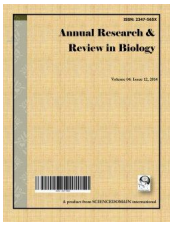

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Effects of Environmental Stress on Nutrients of *Typha domingensis Pers.* Plant in Najaf, Iraq

Muthik A. Guda[1], J. I. Hakeem[1], Maytham M. Alabassi[1] and B. A. Almayahi[1*]

[1]Department of Environment, Faculty of Science, University of Kufa, 54003 Kufa, Najaf Governorate, Iraq.

Authors' contributions

This work was carried out in collaboration between all authors. Author MAG designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors JIH and MMA managed the analyses of the study. Author BAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study determined the natural and environmental characteristics of Baher Al-Najaf Depression (BAND) in Iraq and their effect on nutrients of *Typha domingensis* as responses to environmental stresses in 4 sites. Samples were collected monthly (February 2015 to January 2016). The environmental factors of water and sediment were included: Temperature, Electrical Conductivity (EC), Salinity, pH, Total Dissolved Solids (TDS), Turbidity, Total Suspended Solids (TSS), Dissolved Oxygen (DO), Total Hardness (TH), Total Nitrogen (TN), Total Phosphorus (TP), Sulfate (SO_4^{2-}), Potassium (K^{+1}), Chloride (Cl^{-1}), Sodium (Na^{1+}), and Total Organic Carbon (TOC). The highest values of the environmental factors were found to be at autumn and summer whereas the lowest values were at winter and spring. Environmental factors were ordered significantly as follows: S2> S3> S4> S1. The studied factors of climate were air temperature, relative humidity, the intensity of solar radiation, precipitation rate and evaporation rate. This study has shown that climatic factors effected on water resources and salinity level in BAND. Ionic contents (Na^+ and Cl^-) were increased significantly whereas K^+, TP, and TN were decreased with increasing levels of environmental stresses at each site along with the season. In general, the levels of nutrients (N and P) were

**Corresponding author: E-mail: basimnajaf@yahoo.com, basim.almayahi@uokufa.edu.iq;*

ordered as follows: water <sediments < plants. This means that *Typha domingensis* have the ability the accumulation of nutrients.

Keywords: Typha domingensis; environmental stress; nutrients; phosphor; nitrogen.

1. INTRODUCTION

The availability and uptake of nutrients by macrophytes are affected by many factors in the water, soil, and plant environments. The concentration of elements can influence on the uptake and transport of a nutrient. Macrophytes are varied not only in the rate of nutrient, but also in distributing the elements in the plant. Sodium has a profound effect on calcium mobility and distribution within plant. The environmental stresses were added a new level of complexity to the mineral nutrition of macrophytes. Morphological characteristics of plants can be relevant with nutrient in determining the role and dominance and development of plants [1]. The main objectives of the growth and production of nutrition either causes increasing the Total Nitrogen (TN) and high protein in glycophytic plants or increasing soluble proteins [2]. Total Phosphorus (TP) is the 2nd nutrient, which is required by plants. It is an essential component of nucleic acids, phosphorylated sugars, lipids, and proteins. Phosphorus is high-energy phosphate bonds with adenine, guanine, and uridine. Plants with high growth rate are required a large amount of phosphorus which is often not found in environments [3].

K+ are necessary for photosynthesis under stressful conditions [4]. Cl^{-1} is one of the essential micronutrient elements in plants. It is mainly involved in the photolysis of water by photosystem II. Cl^{-1} *Typha domingensis* is a perennial herbaceous plant of the genus Typha. It is found throughout temperate and tropical regions in worldwide [5]. *Typha domingensis* has the ability to reduce bacterial contamination up to 98% in agricultural water [6]. There are few studies on effects of environmental stress on plant in the BAND. In this study, a sub-acute experiment was conducted to examine the environmental stresses on *Typha domingensis* by testing nutrient and determination the environmental factors such as EC, TDS, TSS, and SAL. In this study the hypotheses were as following:

1. Physical and chemical properties of water and sediments.
2. The climatic factors.
3. The environmental stresses on *Typha domingensis*.

