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COMPARATIVE STUDY ON GROWTH PERFORMANCE OF SOME PERENNIAL TERRESTRIAL ANGIOSPERMS, GROWING IN NON POLLUTED AREA AND POLLUTED AREA AROUND THE KOTA THERMAL POWER STATION, KOTA, RAJASTHAN, INDIA

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ABSTRACT
Present comparative study is based on eco-morphological characteristics of some perennial terrestrial angiosperms facing harmful effects of pollutant emitted by Kota Thermal Power Station (KTPS), Kota, Rajasthan to plants which are growing in non-polluted area away from KTPS. KTPS is situated at 24° 52′ 20″ N and 75° 36′ 50″ E in South West of Kota district. Area around KTPS of 1-1.5 kilometer radius with pollution was taken as sub-study area first. And another area 4-5 kilometer away from KTPS was taken as sub-study area second denoted as non-polluted area. Most dominant plants selected for comparative studies are *Acacia nilotica, A. senegal Albizia labbek, Dalbergia sisso, Eucalyptus rudis, Mangifera indica, Azadirachta indica Prosopis cineraria, Ziziphus mauritiana, Bauhinia variegata, Callistemon lanceolatus,* etc. Parameters for eco-morphological studies were characteristics of tree and these were basal area, structure of canopy, branching pattern, percentage foliar damage and aggregation & association of species. Observations and results indicate that first study area with pollution shows disturbed vegetation because of deposition of various pollutants emitted by KTPS. Here vegetation shows some arid characters simultaneously. There was a reduction in quantity of biodiversity, also observed in comparison to non-polluted site i.e. study area second.There was no marketable difference observed in basal area, canopy structure, and branching pattern of the selected tree species in both the study areas.

KEY WORDS: Eco-morphological characters, KTPS, Pollution, Terrestrial Angiosperms.

INTRODUCTION

Pollutants affect local vegetation directly or indirectly. Emission from thermal power plant adversely affects the plant species growing near the source, (Gordon and Gorham, 1963). Due to polluted air, changes in plant community can be expected both in species composition and in community productivity (Rao, 1977). Trees and shrubs act as pollution sink due to their higher ecological amplitude of tolerance, although the sensitive plants show morphological, anatomical and biochemical changes and act as “Bio-indicator” of pollution levels (Chapekar, 1981). Plant communities can be introduced for the study of stress due pollutant (Dadhich and Kasat,1988).Observations have been made to study the responses of a predominantly deciduous plant community as a whole to various air pollutants in tropical conditions (Dadhich, 1981, 1982). Present study is also in the series of studies on Effect of pollutants on terrestrial angiosperms. Here pollutants emitted by thermal power plants have been studied and tried to find out their effect on plants. There are 82 thermal power stations are operating in the country, Kota Thermal Power Station(KTPS) is first in Rajasthan as ‘coal based power station’ located on the left bank of river Chambal and presently it is running with installed capacity of 1045 MW. Beside power generation KTP generates large number of particulates and gaseous pollutants like oxides of carbon and oxides of nitrogen in form of ‘Fly-ash’ those effect on local vegetation harmfully. Transportation of fly-ash by trucks, tankers, trailers without precautionary measures and local cement industries also contribute in enhancement of pollution level through automobile emission and gaseous pollution into the environment. These pollutants affect the local vegetation directly or indirectly. During the study these harmful effect were studied an observations were carried out.

METHODOLOGY

Study Area

For the purpose of this comparative study two study areas were selected. First study area is around KTPS with 1-1.5 kilometer radius that is showing dangerous pollution and another area 4-5 kilometer away from KTPS that is ‘Chhatravilas Garden’ was taken as study area second denoted as non-polluted area. Study was done during the month of January to march.

Data Collection

Four different plots were established for the study of ecosystem at each site corresponding to each direction. Efforts have been made to select site point was not previously in use for agriculture purpose and hence the impact of human activity was eliminated. Dominant tree species was selected for study purpose. The selected trees were taken approximately with same height and size. Parameter selected for the eco-morphological studies were basal area, canopy, branching pattern, number of main branches and aggregation & association of plants. These parameters were observed and recorded on the spot, tree plant selected randomly and in multiplication of five at both the sites. After the collection of data mean value was calculated. Followings parameters for deciduous trees at both the study area were selected-

1. **Basal Area**- Basal area refers to ground actually penetrated by the stem. Five plants of same species selected at random from five different locations near the KTPS. By using a centimeter tape circumference of each tree at breast height was measured then radius of each plant was calculated with the formula.

