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"A STUDY ON TROPHIC STATUS OF RANI TALAB AND KUBER POND, REWA, MADHYA PRADESH, INDIA

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ABSTRACT:

Managing the trophic status of a pond is vital for fish culture. Different fish species have varying nutrient requirements and environmental tolerances. Therefore, understanding the trophic status helps in selecting suitable fish species and implementing appropriate management strategies. For example, in eutrophic ponds, measures like reducing nutrient runoff from surrounding areas, implementing aeration systems, or introducing species that can help control excessive algal growth may be necessary to maintain a healthy fish population.

In the Kuber Pond, estimated trophic status annual range average value and standard deviation of Secchi disc were 3.71 to 6.71 M and ±0.85 M during the first year of research period in Kuber Pond, Rewa, while phosphorus was 0.87 to 2.58 M and ±0.47 M, chlorophyll was 2.17 to 4.30 mg/l and ±0.66 mg/l respectively. While in Rani Talab Pond were 3.25 to 6.25, 4.92 M and ±1.04 M, during the first year of research period in Rani Talab Pond, Rewa, while phosphorus was 1.07 to 3.18, 2.04 mg/l and ±0.63 mg/l, chlorophyll was 1.97 to 5.85, 3.76 mg/l and ±1.15 mg/l respectively.

Key words: Environment tolerance, eutrophic ponds, algal growth, fish population etc.

INTRODUCTION:

The surface water and land resources of the country play a major role in agriculture, hydropower generation, livestock production, industrialization, forestry, fisheries, navigation, recreational purposes etc. The demand for limited quantity of water has increased manifold and with sewage, industrial runoff, agricultural runoff, various types of chemicals and other man-made sources have depleted large portions of this limited quantity of standard water.

The water features of any water body largely depend on geographical location, climate, weather, topography and depositional pressure. Supermarkets and units located near supermarkets receive good amount of sewage load causing changes in their physico-chemical properties.

The trophic status of a pond ecosystem refers to the nutrient levels and overall productivity within the pond. It provides valuable insights into the availability of resources necessary for supporting various organisms, including fish, in the aquatic environment.

Trophic status of a pond ecosystem plays a crucial role in determining its overall productivity and the potential for fish culture. Assessing and managing nutrient levels is key to creating a balanced and sustainable environment, ensuring the well-being and successful cultivation of fish species.

Holopainen et al., (1996) studied the trophic state of lake Lodiga in relation to phytoplankton community. Number of researchers who made research effort in variety of fishes and their biological properties such as zoological survey of India, Tamot and Awasthi (2010). Carlson (1997) suggested categories trophic parameter of lakes on the basis of nutrients level (Aizaki et al., 1981), Zuoyong et al., (1990) stated the ranges of value for each trophic type (oligotrophication, mesotrophication, eutrophication, hypertrophication)

MATERIALS AND METHODS (METHODOLOGY)

The present piece of research work was carried out during November 2019 to October 2020 keeping in view investigating “Diversity Of Ichthyofauna And Avifauna In Relation To Trophic Status Of Two Aquatic Resources Of District Rewa (M.P.)”

(A) Description of research study site:

Rani Talab Pond and Kuber Pond:

Selected sites are Rani Talab and Kuber Talab in Rewa district of Madhya Pradesh, India. The total area of Rani Talab and Kuber Talab is approx 37.57 acres and 6 acres respectively. The surface quality of the Rani Talab and Kuber Talab are slightly degraded due the pollution from surrounding areas directly entering the water.

(B) Trophic Status Calculation Method:

The Carlson Trophic Status Index (TSI) is a method used to quantify the trophic condition of a water body, usually a lake or reservoir. It was developed by Dr. Robert Carlson in the 1970s as a way to assess the level of eutrophication, which refers to excessive nutrient enrichment in a water body.

The TSI is calculated based on three key parameters: total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi disk transparency. These parameters are indicative of different aspects of water quality and provide information about nutrient levels, algal biomass, and light penetration.

The TSI equation varies slightly depending on the specific version used, but the general formula is as follows:

$TSI = 60 + (10 * \sqrt{(TP)}) - (30 * \ln(Chl\text{-}a)) - (20 * \ln(transparency))$

In this equation, TP is measured in micrograms per liter (µg/L), Chl-a is measured in milligrams per cubic meter (mg/m^3), and transparency is measured in meters (m). The natural logarithm (ln) is used to account for diminishing returns as the variables increase.

