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(RESEARCH ARTICLE)

# Road side flora of Pazhavoor, Tirunelveli district, Tamil Nadu, South India

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## Abstract

Roadsides are habitats with very specific environmental conditions, often substantially differing from their natural surroundings. However, roads can have a positive effect on local vascular plant species richness. The vegetation of Pazhavoor were surveyed, the Road side flora of, a total of 103 species belongs to 87 genera and 34 families are recorded. Out of 34 families, 13 families belongs to Monocot (Liliaceae, Poaceae, Arecaceae, Ascelepiadaceae etc) and 90 families are Dicots (Malvaceae, Euphorbiaceae, Lamiceae, Meliaceae, Acanthaceae, etc). Fabaceae is the most dominant family with 12 species. Euphorbiaceae is the second largest families with 11 species followed by Malavaceae (10), Amaranthaceae (9), Poaceae (8), Acanthaceae (7), Asterceae (4), Solanaceae (3), Rubiaceae (2), Vitaceae (1). No endemic species has been found from the study area. The commonly occurring species are *Abutilon indicum*, *Acalphaindica*, *Barleria sps*, *Cassia auriculata*, *Chlorsis barbata*, *Cocus nucifera*, *Euphorbia sps*, *Jatropha curcus*, *Mollugo nudicaulis*, *Tamarindus indica*, *Tribulus terrestris*, *Tridax prcumbens*, *Vernoniacinerea*. The dominant tree species found are *Azadirachta indica, Cocus nucifera*, *Ficus religiosa* followed by *Tectona grandis.* Among the total 103 species, 12 are trees, 22 shrubs, 64 herbs and 5 climbers. More over 96 species are wild and 7 species are cultivated. Seeds is used to propagate 103 plant species, 2 species by seeds/stem cutting, 3 species were propagated using their bulbs, 2 species were propagated by stem cutting, Rest of the plants propagated using their different plant parts (bud, corm, Rhizome, seed, tubers). In this study environmental conditions and propagules maturity etc were found key factors for their regeneration. These results show that roadside vegetation can contribute to the conservation of the flora of study area.

**Keywords:** Climbers; Flora; Natural; Regeneration; Vegetation; Roadsides

## 1. Introduction

Roads are an integral part of daily life for most people in the world, providing mobility across our landscape. Road side vegetations are open to contaminations of diverse heavy metals and other gaseous pollutants, and to physical disturbances of being trampled by pedestrians and crushed by vehicles continuously. The roadside may be a refuge for more species, and the pattern of vegetation distribution is affected by road age and distance from the road verge [1]. The main reasons for the presence of different species along roads are often changes in physical and chemical properties of soil [2], light conditions [3], as well as microclimate [4]. Roads also influence the spread and growth of species by serving as corridors for movement as well as providing habitat for establishment of propagules. The objectives of this study are to evaluate the current status of species in the study area.

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## 2. Material and methods

The study area Pazhavoor which belongs to Radapuram taluk and Tirunelveli district. Most of people are doing agriculture. They are cultivating Jasminum and ground nuts. There are 2000 houses are available in the study area. Many numbers of ponds and canals are present in the study area. Some of the people are rearing cattles also. Many wind mills are constructed and used in the production of electricity. Here one Shiva temple is there which was constructed by the Pandiya king. Here two primary, one higher secondary schools, police stations, primary health centre and agricultural Co-operative centre are available.

The task of inventorying the plant diversity of Pazhavoor campus was undertaken systematically and intensively from September 2014 to September 2015, to cover most species in flowering and fruiting stages and also to cover various seasons. Field observations were made and plants were photographed. Plant species were identified using regional floras [5-8]. The collected materials were poisoned using standard herbarium techniques [9]. Well-preserved specimens with voucher numbers were deposited in the Herbarium of the P.G Department of Botany and Research, S.T. Hindu College, Nagercoil, Tamil Nadu, India.

## 3. Results and discussion

The vegetation of Pazhavoor were surveyed, the Road side flora of, a total of 103 species belongs to 87 genera and 34 families are recorded (Table 1). Out of 34 families, 13 families belong to Monocot (Liliaceae, Poaceae, Arecaceae, Ascelepiadaceae, etc) and 90 families are Dicots (Malvaceae, Euphorbiaceae, Lamiceae, Meliaceae, Acanthaceae, etc). Fabaceae is the most dominant family with 12 species (Table 1 and Figure 1).

