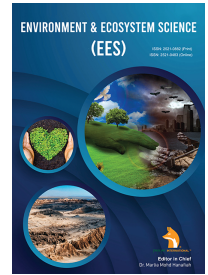




ZIBELINE INTERNATIONAL™
P U B L I S H I N G
ISSN: 2521-0882 (Print)
ISSN: 2521-0483 (Online)
CODEN: EESND2



RESEARCH ARTICLE

PRELIMINARY STUDIES ON AIR POLLUTION TOLERANCE INDEX (APTI) OF SELECTED PLANT SPECIES IN BIKANER CITY

Leela Kaur* and Anuradha

Department of Environmental Science, Maharaja Ganga Singh University, Bikaner (Rajasthan) - 334004, India

*Corresponding Author Email: leela.kaur@gmail.com

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 12 July 2021
Accepted 16 August 2021
Available online 23 September 2021

ABSTRACT

Air Pollution Tolerance Index is used to find out the level of air pollution in any area with the help of plants. Plants are categorized as sensitive, intermediate and tolerant based on their APTI values. The present study examines the Air Pollution Tolerance Index of selected plant species in Bikaner city. The APTI of various plants have been computed with the values obtained by analysis of biochemical parameters such as pH of leaf extract, ascorbic acid content (AAC), total leaf chlorophyll content (TLC) and leaf relative water content (RWC). It was found that plant species Khejri (*Prosopis cineraria*), Neem (*Azadiracta indica*), Babul (*Acacia nilotica*), Ber (*Ziziphus nummularia*), Aak (*Calotropis procera*) and Peepal (*Ficus religiosa*) showed APTI values in the range of 30 to 100 which are tolerant to air pollution. *Datura stramonium* was the only species which falls under the intermediate category due to its APTI value of 21.5. It is recommended that these plants can be grown on national highways to combat air pollution in arid areas. Such plants can be used in the development of green belt.

KEYWORDS

Air Pollution Tolerance Index (APTI), Ascorbic acid, Bikaner city, Plant species, Total chlorophyll.

1. INTRODUCTION

Air pollution is one of the major environmental concerns arising mainly from industrialization, unplanned urbanization, the alarming increase in the vehicle fleet and population growth. About 4.3 million people die from household air pollution and 3.7 million from ambient air pollution, most of them (3.3 and 2.6 million respectively) live in Asia (WHO, 2018). Though, air pollution has become a serious environmental stress to plants during the last few decades (Rajput and Agarwal, 2004). The particulates and gaseous pollutants cause severe setbacks to the overall physiology of plants (Das and Prasad, 2010). Air Pollution tolerance Index (APTI) is an important monitoring and assessment tool of air pollution which defines the tolerance of plants against air pollution as sensitive, intermediate and tolerant plants. Air pollution can be identified by sensitive plants as they are bioindicators of air pollution while air pollution can be prevented by developing green belt in the polluted sites using tolerant plant species. Hence, APTI can be utilized in identifying sensitive and tolerant plants species of any area. Several research works have shown the tolerant and sensitive plant species based on their APTI values (Ninave et al., 2001; Paulsami and Senthilkumar, 2009; Chouhan et al., 2012; Bhattacharya et al., 2013; Dhanam et al., 2014; Tak and Kakde, 2017; Panda et al., 2018; Bharti et al., 2018; Jabeen, 2019; Sahu et al., 2020; Saraswat and Rai, 2021; Shrestha et al., 2021).

The present study is done to investigate the Air Pollution Tolerance Index (APTI) of selected plant species grown on National Highways in Bikaner (Rajasthan).

2. MATERIALS AND METHODS

The experimental section covers study area, sampling, analysis of biochemical parameters and calculation of air pollution tolerance index to find out the tolerant and sensitive plant species on the roadsides in Bikaner.

2.1 Study area

The present study is done in Bikaner city. Which is situated at the latitude of 28.027138 and longitude of 73.302155 with the coordinate of geographical position system (GPS) at 28°1'37.6968"N and 73°18'7.7580" E. Bikaner is located in the northern part of Rajasthan with 230 meters height above sea level. The desert city shares its boundary with Jaisalmer, Jodhpur, Nagaur, Churu, Sriganganagar, Hanumangarh and even international boundary with Pakistan. Bikaner has an extreme climate with summers being too hot and winters being too cold. The arid climate with low rainfall, high temperature, and high evaporation are the characteristics of Bikaner city. The temperature during summer ranges from 28°C to 42°C and in the winter season temperature goes as low as 4°C.