The TSI scale typically ranges from 0 to 100, with higher values indicating more eutrophic conditions. A TSI below 30 suggests an oligotrophic (low-nutrient) state, while values between 40 and 50 represent mesotrophic (moderate-nutrient) conditions. TSI values above 50 indicate eutrophic (high-nutrient) or even hypertrophic (excessively nutrient-rich) waters.

OBSERVATION AND RESULTS

Trophic status

The trophic status of a body of water refers to its nutrient and productivity levels, which are crucial indicators of its overall health and ecological balance. This status is determined by factors such as nutrient concentrations (particularly phosphorus and nitrogen), primary productivity, and the resulting abundance of plants and algae.

Understanding the trophic status of a water body is pivotal for assessing its susceptibility to issues like eutrophication – an excessive growth of plant life due to high nutrient levels – which can lead to oxygen depletion and harm aquatic organisms. The trophic status also influences the overall biodiversity and functioning of aquatic ecosystems.

By evaluating the trophic status, scientists and environmental managers gain insights into the ecological condition of water bodies, enabling them to make informed decisions about conservation, remediation, and management strategies. Monitoring and managing the trophic status of water bodies is essential for maintaining their ecological balance and ensuring sustainable use for human activities such as drinking water supply, fisheries, and recreation.

For the estimation of trophic status annual range average value and standard deviation of Secchi disc were 3.25 to 6.25, 4.92 M and ±1.04 M, during the first year of research period in Rani Talab Pond, Rewa, while phosphorus was 1.07 to 3.18, 2.04 mg/l and ±0.63 mg/l, chlorophyll was 1.97 to 5.85, 3.76 mg/l and ±1.15 mg/l respectively (Table 1).

In the second year of research period in Rani Talab Pond, Rewa Secchi disc was ranged from 2.84 to 6.44 M average annual value 4.88 M and standard deviation ±1.16 M while phosphorus was 1.25 to 3.21, 2.19 mg/l and ±0.56 mg/l and chlorophyll was 1.45 to 3.72, 2.54 mg/l and ±0.65 mg/l respectively (Table 1).

Seasonal variation of Secchi disc highest in winter followed by summer and rainy seasons with 5.76, 5.29 and 3.71 M respectively, phosphorus highest in winter summer and rainy with 2.53, 1.89 and 1.71 mg/l respectively and chlorophyll highest in winter followed summer and rainy with 4.65, 3.47 and 3.15 mg/l during the first year of research period in Rani Talab Pond, Rewa. In the second year of research period in Rani Talab Pond, Rewa same seasonal variation with different values was recorded. Overall trophic status showed that the research site or pond is mesotrophic with average index value was 35 (Table and graphs 1a, 1b, 1c and 1d).

In the Kuber Pond, estimated trophic status annual range average value and standard deviation of Secchi disc were 3.71 to 6.71 M and ±0.85 M during the first year of research period in Kuber Pond, Rewa, while phosphorus was 0.87 to 2.58 M and ±0.47 M, chlorophyll was 2.17 to 4.30 mg/l and ±0.66 mg/l respectively (Table 2 and graph 2a).

In the second year of research period in Kuber Pond, Rewa Secchi disc was ranged from 3.77 to 6.39 M average annual value 5.14 M and standard deviation ±0.78 M while phosphorus was 0.94 mg/l average value 1.65 mg/l and ±0.42 mg/l and chlorophyll was 1.71 to 4.40, 3.29 mg/l and ±0.74 mg/l respectively (Table 2 and graph 2b).

