

## ECOLOGICAL ASPECTS OF *EICHHORNIA CRASSIPES* IN THE WAI THOU LAKE, MANIPUR, NORTH-EASTERN INDIA

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The Waithou lake is a freshwater body which falls at 93° 58'E longitude and 24° 37'N latitude in Thoubal district, Manipur. The present study deals with monthly variation of phytosociological data i.e. density, abundance, frequency, primary productivity and nutrient status of *Eichhornia crassipes*. The highest value of density, abundance, frequency and IVI were recorded to be 72.0 plants m<sup>-2</sup> (April), 100.9 plants m<sup>-2</sup> (April), 71.4% (December to July) and 171.1 (May) respectively. The aboveground biomass varied from 188.0 gm<sup>-2</sup> (March) to 750.4 gm<sup>-2</sup> (July) and the maximum and minimum underground biomass were recorded to be 196.3 gm<sup>-2</sup> (July) and 57.9 gm<sup>-2</sup> (March). The total monthly biomass was found to increase gradually from 245.9 gm<sup>-2</sup> (March) to 946.7 gm<sup>-2</sup> (July) and the values were fluctuated in the remaining months. The annual total production was recorded to be 761.6 gm<sup>-2</sup> yr<sup>-1</sup>. The concentration of nutrients (N, P, K, Na) in different biomass components i.e. leaf, stem and root were estimated and their concentrations followed the sequence as leaf > stem > root. The standing state of nutrients in all the months were found in the order : N > K > P > Na.

**Keywords :** Biomass; Manipur; Net primary productivity; Nutrient status; Phytosociology.

### Introduction

Free floating macrophytes play a significant role in maintaining and regulating the structure of freshwater bodies. *Eichhornia crassipes*, the free floating macrophyte, grows luxuriantly in the freshwater lakes. Several workers have studied various aspects of phytosociology, biomass and net primary productivity of *Eichhornia crassipes* in different freshwater bodies<sup>1-8</sup>. The present study was undertaken to assess monthly variation of density, abundance, frequency, Importance value Index, biomass, net primary productivity and nutrient status of *E. crassipes* in the Waithou lake of Manipur. The submerged macrophytes absorb nutrients from the bottom mud and overlying water<sup>9</sup>. However, for the free floating aquatics, water is much emphasised as a nutrient substrate<sup>10,11</sup>.

The lake is located in the Thoubal district at a distance of 17 km from the Imphal city and is surrounded partially by hills with a mean altitude of 785 m from mean sea level. The lake is oval in shape with maximum length of 1.04 km and breadth of 0.95 km in the rainy season. The depth of the lake varied from 0.75 m to 1.67m. The mean maximum temperature ranged from 25.15°C (January) to 33.27°C (August) and the mean minimum temperature varied from 2.8°C (January) to 20.63°C (August). The mean annual rainfall is 1305.4mm.

### Materials and Methods

At the study site thirty quadrates of 50×50 cm<sup>2</sup> were

employed randomly for determining density, abundance, frequency and Importance Value Index (IVI). The distribution pattern of the species was measured by calculating the ratio of abundance to frequency (A/F ratio)<sup>12-13</sup>. Standing crop biomass was measured by harvest method<sup>14</sup> and the sampling was done monthly in various sites each with five replicates. The plant materials were washed in the running water to remove the mud and were oven dried for 72 hours at 80°C to constant weight. Biomass was assessed on dry basis and has been expressed in gm<sup>-2</sup> and productivity was computed by adding all the positive increments in the standing crop biomass in different months during the study period. Monthly changes in all the portions of the standing crop biomass of the species were added to obtain annual production.

The plant samples i.e. root, stem and leaf were oven dried and the samples were powdered for chemical analysis. Total nitrogen was determined by micro Kjeldahl method<sup>15</sup> and determination of phosphorus was carried out spectrophotometrically by using the phosphomolybdic blue colorimetric method<sup>5</sup>. The concentration of potassium and sodium were estimated through photometry method by using a flame photometer as described by Jackson<sup>16</sup>.

### Results and Discussion

The species was present throughout the year in the lake. The maximum density, frequency, and abundance were

**Table 1.** Monthly variation in the net Primary Productivity ( $\text{gm}^{-2} \text{month}^{-1}$ ) of *Eichhornia crassipes* in the Waithou Lake.

