

Seasonal variation of Soil Nitrogen and Cyanoprokaryote Diversity (Heterocystous and Non-Heterocystous) across two Blocks of North 24 Parganas District, West Bengal, India

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Abstract

In heterocystous cyanoprokaryotes the most notable character is nitrogen fixation. Here a comparative study of soil nitrogen concentration and the presence of heterocystous and non-heterocystous cyanoprokaryotes in a seasonal basis of two block division (Barrackpur-I and Barrackpur-II block of North 24 Parganas district) were made. In soil analysis, seasonal variation shows that heterocystous cyanoprokaryotes favour nitrogen-deficit soils. It shows that nitrogen deficit soil (Barrackpur-I block) induces the stress signal for allow favouring for the production of heterocyst and subsequently increasing or modified by non-heterocystous cyanoprokaryotes when nitrogen content of soil increases (Barrackpur-II block).

Key words : Heterocyst, Nitrogen, Cyanoprokaryotes, North 24 Parganas, West Bengal.

In cyanoprokaryotes heterocyst^{6,17} is important characteristic features in species in this group. Heterocyst mainly develops from vegetative cells¹⁶. It functions as storage organ like akinetes⁶, storage organ¹⁶ and balance nitrogen deficit soil⁷. Particular in cyanoprokaryotes nitrogen can induce on heterocyst production¹⁴.

Basic difference between vegetative and heterocyst is that heterocystes are larger and looks like empty cell in the light microscope and also inactive in photosynthesis¹². It has highly oxygen consumption capacity. Heterocyst

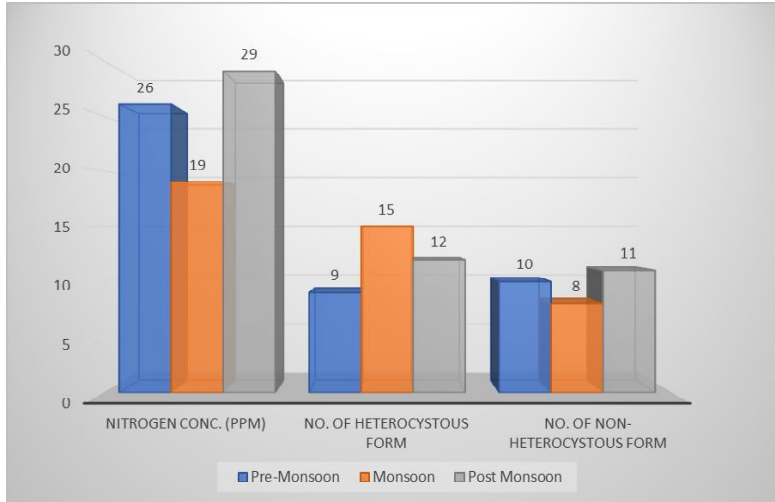
has a thick, laminated cell wall for atmospheric barrier like oxygen. Heterocysts are formed more than one or in regular intervals by transferring vegetative cell to heterocyst¹¹. Heterocyst differentiation in *Anabaena* study by Adam¹, El-Shehawy and Kleiner (2004)⁵. It is also thought that akinetes may be evaluating precursors in heterocyst¹³.

In this study shows that how nitrogen deficit soil induces the stress signal for allow favouring for the production of heterocyst and subsequently increasing or modified by non-heterocystous cyanoprokaryotes when nitrogen

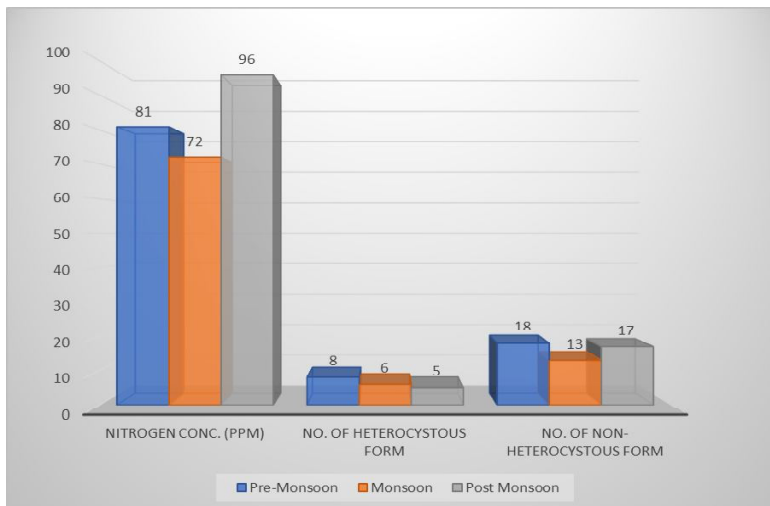
content of soil increases.