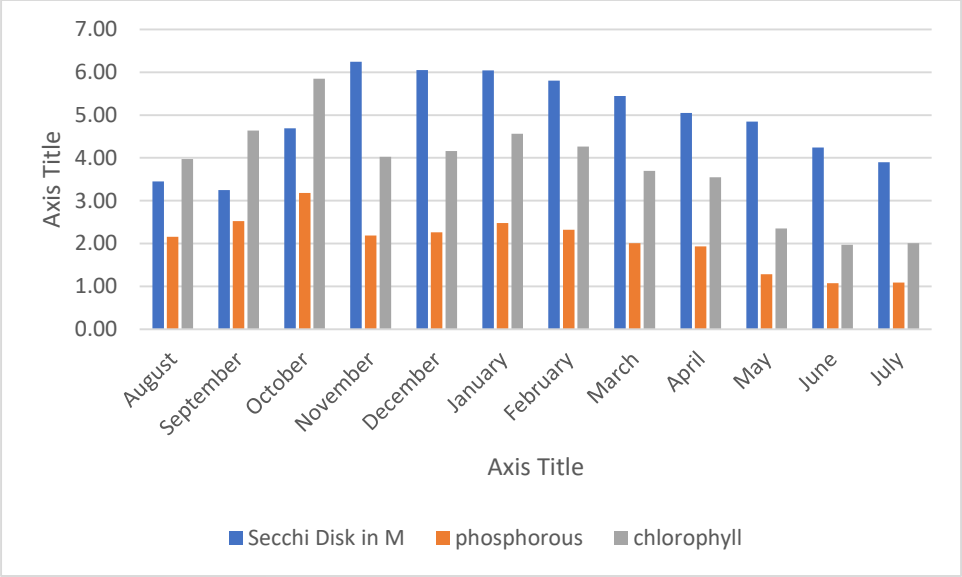
Seasonal variation of Secchi disc highest in winter followed by summer and rainy seasons with 6.02, 5.33 and 4.45 M respectively, phosphorus highest in winter summer and rainy with 1.99, 1.57 and 1.41 mg/l respectively and chlorophyll highest in rainy followed

summer and winter with 3.45, 3.43 and 3.12 mg/l during the first year of research period in Kuber Pond, Rewa. In the second year of research period in Kuber Pond, Rewa same seasonal variation with different values was recorded. Overall trophic status showed that the research side or pond is mesotrophic with average index value was 35 (Table 2 and graphs 2c and 2d).

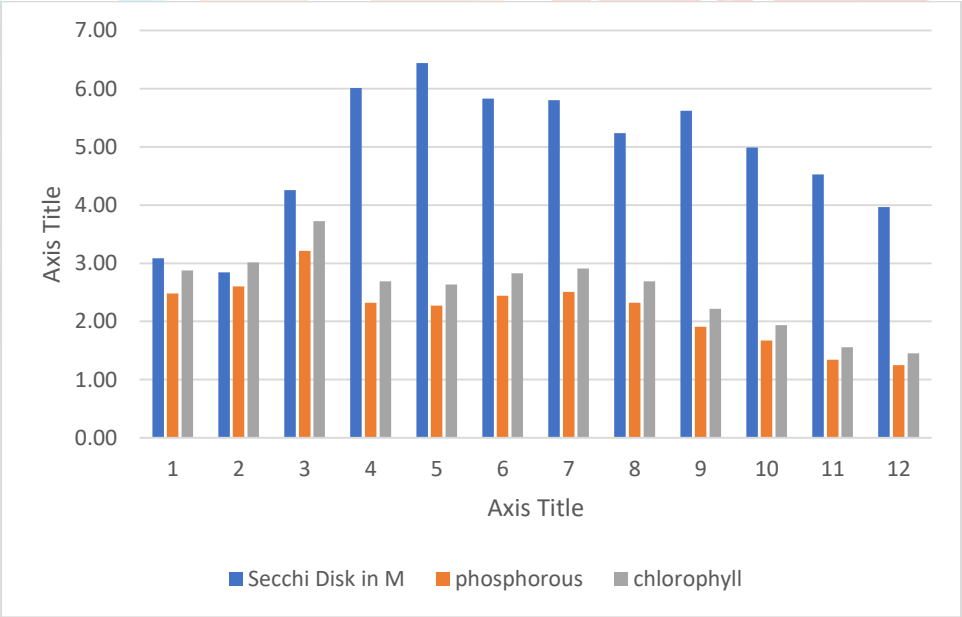
Table 1: Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Rani Talab Pond, Rewa (M.P.) from August 2019 to July 2020 August 2020 to July 2021

