

Original Research Article

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Assessment of Physico-chemical Properties and Weed Dynamics of Dalpatsagar Reservoir, Jagdalpur

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ABSTRACT

Dalpatsagar reservoir is one of the oldest water bodies in Jagdalpur city at Bastar region of Chhattisgarh state. The water bodies is severely infested with different kind of aquatic weed species throughout the year since last decade and it modified the structure of habitat and influenced the aquatic organism. The physico-chemical properties of Dalpatsagar reservoir was changed with season year after year that influence the quality of water and pond ecosystem. The study was carried out at Dalpatsagar reservoir during June 2019 to May 2020 throughout the year. To assess the physico- chemical properties of pond water sample was collected from 11 different locations at Dalpatsagar reservoir. The physico-chemical properties of Dalpatsagar reservoir was observed significantly varied with different season, the maximum value of pH 8.31 and EC 0.47 dSm⁻¹ was recorded in summer season at site of Jhada Tarae (JT) while the minimum value of pH 7.13 at the site of Mundra Dhipka (MD) and EC 0.21dSm⁻¹ at Housing Board Drainage (HBD) was recorded during monsoon season. The value of TDS was highly varied with different season, the TDS was maximum 301.60 mg/L at Jhada Tarae (JT) in summer season while it is observed minimum 202.40 at Jhada Tarae (JT) during monsoon season. The amount of CO₃ and HCO₃ 81.76 mg/L and 306.61 mg/L respectively, was observed higher during winter season while it was minimum during summer season. Dalpatsagar reservoir was severely infested with 20 major aquatic weeds species out of them the 7 most dominant weed species are *Eichhornia crassipes*, *Pistia stratiote*, *Ipomoea aquatica*, *Nelumbo nucifera*, *Alternanthera philoxeroides*, *Nymphaea rubra* and *Hydrilla verticillata* were found throughout the year. The weed density and weed dry matter was observed monthly in throughout the year. The weed density plant/m² was observed higher with *Hydrilla verticillata* followed by *Pistia stratiote* and *Eichhornia crassipes* during September to January month while the weed dry weight g/m² was found higher with *Eichhornia crassipes* followed by *Nelumbo nucifera* and *Nymphaea rubra* at throughout the year.

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Introduction

Wetland ecosystem is a natural ecosystem unit of water habitat which includes both

Biotic components and abiotic environment that influencing the properties of each other and both are necessary for the maintenance of aquatic life. It is also an essential part of

biological diversity and ecosystem functioning and its utility performance varied by the hydrological and ecosystem functioning (Banner and MacKenzie, 2000). In open fresh water wetland, quality of water play primary and important role for survival of aquatic communities, in their water stability and its quality is varied due to variation in physico-chemical properties, because some change in quality of water directly or indirectly affects the pond ecosystem. The aquatic plants diversity is also associated with water quality and they influence the health of ponds ecosystem and economic development (Prakash and Somashekar, 2006). There are various parameters that operate in the freshwater wetland ecosystem and determine the health of the ecosystems are broadly as physical (temperature, density) and chemical (pH, conductivity, TDS etc.). A detail study of these parameters will help in understanding the appropriate structural and functional aspects of an ecosystem. Physico-chemical properties such as temperature, pH, electrical conductivity, TDS, CO₃ and HCO₃ content are known to operate in pond ecosystem, which play a significant role in the composition, distribution and abundance of aquatic macrophytes (Mustapha and Omotosho, 2005). Aquatic weed species *Alternanthera philoxeroides*, *Chara* spp., *Ipomoea* spp. *Eichhornia crassipes*, *Hydrilla verticillata*, *Nelumbo nucifera*, *Nitella* spp. *Nymphaea stellata*, *Salvinia molesta*, *Typha angustata*, *Vallisneria* spp. are primary concern in Indian aquatic condition (Gopal and Sharma 1981). Among these, *Eichhornia crassipes*, alligator weed and lotus species of aquatic weeds are of primary concern in India and all over world. In general, it is estimated that 20-25% of the total utilizable water in India is currently infested with *Eichhornia crassipes* (water hyacinth), while in the state of Assam, Kerala, West Bengal, Orissa and Bihar, more than 40% water bodies are

infested with water hyacinth (Sushilkumar 2011).