**Table 1** List of plant species recorded from the study area

| Sr. No | Name of the plants | Family | Habit | Nature of Plant | Cotyledons |
|---|---|---|---|---|---|
| 1 | *Abutilon indicum*(Link) sweet | Malvaceae | Shrub | Wild | Dicot |
| 2 | *Acalypha fruticosa* Forssk. | Euphorbiaceae | Shrub | Wild | Dicot |
| 3 | *Acalypha indica* L. | Euphorbiaceae | Herb | Wild | Dicot |
| 4 | *Achyranthes aspera* L. | Amaranthaceae | Herb | Wild | Dicot |
| 5 | *Aerva lanata* (L.) Juss.ex.Schult. | Amaranthaceae | Herb | Wild | Dicto |
| 6 | *Aloe vera* (L.) *Burm. f.* | Liliaceae | Herb | Cultivated | Monocot |
| 7 | *Alternanthera pungens* Kunth. | Amaranthaceae | Herb | Wild | Dicot |
| 8 | *Alysicarpus vaginalis* (L.) | Fabaceae | Herb | Wild | Dicot |
| 9 | *Amaranthus hybridus* L. | Amaranthaceae | Herb | Wild | Dicot |
| 10 | *Andrographis echioides* (L.) Nees | Acanthaceae | Herb | Wild | Dicot |
| 11 | *Anisomeles malabarica* (L.) | Lamiceae | Herb | Cultivated | Dicot |
| 12 | *Apluda mutica* L. | Poaceae | Herb | Wild | Monocot |
| 13 | *Aristida purpurea* Nutt. | Poaceae | Herb | Wild | Monocot |
| 14 | *Azadirachta indica* A. *Juss* | Meliaceae | Tree | Cultivated | Dicot |
| 15 | *Barleria cristata* L. | Acanthaceae | Shrub | Wild | Dicot |
| 16 | *Barleria lupulina* Lindi | Acanthaceae | Shrub | Wild | Dicot |
| 17 | *Boerhaavia diffusa* L. | Nyctaginaceae | Herb | Wild | Dicot |
| 18 | *Borassusflabellifer* L. | Arecaceae | Tree | Cultivated | Monocot |
| 19 | *Calotropis gigantean* (L.) | Apocynaceae | Shrub | Wild | Dicot |
| 20 | *Cardiospermum halicacabum* Linn | Sapindaceae | climber | Wild | Dicot |
| 21 | *Cassia auriculata* L. | Fabaceae | Shrub | Wild | Dicot |
| 22 | *Cassia occidentalis* (L.) | Fabaceae | Shrub | Wild | Dicot |
| 23 | *Catharanthus pusillus* (Murray) G.Don | Apocynaceae | Herb | Wild | Dicot |
| 24 | *Celosia argentea* L. | Amaranthaceae | Herb | Wild | Dicot |
| 25 | *Celosia spicata* L. | Amaranthaceae | Herb | Wild | Dicot |