S. No.	Month's Name	Aug. 2019 to Jul 2020			Aug. 2020 to Jul. 2021		
		Secchi Disk in M	phosphorous	chlorophyll	Secchi Disk in M	phosphorous	chlorophyll
1	August	3.45	2.16	3.97	3.09	2.48	2.88
2	September	3.25	2.52	4.64	2.84	2.6	3.02
3	October	4.69	3.18	5.85	4.26	3.21	3.72
4	November	6.25	2.19	4.03	6.01	2.32	2.69
5	December	6.05	2.26	4.16	6.44	2.27	2.63
6	January	6.04	2.48	4.56	5.83	2.44	2.83
7	February	5.81	2.32	4.27	5.80	2.51	2.91
8	March	5.44	2.01	3.70	5.24	2.32	2.69
9	April	5.05	1.93	3.55	5.62	1.91	2.22
10	May	4.85	1.28	2.36	4.99	1.67	1.94
11	June	4.25	1.07	1.97	4.53	1.34	1.55
12	July	3.90	1.09	2.01	3.97	1.25	1.45
Average		4.92	2.04	3.76	4.88	2.19	2.54
	Min.	3.25	1.07	1.97	2.84	1.25	1.45
	Max.	6.25	3.18	5.85	6.44	3.21	3.72
	SD±	1.04	0.63	1.15	1.16	0.56	0.65
Seasonal Variation							
	Season's Name	Secchi Disk in M	phosphorous	chlorophyll	Secchi Disk in M	phosphorous	chlorophyll
	Rainy	3.71	1.71	3.15	3.61	1.92	2.22
	Winter	5.76	2.53	4.65	5.64	2.56	2.97
	Summer	5.29	1.89	3.47	5.41	2.10	2.44

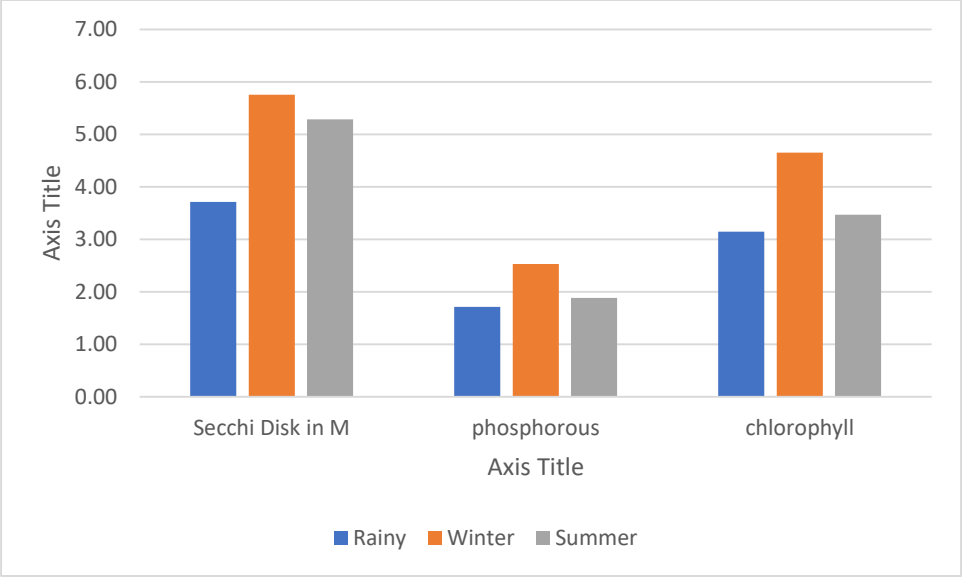
Graph 1a : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Rani Talab Pond, Rewa (M.P.) from August 2019 to July 2020



Graph 1b : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Rani Talab Pond, Rewa (M.P.) from August 2020 to July 2021



Graph 1c : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Rani Talab Pond, Rewa (M.P.) from August 2019 to July 2020



Graph 1d : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Rani Talab Pond, Rewa (M.P.) from August 2020 to July 2021