Dalpatsagar reservoir is one of the oldest freshwater body located in Jagdalpur city in Chhattisgarh state. The area of lake is expanding upto 340.44 acre in between 19°5'41"N and 82°0'43"E. The lake is fairly rich with aquatic macrophytes *Ipomoea aquatic*, *Oryza nivara*, *Oxalis carniculata*, *Ipomoea carnea*, *Typha augustata*, *Echinodorus grisebachii*, *Nymphaea alba*, *Nelumbo nucifera*, *Nymphaea rubra* and *Nymphaea indica* (Pradhan and Patil, 2017). The physico-chemical properties of a Dalpatsagar lake is significantly changed by anthropogenic activity such as entry of domestic waste water, agricultural drainage water and by industrial waste water as well as natural dynamics which consequently affect the water quality, production capacity of pond, Distribution and abundance of aquatic weed species and disturbance in balance of ecological system operating in lake. Further, study on assessment of seasonal variation in physico-chemical properties for one year might reveal whether changes are seasonal fluctuations or due to other factors. Present study aims to investigate the seasonal variations of physico-chemical properties and associated weed flora at Dalpatsagar reservoir.

Materials and Methods

Fresh water body Dalpatsagar reservoir is situated at north-west part of Jagdalpur city in Chhattisgarh state, India in between 19°5'41"N and 82°0'43"E with elevation of 563 m MSL. The average annual rainfall of the area is 1400 mm. the major amount of precipitation occurs between june to September (about 3 to 4 months) which is main source of water in aquatic water body. The average annual temperature is during experiment is between 25°C to 30°C and the

hottest and coolest month was May and January respectively were recorded from meteorological observatory S.G. CARS Jagdalpur.

Sampling site was decided by considering the shallow and deep regions of the water body were must included. At Dalpatsagar reservoir, water and weed sample were collected from 11 different location and these sampling spots are locally named by fisherman as 1. Centre Temple (CT) 2. Shaan Baule (SB) 3. Bade Baule (BB) 4. Island Left (IL) 5. Island Right (IR) 6. Old Narendra Drainage (OND) 7. Mundra Dhipka (MD) 8. Tirupati Balaji Temple (TBT) 9. Jhada Tharae (JT) 10. Housing Board Drainage (HBD) and 11. Ram Temple (RT). To study the seasonal variation of physico- chemical properties and aquatic weed flora, sample were collected regularly during June 2019 to May 2020 at 15 days interval and all samples were immediately brought to the laboratory and determine the parameters within 12-24 hrs of collection. Water samples were collected in air tight glass bottles with proper label according to their name or number.

To determine the physico-chemical properties of collected water sample different water quality parameter was analyzed. The samples were analyzed for physico-chemical properties such as pH, EC (Jackson, 1967), TDS and carbonate & bicarbonate content (Chopra and Kanwar, 1999) using standard procedure. Different types of aquatic weeds were also collected and identified during study. Weed density (plant/m²) and Weed dry weight (g/m²) was recorded by placing a quadrat (1m²) at three random spots in each sampling site during every sampling date.

Results and Discussion

Seasonal variation in physico-chemical properties and floral composition of

Dalpatsagar reservoir was observed regularly and obtained result from analysis of collected sample was present with the help of appropriate table and graphs.

Physico-chemical parameters

pH

pH is a important parameter to determined the water quality of any aquatic ecosystem. The value of pH is related to the acidity or alkalinity of the water sample. A sample is considered to be acidic if the pH is below 7.0 while, it is alkaline if the pH is higher than 7.0. In present study the value of pH at different location of reservoir was observed in the range between 7.13 and 8.31 in Table 1. The observed pH value showed significant seasonal variations with maximum 8.31 in summer season at site of Jhada Tarae (JT) followed by 8.28 at Old Narendra Drainage (OND) and the minimum pH was recorded 7.13 at site of Mundra Dhipka (MD) in monsoon season. It is also reported that the value of pH was increased in water bodies is due to higher metabolic activity of autotrophs, because they utilized the available CO₂ and liberate O₂ thus reducing H⁺ ions concentration significantly Satpathy *et al.*, (2007). During summer season the value of pH is higher due to due to utilization of bicarbonate and carbonate buffer system in Aquatic condition (Ramakrishana, 2003; Mehrotra, 1988).

