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Research Article

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ECOPHYSIOLOGY OF ORNAMENTAL PLANTS: RESPONSES TO ENVIRONMENTAL STRESSORS AND THEIR IMPACTS ON POLLEN PHYSIOLOGY AND FERTILIZATION.

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Abstract

Ornamental plants are those that are grown for their aesthetic value, and as such, they are subjected to a range of environmental stressors that can affect their growth, development, and reproductive success. Environmental stressors include abiotic factors such as temperature, light, water availability, and soil quality, as well as biotic factors such as pathogens and herbivores. In response to these stressors, ornamental plants have developed a range of physiological and biochemical mechanisms to cope with the challenges posed by their environment. For example, they may alter their growth patterns. Various environmental stressors such as high temperature, drought, salinity, and pollution can negatively impact their growth, development, and reproductive success. The aim of this study is to examine the ecophysiology of ornamental plants in response to environmental stressors and their impacts on pollen physiology and fertilization. Result indicated that environmental stress giving negative impacts on pollen germination and on the fertility of ornamental plants.

Keyword: Ecophysiology; Environmental Stressors; Ornamental Plants.

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Introduction

Ornamental plants, like all other plants, are subject to various environmental stressors that can affect their ecophysiology, including their ability to produce viable pollen and successfully fertilize. Environmental stressors can include abiotic factors like temperature, drought, and salinity, as well as biotic factors like pathogens and herbivores. Temperature stress, for example, can affect ornamental plants in different ways depending on the specific species and its thermal tolerance. High temperatures can lead to reduced photosynthesis and impaired pollen development and viability, while low temperatures can lead to reduced growth and delayed flowering. Drought stress can also impact ornamental plants, leading to decreased water uptake and reduced growth, as well as changes in stomatal conductance and photosynthesis that can affect pollen physiology. Salinity stress, which can arise from factors like irrigation with saline water, can also impact ornamental plants, with high levels of salt leading to reduced growth and flowering, as well as reduced pollen viability and fertility. These environmental stressors can also impact the pollination of ornamental plants. For example, high temperatures can lead to reduced flower longevity, resulting in a shorter window of time for pollinators to visit and fertilize the flowers. Drought stress can also reduce nectar production and flower size, which can affect pollinator attraction and success. Additionally, exposure to pollutants or toxins can negatively impact pollinator health and behavior, further reducing pollination success. To explore the physiological ecology of trees under environmental stresses is of great significance to improve forestry production and environmental protection (Liu et al. 2023). In conclusion, understanding the ecophysiology of ornamental plants and their responses to environmental stressors is crucial for successful cultivation and maintenance of these plants. Moreover, as ornamental plants often rely on pollinators for successful fertilization, it is important to consider the impacts of environmental stressors on pollinator behavior and success as well. Present study was done to examine the effects of environmental stress on pollen fertility and pollen physiology of some ornamental plants of Sonpur city of district saran, state Bihar of India.

MATERIAL AND METHODS

Study Area

Sonpur is a city and sub-division in the Indian state of Bihar. It is situated on the banks of the River Gandak and Ganges in the Saran District. The town is situated at 25.7°N 85.1832°E at an altitude of 42 meters.

Climate of the Study Area

Yearly temperature of the district is 30.41ºC. Sonpur typically receives about 24.2 millimeters of Precipitation and containing 26.65 rainy days annually.

Sample Material Collection

Flower sample of the ornamental plants of Hibiscus rosasinensis, Bougainvillea, Cestrum nocturnum were collected at morning time. The ecological conditions of soil, water and light was same. Collected plant samples were wrapped in polythene bags (to minimize evaporation losses). They were brought to the laboratory for further study. Bougainvillea is one of the most important perennial ornamental shrubs, sometimes a climber, in tropical and subtropical gardens. It is a very important floriculture crop for multipurpose use (Datta and Janakiram2020)

Pollen Physiology Examination

Pollen Fertility of all the ornamental plants were examined by using Alexander staining. Alexander staining was prepared by combining 20ml Ethyl alcohol, Malachite green in the quantity of 2ml of 1% solution in 95% alcohol, distilled water 50ml, glycerol 40%, Acid Fuchsin in the ratio of 10ml of 1% aqueous solution, phenol 50gm and lactic acid 3ml.

In Vitro Pollen Germination

The pollen was collected soon after the dehiscence of anthers. Pollen germination was observed by hanging drop technique using Brewbaker and Kwack's medium. The cultures were stored in diffused sunlight at room temperature (28+2°C) for 8 hours. All the cultures were run in duplicate and average results were recorded. The length of the pollen tubes was measured. Freshly collected pollen from plants growing at Sonpur with different RH and temperature-= 28 were in BOD incubator, dessicator were stored" The viability of pollen was checked at the intervals of 24 hrs.