Month	Shoot	Root	Sub-total.
January	—	—	—
February	-129.60	-7.16	—
March	-108.00	-18.33	—
April	68.76	5.37	74.13
May	284.80	54.12	338.92
June	88.04	8.64	96.68
July	120.80	70.26	191.06
August	-151.20	-16.66	—
September	-367.20	-50.60	—
October	60.80	-34.40	60.80
November	-60.00	-20.80	—
December	-20.40	-3.16	—
Annual production ( $\text{gm}^{-2} \text{yr}^{-1}$ )	623.20	138.39	761.59

recorded to be 72.0 plants  $\text{m}^{-2}$  (April), 71.4% (January to July and December) and 100.9 plants  $\text{m}^{-2}$  (April) (Fig. 1). The maximum value of Importance value index was found to be 171.1 in the month of May and the values were fluctuated in all months during the study period. The ratio of abundance to frequency was 1.4 and 5.5 in the maximum density occurring months of April and June respectively. The maximum above ground biomass was recorded to be 750.4  $\text{gm}^{-2}$  in July and minimum was 188.0  $\text{gm}^{-2}$  in March.

**Table 2.** Monthly variation in concentration of nutrients ( $\text{mg g}^{-1}$ ) in biomass components of *Eichhornia crassipes*.

Biomass Components	Nutrients	Months											
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Leaf	N	1.09	1.62	1.99	2.59	2.39	1.39	1.49	2.79	1.79	0.99	0.96	0.93
	P	0.03	0.04	0.05	0.06	0.05	0.04	0.05	0.06	0.07	0.08	0.05	0.04
	K	0.13	0.14	0.15	0.16	0.15	0.14	0.15	0.17	0.18	0.19	0.14	0.13
	Na	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Stem	N	0.39	0.35	0.38	0.41	0.59	0.61	0.79	1.07	0.59	0.59	0.70	0.55
	P	0.02	0.03	0.04	0.01	0.03	0.02	0.02	0.03	0.01	0.02	0.03	0.02
	K	0.10	0.08	0.13	0.09	0.13	0.11	0.07	0.12	0.06	0.13	0.09	0.10
	Na	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.02
Root	N	0.31	0.29	0.27	0.26	0.39	0.33	0.39	0.79	0.49	0.39	0.52	0.39
	P	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
	K	0.06	0.05	0.04	0.03	0.07	0.04	0.02	0.02	0.05	0.04	0.04	0.05
	Na	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

The highest and lowest below ground biomass were estimated to be 196.3  $\text{gm}^{-2}$  (July) and 57.9  $\text{gm}^{-2}$  (March). Monthly biomass values were found to increase gradually from March (245.9  $\text{gm}^{-2}$ ) to July (946.7  $\text{gm}^{-2}$ ) and no consistent trend was observed after July (Fig. 2). Maximum monthly net productivity was recorded to be 284.9  $\text{gm}^{-2}$  in the month of May followed by 120.9  $\text{gm}^{-2}$  in July, 88.00  $\text{gm}^{-2}$  in June, 68.8  $\text{gm}^{-2}$  in October. Negative production was recorded in the remaining months.

The maximum below ground productivity was found to be 70.3  $\text{gm}^{-2}$  (July), followed by 54.1  $\text{gm}^{-2}$  (May), 8.6  $\text{gm}^{-2}$  (June) and 5.4  $\text{gm}^{-2}$  (April) respectively. No production was evident in the remaining months. (Table - 1). The ranges of the values for daily net productions of *E. crassipes* was found to be 2.0  $\text{gm}^{-1} \text{day}^{-1}$  in (October) and 11.0  $\text{gm}^{-2}$  in May.

Monthly variation in the concentrations of NPK and Na in the different components i.e. leaf, stem and root of *Eichhornia crassipes* are set in Table - 2. The mean concentration of N, P, K & Na in various biomass components of leaf, stem and root were found fluctuating in different months. The mean concentration of total nitrogen was found increasing from January to May and fluctuated thereafter. The minimum value was marked in January (0.60  $\text{mg g}^{-1}$ ) and maximum value at August (1.76  $\text{mg g}^{-1}$ ) whereas the mean concentration of phosphorus ranged from 0.02  $\text{mg g}^{-1}$  to 0.04  $\text{mg g}^{-1}$  (Fig. 3).

The mean concentration of potassium was found between 0.09  $\text{mg g}^{-1}$  and 0.12  $\text{mg g}^{-1}$  whereas the values for sodium ranged from 0.01  $\text{mg g}^{-1}$  to 0.02  $\text{mg g}^{-1}$ . The greater values for sodium were marked at May, June, August, November and December (Fig 4).