EC

Electrical conductivity of water is indicate the presence of salt concentration in water, it is the capacity of water to conduct electricity and used as a tool to indicating the purity of water. It was discovered from present study that the value of EC of water is ranged between 0.21 dSm⁻¹ to 0.47 dSm⁻¹ (Table 2). At Dalpatsagar reservoir it is recorded that the

value of EC is higher 0.47 dSm⁻¹ at Jhada Tarae (JT) during summer season followed by 0.45 dSm⁻¹ at Ram Temple site. While the minimum EC was recorded during monsoon season as 0.21dSm⁻¹ at Housing Board Drainage (HBD) site. Gupta and Paul (2013) also observed the maximum electric conductivity (EC) during summer season and

in monsoon season conductivity is gradually decrease is due to increased volume of water as a result of frequent rain that caused a decline in salt concentration. The value of EC is positively correlated with the pH value, as pH value was increases the value of EC also increases significantly (Guptaa, 2009).

Table.1 Seasonal Variation in pH of Water sample at Dalpatsagar reservoir

Season	CT	SB	BB	IL	IR	OND	MD	TBT	JT	HBD	RT
Monsoon	7.39	7.42	7.44	7.56	7.54	7.52	7.43	7.54	7.60	7.51	7.45
Winter	7.40	7.40	7.63	7.90	7.66	7.73	7.57	7.47	7.45	7.36	7.55
Summer	8.05	8.27	8.15	8.08	8.25	8.28	8.27	8.04	8.31	8.19	7.84
Min.	7.39	7.40	7.44	7.56	7.54	7.52	7.43	7.47	7.45	7.36	7.45
Max.	8.05	8.27	8.15	8.08	8.25	8.28	8.27	8.04	8.31	8.19	7.84
Mean	7.61	7.70	7.74	7.85	7.82	7.84	7.76	7.68	7.78	7.69	7.62
Sd	0.38	0.50	0.37	0.26	0.38	0.39	0.45	0.31	0.46	0.45	0.20
CV	4.95	6.47	4.74	3.37	4.86	4.98	5.76	4.03	5.89	5.80	2.63

Table.2 Seasonal Variation in EC (dSm⁻¹) of Water sample at Dalpatsagar reservoir

Season	CT	SB	BB	IL	IR	OND	MD	TBT	JT	HBD	RT
Monsoon	0.28	0.27	0.29	0.34	0.31	0.33	0.24	0.27	0.26	0.21	0.31
Winter	0.36	0.36	0.34	0.37	0.37	0.35	0.35	0.34	0.33	0.33	0.32
Summer	0.42	0.42	0.44	0.40	0.40	0.39	0.44	0.43	0.47	0.38	0.45
Min.	0.28	0.27	0.29	0.34	0.31	0.33	0.24	0.27	0.26	0.21	0.31
Max.	0.42	0.42	0.44	0.40	0.40	0.39	0.44	0.43	0.47	0.38	0.45
Mean	0.35	0.35	0.36	0.37	0.36	0.35	0.34	0.35	0.36	0.31	0.36
Sd	0.04	0.03	0.06	0.03	0.03	0.03	0.04	0.05	0.07	0.03	0.07
CV	11.41	8.49	15.89	8.47	8.77	7.68	12.46	13.73	20.50	8.42	18.24

Table.3 Seasonal Variation in TDS (mg/l) of water sample at Dalpatsagar reservoir

Season	CT	SB	BB	IL	IR	OND	MD	TBT	JT	HBD	RT
Monsoon	230.40	229.60	216.80	235.20	233.60	222.40	226.40	216.80	213.60	213.60	202.40
Winter	223.20	257.60	226.40	217.60	218.40	256.00	243.20	231.20	231.20	239.20	238.40
Summer	271.20	265.60	284.00	257.60	258.40	247.20	280.00	275.20	301.60	244.80	285.60
Min.	223.20	229.60	216.80	217.60	218.40	222.40	226.40	216.80	213.60	213.60	202.40
Max.	271.20	265.60	284.00	257.60	258.40	256.00	280.00	275.20	301.60	244.80	285.60
Mean	241.60	250.93	242.40	236.80	236.80	241.87	249.87	241.07	248.80	232.53	242.13
Sd	25.89	18.90	36.35	20.05	20.19	17.42	27.41	30.42	46.57	16.63	41.73
CV	10.71	7.53	14.99	8.47	8.53	7.20	10.97	12.62	18.72	7.15	17.23

Table.4 Seasonal Variation of CO₃ (mg/l) content in water sample at Dalpatsagar reservoir