RESULT AND DISCUSSION

Morphological Studies of Bougainvillea Spectabilis

This a member of family Nyctaginaceae which is distinguished by the presence of colored spepaloid bracts, pataloid calyx and monocarpellary ovary. It is woody, scandent or straggling shrub, climbing by the help of thrones. Leaves and stems pubescent, Leaves ovate to orbicular ovate. Flowers small clustered at the end of branches. Commonly cultivated as an ornamental plants. *Bougainvillea* exhibits a rich bract color, long flowering period, and high tolerance to poor soil and high temperatures and is therefore widely planted in the main tropical and subtropical regions of the world (Chang Shengxin et al. 2021). Pollen grains of the family Nyctaginaceae have been studied by different authors time to time (Pramanic et al. 2015).

Fig-1 Google Map of the Study Area

Fig-2 The ornamental plants of Cestrumnocturnum, Bougainvillia, Hibiscus-rosa sinenesis

Morphological Studies of Cestrum nocturnum

It is belongs to family Solanaceae commonly known as "rat ki rani". It is a shrub, flowers are greenish yellow and it is commonly cultivated in gardens for its fragrant flowers, which are scanted at night. Flowering starts in month of July and remain in bloom until the end of September. Pollen morphological characters, as a useful tool in better understanding of the taxonomic disputes and classification of plants, have been critically employed in several angiosperm families since decades (Pramanic et al. 2015). The Cestrum genus is karyotypically exceptional in Solanaceae. It is characterized by a basic number x = 8, a large chromosomal and genomic size, complex heterochromatin patterns, B-chromosomes (Bs) with particular heterochromatin and distribution of 18–5.8–26S and 5S rDNA. Cestrum nocturnum L. has a diploid number of 2n = 16 plus a variable number of B-chromosomes (Montechiari et al. 2020).

Morphological Studies of hibiscus rosa-sinensis

It is the member of family Malvaceae commonly known as shoe flower in Chinese. It is an evergreen, woody, glabrous, showy shrub, 5-8ft high.

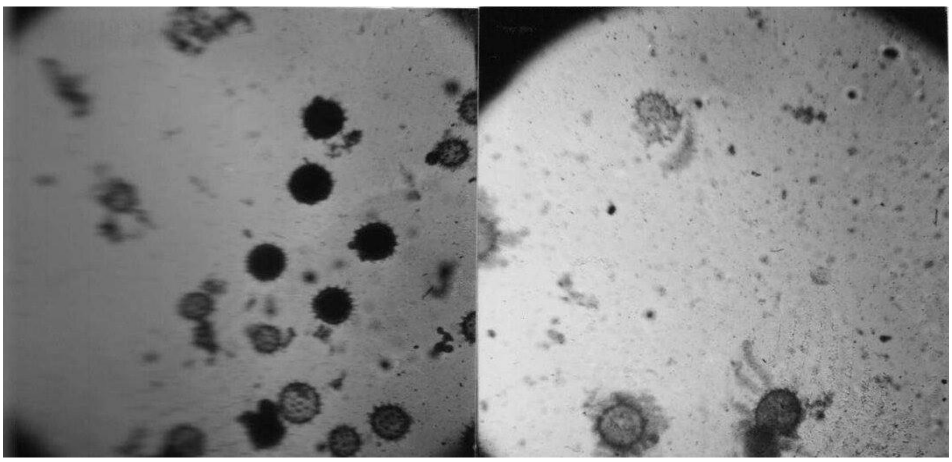

Fig-3 Shows the Pollen grains of Cestrum nocturnum in TTC and pollen grains of Cestrum nocturnum to germination on stigmatic surfaces.