Monthly changes in the standing states of

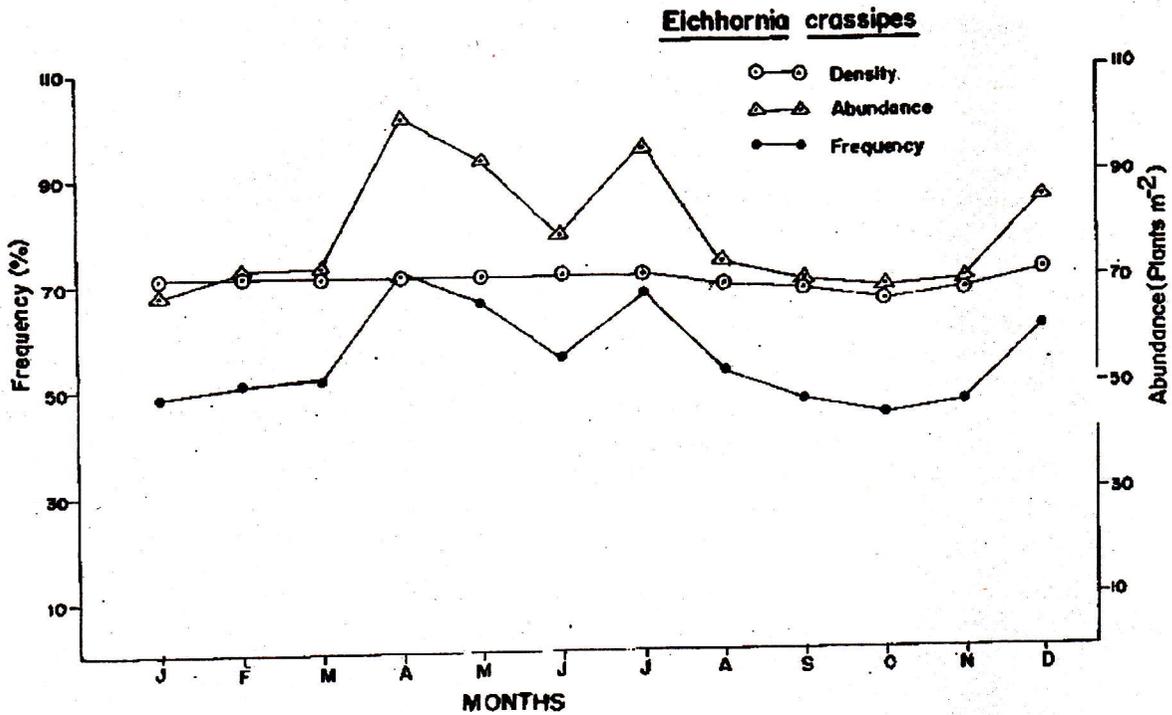


Fig.1. Monthly variation of Density, Abundance, and Frequency in *Eichhornia crassipes*.