| Sr. No | Name of the plants | Family | Habit | Nature of Plant | Cotyledons |
|---|---|---|---|---|---|
| 26 | *Chlorsis barbata* (L.) | Poaceae | Herb | Wild | Dicot |
| 27 | *Cissus quadarangularis* L. | Vitaceae | Shrub | Wild | Dicot |
| 28 | *Cleome viscosa* L. | Cleomaceae | Herb | Wild | Dicot |
| 29 | *Clitoria ternatea* L. | Fabaceae | Herb | Wild | Dicot |
| 30 | *Cocus nucifera* L. | Arecaceae | Tree | Cultivated | Monocot |
| 31 | *Corchorus olitorius* L. | Malvaceae | Herb | Wild | Dicot |
| 32 | *Corchorus trilocularis* L. | Malvaceae | Herb | Wild | Dicot |
| 33 | *Crotalaria retusa* L. | Fabaceae | Herb | Wild | Dicot |
| 34 | *Croton sparsiflorus* Baill | Euphorbiaceae | Herb | Wild | Dicot |
| 35 | *Cyperus odoratus* L. | Cyperaceae | Herb | Wild | Dicot |
| 36 | *Dactyloctenium aegyptium* (L.) willd. | Poaceae | Herb | Wild | Monocot |
| 37 | *Daemia extensa* (Jacq.) R.Br. Ex schult | Asclepiadaceae | climber | Wild | Monocot |
| 38 | *Datura metel L.* | Solanaceae | Shrub | Wild | Dicot |
| 39 | *Delonix regia (Bajex Hook)* Raf. | Fabaceae | Tree | Wild | Dicot |
| 40 | *Digera muricata* (L.) Mart | Amaranthaceae | Herb | Wild | Dicot |
| 41 | *Eragrostis tenella* (L.) | Poaceae | Herb | Wild | Monocot |
| 42 | *Euphorbia antiquorum* L. | Euphorbiaceae | Shrub | Wild | Dicot |
| 43 | *Euphorbia hirta* L. | Euphorbiaceae | Herb | Wild | Dicot |
| 44 | *Euphorbia retusa* Forssk | Euphorbiaceae | Herb | Wild | Dicot |
| 45 | *Euphorbia trigona* Mill. | Euphorbiaceae | Shrub | Wild | Dicot |
| 46 | *Evolvulus alsinoides* (Linn.)Linn. | Convolvulaceae | Herb | Wild | Dicot |
| 47 | *Ficus religiosa* L. | Moraceae | Tree | Wild | Dicot |
| 48 | *Gomphrena celosioides Mart.* | Amaranthaceae | Herb | Wild | Dicot |
| 49 | *Gomphrena globosa* L. | Amaranthaceae | Herb | Wild | Dicot |
| 50 | *Gynandra pentaphylla* L. | Capparaceae | Herb | Wild | Dicot |
| 51 | *Hibiscus rosa-sinensis*L. | Malvaceae | Shrub | Cultivated | Dicot |
| 52 | *Indigofera linifolia* L. | Fabaceae | Herb | Wild | Dicot |
| 53 | *Ipomea pestigridis* L. | Convolvulaceae | climber | Wild | Dicot |
| 54 | *Jatropha curcus* L. | Euphorbiaceae | Shrub | Wild | Dicot |
| 55 | *Jatropha gossypifolia* L. | Euphorbiaceae | Shrub | Wild | Dicot |
| 56 | *Justicia adhatoda* L. | Acanthaceae | Shrub | Wild | Dicot |
| 57 | *Justicia procumbens* L. | Acanthaceae | Herb | Wild | Dicot |
| 58 | *Justicia simplex* D.Don | Acanthaceae | Herb | Wild | Dicot |
| 59 | *Kyllinga brevifolia* (Rottb.) | Cyperaceae | Herb | Wild | Monocot |
| 60 | *Lantana camera* L. | Verbenaceae | Shrub | Wild | Dicot |
| 61 | *Lawsonia inermis* L. | Lythraceae | Shrub | Wild | Dicot |
| 62 | *Leucas aspera* (willd.) | Lamiaceae | Herb | Wild | Dicot |
| 63 | *Melhania incana* Heyne ex wight al Arn. | Malvaceae | Herb | Wild | Dicot |
| 64 | *Mollugo nudicaulis* Lam. | Molluginaceae | Herb | Wild | Dicot |
| 65 | *Mollugo pentaphylla* | Molluginaceae | Herb | Wild | Dicot |
| 66 | *Mukia maderaspatana* (L.)M. Roem | Cucurbitaceae | Herb | Wild | Dicot |
| 67 | *Ocimum tenuiflorum L.* | Lamiaceae | Herb | Wild | Dicot |
| 68 | *Oldenlandia umbellate* L. | Rubiaceae | Herb | Wild | Dicot |
| 69 | *Opuntia littoralis* Mill. | Cactaceae | Herb | Wild | Dicot |
| 70 | *Oxystelma esculentum* (L.f.)Sm. | Apocynaceae | climber | Wild | Dicot |