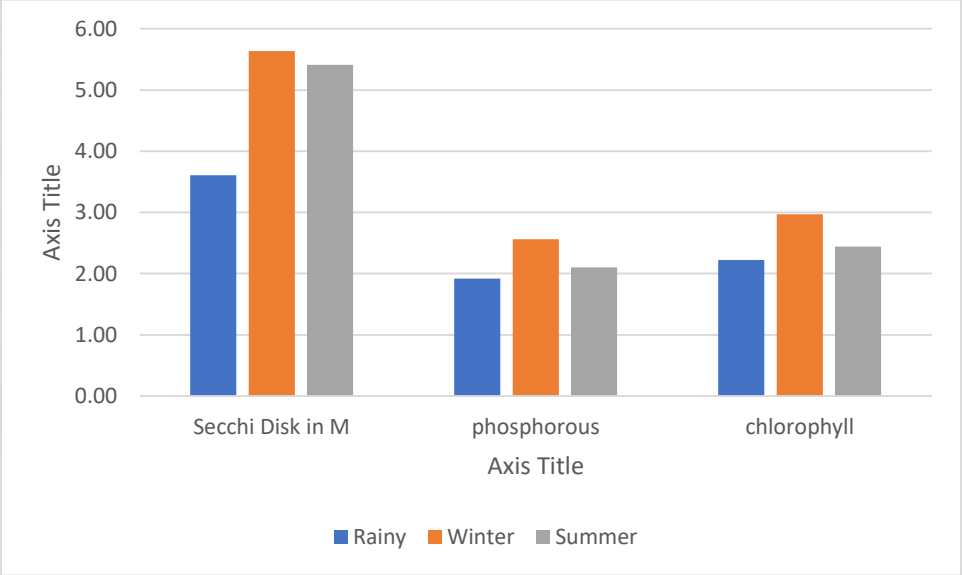


Table 2 : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Kuber Pond, Rewa (M.P.) from August 2019 to July 2020 August 2020 to July 2021

S. No.	Month's Name	Secchi Disk in M	Phosphorus	Chlorophyll	Secchi Disk in MM	Phosphorus	Chlorophyll
1	August	5.43	1.93	2.82	5.15	1.86	2.77
2	September	4.62	1.91	2.42	4.89	1.95	2.51
3	October	5.60	2.58	2.17	4.15	2.41	1.72
4	November	6.71	1.87	3.59	6.10	1.74	3.51
5	December	5.98	1.75	3.42	6.39	1.70	3.75
6	January	5.82	1.77	3.29	5.72	1.83	3.13
7	February	5.42	1.88	2.89	5.70	1.88	3.03
8	March	5.71	1.62	3.53	5.33	1.74	3.06
9	April	5.43	1.53	3.55	5.31	1.43	3.71
10	May	4.78	1.27	3.77	4.80	1.25	3.83
11	June	4.03	0.94	4.30	4.42	1.01	4.40
12	July	3.71	0.87	4.26	3.77	0.94	4.02
Average		5.27	1.66	3.33	5.14	1.65	3.29
Min.		3.71	0.87	2.17	3.77	0.94	1.72
Max.		6.71	2.58	4.30	6.39	2.41	4.40
SD±		0.85	0.47	0.66	0.78	0.42	0.74
	Season's Name	Secchi Disk in M	Phosphorus	Chlorophyll	Secchi Disk in MM	Phosphorus	Chlorophyll
	Rainy	4.45	1.41	3.45	4.56	1.44	3.42
	Winter	6.02	1.99	3.12	5.59	1.92	3.03
	Summer	5.33	1.57	3.43	5.28	1.58	3.41

Table 2a : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Kuber Pond, Rewa (M.P.) from August 2019 to July 2020