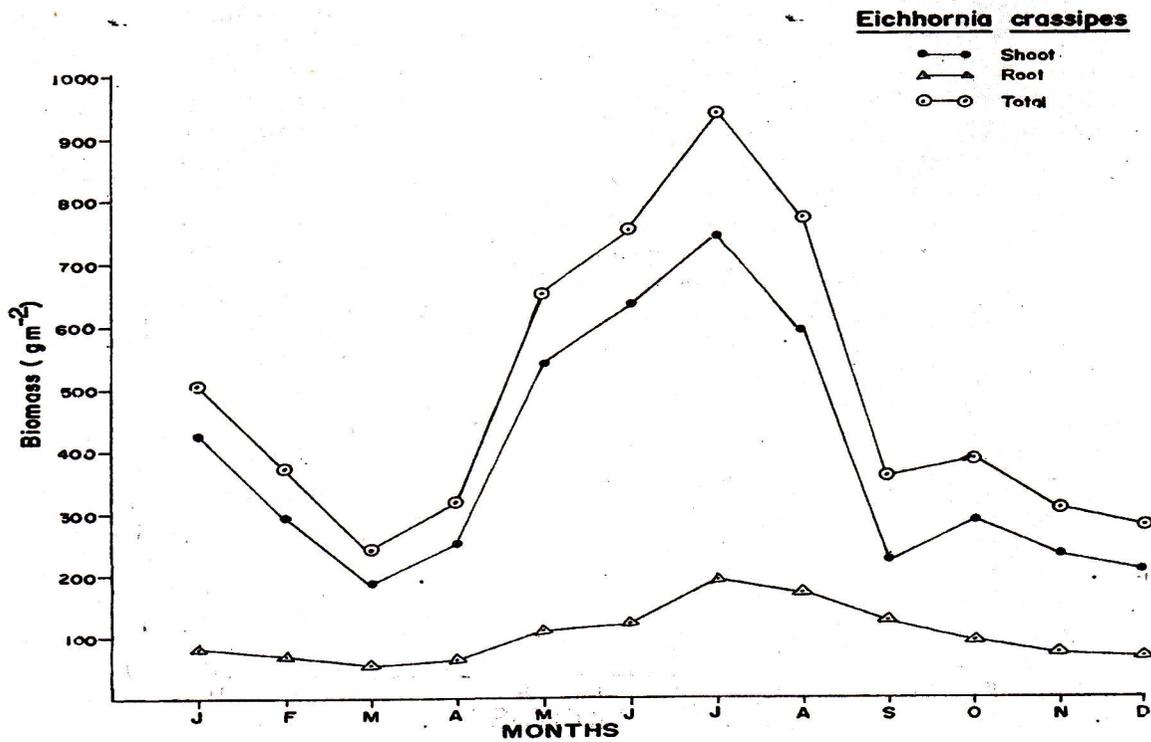


Fig.2. Monthly variation in the biomass of shoot, root and total of *Eichhornia crassipes*.

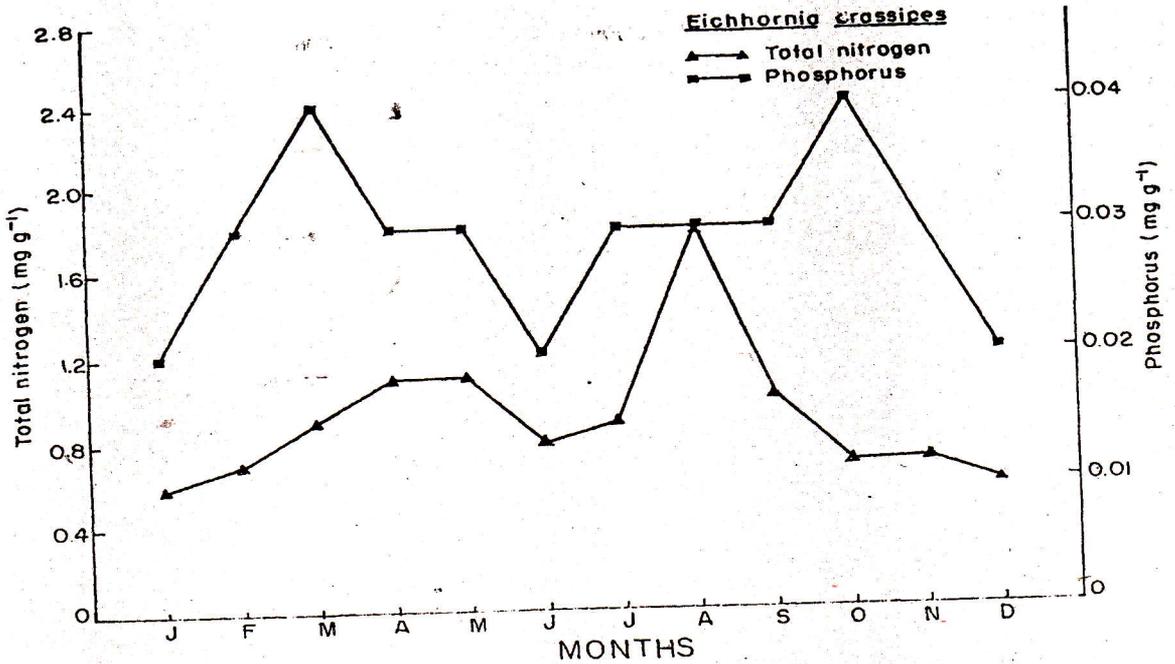


Fig.3. Monthly variations of total nitrogen and Phosphorus in *Eichhornia crassipes*.