2. MATERIALS AND METHODS

The BAND is located in the province of Najaf in Iraq. The area of BAND is about 360-750 km^2 with a longitude of 43˚ 40 - 44˚ 25 E and a latitude of 31˚ 40 - 32˚ 10 N and an altitude of about 11 m at the sea level, as shown in Fig. 1. In this study, four sites were studied. Site 1 (044.29471 E, 31.97540 N) is containing various chemicals due to detergent and agricultural pesticides. Site 2 (044.29262 E, 31.97603 N) is containing different chemicals from industrial materials. The water of site 3 (044.21085 E, 31.98756 N) has salts due to ground wells. Site 4 (044.20642 E, 32.00087 N) is located near the strategic oil line.

Water samples were collected monthly (February 2015 and January 2016) for 3 times in each site. All samples were collected from a depth of 30 cm. Water temperature (C˚), pH, Electrical Conductivity (EC) and Salinity and Dissolved Oxygen (DO) were measured using Multi-Lab Pilot V.4. Turbidity was measured using a Nephelometer Lamotte (WTW) U.S.A 1979. TDS, TSS, Cl^{-1}, Na^{+1}, K^{+1}, SO_4^{-2}, TN, and TP were measured using adopted methods of American Public Health Association [7]. The climatological features of the sites were included air temperature, relative humidity, the intensity of solar radiation, precipitation rates, day, and evaporation rate. Plant materials were collected in four different sites. It was harvested seasonally during this study. Plants were cleaned by tap water and distilled water. Fresh plant leaves were separated from plants and were kept in a cool place of 4°C. Dried samples were grinded using a mortar before a digestion procedure. TN was determined using Micro-Kjeldahl method [8]. TP was determined according to Chen Jr. et al., 1956 [9] using the digested plants solution mixed with the reagent at a ratio of (1:1). Test tubes were closed and were incubated in the dark place at 37°C (1.5 to 2 h). The light absorbance was read at 750 nm using a spectrophotometer. The standard curve was adjusted in the range of

