

Impact Of Climate Change on Flowering Pattern of Anthocephalus Cadamba in Bhopal and Its Interpretation

Anjana Nair¹, Dr. Abha Rani Pande², Dr. Ranjana Varma³, Vishal Verma⁴, Shubhangini Bala Durge⁵
MVM College, Bhopal

Abstract—This study aimed to determine the impact of climate change on flowering pattern of Cadamba in Bhopal, and nearby areas of Bhopal, in Madhya Pradesh; for the survival benefits as the plant is an early succession species and can grow along riverbanks and in transitional zone between swampy, permanently flooded and periodically flooded areas. The fieldwork conducted to study the new flowering pattern in *Anthocephalus cadamba* observed during the period between 2018 to 2024. Since long it has been observed that the flowering occurred only once in a year (June- July) in Bhopal and nearby areas. The observation indicates that the flowering behaviour of Kadamb tree shows a significant change in flowering pattern and that has the scientific relevance and evolution of tree for daily survival and genetic survival. The study will help to understand the evolution of Kadamb tree for response to climate change and extreme environmental conditions.

I. INTRODUCTION

Anthocephalus cadamba, Family- Rubiaceae, with Hindi common name Kadamb, English common name Burflower-tree, Laran, Leichard Pine is a deciduous, tropical tree native to South and South Asia. Tree up to 45m tall, without branches for more than 25m. Diameter up to 10-160cm but normally less; sometimes with buttresses. The crown is umbrella shaped and the branches are characteristically arranged in tires. It is one of the most frequently planted trees in the tropics. The tree is grown along avenues, roadsides and villages for shade. It is suitable for reforestation programs as the fast growth rate of this tree makes it suitable for reforestation projects (Otsamo et al., 1997). It is also used as green manure. It has scented orange flowers in dense globe shaped structures.

Anthocephalus cadamba is overall a big tree. Its bark is deep grey with longitudinal fissures and thin scales that exfoliate. The leaves are oval in shape with pronounced veins measuring around 30x30 cm in

length and width. The flowers are small, orange, and arranged on globose shaped cymose capitata inflorescence which contains nearly 2000 flowers and produces around 8000 seeds. Generally flowering occurs in Bhopal during June-July month. Further, the mature fruit is spherical, firm and yellow in colour with a sweet and tart flavour. Seeds are trigonal in shape.



Buttress



Branching Pattern



Bark



Flowering



Inflorescence (Cymose Capitat)



Seeds

The other names of the plant are *Neolamarckia cadamba*, *Nauclea cadamba* (Roxb.) *Anthocephalus cadamba* (Roxb.) Miq *Samama cadamba* (Roxb.) Kuntze, *Anthocephalus morindifolius* korth, *Nuclea megaphylla* (S. Moore) etc. It has three species.

II. MATERIALS AND METHODS

In the year 2023 it has been observed that *Anthocephalus cadamba* is showing flowering in the month of May, July and September. The changes in flowering pattern has drawn the attention and it has been observed that in the year 2024 the plants started showing flowering multiple times in a year. The first flowering observed in July (around 28th July), then repeated flowering observed in Mid-August and around 10th September. The second and third flowering was less in number. Since 2018 observation has been made which concludes that there is a shifting of flowering time as well as flowering pattern in *Anthocephalus cadamba* in Bhopal:

S.No.	YEAR	MONTH	DATE OF FLOWERING PICTURES TAKEN
1	2018	JULY	21 st JULY 2018
2	2019	JUNE	29 th JULY
3	2020	JUNE	6 th JUNE 2020
4	2021	JULY	2 nd AUGUST 2023
5	2022	AUGUST	12 th AUGUST
6	2023	MAY JULY SEPTEMBER NOVEMBER	25 th MAY, 21 st JULY, 2 nd SEPTEMBER 2023, EARLY NOVEMBER
7	2024	JULY, AUGUST, SEPTEMBER	28 th JULY, MID AUGUST, 10 th SEPTEMBER
8	2025	JUNE AUGUST	22 nd JUNE 3 rd AUGUST

Table 1: Date on which flowering is observed and picture taken

Climate change is affecting a diversity of species in a variety of ways (Hughes, 2000; Parmesan, 2006; Walther et al., 2002) In particular, climate warming is causing shifts in the timing of life history events for many species (Parmesan and Yohe, 2003; Root et al., 2003). Insect larvae are maturing into adults sooner, some bird species laying eggs earlier in the season, and many plants are blooming earlier (Hughes, 2000; Parmesan and Yohe, 2003). In addition to advancing many phenological events, climate warming is altering the distribution of both plant and animal species. For example, treelines are gradually increasing in elevation, and butterfly ranges are shifting northward (Hughes 2000).

