Diversity of Algae inthe Paddy Fields of Igatpuri Tehsil, Nashik District, Maharashtra.

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Abstract

Bio-fertilization is a sustainable agricultural implementation that includes using bio fertilizers to increase soil nutrient content resulting in higher productivity. Soil micro-flora has been exposed to improve soil fertility and large amount of biomass productivity and identified as a correct environmentally friendly bio-based fertilizer for pollution free agricultural applies.

The large number of cyanobacteria can fix nitrogen from the atmosphere and several species including Anabaena sp, Nostoc sp, and Oscillatoriasp. is known to be effective cyanobacterial based bio fertilizers. Chlorella volgens, Scenedesmus dimorphous, Anabaena azolla, and Nostoc sp, are some of the green microalgae and cyanobacteria species that havebeen successfully used as bio fertilizers to boost crop growth.

Instead of the usage of inorganic and organic fertilizers that have polluted impacts to soil as well as water and environment also, in addition to their human carcinogenic effects. A large number of taxa of soil born algae have been recorded from different localities of Igatpuri Tehsil, Microcysts, Gleocapsa,Oscillatoria, Pediastrum,Scenedesmus, Actinastrum, Anabaena, Coelastrum, Euastrum, Cosmarium and Chroococcus are found to be dominant genus at certain locations of the Igatpuri during rainy season and winter season.

Keywords- Bio fertilization, Microalgae, soil algae, soil fertility**,** Paddy field.

Introduction-

Algae are vital to primary production, nutrient cycling, and the food web in both aquatic and terrestrial ecosystems (Daw, 1998). Over 30 years ago, researchers explored the presence and distribution of algae in soil (Dovey, 1989). Algae constitute an essential part of the soil ecosystem, acting as the autotrophic elements within the biotic community of all soil types. Furthermore, algae contribute to the ecological stability of soil ecosystems by participating in

nutrient conservation, aiding natural soil formation, and enhancing the texture and structure of the soil.

In agriculture, algae are significant as they contribute organic matter to the soil and are utilized as biofertilizers due to their involvement in various biological processes such as oxygenic photosynthesis and nitrogen fixation (Ernst et al., 1998). Notably, the nitrogen-fixing species include genera such as Anabaena, Calothrix, Nostoc, and Sytonema. Understanding the algal community in soil can aid in the conservation of soil and its living organisms. Additionally, soil quality and type, influenced by physical and chemical factors, play a crucial role in determining algal diversity.

The presence of algae in paddy fields varies with the seasons. A seasonal survey was conducted during field trips in the year 2021-22. The conditions in paddy fields are ideal for algal growth. This research highlights the seasonal diversity of algae in paddy fields and underscores their significance in agriculture. Algae serve as a biofertilizer for crops and are utilized in agricultural practices globally, enhancing soil aggregation and overall soil quality. Blue-Green Algae (BGA) are particularly effective for nitrogen fixation. Paddy fields provide favourable environments for algal development and growth.

The physico-chemical factors such as pH, electrical conductivity (EC), temperature, light, organic matter, and soil quality all contribute to the proliferation of algae in agricultural fields.

This study documents the diversity and distribution of algae in selected rice fields of Igatpuri tehsil, Nashik, for the first time.

Study area-

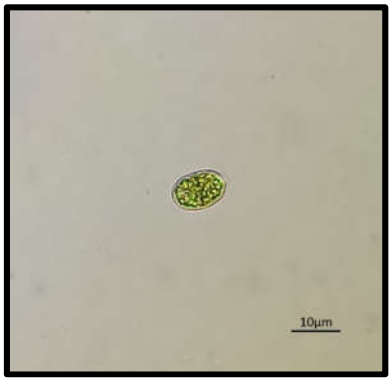
Igatpuri is located in the Nashik district, nestled in the Western Ghats of India. Igatpuri tehsil lies between 19°41’50.34’’N latitude and 73°33’39.37’’E longitude. Positioned 2,000 feet above sea level, it experiences high humidity, with an average of 87%. The region has a tropical climate, with temperatures averaging around 25°c; the highest can reach 29°c, while the lowest averages approximately 21°c. Annual rainfall in Igatpuri amounts to about 3,498 mm.

