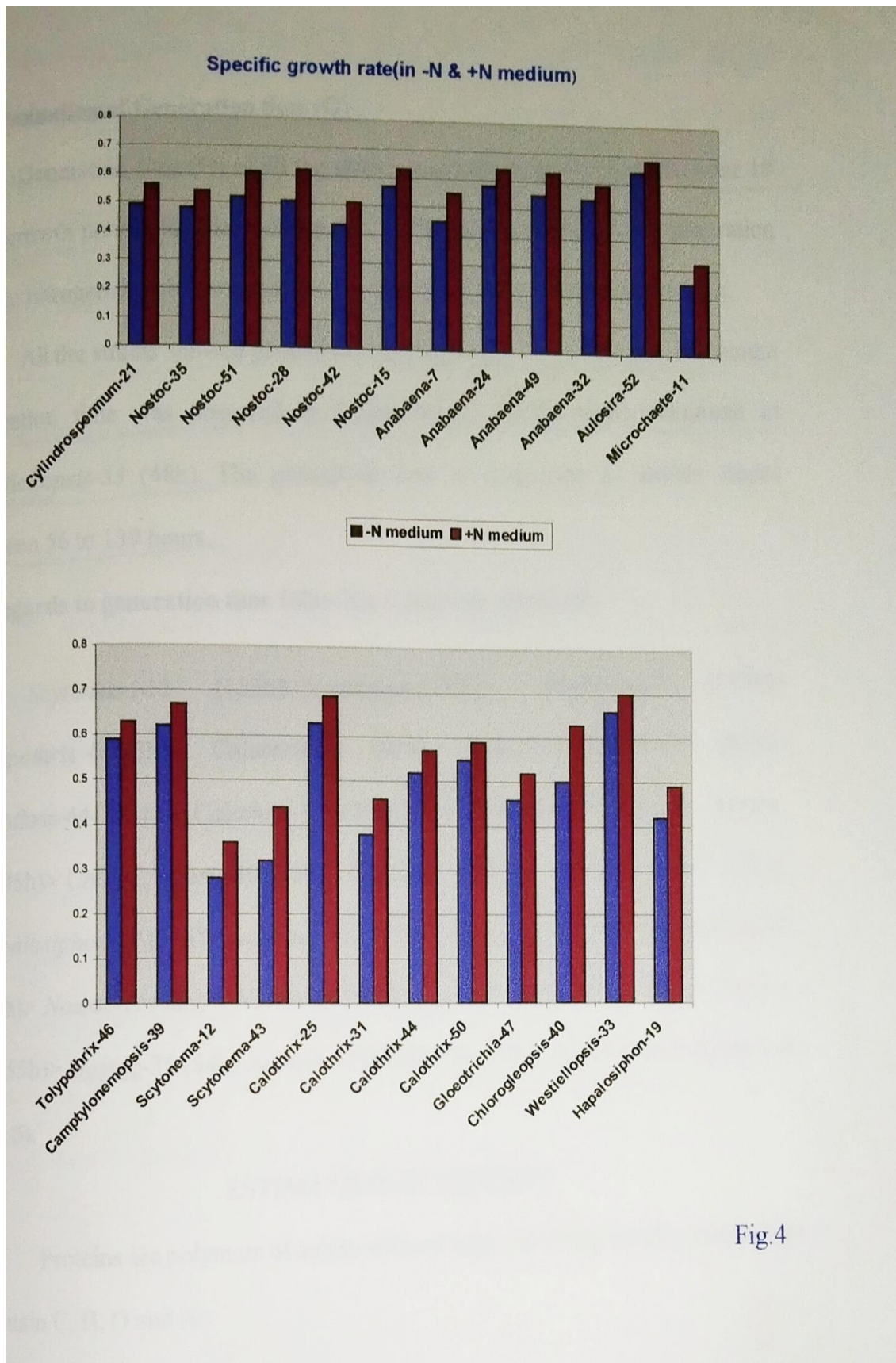


Fig.4

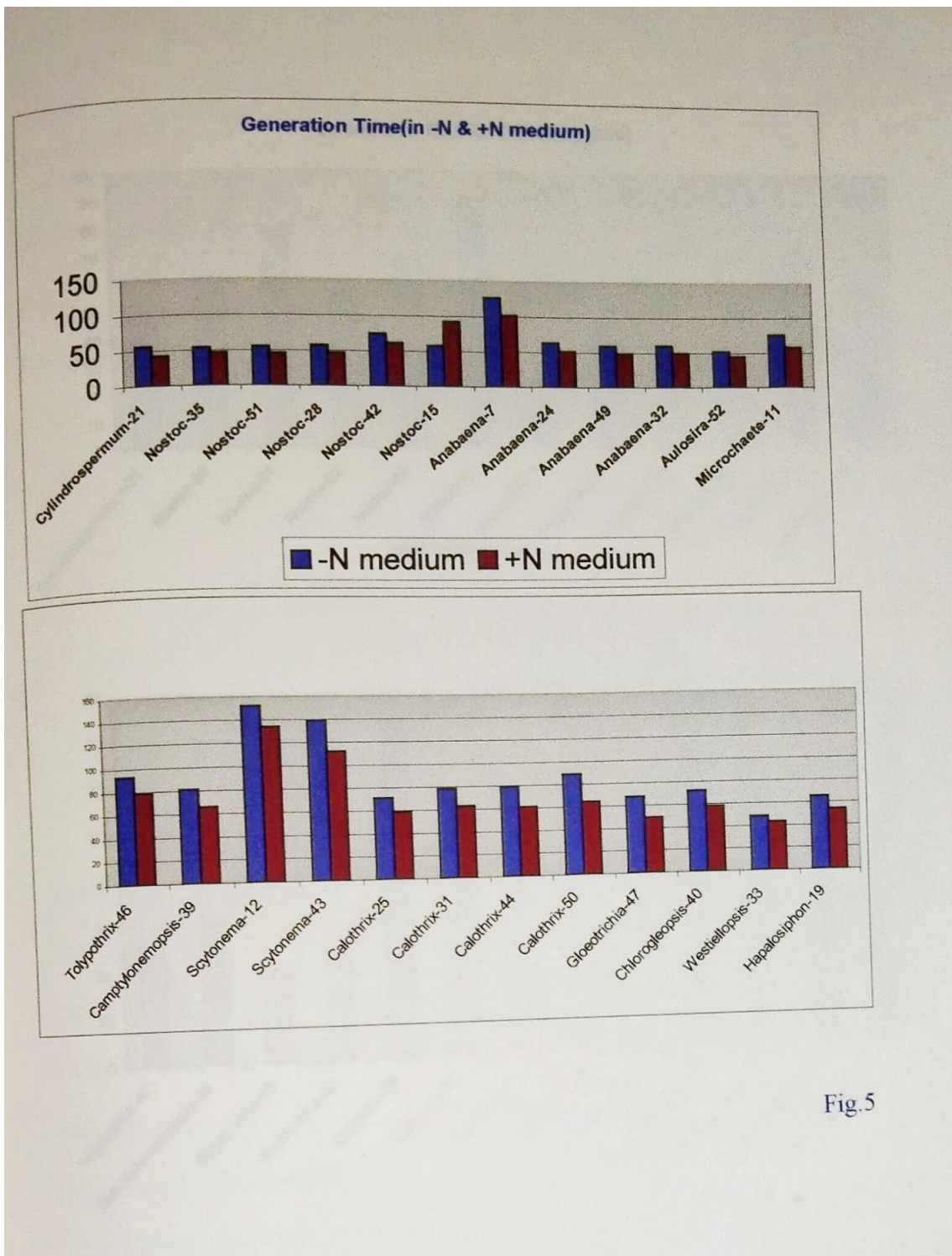


Fig.5

REFERENCES

1. Adhikary 1989, Effect on the growth, photosynthetic oxygen evolution and nitrogen fixation of *Westilopsis prolifica* J. Gen Appl. Microbiol. 35:319-325.
2. Bryant D.A. 1994, the molecular biology of Cyanobacteria kluwer Academic Publisher, The Neither Land.
3. Bourrelly P. 1970b Less algae d, ceaudouce. III N. Boubee & cie. Paris, 512
4. Banergy J.C. 1935, On algae found in soil samples from alluvial paddy field of Faridpur, Bengal. Sci and cult 1:298-299.