Quick Response Code



Access this article online

Website:
www.environecosystem.com

DOI:
10.26480/ees.02.2021.117.120

Humidity is highest in August with mean daily relative humidity is 71% in the morning and 52% in the evening. The soil of Bikaner district is predominantly light-textured, weak-structured but well-drained. The soil of the area is alkaline. The group vegetation in Bikaner is mixed vegetation of xerophyte plants.

The study was conducted during the months of January to March, 2019 in Bikaner. Two different sites have been selected for the study which is National Highways N.H. 11 and N.H. 89. The first site is the Karni industrial area which is situated about 8.4 Km north-east of Bikaner at 27° 56'20" N latitude and 73° 02'54" E longitude which acquires about 1 Km area. While the second site is Sagar village area situated about 8 Km north-east of Bikaner at 28° 00'50" N latitude, and 73° 24'31" E longitudes. The common plant species grown on both sites are Khejri (*Prosopis cineraria*), Neem (*Azadirachta indica*), Babul (*Acacia nilotica*), Ber (*Ziziphus nummularia*), Aak (*Calotropis procera*), Datura (*Datura stramonium*), and Peepal (*Ficus religiosa*).

2.2 Sampling of Plant species

Seven dominant tree species i.e., Khejri (*Prosopis cineraria*), Neem (*Azadirachta indica*), Babul (*Acacia nilotica*), Ber (*Ziziphus nummularia*), Aak (*Calotropis procera*), peepal (*Ficus religiosa*) and Datura (*Datura stramonium*) were selected because of their presence at both sites. For the investigation, the leaves of these tree species were collected in 1 Km area of both sites. The leaf samples were put in polyethylene bags and marked with marking tapes. These were immediately taken to the laboratory for analysis.

2.3 Analysis of Biochemical parameters

Biochemical parameters such as pH of leaf extract, ascorbic acid content (AAC), total leaf chlorophyll content (TLC) and leaf Relative water content (RWC) were analyzed using the Lohe method (Lohe, 2015), Okeri and Alonge (2015) method, Arnon method (Arnon, 1949), and Turner method (Turner, 1981) respectively. These were used to compute the APTI (Air Pollution Tolerance Index) values.

2.4 Calculation of Air Pollution Tolerance Index (APTI)

The Air pollution tolerance index is an empirical relation which evaluates the tolerance level of plant species towards air pollution which evaluates the tolerance level of plant species towards air pollution from leaf biochemical parameters such as leaf extract pH, relative water content of the leaf, ascorbic acid, and total chlorophyll. This method was formulated by Singh and Rao (1991). APTI is calculated using the following equation:

$$APTI = [A (T + P)] + R / 10$$

Where; A – Ascorbic acid content (mg/g); P – pH of leaf extract; T – Total chlorophyll (mg/g); R – Relative water content of leaf (%).

Plants having APTI range of 30-100 are tolerant, APTI of 17-29 are intermediate while APTI of 1-16 are called sensitive plants.

3. RESULTS AND DISCUSSIONS

Biochemical characteristics (pH, relative water content, total chlorophyll content and ascorbic acid) and Air Pollution Tolerance Index (APTI) of selected plant species from the Karni Industrial area (Site-1) and Sagar village (Site-2) of Bikaner city (Rajasthan) are shown in Table 1.

Table 1: Biochemical characteristics and Air Pollution Tolerance Index (APTI) of selected plant species from the study area.

Plant species	Sampling sites	pH	RWC (%)	TCC (mg/g)	AA (mg/g)	APTI
<i>Calotropis procera</i>	Site-1	6.3	75.8	32.0	40.0	161
	Site-2	4.2	81.8	16.1	37.8	84.91
<i>Azadirachta indica</i>	Site-1	7.2	70.05	34.7	55.4	239.4
	Site-2	7.9	65.7	21.3	46.0	141.4
<i>Ziziphus nummularia</i>	Site-1	5.1	60.0	12.2	42.1	78.83
	Site-2	7.9	77.4	17.5	51.8	139.7
<i>Acacia nilotica</i>	Site-1	6.9	63.9	29.2	30.4	116.7
	Site-2	7.1	83.4	18.5	50.3	137.3
<i>Prosopis cineraria</i>	Site-1	6.2	63.6	40.6	51.1	245.4
	Site-2	8.0	72.4	24.1	50.7	170.7
<i>Datura stramonium</i>	Site-1	7.1	55.0	52.7	56.5	343.7
	Site-2	4.0	55	12	15	29.5
<i>Ficus religious</i>	Site-1	6.6	64.1	37.8	55	251.2
	Site-2	7.6	64.1	15.9	19.1	53.04