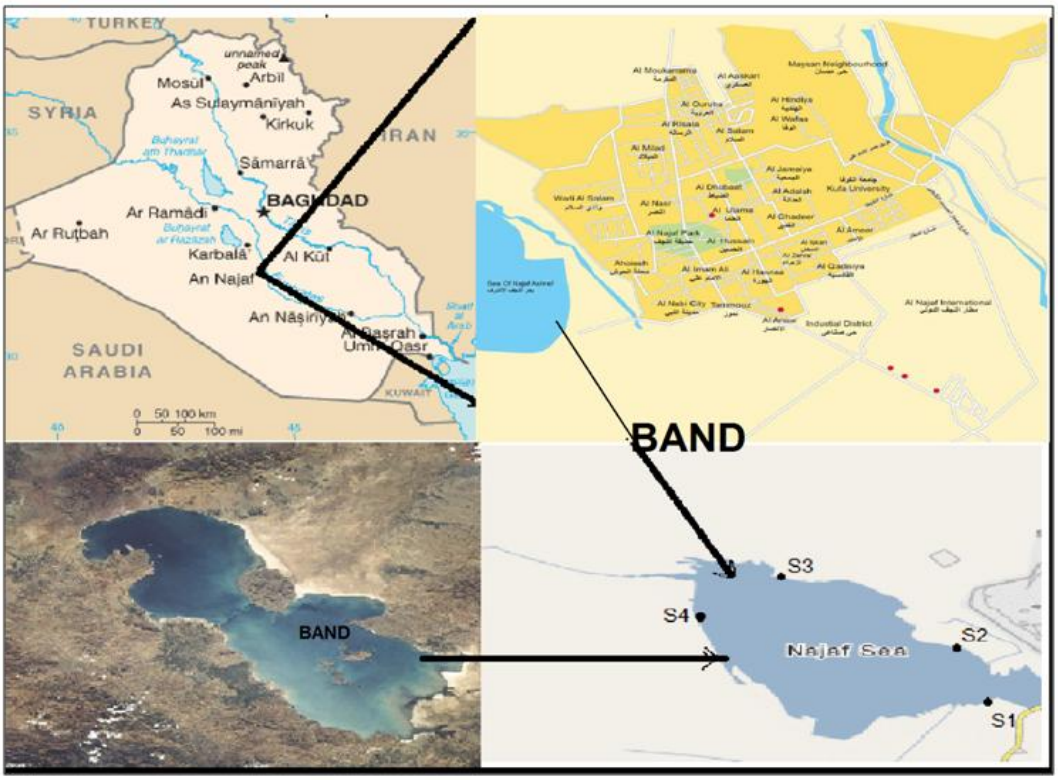

Fig. 1. Province of Najaf in Iraq with sampling sites

50 to 350 nM of phosphate. Na^{+1} and K^{+1} were determined using Flame Photometer (Perkin-Elmer 5000, USA). The analysis of data was performed using SAS version 9.1 (SAS Institute Inc., Cary, NC, USA). The data were presented for each treatment and were compared using the LSD test at the 0.05 level.

3. RESULTS

The *Typha domingensis macrophytes* of water, sediments, and climate were compared among the four contaminated sites. The spatial and temporal changes of the physicochemical parameters of water and sediments in the BAND are illustrated. Table 1 is shown the climate of the BAND with seasons (2015 to 2016). All physicochemical parameters were as follows: site 2 > site 3 > site 4> site 1.

TN was increased significantly ($p < 0.05$) in S1 and S3 at the spring while it is increasing in S2 and S4 at the summer. The TN was decreased significantly at the winter and autumn more than other seasons. The highest and lowest of TN were found in S1 and S4, respectively at the spring and winter as shown in Fig. 2.

TP was decreased in S1, S2, S3, and S4 in all seasons (not significantly). TP has low value in S2 and S4 (not significant) as shown in Fig. 2. The highest parameters were found at the autumn (S1) comparison with other sites at all seasons (Fig. 3).

K^+ was decreased significantly ($p < 0.05$) at all sites and seasons with increasing the stress factors (Fig. 4). The highest value of K^+ was found in S1 as shown in Fig. 4. The lowest value found to be at the autumn at all sites.

Na^+ was increased in all sites and seasons of *Typha domingensis Pers.* along with increasing stress factors ($p<0.05$). The highest Na^+ found in S4 at the autumn. The lowest value found to be in the winter at all sites and seasons (Fig. 5).

Cl^{-1} in *Typha domingensis* leave was increased at all sites. The Cl^{-1} was decreased significantly in winter more than other seasons. Highest Cl^{-1} was found in S1 and S2 at the autumn whereas, highest Cl^{-1} found in S3 and S4 in the spring and summer, respectively (Fig. 6).

Table 1. Climatic parameters in the BAND

N	Month	Evaporation rates mm^{-1}	Precipitation rates mm^{-1}	Relative humidity %	Average temperature °C	Day length h^{-1}
1	Feb. 2015	112.4	18.7	70.3	12.5	11.5
2	Mar. 2015	187. 6	15.4	56	17.5	12
3	April 2015	321	11.3	46	22.7	12.3
4	May 2015	435. 2	0.07	40.2	28.6	13.5
5	Jun. 2015	535. 6	0	36.3	33.4	14.5
6	July 2015	605.2	0	25.2	36.5	13.6
7	Aug. 2015	613.4	0	23.5	37.8	13.6
8	Sep.2015	396.3	0	25.6	32.4	13.02
9	Oct. 2015	238.7	0	35.3	30.2	12.5
10	Nov. 2015	196.3	18.1	50.7	25.3	11.6
11	Dec. 2015	121.3	11.8	65.6	18.4	10
12	Jan.2016	84.6	102.7	62.6	12.1	10.2
13	Annual Rate	322	14.8	44.7	25.6	12.3