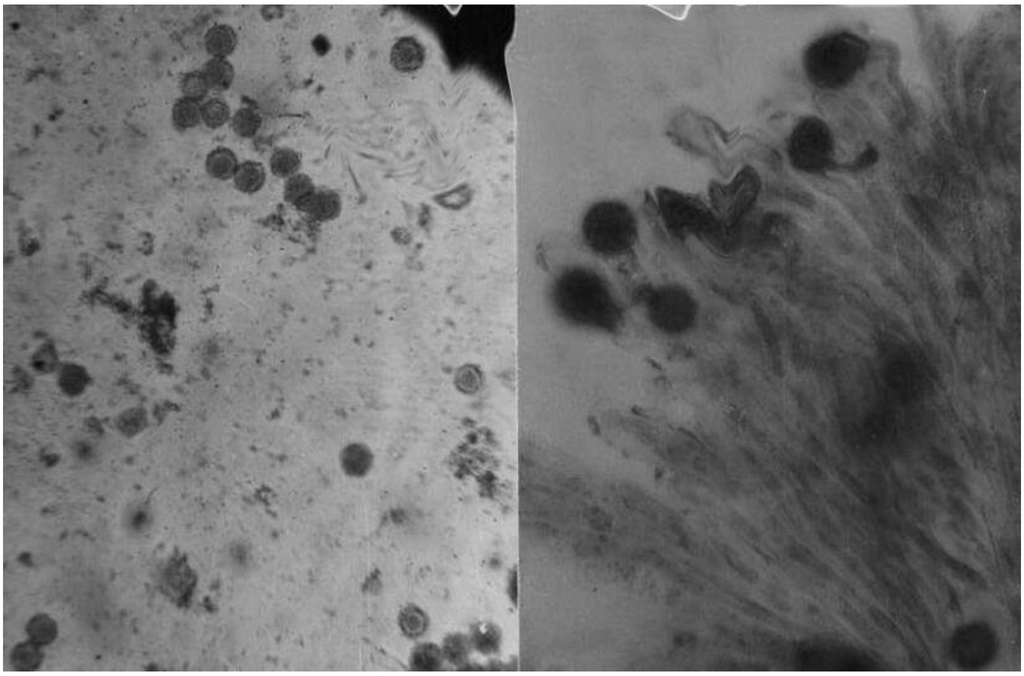

Fig-4 Shows the Pollen grains of Bougainvillea in TTC and In vitro pollen germination

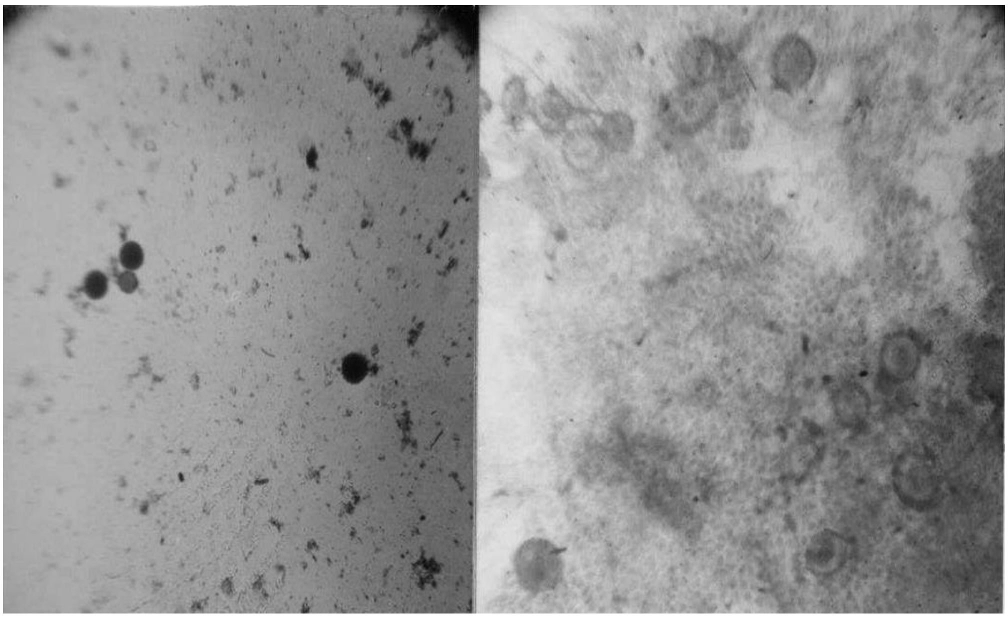

Fig-5 Shows the Pollen grains of Hibiscus rosa-sinensis showing pollen fertility as checked by TTC and inorganic acid test in Hibiscus rosa- sinensis

Pollen Physiology

Table- 1 Shows the Pollen fertility of Cestrum nocturnum and in vitro pollen germination

Flowering Period	Pollen Fertility (%)			In vitro Germination	
	Alexander stain	Tetrazolium chloride	Inorganic acid test	Germination Percentage	Pollen tube length
February	82	85	25	65.5	199
March	80	81	20	61.2	190
April	70	72	45.0	59.0	82.6
May	56	56	0.7	34	70.4
Jun	58	55	4.5	37	74.8
July	72	70	11	40.3	89.1
August	78	78	14	42.5	99.3
September	78	80	18.2	50.1	102.1
October	80	85	19.0	40.5	100

Table-2 Shows the Pollen fertility and in vitro pollen germination of Hibiscus rosa-sinensis

Flowering Period	Pollen Fertility (%)			In vitro Germination	
	Alexander stain	Tetrazolium chloride	Inorganic acid test	Germination Percentage	Pollen tube length
July	55.4	50	0.4	35.1	135.8
August	62.5	64	11	45.5	170.2
September	60.0	64	11.3	50	175.2

Table-3 Shows the Pollen fertility of Bougainvillea and in vitro pollen germination