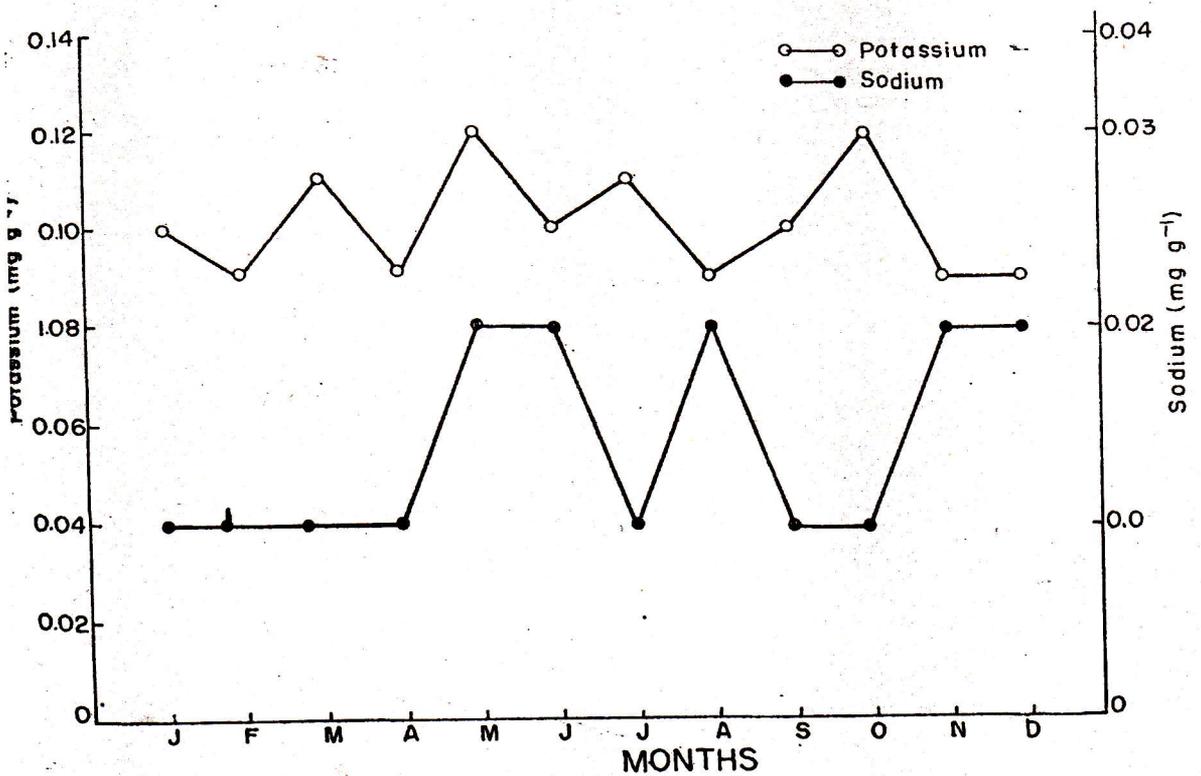


Fig.4. Monthly variations of Potassium and Sodium in *Eichhornia crassipes*.

**Table 3.** Standing State of nutrients of *E. crassipes*.

Nutrients	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
N	2035.8	1488.8	1229.3	1920.0	3953.5	3022.4	3786.4	8021.6	1082.4	1548.8	1225.6	1131.6
P	10.17	7.40	7.37	6.40	19.76	15.11	18.93	15.57	7.21	11.61	6.13	8.49
K	45.81	33.49	24.59	28.80	72.48	68.00	66.27	62.30	36.08	34.85	24.51	25.46
Na	5.09	3.72	2.46	3.20	13.17	7.56	9.47	15.58	7.22	3.87	6.13	5.66

nutrients (N, P, K and Na) has been set in Table -3. The maximum values of the standing state of nitrogen (8021.64 mg m<sup>-2</sup> in August), phosphorus (19.76 mg m<sup>-2</sup> in May), potassium (72.48 mg m<sup>-2</sup> in May) sodium (15.58 mg m<sup>-2</sup> in August) in *E. crassipes* have been estimated. The minimum values were found to be 1131.36 mg m<sup>-2</sup> for nitrogen in December, 6.13 mg m<sup>-2</sup> for phosphorus in November, 24.51 mg m<sup>-2</sup> for potassium in November and 2.46 mg m<sup>-2</sup> for sodium in March. The values of nutrients fluctuated in all the months. The accumulations of nutrients were found to be in the order: N> K> P> Na.

No regular trend for density, frequency, abundance and Importance value index were evident in the study site. Shah and Abbas<sup>3</sup> reported the value of density in the range of 8.5 plants m<sup>-2</sup> (January) to 10.8 plants m<sup>-2</sup> (February) in the river Ganges. The present value of 72.0 plants m<sup>-2</sup> (April) was found higher than the reported values. However, the present frequency value of 71.4% was found higher than the value of 6.0% in Kolleru lake<sup>5</sup>. In Pichhola lake the maximum value of Importance value index was recorded to be 51.5 in *E. crassipes*<sup>17</sup>. The present value of Importance value index (171.0) was found higher than the reported value. The plant species exhibited an aggregate nature in the present study of distribution.