| Sr. No | Name of the plants | Family | Habit | Nature of Plant | Cotyledons |
|---|---|---|---|---|---|
| 71 | *Parthenium hysteron Phorus* L. | Asteraceae | Herb | Wild | Dicot |
| 72 | *Pavonia odorata* Cav | Malvaceae | Shrub | Wild | Dicot |
| 73 | *Pavonia zeylanica* (L.) | Malvaceae | Shrub | Wild | Dicot |
| 74 | *Pedalium murex* L. | Pedaliaceae | Herb | Wild | Dicot |
| 75 | *Peristrophe bicalyculata* (Retz.) Nees | Acanthaceae | Herb | Wild | Dicot |
| 76 | *Phyllanthus amarus* L. | Euphorbiaceae | Herb | Wild | Dicot |
| 77 | *Physalis minima* L. | Solanaceae | Herb | Wild | Dicot |
| 78 | *Plumbago zeylanica* L. | Plumbaginaceae | Herb | Wild | Dicot |
| 79 | *Pongamia pinnata* (L.) | Fabaceae | Tree | Wild | Dicot |
| 80 | *Prosopis juliflora* (SW) DC. | Fabaceae | Tree | Wild | Dicot |
| 81 | *Ricinus communis* L. | Euphorbiaceae | Shrub | Wild | Dicot |
| 82 | *Saccharum spontaneum* L. | Poaceae | Herb | Wild | Monocot |
| 83 | *Senna uniflora* (Mill.) | Fabaceae | Herb | Wild | Dicot |
| 84 | *Setaria barbata* (Lam.) Kunth | Poaceae | Herb | Wild | Monocot |
| 85 | *Sida acuta Burm.*f. | Malvaceae | Herb | Wild | Dicot |
| 86 | *Solanum trilobatum* L. | Solanaceae | Herb | Wild | Dicot |
| 87 | *Spermacoce hispida* L. | Rubiaceae | Herb | Wild | Dicot |
| 88 | *Stachytarpheta jamaicensis* (L.) Vahl | Verbaenaceae | Herb | Wild | Dicot |
| 89 | *Tamarindus indica* L. | Fabaceae | Tree | Wild | Dicot |
| 90 | *Tecoma stans* (L.) Juss. Ex kunth | Bignoniaceae | Tree | Wild | Dicot |
| 91 | *Tectona grandis* L. F | Lamiaceae | Tree | Wild | Dicot |
| 92 | *Tephrosia candida Dc.* | Fabaceae | Herb | Wild | Dicot |
| 93 | *Tephrosia purpurea* (L.) Pers. | Fabaceae | Herb | Wild | Dicot |
| 94 | *Thespesia populnea* (L.) sol. ex correa | Malvaceae | Tree | Wild | Dicot |
| 95 | *Thevetia peruviana* L. | Apocynaceae | Tree | Wild | Dicot |
| 96 | *Trianthema decandra* L. MANT. | Aizoaceae | Herb | Wild | Dicot |
| 97 | *Trianthema Portulacastrum* L. | Aizoaceae | Herb | Wild | Dicot |
| 98 | *Tribulus terrestris* L. | Zygophyllaceae | Herb | Wild | Dicot |
| 99 | *Tridax procumbens* L. | Asteraceae | Herb | Wild | Dicot |
| 100 | *Triumfetta rhomboidea* L. | Malvaceae | Herb | Wild | Dicot |
| 101 | *Vernonia cinerea* (L.) | Asteraceae | Herb | Wild | Dicot |
| 102 | *Xanthium strumarium* L. | Asteraceae | Herb | Wild | Dicot |
| 103 | *Zea mays* L. | Poaceae | Shrub | Cultivated | Monocot |

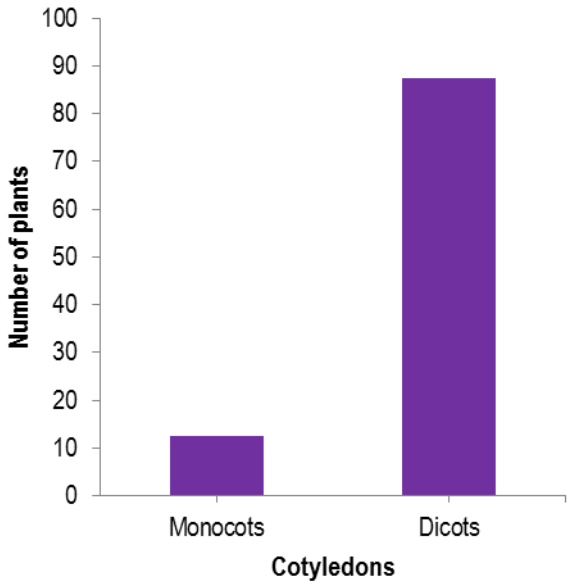


**Figure 1** Cotyledon wise distribution of plant species in the study area

Euphorbiaceae is the second largest families with 11 species followed by Malavaceae (10), Amaranthaceae (9), Poaceae (8), Acanthaceae (7), Asterceae (4), Solanaceae (3), Rubiaceae (2), Vitaceae (1) (Table 6, Figure 6) .No endemic species has been found from the study area. The commonly occurring species are *Abutilon indicum*, *Acalpha indica*, *Barleria sps*, *Cassia auriculata*, *Chlorsis barbata*, *Cocus nucifera*, *Euphorbia sps*, *Jatropha curcus*, *Mollugo nudicaulis*, *Tamarindus indica*, *Tribulus terrestris*, *Tridax prcumbens*, *Vernonia cinerea*. The dominant tree species found are *Azadirachta indica, cocus nucifera, Ficus religiosa* followed by *Tectona grandis* (Figure 2). Among the total 103 species, 12 are trees, 22 shrubs, 64 herbs and 5 climbers (Figure 3). More over 96 species are wild and 7 species are cultivated (Figure 4).