Season	CT	SB	BB	IL	IR	OND	MD	TBT	JT	HBD	RT
Monsoon	54.76	58.51	57.38	52.88	61.51	55.51	54.38	56.26	61.88	51.76	54.01
Winter	60.38	81.76	52.51	57.76	67.13	69.01	54.38	51.76	68.26	53.63	66.76
Summer	54.01	48.76	57.01	55.13	57.76	55.51	51.76	48.01	56.63	49.88	57.01
Min.	54.01	48.76	52.51	52.88	57.76	55.51	51.76	48.01	56.63	49.88	54.01
Max.	60.38	81.76	57.38	57.76	67.13	69.01	54.38	56.26	68.26	53.63	66.76
Mean	56.38	63.01	55.63	55.26	62.13	60.01	53.51	52.01	62.26	51.76	59.26
Sd	3.48	16.96	2.71	2.44	4.72	7.80	1.52	4.13	5.82	1.88	6.67
CV	6.18	26.91	4.88	4.42	7.60	12.99	2.83	7.94	9.35	3.62	11.25

Table.5 Seasonal Variation of HCO₃ (mg/l) content in water sample at Dalpatsagar reservoir

Season	CT	SB	BB	IL	IR	OND	MD	TBT	JT	HBD	RT
Monsoon	178.47	175.42	147.96	180.00	213.56	189.15	166.27	189.15	164.74	195.25	173.90
Winter	257.79	305.08	259.32	227.28	306.61	239.49	228.81	200.59	231.86	216.61	277.62
Summer	175.42	164.74	172.37	166.27	176.95	173.90	161.69	190.68	125.85	151.01	167.79
Min.	175.42	164.74	147.96	166.27	176.95	173.90	161.69	189.15	125.85	151.01	167.79
Max.	257.79	305.08	259.32	227.28	306.61	239.49	228.81	200.59	231.86	216.61	277.62
Mean	203.90	215.08	193.22	191.18	232.37	200.84	185.59	193.47	174.15	187.62	206.44
Sd	46.70	78.12	58.53	32.01	66.85	34.32	37.50	6.21	53.63	33.45	61.72
CV	22.90	36.32	30.29	16.74	28.77	17.09	20.21	3.21	30.80	17.83	29.90

Table.6 Major dominant aquatic weed species found in Dalpatsagar reservoir

S.No.	Scientific Name	Family	Common Name
1	<i>Eichhornia crassipes</i> (mart.) solms	Pontederiaceae	Water hyacinth
2	<i>Pistia stratiotes</i>	Araceae	Water lettuce
3	<i>Ipomoea aquatica</i> Forssk	Convolvulaceae	Swanry Morning glory
4	<i>Nelumbo nucifera</i> Gaertn.	Nelumbonaceae	Indian lotus
5	<i>Alternanthera philoxeroides</i> (Mart.)Griseb.	Amaranthaceae	Alligator weed
6	<i>Nymphaea rubra</i> Roxb. ex Andrews	Nymphaeaceae	Red WaterLily
7	<i>Cyperus javanicus</i> Houtt. Houttuyn	Cyperaceae	Javanese Flat Sedge
8	<i>Nymphaea alba</i> L.,	Nymphaeaceae	White water lily
9	<i>Nymphoides indica</i> (L.) Kuntz	Menyanthaceae	Yellow Waterlily
10	<i>Echinodorus grisebachii</i> Small	Alismataceae	Amazon sword plant
11	<i>Oxalis corniculata</i> L.	Oxalidaceae	Creeping wood sorrel
12	<i>Ipomoea sagittifolia</i>	Convolvulaceae	Morning Glory
13	<i>Ipomoea carnea</i> Jace.	Convolvulaceae	Pink morning glory
14	<i>Oryza nivara</i> S.D. Sharma & Shastry	Poaceae	Indian wild rice
15	<i>Alternanthera sessilis</i> (L.)	Amaranthaceae	Sessile joyweed
16	<i>Potamogeton crispus</i> L.	Potamogetonaceae	Curled pondweed
17	<i>Lamna minor</i> L.	Araceae	Common duckweed
18	<i>Potamogeton amplifolius</i> Tuckerman	Potamogetonaceae	Largeleaf pondweed
19	<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Hornwort/Coons Tail
20	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Water thyme