Collection of samples-

The study area has been chosen using random sampling across various paddy fields in the Igatpuri region. Soil samples were gathered during two distinct seasons: from July to September and from December to February. Algal samples were collected using plastic bottles from the waterlogged and moist surfaces of the paddy fields. Additionally, filamentous algae floating on the water were retrieved with forceps, and approximately 20 grams of soil was scraped from the top 1 cm layer of the soil.

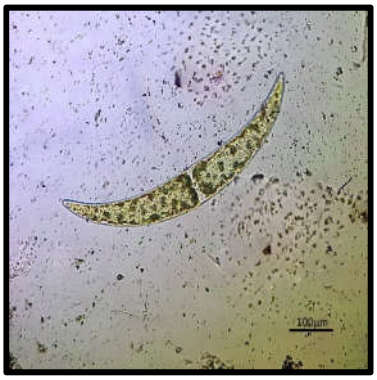
The collected samples were analysed in the laboratory and preserved in 4% formaldehyde solution. The microscope was calibrated using the micrometric method, after which the preserved samples were mounted under a light binocular microscope. Micrometric measurements were then taken using ocular and stage micrometer, and photographs were captured. Identification of the algae in the images was conducted using standard monographs, research articles, and online algal databases. Furthermore, ImageJ software was utilized for measuring microalgae and for adding scale bars to the photographs.

The current study concludes that paddy soils contribute to a notable diversity of Blue Green Algae across various locations in the Siddip region. Additional research is needed to explore the species variation within the dominant genera at the selected paddy field sites. The study examined the composition and distribution of various algal forms present in the paddy fields. Despite the abundant nitrogen available in the atmosphere, most plants, with the exception of a few Cyanobacteria, are unable to utilize it for their growth and development. Consequently, crop productivity largely relies on synthetic nitrogen fertilizers, which can be expensive for less affluent farmers. Utilizing blue green algae, such as Nostoc and Anabaena, could significantly boost the productivity of paddy crops. Algal-based bio-fertilizers are environmentally friendly, but unlike chemical fertilizers, they do not cause dramatic visible changes in crop growth and yield. The presence of algae in paddy fields influences growth in several ways, primarily through nitrogen fixation or the release of growth-enhancing substances, or a combination of both.

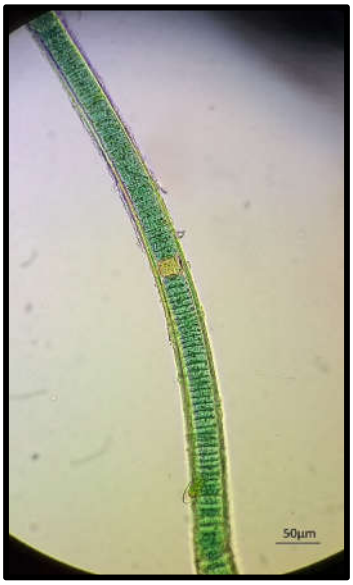


Chlorococcum humicola

Ankistrodsmus eusiformis



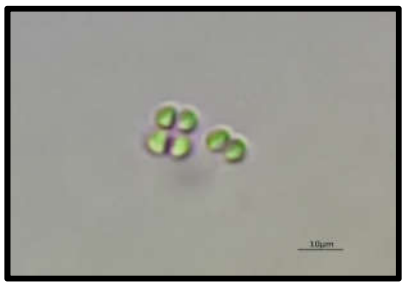
Closteriumehrenbregii



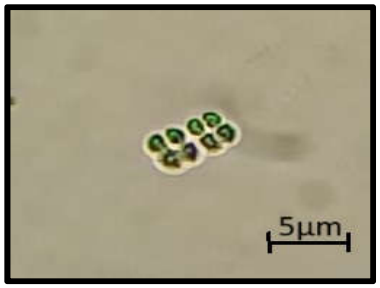
Lyngya sp.