3.1 pH

The lowest pH (4) was observed at site-2 in *Datura stramonium* while the highest pH (8) was detected at site-2 in *Prosopis cineraria* (Figure 1). Plants with lower and higher pH are more susceptible, while those with pH around 7 are more tolerant. But in overall observations, most plants showed alkaline pH (Table 1).

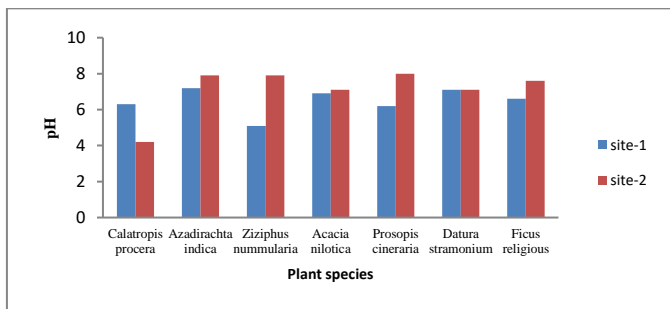


Figure 1: pH of leaf extract of different plant species at site-1 and site-2.

3.2 Relative Water Content (RWC)

RWC of a leaf is the water present in it relative to its full turgidity. High water content within the plant body helps to maintain its physiological

balance under stress conditions such as exposure to air pollution when the transpiration rates are usually high. It also serves as an indicator of drought resistance in plants. Due to air pollution, there is a reduction in transpiration rate and damage to the leaf engine that pulls water up from the roots (1-2 % of the total). Consequently, the plants neither bring minerals nor cool the leaf. Reduction in relative water content of plant species is due to the impact of pollutants on transpiration rate in leaves (Swami et al., 2004). The lowest relative water content was observed at site-2 in *Datura stramonium* (55 %) while the highest Relative water content was noticed at site-2 in *Acacia nilotica* (83.41 %) (Figure 2).

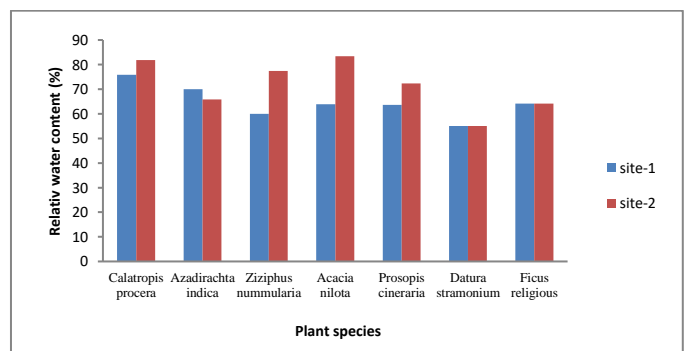


Figure 2: Relative water content (%) in different plant species at site-1 and site-2.

3.3 Total Chlorophyll Content (TCC)

Chlorophyll content of plants signifies its photosynthetic activity as well as the growth and development of biomass. It is well evident that chlorophyll content of plants varies from species to species; the age of leaf and also with the pollution level as well as with other biotic and abiotic conditions (Abida and Harikrishna, 2010). The highest total chlorophyll content was found in *Prosopis cineraria* at site-1 and the lower content of chlorophyll was estimated in *Datura stramonium* at site-2 (Table 1 and Figure 3).