Fig.1 Weed Density in different month at Dalpatsagar reservoir

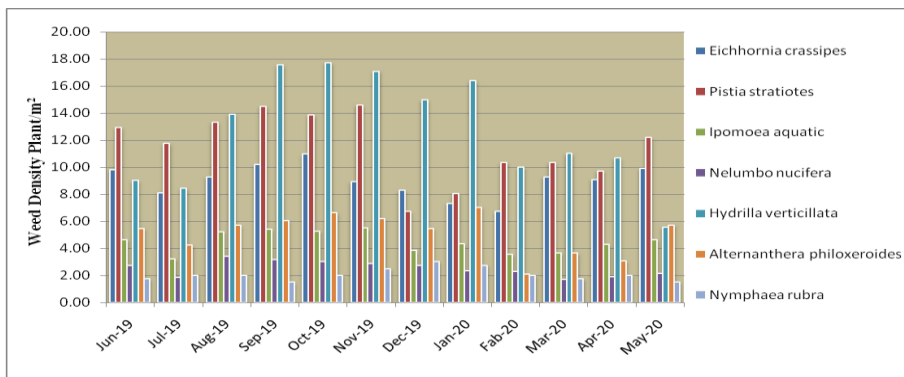
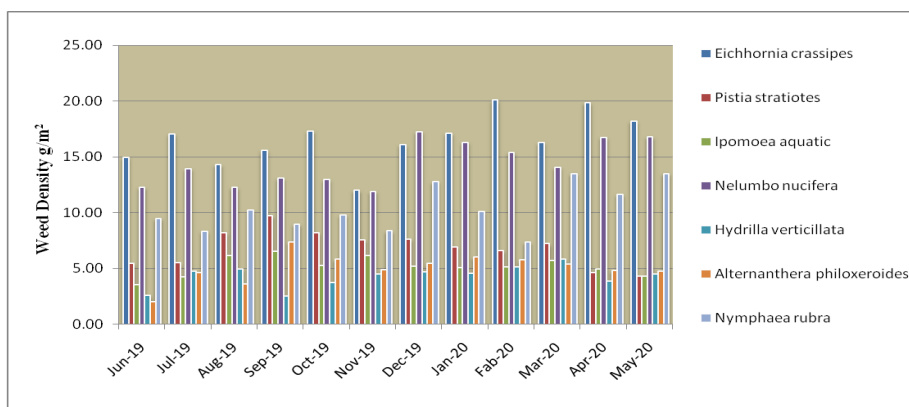


Fig.2 Weed dry weight in different month at Dalpatsagar reservoir



Total Dissolved Solid (TDS)

Total Dissolved Solid (TDS) is act as a indicator of dissolved substances in water. The total dissolved solids are somehow correlated with pH and EC that depends on escaping of acid forming materials, external dissolved salt and evaporation rate. Observed data on TDS of Dalpatsagar reservoir was significantly differed as time passed with seasonal variations. The TDS values obtained from present study ranged between 202.40 – 301.60 mg/L With highly significant seasonal variations (Table 3). The value of TDS was maximum 301.60 mg/L at Jhada Tarae (JT) in summer season followed by 285.60 mg/L at Ram Temple (RT) site and the minimum TDS 218.40 mg/l at Island Right (IR) and 202.40 mg/l at Jhada Tarae (JT) was recorded during winter and monsoon season

respectively. The maximum TDS value was recorded during summer season is may be correlated to the increased water temperatures which lead to increase the evaporation rate as well as increase the dissolved solids in water and the minimum value of TDS at reservoir were evident with the high water level in post monsoon due to the excessive dilution, stagnation and low rate of evaporation (Mathur *et al.*, 2008). Similar study on TDS was quoted by Patil *et al.*, 2011.

Carbonate (CO₃) and Bicarbonate (HCO₃) Content

In freshwaters reservoir, occurrence of CO₃ and HCO₃ ions are the result of removal of CO₂ produced by the process of photosynthesis activity or by dissolved

carbonate or bicarbonate salts in the water. In pond ecosystem higher value of pH is due to reduced photosynthetic activity and assimilation of CO₂ and Bicarbonate during in summer season. During study period the amount of carbonate (CO₃) was recorded in the range of 48.01 mg/L to 81.76 mg/L at different location of reservoir (Table 4). The higher carbonate content was noted in winter season as 81.76 mg/L at Shaan Baule (SB) followed by 69.01 mg/L at Old Narendra Drainage (OND) (Table 4). Meanwhile minimum carbonate (CO₃) content 48.01 mg/L was recorded during summer season at Tirupati Balaji Temple site and in other location amount of CO₃ was quite similar during summer season. The reason behind the higher CO₃ content during winter may be due to the uptake of free carbon dioxide by aquatic microphytes macrophytes (Sharma, 2002 and Singh, 2004) at all the study sites. During the same period bicarbonate (HCO₃) content in the water of different location was varied from 125.85 mg/L to 306.61 mg/L (Table 5). The amount of HCO₃ was recorded similar trend as carbonate content. The maximum amount of bicarbonate (HCO₃) 306.61 mg/L during winter season at island Right (IR) followed by 305.08 mg/L at Shaan Baule site. In summer season the amount of bicarbonate was observed significantly less 125.85 at Jhada Tarae (JT) location. The amount bicarbonate was recorded minimum during summer may be due to its maximum utilization by photosynthetic activity of micro and macrophytes (Kaul *et al.*, 1980 and Naik *et al.*, 2015). In general the higher carbonate and bicarbonate is due to the accumulated organic matter which is produced from decay and decomposition of vegetation and domestic sewage (Shrinivas and Aruna 2018).