Bhopal the capital city of Madhya Pradesh has a humid subtropical climate (CWA) with cool & dry winters, a hot summer and a humid monsoon season. Summer starts in late March and go on until mid- June, the average temperature being around 30°C (86°F), with the peak of summer in May, when the highs regularly exceed 40°C (104°F) Extreme high in May was 46.7°C on 19th May 2016 and in June it was 45.9°C on 7th June 2019. The monsoon starts in late June and ends in late September. These months see about 40 inches (1020mm) of precipitation, The average temperature is around 25°C (77°F) and the humidity is quite high. Temperature rise again up to early November when winter starts, which lasts up to early March. Winters in Bhopal are cool, with average daily temperature

around 16°C (61°F). The winter peaks in January when temperature may drop close to freezing on some nights. Lowest temperature ever recorded was 0.3°C. Total annual rainfall is about 1146mm (46 inches). The soil type is deep medium black soil.

In this location, the month that receives most sunshine is May, with a mean number of daily hours being 11.87. In Bhopal, the month that experiences the least number of daily sunshine hours is January with an average duration of 9.39 hours per day. The month with the least amount of precipitation is April exhibiting a mere 4mm rainfall. Most of the precipitation here falls in July, averaging 378mm. The month of May boasts the highest average temperature with a recorded maximum 33.8°C (92.9°F). January is the coldest month, with temperatures averaging 17.8°C (64.1°F). The month with highest relative humidity is August (85.45%). The month with lowest relative humidity is April (20.76%). *Anthocephalus cadamba* was observed growing naturally in various places of Bhopal like Shahpura, Arera Colony, Rohit Nagar, Gehukheda, Patel Nagar area, Kolar area, Nehru Nagar area, Bairagarh Chichli area, Divine Nagar Area, Roshanpura area etc with flowering in the month of June-July.



21st July 2018



2nd August 2021



June 6th 2020



2nd September 2023



June 21st 2021



August 25, 2024



September 26, 2024



8th August 2025S

In recent years it has been observed that the climatic conditions of Bhopal is showing variations specially in temperature and precipitation. A report prepared by ENVIRONMENT PLANNING AND COORDINATION ORGANISATION (EPCO) on Climate Change Vulnerability Assessment for Madhya Pradesh A Technical Report on Climate change impacts on Selected Sectors (Water, Forestry, Agriculture and Health) shows that historical data and projected changes in rainfall and temperature for Bhopal district were analysed using IMD and NASA’s NEX-GDDP datasets, by following the multi modal mean (MMM) approach and it shows that:

Warm days have gone up by 10 percent: The maximum temperature has been observed to show a significant increasing trend in April and May. This trend has accelerated over the last two decades. The mean percentage of warm days is more pronounced in the recent years, having increased by 10 percent. Warm days may go up by 35 percent of the present climate – Bhopal district is projected to experience a warming of 2°C to 3°C under RCP4.5 and a warming of 2°C to 5°C under RCP5.1. The percentage of warm days is also projected to increase by more than 35 percent in the future.

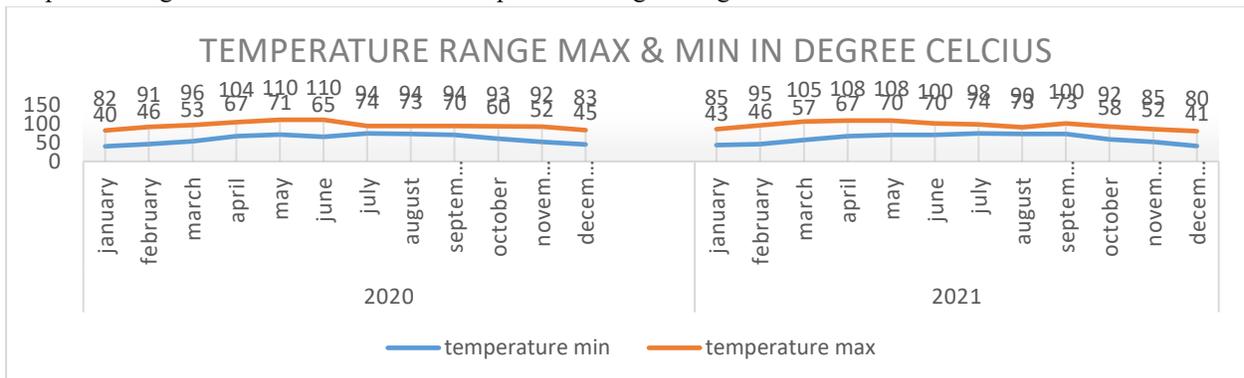
Cold Days are Decreasing: The minimum temperature also projects an increasing trend and the cold days (in percentage) may decrease in all the epochs under changing climatic conditions.