Closterium lunula

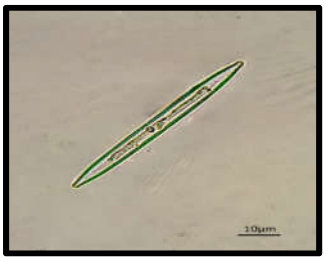
Chlorella vulgaris



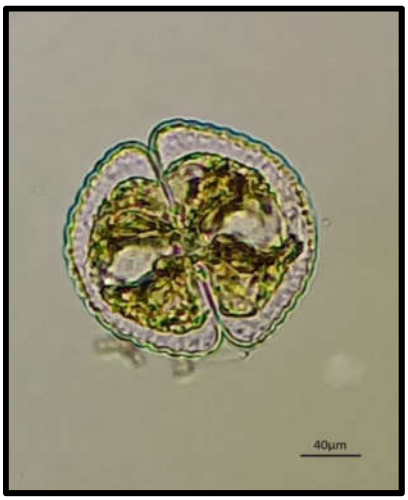
Gleocapsa sp.



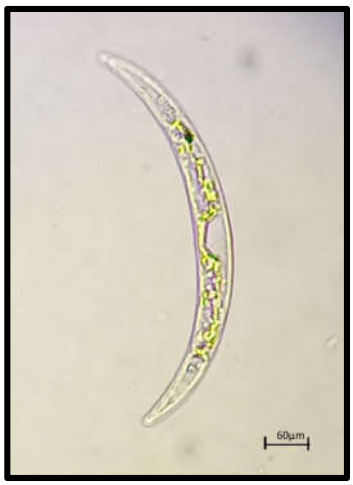
Merismopedia glauca



Synedra rumpens



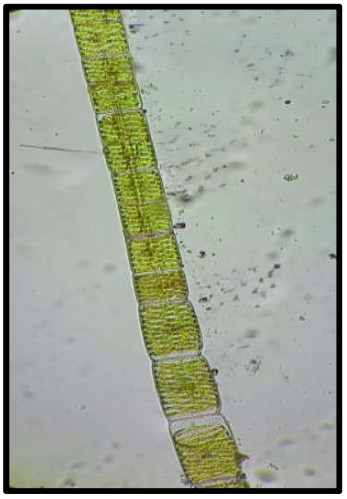
Cosmarium formosulum



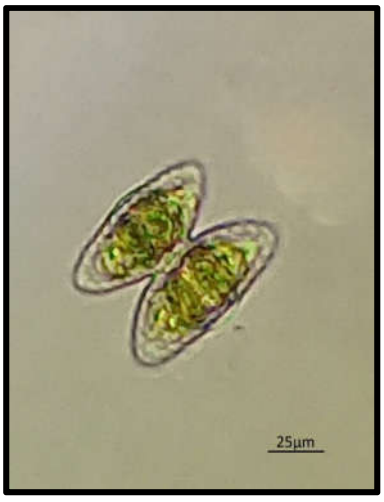
Closterium parvulum

Gyrosigma acuminatum

Microcystis sp.



Syprogyra sp.



Staurastrum avicula

Oedogonium crispum

Rhopalodia gibba

Syprogyra sp.

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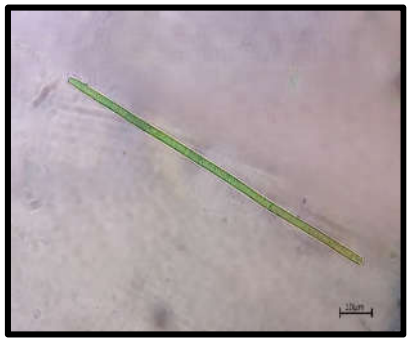
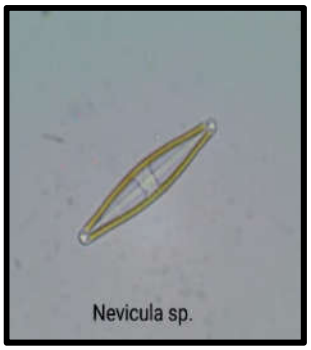
Zygnema sp



Oscillatoria limosa



Navicula sp.