The present estimated value of biomass for *E. crassipes* is very much comparable with the value reported by Singh<sup>18</sup> in the Surhatal lake in the Balia (908.4 gm<sup>-2</sup>). The values reported for *E. crassipes* in the Waithou lake has been found higher than those reported by Shahai and Sinha<sup>19</sup> (720 gm<sup>-2</sup>) from Ramgarh lake in Gorakpur, Shah and Abbas<sup>3</sup> (350.4 gm<sup>-2</sup>) from Tankighat and 449.6 gm<sup>-2</sup> from Tilokothighat of Bhagalpur, Singh and Sahai<sup>4</sup> (630 gm<sup>-2</sup>) from Jalwania pond of Gorakpur, Billore and Vyas<sup>17</sup> (5.0 to 25.0 gm<sup>-2</sup>) from Udaipur. The present findings were quite lower than the values reported by Westlake<sup>20</sup> (1500 gm<sup>-2</sup>) in Mississippi lake and Gopal *et al.*<sup>2</sup> (2067 gm<sup>-2</sup>) in Jaipur lake. The maximum biomass of the macrophytic species usually occurs during the flowering period of July and August in the northern hemisphere<sup>21</sup>. In the present study *E. crassipes* exhibited the maximum biomass in the flowering month of July.

The annual net production was found to be 761.6 gm<sup>-2</sup> yr<sup>-1</sup>. The present value was quite higher than the value reported by Billore and Vyas<sup>17</sup> (80 gm<sup>-2</sup> yr<sup>-1</sup>) in pichhola lake, Udaipur. Among the aquatic macrophytes *E. crassipes* is one of the productive aquatic macrophytes and extending in the tropical and subtropical regions of the world<sup>22</sup>. Daily net primary productivity of *E. crassipes* (2.0 – 11.0 gm<sup>-2</sup> day<sup>-1</sup>) in the present study was found higher than the values reported by Billore and Vyas<sup>17</sup> (0.10 gm<sup>-2</sup> day<sup>-1</sup>) in Pichhola lake, Udaipur, Singh<sup>18</sup> (1.22 gm<sup>-2</sup> day<sup>-1</sup>) in Surhatal lake, Ballia, Saha (0.3 gm<sup>-2</sup> day<sup>-1</sup>) in Mukhra and Tiwari pond, Bhagalpur. The present values are comparable to the value reported by Westlake<sup>20</sup> (7.4-22 gm<sup>-2</sup> day<sup>-1</sup>) in Neworleans. Das<sup>23</sup> (3.5–9.5 gm<sup>-2</sup> day<sup>-1</sup>) in Varanasi, Sinha<sup>4</sup> (3.8 gm<sup>-2</sup> day<sup>-1</sup>) in Gorakpur and the values are found lower than the higher values reported by Yount and Crossman<sup>25</sup>. De Busk *et al.*<sup>26</sup> (2–29 gm<sup>-2</sup> day<sup>-1</sup>) in central and southern region of Florida. The more productivity of the plant species was due to its fully exposing to sunlight and regular multiplication throughout the year. The present study site has been found to be a eutrophic lake due to its continues coverage of *E. crassipes* in all the months of the year.

The concentration of nutrients in all the biomass components of *E. crassipes* were found in the order : Leaf > Stem > Root. The concentration of nutrients were found to follow the decreasing trend : N > K > P > Na. A more or less trend of N, P, K, & Na was observed for concentration of the nutrients in four macrophytes in a wetland in Varanasi<sup>27</sup>.

The standing state of nutrients (NPK and Na) in all the months for *E. crassipes* were fluctuating. The present values are found comparatively lower than those in Wetlands of Kashmir where Kaul *et al.*<sup>28</sup> reported 16.79 - 124.30 kg ha<sup>-1</sup> yr<sup>-1</sup> of Nitrogen, 0.79 - 10.24 kg ha<sup>-1</sup> yr<sup>-1</sup> of Phosphorus, 16.21 - 251.67 kg ha<sup>-1</sup> yr<sup>-1</sup> of Potassium and 2.52 - 32.30 kg ha<sup>-1</sup> yr<sup>-1</sup> of Sodium.

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