$r = c / 2\pi$ $\pi = 3.14$

Basal Area = πr^2 or $4\pi c^2$

r = Radius

c = Circumference

2. **Canopy cover**- Area occupied by the above ground part of the plant, it is called herbage cover or canopy cover, it includes branches, leaves inflorescence etc. To calculate canopy cover distance from stem to the extreme boundary of shed is taken, this distance is the radius (r) for canopy cover, reading should be taken at mid-noon when sun is over the head, it is helpful in taking perfect shadow of the plant, reading should be taken from 4 sides of stem then mean of radius will be calculated.

$r^* = r1+r2+r3+r4$…… Canopy= πr^2.

3. **Abundance**- Abundance may not be expressed in quantitative terms, but expressed as qualitative character, because tree plants are not found uniformly distributed in an area, they found in smaller patches or groups. Differing in number at each place, abundance is divided into five arbitrary groups depending upon the number of plants. These groups are- Very rare, Rare, Common, Frequent and Very frequent.

4. **Sociability**- It denotes the proximity of plant to another. Plants generally grow as isolated individuals, in patches, colonies or groups. Each species or some species may differ in sociability value. Thus sociability expresses the degree of association between species. Braun Blanquet (1932) divided plant into five sociability groups. These are-

S1-Plant (stem) found quite separately from each other, growing singly

S2-A group of 4-6 plants at one place

S3-Many smaller and scattered groups at one place

S4-Several bigger groups of many plants at one place

S5-A large group occupying larger area.

5. **Total number of main branches**- All selected trees show dichotomous branching pattern, to calculate the number of main branches in a tree binocular is used and start the counting from very first branching to the upper most branch After the counting of number the branches trees are categories in to following categories,

i. Highly branched – More than 12 branches
ii. Moderate branches – 8 to 12 branches
iii. Less branches – 4 to 8 branches
iv. Very less branches – 0 to 4 branches

6. **Branching pattern of tree**- Branches play role in formation of canopy architecture of the tree species. According to branching pattern various types of canopy structure are formed as sparse, irregular, globular, spreading crown, open, semi-dense etc.

RESULTS & DISCUSSION

In present study **21** tree species were observed which include approximately all tree species observed by previous workers during last two decades, except *Lannea coromandelich, Poinciana regia* (Dadhich and Kasat 1988). In these 21 tree species (Table-1) *Cassia siamea, Cassia fistula, Azadirachta indica, Delonix regia, Bauhinia variegate, Albizia lebbeck* were found near the campus while *Anoegissus spp, Acacia nilotica* and, *Zizyphus spp* were dominant far away from main plant and near to fly-ash dumping area. Results indicates that trees found in most abundance at first sub area are *Acacia nilotica Albizia lebbek and Ziziphus spp* in comparison to *Azadirechta indica* and *Dalbergia sissoo* of sub area second. *Ficus banghalensis* was rare plant for first study area while present commonly in sub area second.*Eucalyptus rudis*, *Cassia siamea* distributed equally at both the sites. According to sociability only *Acacia nilotica* and *Ziziphus mauritiana* show slight grouping patterns at sub-area I. Maximum branches, dense branching pattern and spreading dense canopy architecture was observed in *Ficus banghalensis*, minimum branches with sparse canopy observed in *Eucalyptus rudis* at both the sites. Maximum basal area occupied by *Ficus banghalensis* at subarea I which is more than the same plant present at subarea II. Minimum basal area occupied by *Eucalyptus rudis* followed by *Cassia siamea* at subarea I, while minimum basal area at subarea II occupied by *Cassia siamea* and *Ziziphus mauritiana* .At both the sites largest canopy cover was of *Ficus banghalensis* followed by *Azadirachta indica.* While a remarkable difference was observed in canopy cover of *Eucalyptus rudis* and *Cassia siamea* at both sub-study areas. The overall picture shows that the small canopy covers ware present at subarea I in comparison to subarea II. Lynch.1951 documented the reductions in annual diameter growth in trees of polluted area. But in this study the relationship between total basal area of tree species and distance from the power plant was poor, however the extent and type of damage to leaves was observed in the tree species, which is affected mostly by direction of wind, distance from chimneys, fly ash hopper and dumping area. Maximum symptoms were observed at south east direction of power plant. *Prosopis cinereria, Bougainvillea, Ziziphus mauritaina, Bauhinia variegata, Callistemon lanceolatus* show some leaves injury symptoms, may be due to combined effect of all the factors discussed earlier. It was observed that the trees like *Mangifera indica, Azadirachta indica, Acacia nilotica, Eucalyptus rudis* show more resistance to emissions as compare to other trees. It can further be discussed that the vegetation around thermal power station, though not exhibiting the apparent symptoms of pollution injury, but was constantly under stress due to pollution. Herbal species were the most susceptible while already established woody perennials could cope up with the stress, so that they did not show any permanent visible injury, the work of Thakre and Aggarwal (1987), & Dadhich and Kasat (1988) confirm this view. Such studies are very significant as the information furnished can be utilized in making a pollution free industrial complex, which is suitable for human habilitations. The main objective of present study is to identify pollution tolerant species and to suggest an ecological model in the form of green belt around industrial complex to mitigate pollution. *Mangifera indica, Azadirachta indica, Acacia nilotica, Eucalyptus rudis Albizia lebbek and Ziziphus spp* may provide a natural sink for them. Though under stress, they did not show any permanent visible injury. In the comparative study between two decades on some common plants were identified that were remain unchanged e.g. *Cassia siamea, Cassia fistula, Azadirachta indica, Delonix regia, Bauhinia variegate, Albizia lebbeck, Ipomoea fistulosa, Thevetia peruviana, Zizyphus nummularia, Solanum xanthocarpum Chenopodium album, Euphorbia hirta, Phyllanthus fraternus, Croton banplandianum Alternanthera pungens* and *Tridex procombens.* These plants may provide a natural sink for pollutants of KTPS. In general plants growing in polluted area were stunted in comparative to unpolluted area, some visual injury symptoms like burning of leaf margins and tip, necrosis and chlorosis were observed, the dust covered the leaves show brown necrotic lesions starting at the tip and progressing down the lamina, maximum necrosis and chlorosis observed in *Ziziphus* and *Cassia* (Varshney and Garg, 1980).