5. De, P. K. 1939, The role of blue-green algae in nitrogen fixation in rice fields.
6. Dixit and Tiwari G.L. 1990, Determination of nitrogenase activity of blue-green algae from paddy fields of Bihar, district Pratapgarh (U.P.) New Agriculturist. 1: 55-58.
7. Dixit, R., Singh, S., and Singh, A. (2020). Effect of nitrogen deficiency on the physiology and biochemical composition of microalga *Scenedesmus rotundus*-MG910488 J. Basic Microbiol. 60, 158–172. doi: 10.1002/jobm.201900383
8. Drouet, F. 1978, 1981, Revision of the Nostocaceae with constricted trichomes. Beih.2. Nova Hedwigia. 57; 1-258.
9. Fogg G.E., Stewart, W.D.P., Fay, P and Walsby, A.E. 1973, The Blue green algae. Acad. Press, London:459.
10. Fay, P & Van Baalen, C. 1987, The Cyanobacteria, Elsevier, Amsterdam.
11. Fogg, G. E. 1944, Growth and heterocyst production in *Anabena cylindrical* Lemm. Phytologist, 43:164-175.
12. Fogg G. E. 1949, Growth and heterocyst production in *Anabena cylindrical* Lemm. II. In relation to carbon and nitrogen metabolism. Ann.Bot.N.S. 13: 214-259.
13. Geitler 1932, Cyanophyceae in Rabenhorst's kryptogamenflora. Leipzig. 14:1196
14. Gonjalves, E.A. and Gangla 1949, Observation on the algae of paddy field soil. Jour Univ. Bombay 18 (3): 51-59
15. Gupta A.B. 1966, Algal flora and its importance in economy of rice fields, Hydrobiol, 28:213-222.
16. Kaushik, B.D. and Subhashini, D. 1985, Amelioration of salt affected soils with blue-green algal improvement in soil properties. Proc. Ind. Nat. Sci. Acad. 51: 380-389.
17. Khan, S.I. 1957, Cultures of algae of rice fields around Dehradun, India, Rev. Algal, 11 333-338.
18. Komarck, J. and Anagnostidis 1989; Modern approach to the classification system of Cyanophytes-4-Nostocales, Arch. Hydrobiol, Suppl. 82(3): 247-345.
19. Laloraya, V.K. and Mitra, A.K. 1973 a & b, Studies on the blue-green algae of the paddy fields of India. Part-I Cultural studies, general consideration and distribution of the blue-green algae in paddy field of India. Nova Hedwigia. 47:227-260.
20. Mitra, A.K. 1951, the algal flora of certain Indian soils. Indian J. Agri. Sci. 21: 357- 373 Pandey D.C. 1965; a study in the algae from paddy field soil of Ballia and Ghazipur district. Nova Hedwigia 9:299-334.
21. Pandey, D.C. and Mitra, A.K. 1963, On the morphology and life history of new species of *Anabaenopsis* sp Nov. Nova Hedwigia. 6:345-350.
22. Roy Choudhary, P. and Kaushik B.D. 1989, Intra and Intergeneric variation in nitrogen fixing potential of Cyanobacteria, Acta Botanica India 17:217-273.
23. Sankaran, A. 1971: Work done on blue-green algae in relation to agriculture. I.C.A.R. Tech. Bul. (agri) Publ. By ICAR-New Delhi 27: 1-28
24. Staley et al. 1989, Bergey's manual of Systematic Bacteriology, Vol.3.
25. Starmach, K. 1966; Cyanophyta-sinice-floraslodkow, PWN Warszawa. Polski, 2;1-808.
26. Stewart, W.D.P. 1969, Biological and ecological aspect of nitrogen fixation by rice living micro organism. Proc. Roy Soc. 172B: 367-388.
27. Singh P.K. 1973, Effects of pesticides on blue-green algae, Arch. Microbiol 89: 317-320.
28. Singh Vivek 2002; Strain selection and characterization of blue green algae suitable for biofertilizer technology, Ph.D. Thesis A.P.S. University Rewa M.P
29. Singh Vivek 2009, Application and observation on soil base starter culture for blue green algal biofertilizer technology. Nat. Jour. of life sciences 6(3)366-368.
30. Singh Vivek 2019, Determination of tolerance level of blue green algae to different pesticides. Life Science bulletin, Vol.16 (1&2):102-104
31. Singh Vivek 2020, Pigment analysis of some blue green algae. Res. Jour. of Agril. Sci. 11(6):1343-1346
32. Tiwari G.L. 1971, Fixation of elementary nitrogen by *Scytonema geitleri* in pure and unialgal culture. Curr.Sci.40:330-331.
33. Tiwari G.L. 1979, Study of blue green algae from paddy field soil. Nova Hedwigia 63:133-159.
34. Tripathi I.C. Ayyappan S. and Adhikari S. P. 1990; Isolation and growth local Heterocystous Cyanobacteria for using as Bio-fertilizer. Proc. Nat. Symp. Cyanobacterial nitrogen fixation IARI ED. B.D. Kaushik: 367-370
35. Venkataraman, G.S. 1979, Algal inoculation of rice fields. In: Nitrogen and Rice International Res. Inst. Manila: 311- 321.
36. Venkataraman 1981, Blue-green algae for rice production. Manual for its promotion FAO Soil Bull. 46:102.
37. Verma, A.K. 1973, *Scytonematopsis* from Indian rice fields soils, Nova Hedwigia 47: 625-635.