Pinnulariasp

Nostoc sp

Nitzschia reversa.

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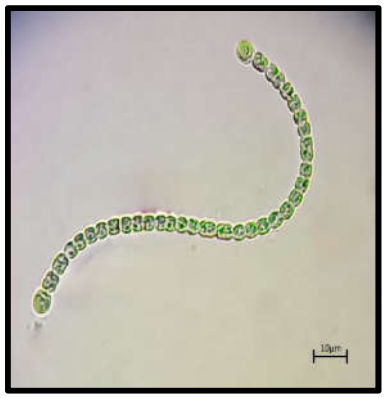
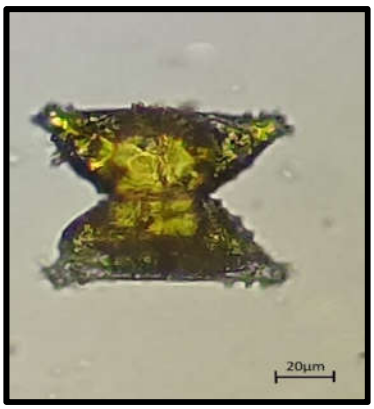
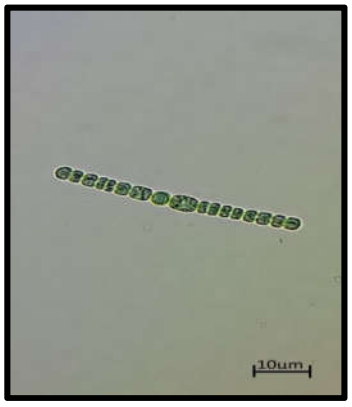




Anabaena sphaeric



Straurastrum sp.

Anabaena sp.

List of Species

Sr No.	Name of algae	Class
1	Chlorococcum humicola	Chlorophyceae
2	Ankistrodsmus eusiformis	Chlorophyceae
3	Closteriumehrenbregii	Chlorophyceae
4	Lyngya sp.	Cyanophyceae
5	Closterium lunula	Chlorophyceae
6	Chlorella vulgaris	Chlorophyceae
7	Gleocapsa sp.	Cyanophyceae
8	Merismopedia glauca	Cyanophyceae
9	Synedra rumpens	Bacillariophyceae
10	Cosmarium formosulum	Chlorophyceae
11	Closterium parvulum	Chlorophyceae
12	Gyrosigma acuminatum	Bacillariophyceae
13	Microcystis sp.	Cyanophyceae
14	Syprogyra sp.	Chlorophyceae
15	Staurastrum avicula	Zygnematophyceae
16	Oedogonium crispum	Chlorophyceae
17	Rhopalodia gibba	Bacillariophyceae
18	Syprogyra sp.	Chlorophyceae
19	Zygnema sp.	Chlorophyceae
20	Oscillatoria limosa	Cyanophyceae
21	Navicula sp.	Bacillariophyceae
22	Pinnularia sp.	Bacillariophyceae
23	Nostoc sp.	Cyanophyceae
24	Nitzschia reversa	Bacillariophyceae
25	Anabaena sphaeric	Cyanophyceae
26	Staurastrum sp.	Zygnematophyceae
27	Anabaena sp.	Cyanophyceae

Table 1. Species Diversity by Algal Class in Paddy Fields of Igatpuri

Algal Class	Number of Species	Percentage Contribution (%)
Chlorophyceae	11	40.7
Cyanophyceae	8	29.6
Bacillariophyceae	6	22.2
Zygnematophyceae	2	7.5
Total	**27**	**100**

The algal diversity observed in the paddy fields of Igatpuri revealed a total of 27 species distributed across four major algal classes (Table 1). Among these, Chlorophyceae (40.7%) and Cyanophyceae (29.6%) were the most dominant groups, followed by Bacillariophyceae (22.2%) and Zygnematophyceae (7.5%). This indicates that green algae and blue-green algae constitute the core algal flora of the region, supporting both photosynthetic productivity and nitrogen fixation within the ecosystem.