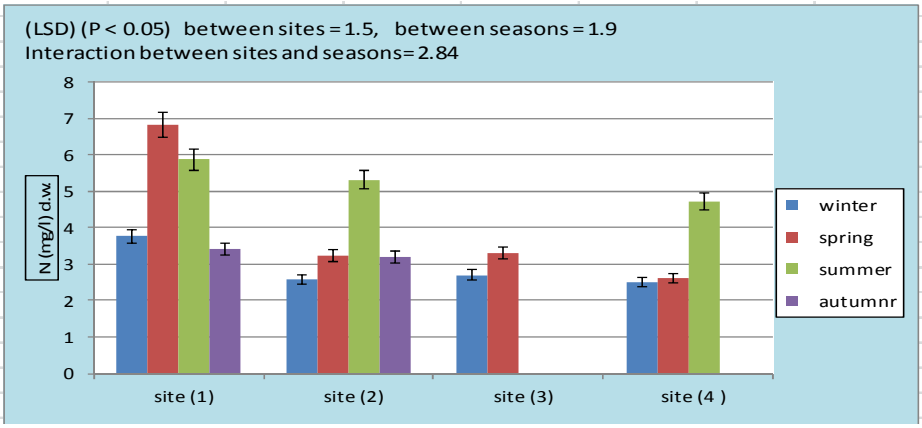

Fig. 2. TN in *Typha domingensis*

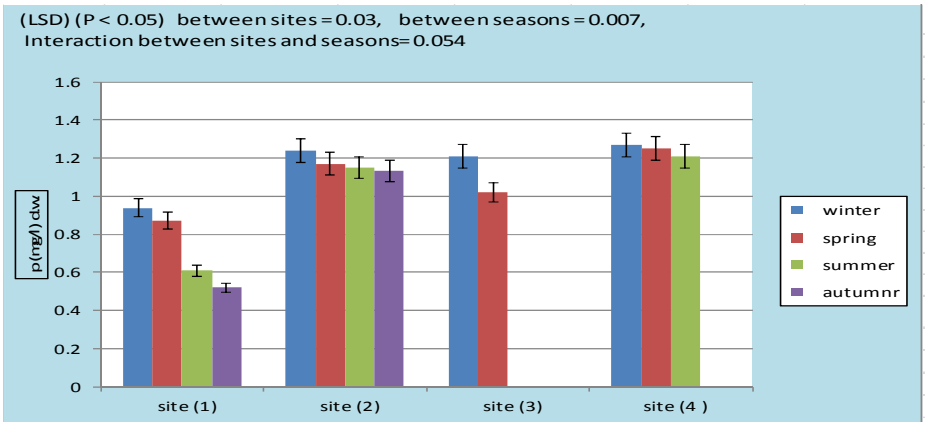

Fig. 3. TP in *Typha domingensis*

4. DISCUSSION

Physical and chemical factors of a water body, if exceeds the threshold level, causes some stresses. The imbalance between production and elimination of the oxygen was caused by many chemicals [10,11]. The wastewater and industrial pollutants has higher effects than other