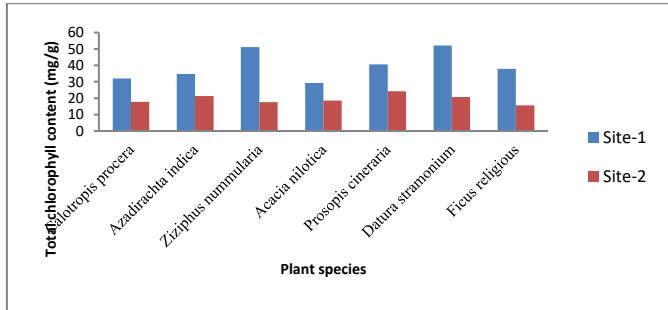


Figure 3: Total chlorophyll content (mg/g) in different plant species site-1 and site-2

3.4 Ascorbic Acid (AA)

Ascorbic acid is a strong reductant and it activates many physiological and defense mechanisms in plants. Its reducing power is directly proportional to its concentration (Raza and Murthy, 1988; Agbaire and Esiefarienrhe, 2009). The result of the study revealed that *Datura stramonium* had the highest as well as the lowest ascorbic acid content at site-1 (56.5 mg/g) and site-2 (15 mg/g) respectively (Figure 4).

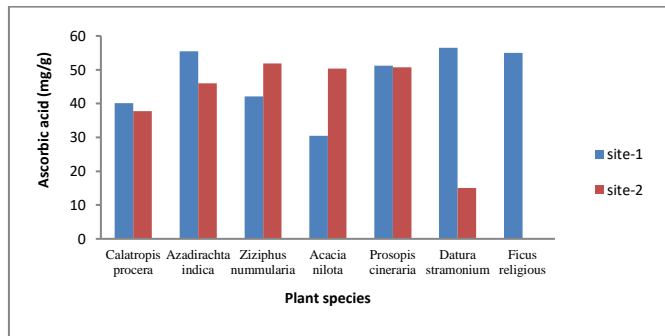


Figure 4: Ascorbic acid content (mg/g) in different plant species at site-1 and site-2.

3.5 Air Pollution Tolerance Index (APTI)

In the present study, it was found that 6 species showed APTI values in the range of 30 to 100 which are Khejri (*Prosopis cineraria*), Neem (*Azadirachta indica*), Babul (*Acacia nilotica*), Ber (*Ziziphus nummularia*), Aak (*Calotropis procera*) and Peepal (*Ficus religiosa*). *Datura stramonium* was the only species which falls under the intermediate category as it has APTI value of 21.5 (Table 1).

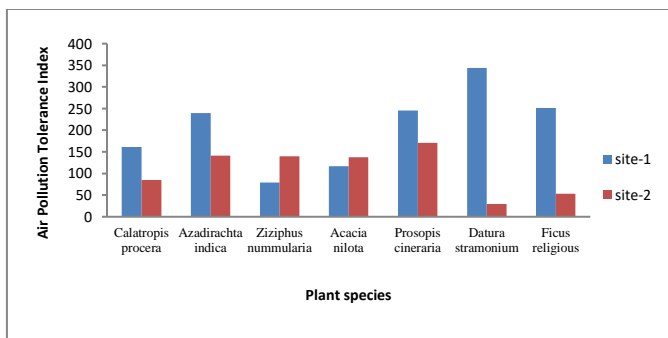


Figure 5: Air Pollution Tolerance Index (APTI) of selected plant species.

In this study, *Calotropis procera* and *Acacia nilotica* had higher relative water content at site-2. Thus, the higher relative water content at the road sites might be responsible for the normal functioning of biological processes in these plants. Under the condition of stress, high relative water content inside a plant's organs will keep up its physiological equilibrium.

4. CONCLUSION

The present study was done to investigate tolerance of different plant species against air pollution in Bikaner. It was found that except *Datura stramonium*, all selected plant species were in the range of tolerant due to their high APTI. It is recommended that plants such as Khejri (*Prosopis cineraria*), Neem (*Azadirachta indica*), Babul (*Acacia nilotica*), Ber (*Ziziphus nummularia*), Aak (*Calotropis procera*), *Datura (Datura stramonium)* and Peepal (*Ficus religiosa*) can be grown on national highways to combat air pollution in arid ecosystems. Air pollution can be combated with the help of APTI tool by identifying and selecting tolerant plant species in a particular area.

REFERENCES

Abida, B. and Harikrishna, S. 2010. Evaluation of some tree species to absorb air pollutants in three industrial locations of South Bengaluru, India. E-Journal of Chemistry 7: 51- 56.