Flowering Period	Pollen Fertility (%)			In vitro Germination	
	Alexander stain	Tetrazolium chloride	Inorganic acid test	Germination Percentage	Pollen tube length
March	80.2	77.5	66.8	66.5	199.2
April	85.3	85.2	70.6	62.2	190.1
May	75.5	90.0	70.5	58.0	85.6
Jun	72.3	65.5	80.5	54.5	75.5
July	60.6	72.2	77.2	30.2	89.3
August	72.8	60.3	66.8	35.2	90.5
September	86.6	58.4	58.9	40.5	98.4
October	70.3	80.0	78.9	50.8	78.5
November	70.0	85.2	60.6	45.2	78.9

The table-1 provides information on the flowering period of a Cestrum nocturnum plant along with various characteristics related to its pollen fertility and in vitro germination. The Cestrum nocturnum flowering period occurs in three months - July, August, and September. The pollen fertility percentages recorded during the three months are 55.4% in July, 62.5% in August, and 60.0% in September. In vitro germination refers to the process of pollen grain growth and development outside of the plant. The Alexander stain test measures the ability of pollen grains to germinate. The recorded values are 50% in July, 64% in August, and 64% in September. Tetrazolium chloride is another test used to assess pollen germination. The values recorded are 0.4% in July, 11% in August, and 11.3% in September. The inorganic acid test is another method to evaluate pollen germination. The values recorded are 35.1% in July, 45.5% in August, and 50% in September. The overall percentage of germinated pollen grains for each month recorded values are 35.1% in July, 45.5% in August, and 50% in September. Pollen tube length refers to the length of the tube that emerges from the pollen grain during germination. The values recorded are 135.8 in July, 170.2 in August, and 175.2 in September. These measurements provide insights into the plant's reproductive health, specifically related to pollen fertility and in vitro germination characteristics. The table-2 provides information about the flowering period of a Hibiscus rosa-sinensis plant species and various measurements related to its pollen fertility and in vitro germination. Flowering Period of Hibiscus rosa-sinensis plant species is from February to October, Pollen Fertility (%) percentage of pollen grains ranges from 56% to 82% throughout the flowering period. In vitro Germination refers to the ability of pollen grains to germinate under laboratory conditions. Alexander Stain measurement indicate the values ranges from 0.7% to 45%. Tetrazolium Chloride values ranges from 34% to 85%. Inorganic Acid Test measurement indicates the percentage of pollen grains that exhibit viability when subjected to an inorganic acid test. The values range from 4.5% to 19%. Germination Percentage values ranged from 34% to 65.5%. Pollen Tube Length the values ranged from 70.4 units to 199 units. Overall, the table presents data on pollen fertility, viability, and germination of the plant species during different months of the flowering period. These measurements help in understanding the reproductive capabilities and development of the plant's pollen during each month. The table provides information about the flowering period of a certain plant and various measurements related to pollen fertility and germination. The table-3, represents the flowering periods of Bougainvillea from March to November. Pollen Fertility (%) represents the percentage of pollen grains that are fertile and capable of fertilization. In vitro Germination shows the percentage of pollen grains that germinated successfully using the Alexander staining method. Tetrazolium chloride displays the percentage of pollen grains that showed germination using the tetrazolium chloride method. Inorganic acid test indicates the percentage of pollen grains that exhibited germination in an inorganic acid test. Germination Percentage represents the overall percentage of pollen grains that successfully germinated. Pollen Tube Length provides the average length of the pollen tubes that developed during germination. The values in each column correspond to different months, starting from March and ending in November. For example, in March, the pollen fertility percentage is 80.2%, the Alexander stain germination percentage is 77.5%, the tetrazolium chloride germination percentage is 66.8%, the inorganic acid test germination percentage is 66.5%, and the average pollen tube length is 199.2 units. The results clearly indicated that the pollen fertility of all these ornamental plants increases with the decrease in temperature and rise in relative humidity. The findings of the in vitro pollen germination have clearly indicated that Brewbaker and Kwack's medium was for in vitro pollen germination and the highest germination percentage is recoded after one hour in all the ornamental plants studied. The in vitro pollen germination studies also indicate that by the rise in daily temperature pollen grains lose their power of germination and become nonviable. These studies confirmed the effect of temperature and relative humidity on pollen fertility. The studies on the pollen longevity have also indicated that with the rise in temperature pollen grains become non-viable.

CONCLUSION

Pollen physiological studies revealed that pollen fertility as checked by Alexander stain, Tetrazolium chloride and inorganic acid test decreases with the increase in temperature in all these ornamental plants. The percentage of pollen germination increased with the increase in pollen fertility and decreased with the decrease in pollen fertility. It is concluded that pollen grains of the plants studied presently are highly sensitive to environmental conditions, particularly to temperature and relative humidity. The environmental changes by change in pollen fertility reduced pollen germination on stigma and therefore, reduced fertilization and finally the seed set. Thus, environmental changes, particularly in temperature and RH –induce changes in pollen fertility and finally seed set

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