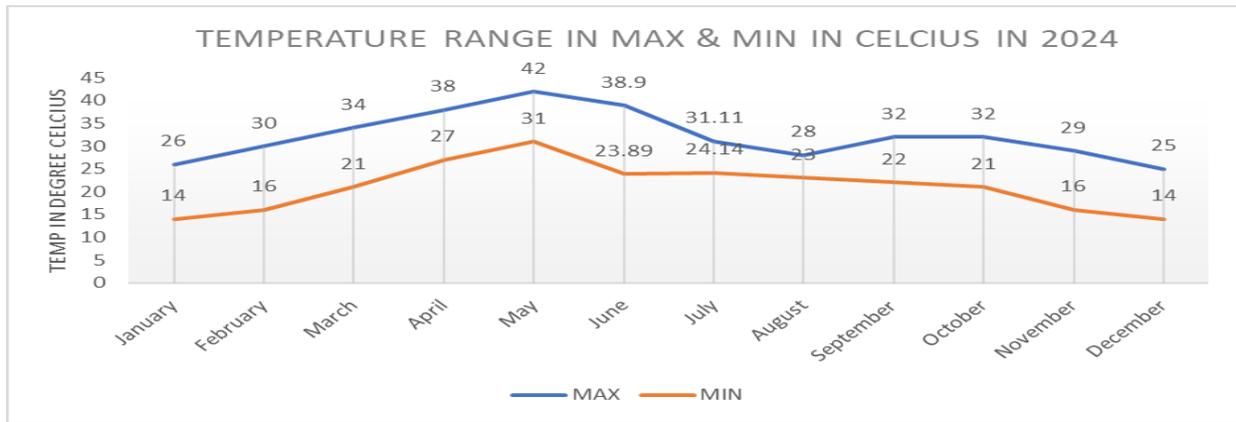
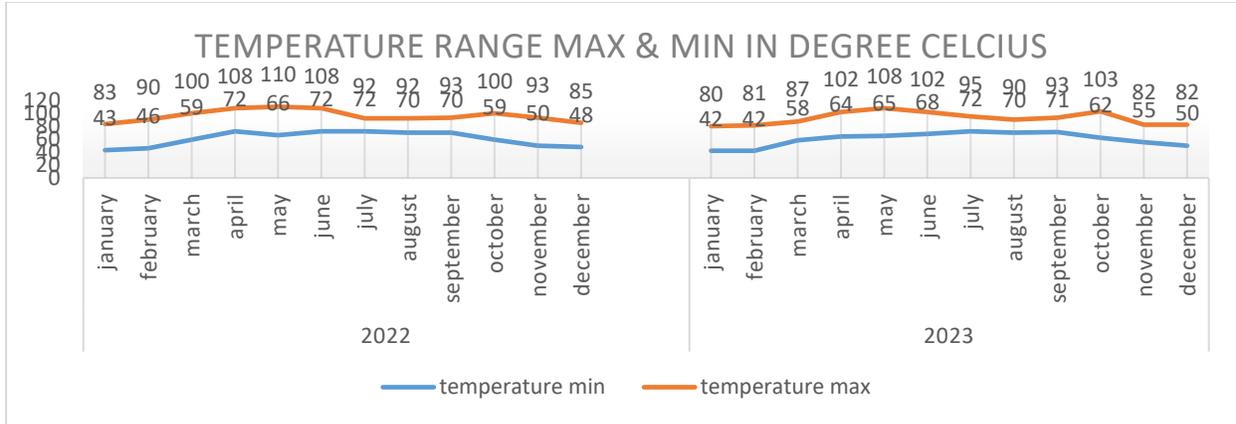
Rainy days are projected to increase: The monsoon rainfall does not show any significant trend. July and August months are the principle rainy months for the district. The variability in rainy days is higher and shows a slight decreasing trend in monsoon months for the period 1951-2018. The seasonal rainfall of the district is projected to increase by 5 to 21 percent under RCP4.5 and by 17 to 39 percent under RCP8.5 emission scenarios. The number of rainy days is also projected to increase during the monsoon season, particularly during July and August.

Projected changes in temperature and rainfall are likely to affect the crop productivity and crop water demand (evapotranspiration)EPCO.

The temperature graph of Bhopal for 2020 to 2023 shows a varied pattern of maximum and minimum temperature and a different precipitation pattern which directly affecting the survival of plants and showing physiological changes in plants.

Graph Showing Maximum and Minimum Temperature Range in degree celcius





III. AIR QUALITY IN BHOPAL

The overall trend of air quality of Bhopal city (based on AQI) shows increase in pollution level continuously and moving from Satisfactory to Moderate level. The natural dust, construction activities, vehicular movement, industrial emission, weather, seasonal variation can contribute to air pollution.