Achakzai, K., Khalid, S., Adrees, M., Bibi, A., Ali, S., Nawaz, R., Rizwan, M. 2017. Air pollution tolerance index of plants around brick kilns in Rawalpindi, Pakistan. Journal of Environmental Management 109: 252- 258.

Agbaire, P.O. and Esiefarienrhe, E. 2009. Air pollution tolerance indices (APTI) of some plants around Otorogun Gas Plant in Delta State, Nigeria. Journal of Applied Sciences and Environment Management 13(1): 11-14.

Arnon, D.I. 1949. Copper enzymes in isolated chloroplasts. Polyphenol oxidase in beta vulgaris. Plant Physiology 24, 1.

Bharti, S.K., Trivedi, A., Kumar, N. 2018. Air pollution tolerance index of plants growing near an industrial site. Urban Climate 24: 820-829.

Bhattacharya, T., Kriplani, L., Chakraborty, S. 2013. Seasonal variation in air pollution tolerance index of various plant species of Baroda City. Universal Journal of Environmental Research and Technology 3(2): 199- 208.

Chouhan, A., Iqbal, S., Maheshwari, R.S., Bafna, A. 2012. Study of air pollution tolerance Index of plants growing in Pithampur Industrial area sector 1, 2 and 3. Research Journal of Recent Sciences 1: 172-177.

Das, S. and Prasad, P. 2010. Seasonal variation in air pollution tolerance indices and selection of plant species for industrial areas of Rourkela. Indian Journal of Environmental Protection 30(12):978-988.

Dhanam, S., Rajapandian, P., Elayaraj, B. 2014. Air Pollution Tolerance Index and Biochemical constituents of some plants growing in Neyveli Lignite Corporation (NLC), Tamil Nadu, India. Journal of Environmental Treatment Techniques 2(4): 171-175.

Giri, S., Shrivastava, D., Deshmukh, K., Dubey, P. 2013. Effect of air pollution on chlorophyll content of leaves. Current Agriculture Research Journal 1(2): 93-98.

Health Effects Institute, 2020. State of Global Air 2020. Special Report. Boston, MA: Health Effects Institute.

Jabeen, R. 2019. Air Pollution Tolerance Index (APTI) of some plants growing on the roads of Abha, Saudi Arabia. Bioscience Biotechnology Research Communications 12(3): 631-636.

Kaler, N.S., Bhardwaj, S.K., Gupta, R.K. 2017. Evaluation of air pollution tolerance index of certain plant species grown alongside Parwanoo to Solan National Highway- 22 in Himachal Pradesh, India. Journal of Applied and Natural Science 9(1), 196-200.

Kavitha, K. and Shailaja. 2016. Air Pollution Tolerance Index (APTI) of certain plants of Hyderabad city. SSRG International Journal of Agriculture & Environmental Science 3(6), 4-6.