Table 2. Seasonal Distribution of Algal Species (2021–22)

Season	Chlorophyceae	Cyanophyceae	Bacillariophyceae	Zygnematophyceae	Total Species
Monsoon (Jul–Sep)	10	7	4	1	22
Winter (Dec–Feb)	8	6	5	2	21
Cumulative	**11**	**8**	**6**	**2**	**27**

The seasonal analysis (Table 2) demonstrated clear variations in species composition. During the monsoon season (July–September), 22 species were recorded, with Chlorophyceae (10 species) and Cyanophyceae (7 species) showing higher representation due to favorable moisture and

nutrient-rich conditions. In contrast, the winter season (December–February) recorded 21 species, with slight reductions in Chlorophyceae and Cyanophyceae but a relative increase in Bacillariophyceae and Zygnematophyceae, indicating that diatoms and filamentous algae are better adapted to cooler and stable waterlogged conditions. The cumulative seasonal records accounted for the full diversity of 27 species across both seasons.

Table 3. Diversity Indices of Algal Communities

Season	Shannon Index (H')	Simpson Index (D)	Evenness (E)
Monsoon	2.87	0.88	0.79
Winter	2.65	0.85	0.76
Average	**2.76**	**0.87**	**0.78**

The diversity indices (Table 3) further support this trend. The Shannon diversity index (H') was slightly higher during the monsoon (2.87) compared to winter (2.65), suggesting greater evenness and richness of species in wetter conditions. Similarly, the Simpson's index of dominance (0.88 in monsoon, 0.85 in winter) indicates a stable and diverse algal community with no single species dominating excessively. The evenness values (0.79 in monsoon, 0.76 in winter) highlight a balanced distribution of species across both seasons, with marginally higher uniformity during the monsoon.

Table 4. Dominant Genera and Ecological Roles

Genus	Algal Class	Ecological Role
Nostoc	Cyanophyceae	Nitrogen fixation, biofertilizer
Anabaena	Cyanophyceae	Nitrogen fixation, growth-promoting substances
Spirogyra	Zygnematophyceae	Contributes to soil organic matter
Chlorella	Chlorophyceae	Oxygen production, nutrient cycling
Navicula	Bacillariophyceae	Silica cycling, soil stabilization

An analysis of dominant genera (Table 4) highlights the ecological significance of these algae. Nostoc and Anabaena (Cyanophyceae) are vital contributors to biological nitrogen fixation,

providing natural fertility to paddy soils. Spirogyra (Zygnematophyceae) plays a role in organic matter enrichment, while Chlorella (Chlorophyceae) enhances oxygen levels and nutrient cycling. In addition, Navicula (Bacillariophyceae) contributes to silica cycling and soil stabilization. Together, these genera reinforce the importance of algal diversity in maintaining soil fertility, improving crop productivity, and supporting ecological stability in paddy ecosystems.

Discussion

The present investigation of algal diversity in the paddy fields of Igatpuri tehsil, Nashik, revealed a total of 27 species belonging to four major algal classes: Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Zygnematophyceae. Among these, Chlorophyceae (40.7%) and Cyanophyceae (29.6%) were found to be dominant (Table 1), whereas Bacillariophyceae (22.2%) and Zygnematophyceae (7.5%) occurred in relatively smaller proportions. This pattern of dominance is consistent with earlier reports by *Kaushik (1987)* and *Singh et al. (2014)*, who also observed green algae and blue-green algae as the principal contributors to algal diversity in Indian rice fields. The abundance of Chlorophyceae highlights their adaptability to nutrient-rich flooded conditions, while the prevalence of Cyanophyceae emphasizes their ecological role in nitrogen fixation and soil fertility enhancement.