Weed dynamics in Dalpatsagar reservoir

Dalpatsagar reservoir is severely infected with different aquatic weed species in throughout

the year and continuously affects the water quality and pond ecosystem. The floristic composition of aquatic macrophytes was found different in different seasons, during the study period 20 major weed species was observed in the different site of Dalpatsagar reservoir and each of them belonging to the different family. Out of 20 major weed species 7 dominant aquatic weed species *Eichhornia crassipes* (mart.) solms, *Pistia stratiote*, *Ipomoea aquatic* Forssk, *Nelumbo nucifera* Gaertn., *Alternanthera philoxeroides* (Mart.) Griseb., *Nymphaea rubra* Roxb. ex Andrews. And *Hydrilla verticillata* were found throughout the years which highly affected the pond ecosystem, similar weed species also recorded by Pradhan and Kumar 2019.

The list of commonly found weed plants seen in different sampling sites of Dalpatsagar reservoir has been shown in the Table 6.

Weed density

Fig. 1 shows the monthly variation of aquatic weed density throughout the year with different environmental condition at Dalpatsagar reservoir. The weed density is measure of number of weed plant in per m². During present study out of 20 major weed species 7 most dominant aquatic weed species are considered namely *Eichhornia crassipes*, *Pistia stratiote*, *Ipomoea aquatic*, *Nelumbo nucifera*, *Alternanthera philoxeroides*, *Nymphaea rubra* and *Hydrilla verticillata* were found throughout the year. Among of these weed species the maximum weed density was recorded 5.55 to 17.73 with *Hydrilla verticillata* in throughout the year while it is higher during September to January month followed by *Pistia stratiote* which was approximately 13.00 and *Eichhornia crassipes* was nearly 8.0 to 10 in throughout the year. Other weed species *Nelumbo nucifera* and *Nymphaea rubra* had large size

leaves they also found 2 to 3 plant per m² and comparatively density of *Alternanthera philoxeroides* and *Ipomoea aquatica* also found throughout the year. It is observed that the highest weed density was recorded after post monsoon season (Oct-19 to Feb-20) during one year of observation.

Weed dry weight

Weed dry weight was recorded in g/m² during the study period (Fig. 2) at Dalpatsagar reservoir. The highest weed dry matter was observed with *Eichhornia crassipes* 14.28 to 20.07 g/m² followed by *Nelumbo nucifera* which is 12.24 to 17.24 and *Nymphaea rubra* 7.35 to 13.49 g/m² during throughout the year. The weed dry matter of *Nelumbo nucifera* and *Nymphaea rubra* was quiet higher due to their large leaves size attain maximum weight during study period. Among of this weed species other weed species *Pistia stratiote*, *Ipomoea aquatica*, *Alternanthera philoxeroides* and *Hydrilla verticillata* also contribute significant amount of weed dry weight at throughout the year. Overall highest weed dry weight was as similar to the density of weeds because they are positively correlated to each other, as the weed density increases weed dry weight was also increases significantly.

In conclusion the physico-chemical properties of Dalpatsagar reservoir at different location was found significantly difference with different season and influenced the changing water quality as well as distribution and abundance of aquatic macrophytes. The value of pH, EC and TDS was highest during summer season while The CO₃ and HCO₃ content was maximum during post monsoon season respectively. The aquatic weed dynamics was found with different in different seasons. Dalpatsagar reservoir is severely infested with 20 different major aquatic weed species but the most dominant 7

weed species named as *Eichhornia crassipes*, *Pistia stratiote*, *Ipomoea aquatic*, *Nelumbo nucifera*, *Alternanthera philoxeroides*, *Nymphaea rubra* And *Hydrilla verticillata* were found throughout the years and affecte the pond ecosystem continuously.

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