- Kumari, J. and Deswal, S. 2017. Assessments of air pollution tolerance index of selected plants unveil to traffic roads of Noida, Uttar Pradesh. *International Journal on Emerging Technologies* 8(1): 179-184.
- Leghari, S.K., Zaidi, M.A., Ahmed, M., Nazim, K. 2011. Air pollution tolerance index (APTI) of various plants species growing in Quetta city, Pakistan. *Pakistan Journal of Botany* 1(1), 81-86.
- Lohe, R.N., Tyagi, B., Singh, V., Kumar Tyagi, P., Khanna, D.R., Bhutiani R. 2015. A comparative study for pollution tolerance index of some terrestrial plant species. *Global Journal of Environmental Science and Management* 1(4): 315-324.
- Narwaria, Y.S. and Kush, K. 2012. Environmental assessment of air pollution on roadside plants species at Dehradun, Uttarakhand, India. *Journal of Environmental Research and Development* 7(2), 710-714.
- Ninave, S.Y., Chaudhari, P.R., Gajghate, D.G., Tarar, J.L. Foliar, A.D. 2001. Biochemical features of plants as indicators of air pollution. *Bulletin of Environmental Contamination and Toxicology* 67(1): 133-140.
- Okeri, H.A. and Alonge, P.O. 2006. Determination of the ascorbic acid content of two medicinal plants in Nigeria. *Pakistan Journal of Pharmaceutical Sciences* 19(1), 44-48.
- Panda, L.R.L., Aggarwal, R.K., Bhardwaj, D.R. 2018. A review on Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API). *Current World Environment* 13(1): 55-65.
- Pandey, K. 2020. Air pollution: Half of India's death toll in these 5 states. Down to Earth, December Issue, Centre for Science and Environment, New Delhi. Access: <https://www.downtoearth.org.in/news/air/air-pollution-half-of-india-s-death-toll-in-these-5-states-74768> on 14 March, 2021.
- Paulsamy, S. and Senthilkumar, P. 2009. Identification of Air Pollution Tolerant Tree Species for the Industrial City, Tirupur, Tamil Nadu. *Nature Environment and Pollution Technology* 8(3): 585-588.
- Rai, P.K., Panda, L.S., Chutia, B.K. 2014. Assessment of air pollution tolerance indices for certain roadside plants in Aizawl, Mizoram, India. *An International Biannual Journal of Environmental Science* 8(2): 33-39.
- Rajput, M., Agrawal, M. 2004. Physiological and yield responses of pea plants to ambient air pollution. *Indian Journal of Plant Physiology* 9(1): 9-14.
- Rathore, D.S., Kain, T., Gothalkar, P. 2018. A Study of Air Pollution Status by Estimation of APTI of Certain Plant Species Around Pratap nagar Circle in Udaipur City. *International Journal of Agriculture, Environment and Biotechnology* 11(1), 33-38.
- Ritchie, H. and Rose, M. 2018. Causes of Death. Retrieved from: <https://ourworldindata.org/causes-of-death> on 12 July, 2021.
- Sahu, C., Basti, S., Sahu, S.K. 2020. Air pollution tolerance index (APTI) and expected performance index (EPI) of trees in sambalpur town of India. *SN Applied Sciences* 2: 1327.
- Saraswat, P., and Rai, A. 2021. Evaluating Air Pollution Tolerance Index (APTI) of Two Plant Species from Industrial Area of Jodhpur. *International Journal of Energy and Environmental Science* 6(1): 11-15.
- Shrestha, S., Baral, B., Dhital, N.B. Yang, H-H. 2021. Assessing air pollution tolerance of plant species in vegetation traffic barriers in Kathmandu Valley, Nepal. *Sustainable Environment Research* 31(3), 1-9.
- Shrestha, S., Baral, B., Dhital, N.B., Yang, H-H. 2021. Assessing air pollution tolerance of plant species in vegetation traffic barriers in Kathmandu Valley, Nepal. *Sustainable Environment Research* 31: 3.
- Singh, S.K., Rao, D.N., Agrawal, M., Pandey, J., Naryan, D. 1991. Air pollution tolerance index of plants. *Journal of Environmental Management* 32(1): 45-55.
- Sumangala, H.P., Aswath, C., Laxman, R.H., Namratha, M.R. 2018. Evaluation of Air Pollution Tolerance Index (ATPI) of Selected Ornamental Tree Species of Bengaluru, India. *International Journal of Pure & Applied Bioscience* 6(3): 366-373.
- Swami, A., Bhatt, D., Joshi, P.C. 2004. Effects of automobile pollution on Sal (*Shorea robusta*) and Rohini (*Mallotus philippinensis*) at Asarori, Dehradun, Himalayan. *Journal of Environmental Zoology* 18(1): 57-61.
- Tak, A.A., and Kakde, U.B. 2017. Assessment of Air Pollution Tolerance Index of plants: A comparative study. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(7): 83-89.
- Ter, S., Chettri, M.K., Shakya, K. 2020. Air Pollution Tolerance Index of some tree species of Pashupati and Budhanilkantha area, Kathmandu. *Amrit Research Journal* 1(1): 21-28.
- Turner, N.C. 1981. Techniques and experimental approaches for the measurement of plant water stress. *Plant Soil* 58: 339-366.
- Veni, K., Marimuthu, Lavanya, K. 2014. Air pollution tolerance index of plants a comparative study. *International Journal of Pharmacy and Pharmaceutical Sciences* 6(5): 320-324.
- Viradiya, S., Kaneria, M., Misan, V. 2020. Comparative Assessment of Air Pollution Tolerance Index (APTI) of Selected Plants from two different Industrial sites of Rajkot. *Proceedings of the National Conference on Innovations in Biological Sciences 2020*, 109-117.