TABLE:-1

S. No.	Name of Tree with Family	Study Subareas	Circumference in meter (m)	Basal area In Sq. meters (m^2)	Radius (meter)	Canopy Area	Abundance	Sociability	Total number of main branching
1.	*Eucalyptus rudis* (Myrtaceae)	Subarea I	20.096	32.154	3.2	32.2	Common	S2	5 to 7 & 7 to 8
		Subarea II	27.632	60.790	4.4	60.8			
2.	*Azadirachta indica* (Miliaceae)	Subarea I	36.424	105.629	5.8	105.6	Common	S1	7 to 8
		Subarea II	37.052	109.303	5.9	109.3			
3.	*Albizia lebbek* (Mimosaceae)	Subarea I	31.4	78.5	5	78.5	Frequent	S3	8 to 10
		Subarea II	35.168	98.470	5.6	98.5			
4.	*Ficus banghalensis* (Moraceae)	Subarea I	37.68	113.04	6	113.0	Rare	S1	12 to 18
		Subarea II	50.24	200.96	8	201.0			
5	*Ficus glomerata* (Moraceae)	Subarea I	27.004	58.059	4.3	110.0	Rare	S1	10 to15
		Subarea II	35.168	98.470	5.6	191.0			
6.	*Acacia nilotica* (Mimosaceae)	Subarea I	28.888	66.442	4.6	66.4	Very much frequent	S4	8 to 12
		Subarea II	30.144	72.346	4.8	72.3			
7	*Acacia senegal* (Mimosaceae)	Subarea I	28.888	66.442	4.6	59.4	Frequent	S4	8 to 12
		Subarea II	28.888	66.442	4.6	69.2			
8.	*Cassia siamea* (Caesalpineaceae)	Subarea I	25.748	52.783	4.1	55.4	Common	S3	8 to 12
		Subarea II	32.656	84.906	5.2	84.9			
9.	*Ziziphus mauritaina* (Rhamnceae)	Subarea I	22.608	40.694	3.6	40.7	Very much frequent	S4	8 to 12
		Subarea II	20.096	32.154	3.2	32.2			
10.	*Dalbergia sissoo* (Fabaceae)	Subarea I	27.632	60.790	4.4	60.8	Frequent	S3	8 to 12
		Subarea II	30.144	72.346	4.8	72.3			
11.	*Albizia lebbek* (Mimosaceae)	Subarea I	31.4	78.5	5	78.5	Frequent	S3	8 to 10
		Subarea II	35.168	98.470	5.6	98.5			
12.	*Holoptelea integrifolia* (Ulmaceae)	Subarea I	28.26	63.585	4.5	101.0	Frequent	S1	10 to 15
		Subarea II	36.424	105.630	5.8	184.0			

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