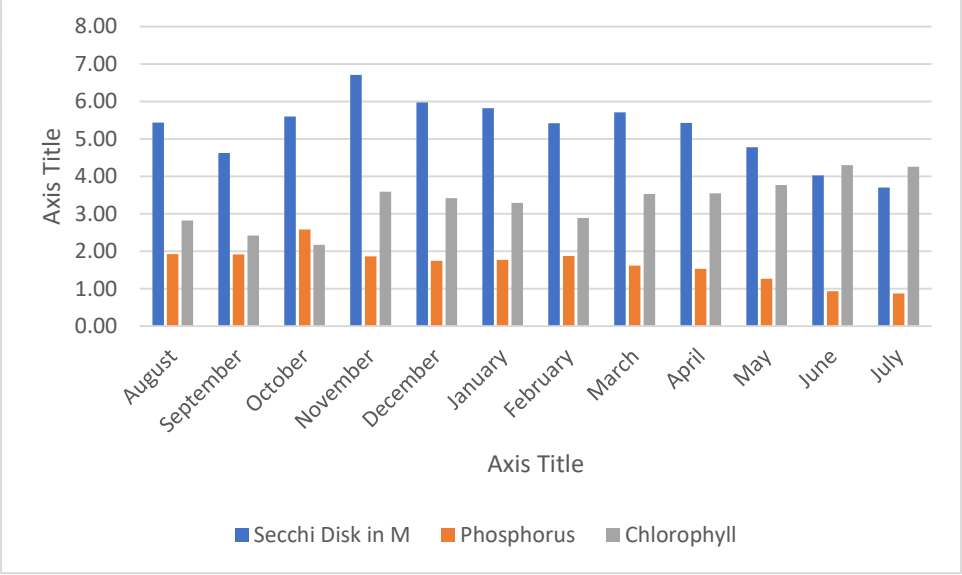


Table 2b : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Kuber Pond, Rewa (M.P.) from August 2020 to July 2021

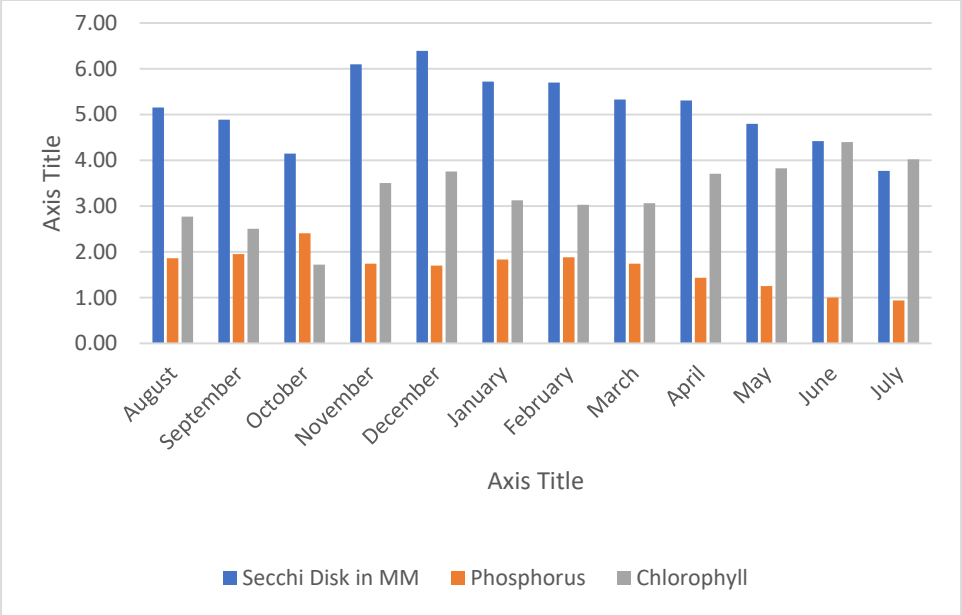


Table 2c : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Kuber Pond, Rewa (M.P.) from August 2019 to July 2020