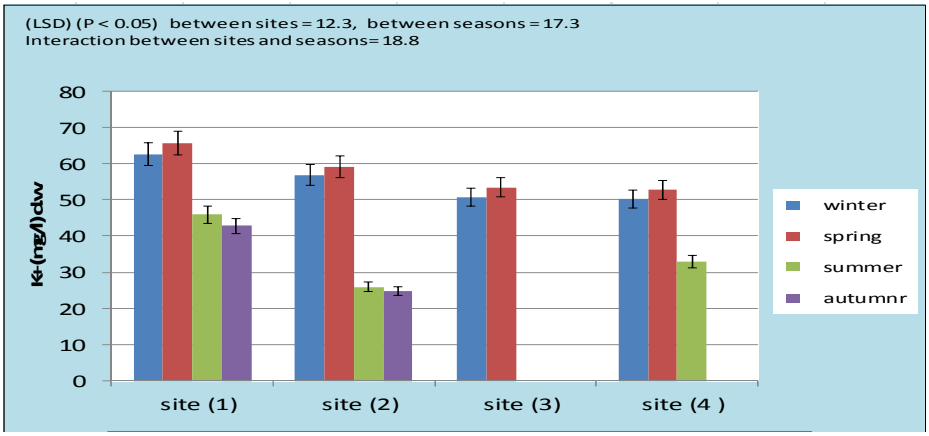

Fig. 4. K^{+1} in *Typha domingensis*

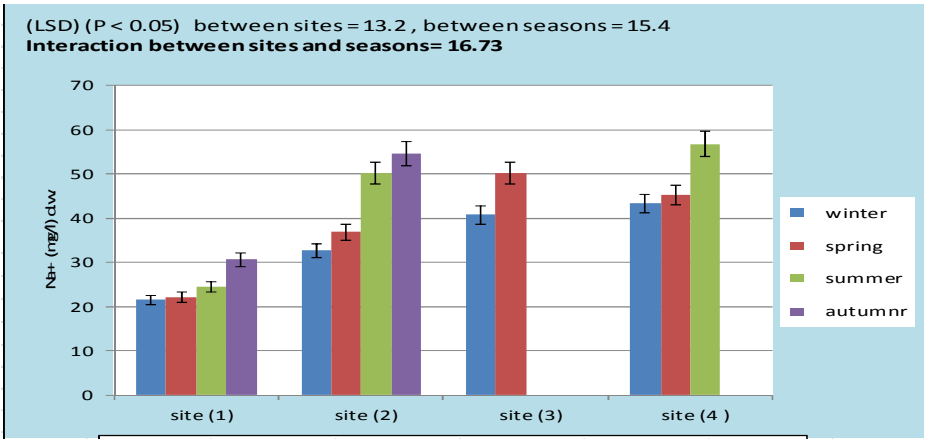

Fig. 5. Na^{1+} in *Typha domingensis*

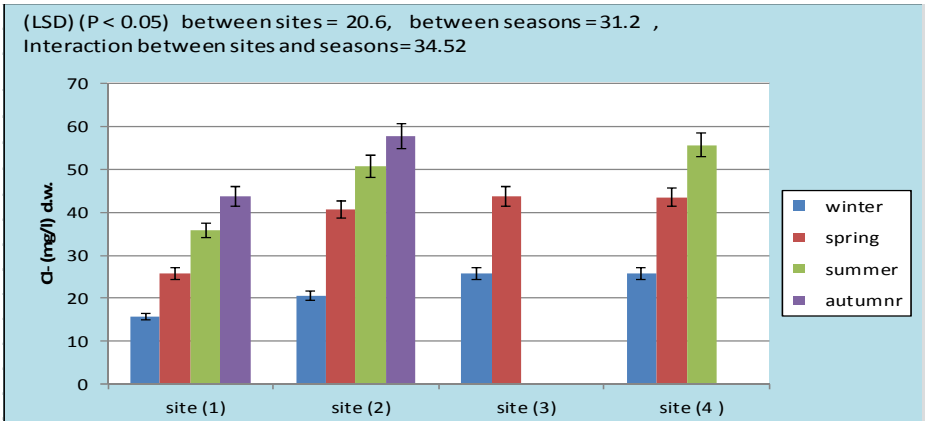

Fig. 6. Cl^{-1} in *Typha domingensis*

pollutants. The higher concentration of salts at site 3 was the second stress. The solubility of oxygen and other gases will decrease as increasing the temperature. This means that cool lakes contain more dissolved oxygen than warmer lakes. If water is too warm, it will not contain enough oxygen for aquatic organisms. Whereas DO, TP, and NO_3^{-2} are increasing as

annual precipitations are increased. Plants have two major mechanisms to increasing the phosphorus efficiency: Normal P and P uptake: Plant growth rate is reduced. Phosphate and organic acid production are increased. Cellular injury has an increasing significantly with Na+ and decreasing with K+ [11,12]. In general, the levels of the major nutrients N and P at all seasons and sites were as follows: water <sediments<plants. Nutrients were changed due to a higher concentration of pollutants (Figs. 1-6). The environmental stress affects the stored nutrients. Then, its effectiveness will reduce for the growth and reproduction.

5. CONCLUSIONS

This study is supporting the hypothesis of major nutrients (N and P) at all seasons. The nutrients were found to be as follows in: water < sediments < plants. This study indicates that *Typha domingensis* plants have the ability of the nutrients accumulation. The nutrients were changed due to the high concentration of pollutants. The results were showed that pollutants are like salinity, high temperature, and Ph, not only led to reducing nutrient, but are also increased the levels of Cl^{-1} and Na^{+1} in the plants. The main result of this study showed that the environmental stress affected the stored nutrients.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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