The seasonal variation (Table 2) showed that monsoon conditions favored greater algal diversity (22 species) compared to winter (21 species). The monsoon season, characterized by high moisture, warm temperatures, and nutrient-rich soil, provides an ideal environment for rapid algal proliferation, particularly of Chlorophyceae and Cyanophyceae. These findings are in agreement with *Sahu and Mishra (2013)*, who reported maximum algal diversity during the rainy season due to optimum hydrological conditions. In contrast, during winter, the slight reduction in green and blue-green algae accompanied by an increase in diatoms (Bacillariophyceae) and filamentous algae (Zygnematophyceae) suggests a shift in dominance toward taxa adapted to cooler and stable aquatic conditions. Such seasonal fluctuations in community composition have also been highlighted by *Rai and Kumar (2004)* in studies of rice field ecosystems.

The diversity indices (Table 3) provide a quantitative measure of algal distribution. The Shannon index (H') values of 2.87 in monsoon and 2.65 in winter indicate a moderately high diversity, with greater richness during the rainy season. Similarly, the Simpson's index (0.88 and 0.85) demonstrates that the community is relatively stable, with no single taxon exerting dominance.

These values are comparable to those reported by *Pandey et al. (2017)*, who observed high algal diversity in paddy soils of the Eastern Ghats, particularly during wetter months. The evenness values (0.79 in monsoon, 0.76 in winter) confirm that algal species are well-distributed across both seasons, reflecting ecological balance within the system.

The ecological roles of dominant genera (Table 4) highlight their agricultural significance. Nostoc and Anabaena (Cyanophyceae) are well-known for their nitrogen-fixing ability, thereby enriching the soil with biologically available nitrogen, which is particularly beneficial in rice cultivation systems where nitrogen is a limiting factor (*Singh, 2012*). The presence of Spirogyra (Zygnematophyceae) contributes to organic matter buildup, improving soil structure and fertility. Chlorella (Chlorophyceae) enhances oxygen production and nutrient recycling, while diatoms like Navicula (Bacillariophyceae) play an important role in silica cycling and soil stabilization. These functional contributions of algae are well-documented by *Whitton (2000)* and *Roger & Reynaud (1982)*, who emphasized the role of algal consortia in improving soil fertility and sustaining rice field productivity.

The overall findings of this study reinforce the ecological significance of algae in paddy ecosystems. Algae not only contribute to primary production and oxygen balance but also act as natural biofertilizers through nitrogen fixation and organic matter input. This reduces the dependency on synthetic fertilizers, which are both costly and environmentally unsustainable. Similar conclusions were drawn by *Subramanian and Kaushik (1981)*, who demonstrated that inoculation of rice fields with blue-green algae significantly enhanced grain yield. In the Igatpuri region, the presence of nitrogen-fixing species such as Nostoc and Anabaena suggests their potential for development into locally adapted biofertilizer formulations.

Conclusion:

The present study reveals a rich diversity of algae in the paddy fields of the Igatpuri region. A total of 27 species from various algal classes have been identified, highlighting the ecological significance of these organisms in the agricultural ecosystem.

Species Distribution

- Chlorophyceae: 11 species
- Cyanophyceae: 8 species
- Bacillariophyceae: 6 species
- Zygnematophyce: 2 species

Dominance of Algal Classes:

Among the identified species, members of the Chlorophyceae and Cyanophyceae classes are found to be more dominant compared to those from the Bacillariophyceae and Zygnematophyce classes.

Ecological Significance

The diversity of algae is crucial for maintaining the health of the paddy field ecosystem. Their roles include:

- Nutrient Cycling: Algae facilitate the cycling of nutrients within the ecosystem.
- Habitat Provision: They serve as a habitat and food source for various aquatic organisms.
- Oxygen Production: Through photosynthesis, algae contribute significantly to oxygen levels in the water.

This study underscores the importance of algal diversity in paddy fields and its impact on ecosystem functioning. The findings not only contribute to the baseline knowledge of algal flora in the region but also emphasize their application in sustainable agriculture.Future studies should focus on the molecular characterization of dominant species, seasonal succession dynamics, and experimental trials of algal-based biofertilizers to reduce chemical fertilizer dependency and improve long-term soil health.

Acknowledgments

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