Freshly algal samples were collected from Barrackpur-I and Barrackpur-II block of North 24 Parganas district, West Bengal (India) and specimens were preserved in 5%

formalin solution, stored in polythene bags (dimensions 4"×3"), and appropriately tagged. Relevant ecological information was recorded in the field data book. The pH and temperature of the water bodies were measured using Merck pH indicator strips (range 1–10). For



Graph 1. Seasonal variation graph depicting Nitrogen concentration and the distribution of Heterocystous and Non-Heterocystous cyanoprokaryotes in Barrackpur-I Block



Graph 2. Seasonal variation graph depicting Nitrogen concentration and the distribution of Heterocystous and Non-Heterocystous cyanoprokaryotes in Barrackpur-II Block.

Table-1. Seasonal Dynamics of Nitrogen Levels and Cyanobacterial Community Structure for Barrackpore I Block

Season	Nitrogen Conc. (ppm)	No. of Heterocystous form	No. of Non-Heterocystous form
Pre-Monsoon	26	09	10
Monsoon	19	15	8
Post Monsoon	29	12	11

Table-2 Seasonal Dynamics of Nitrogen Levels and Cyanobacterial Community Structure for Barrackpore II Block

Season	Nitrogen Conc. (ppm)	No. of Heterocystous form	No. of Non-Heterocystous form
Pre-Monsoon	81	8	18
Monsoon	72	6	13
Post Monsoon	96	5	17

microscopic examination, algal samples were mounted in either 10% glycerin or G.F.W. solution following the method of Bando². Detailed observations were carried out using an Olympus (GB model) compound microscope. Camera Lucida sketches were prepared for taxonomic identification up to the species level, and high-resolution digital images were captured using the Nstavision Stereo Zoom microscope. Identification of algal specimens was performed with the aid of standard taxonomic references^{4,9,10,15}. Nitrogen estimated by colorimetric methods³.

The heterocystous cyanoprokaryotes can form the initial patch on any initial bare area. One of the reasons behind this appears to be its more stress withstanding capability than the non-heterocystous form. Actually the heterocystous species form the basic ecological platform for non-heterocystous and other

group of algae like green algae and diatom in later stages. In this study in Barrackpur-I block (Table-1, Graph 1), during monsoon nitrogen concentration dips possibly due to leaching, runoff or dilution from rainfall and then rises post-monsoon likely from nutrient buildup or reduced runoff. We saw that heterocystous forms are highest during monsoon (15 forms, Graph 1) because nitrogen-fixing cyanobacteria thrive in low nitrogen conditions during monsoon, as heterocystous forms are known for nitrogen fixation. But in Barrackpur-II block (Table-2, Graph 2) in monsoon period due to dilution of effect of water the soil nitrogen content was found reduced than other two seasons and it was normally expected heterocystous form could increase than the non-heterocystous form but it was found that both non-heterocystous and heterocystous form decreased. It has been found that in that particular area some other green algae namely

Scenedesmus quadricauda (Turpin) Brébisson and a diatom *Nitzschia obtusa* W. Smith formed a new patch as also supported by Ogawa and Carr, 1969. Probably the basic nutritional and other factor provided by the heterocystous and non-heterocystous forms in the pre monsoon season help to initiate the new patch in this way.

In this analysis, the main focus is on the role of nitrogen, assuming that all other soil parameters remain constant. In practical field situations, this scenario is uncommon. Various other environmental and soil factors such as soil pH, moisture content, organic matter, temperature, and microbial activity also play significant roles in influencing the presence and abundance of cyanoprokaryotic forms. Therefore, while nitrogen dynamics provide a central aspect of this study, it is important to recognize that the observed patterns result from the complex interplay of multiple factors.

This study shows the important role of nitrogen concentration in influencing the seasonal dynamics of cyanoprokaryotic forms in the studied regions.

In the Barrackpore-I block, nitrogen concentration was found to decrease during the monsoon due to leaching, runoff, and dilution from rainfall, with a subsequent increase in the post-monsoon period likely due to nutrient buildup. Correspondingly, the highest abundance of heterocystous forms during the monsoon indicated their dominance under low-nitrogen conditions.

However, in the Barrackpore-II block, although soil nitrogen content also decreased

during the monsoon, both heterocystous and non-heterocystous forms declined. Interestingly, other algal groups such as *Scenedesmus quadricauda* (Turpin) Brébisson and *Nitzschia obtusa* W. Smith were observed to form new patches during this period, suggesting a more complex ecological interaction. It appears that the ecological groundwork laid by cyanoprokaryotes during the pre-monsoon season may have facilitated the growth of these algae in later stages.

It is important to note that this study primarily focused on nitrogen concentration, assuming other soil parameters remained constant. In reality, multiple environmental factors such as soil moisture, pH, organic matter, temperature, and microbial interactions also play crucial roles in shaping these communities. A more holistic approach, considering these additional parameters, would be essential to fully understand the intricate ecological relationships driving these seasonal shifts.

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