Pollution significantly impact plant physiology, disrupting essential processes like photosynthesis and growth. Air pollutants like particulate matter, ozone, sulphur di oxide, and nitrogen oxides can impair chlorophyll's function, reducing the plant's ability to convert light into chemical energy.

Pollution, particularly air pollution, can negatively impact plant flowering by altering floral scents, reducing pollinator attraction, and potentially damaging plant tissues. This can lead to reduced pollination, fewer fruits, and ultimately, a decline in plant population.

OBSERVATIONS:

According to research the multiple flowering may occur to combat critical climatic conditions to get survival benefit and adaptation. Table 2 is showing flowering period of "*Anthocephalus cadamba*" in different countries of the world annually:

COUNTRY NAME	FLOWERING
India	5 th May to 6 th June month of same year
Indonesia	4 th April to 8 th August month of same year
Laos	4 th April to 8 th August month of same year
Philippines	4 th April to 5 th May of same year
Malaysia	6 th June to 9 th September
Sri Lanka	9 th September month of same year

Table 2 flowering period of "*Anthocephalus cadamba*" in different countries of the world annually

If we compare the data of table 1 and 2, it indicates that the climatic condition of Bhopal is changing due to which the plant is showing variation in flowering time as well as flowering pattern and confirming the climate change in city.

One of the interesting observation is the flowering pattern observed in the year 2024, the flowering was started in July month and it was a normal blooming with abundance of flowering but the plants started showing repeated flowering in Mid-August as well as in the end of September month and that was with limited flowering, few countable number of flowers and it was observed in many plants which are growing in different parts of Bhopal.

IV. RESULT

The probable reason may be due to the availability of pollinators as the climatic changes may affect the physiology of animal pollinators also or may be the disturbance in the hormonal physiology of plant due to the climatic differences or it may be the transition period of flowering season which help Kadamba tree to adapt for the climatic changes. Less research work is available on relation between pant-pollinator interaction and climate change specially in Bhopal. Further research and follow up is needed with regard to this.

One of the most remarkable aspects of the Kadamba tree is its adaptability. According to Hindu mythology, Kaliya the poisonous Naga (Cobra Snake) living in the Yamuna River, in Vrindavana in India. The water of the Yamuna for four leagues all around him boiled and bubbled with poison. No bird or beast could go near, and only one solitary Kadamba tree grew on the river bank. Compare to other species of trees, kadamba shows good adaptation capacity to survive in variety of climatic conditions. It thrives in various states across India, spanning different ecological niches, from the fertile plains of India to the misty hills of the Western Ghats. We can find this magnificent tree in Western Ghats, Eastern Ghats, Central India, Southern India and Northern Plains. Its ability to grow in different soil types and climatic conditions makes it a symbol of resilience in the face of environmental challenges and can be used as indicator of environmental changes.

Because these studies were all relatively short-term, it is possible that these responses are simply stress-

related; additional data are needed to determine whether these interpretations are correct.

REFERENCES

- [1] Jøker, D. 2000 *Neolamarckia cadamba* (Roxb.) Bosser (*Anthocephalus chinensis* (Lam.) A. Rich. ex Walp.). Seed Leaflet No. 17, September 2000. Danida Forest Seed Centre, Denmark.
- [2] Krisnawati, H., Kanninen, M. and Kallio, M.H. 2010 Stand growth and management scenarios for *Anthocephalus cadamba* Miq. plantations in Indonesia. Unpublished manuscript
- [3] Climate Change and Environment Action Plan of Bhopal District, Vasudha Foundation, 2022 (EPCO)Madhya Pradesh
- [4] Alam, M. A., Akter, R., Subhan, N., Rahman, M. M., Majumder, M. M., Nahar, L. and Sarker, S. D. 2008. Antidiarrhoeal property of the hydroethanolic extract of the flowering tops of *Neolamarckia cadamba*. *Revista Brasileira de Farmacognosia*. 18: 155- 159.
- [5] Ali, S., Ishteyaque, S., Khan, F., Singh, P., Soni, A. and Mugale, M.N. 2021. Accelerative wound-healing effect of aqueous *Neolamarckia cadamba* leaf extract in a diabetic rat model. *The International Journal of Lower Extremity Wounds*. 15347346211018330.
- [6] Ambujakshi, H.R., Antony, S.T., Kanchana, Y., Patel, R. and Thakkar, H. 2009. Analgesic activity of *Neolamarckia cadamba* leaf extract. *Journal of Pharmacy Research*. 2(8): 1279-1280.