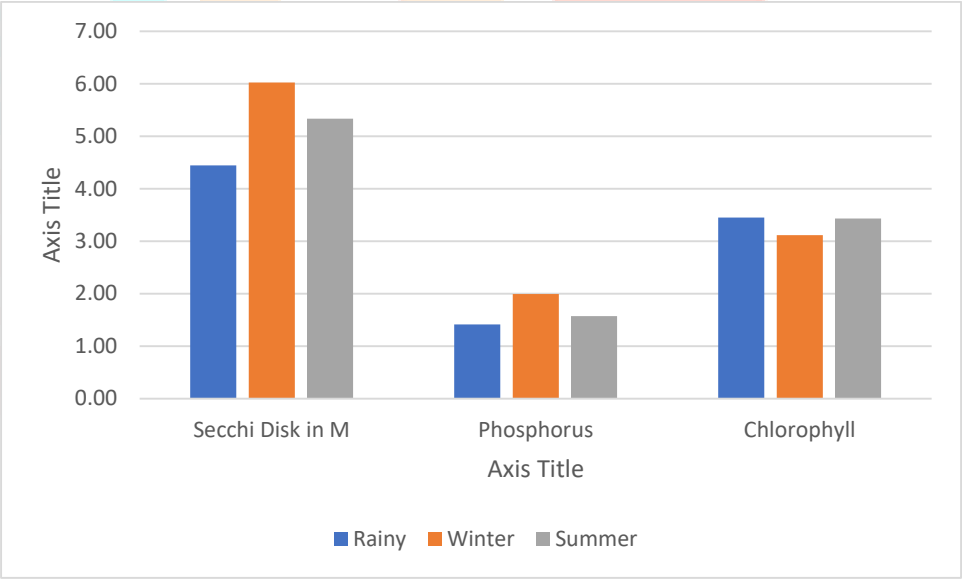
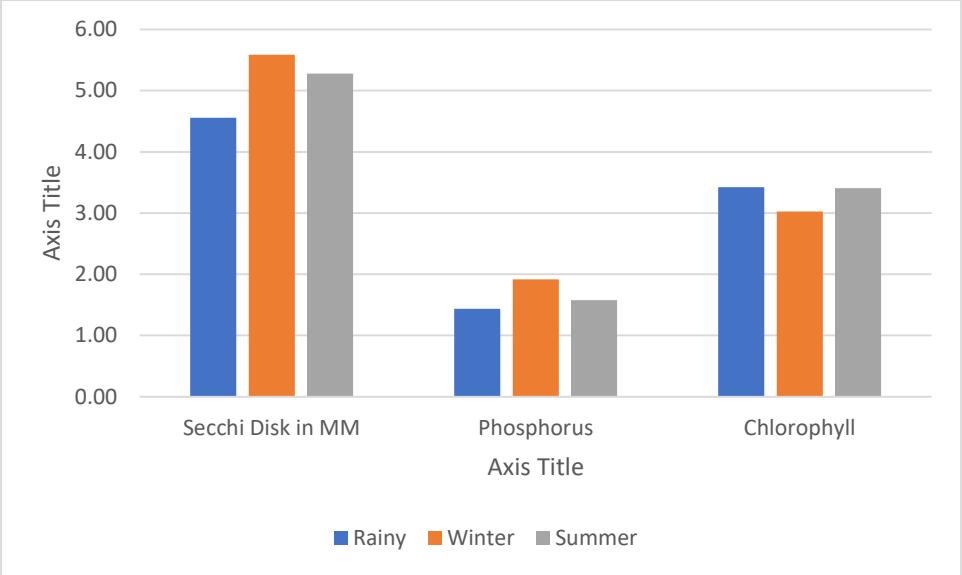


Table 2d : Average Monthly and Seasonal variation of Trophic Status in Four Sampling Sites of Kuber Pond, Rewa (M.P.) from August 2020 to July 2021



DISCUSSION

Trophic status

By evaluating the trophic status, scientists and environmental managers gain insights into the ecological condition of water bodies, enabling them to make informed decisions about conservation, remediation, and management strategies. Monitoring and managing the trophic status of water bodies is essential for maintaining their ecological balance and ensuring sustainable use for human activities such as drinking water supply, fisheries, and recreation.

For the estimation of trophic status annual range average value and standard deviation of Secchi disc were 3.25 to 6.25, 4.92 M and ±1.04 M, during the first year of research period in Rani Talab Pond, Rewa, while phosphorus was 1.07 to 3.18, 2.04 mg/l and ±0.63 mg/l, chlorophyll was 1.97 to 5.85, 3.76 mg/l and ±1.15 mg/l respectively (Table 1).

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During the study, the CTSI ranged from 37.8-44.19, indicating oligotrophic (low productivity) to mesotrophic state (moderate productivity) of the ponds. Oligotrophic state of Pond 1 throughout the study was unexpected considering the higher nutrient levels. Abundance of duckweed and other macrophytes covering the pond was probably responsible for its low algal content, and therefore, its low productivity. Weed covering prevents sunlight penetration in ponds, inhibiting photosynthetic activity and decreasing chlorophyll concentration and hence phytoplankton abundance (Uka, 2009).

The direct effect of this is low production in natural fish food (phytoplankton and zooplankton), thus resulting in overall low fish productivity. The mesotrophic state in three of the four months of study indicated moderate productivity in Pond 2. Fish production is optimal in productive water bodies (Vidovic, 2015). Phytoplankton abundance in this pond was higher as indicated by the green coloration of the water, making it suitable for fish farming. Phytoplankton in ponds stimulates the growth of zooplankton which is a source of food for fish. The oligotrophic state of the pond in the month of June was due to dilution by rainfall and reduced solar radiation. Rainfall is one of the factors limiting available nutrient in water bodies. High water level period coincided with oligotrophic status in Selingue Reservoir, Mali (Arfi, 2003).

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