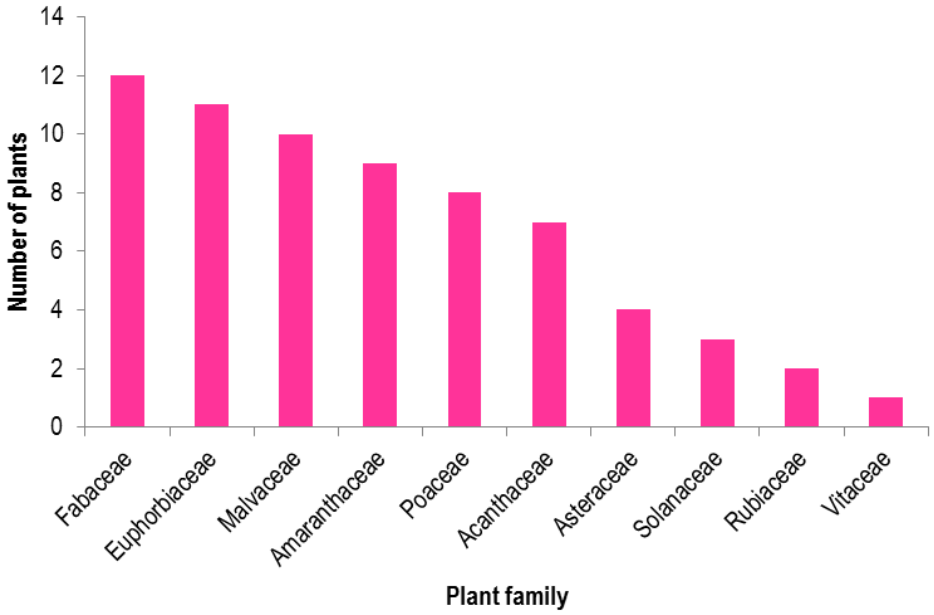


**Figure 2** Dominant families observed during the study period

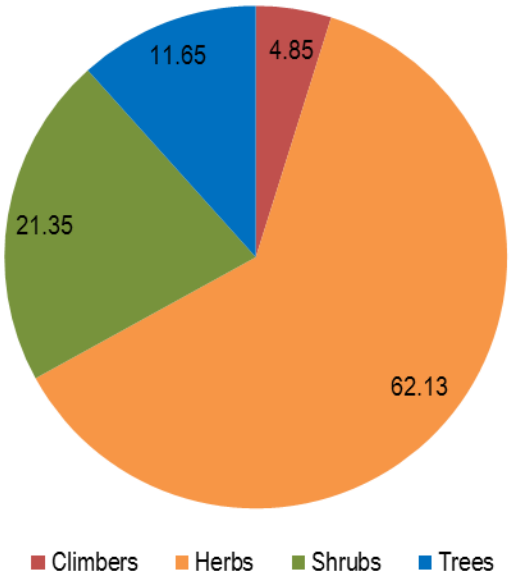


**Figure 3** Habit wise distribution of plant species in the study area

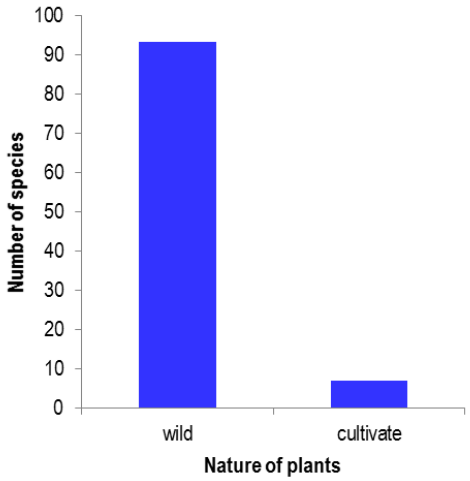


**Figure 4** Plant species under Wild/Cultivated ornamental categories

Seeds is used to propagate 103 plant species, 2 species by seeds/stem cutting, 3 species were propagated using their bulbs, 2 species were propagated by stem cutting, Rest of the plants propagated using their different plant parts (bud, corm, Rhizome, seed, tubers) (Figure 5). In this study environmental conditions and propagules maturity etc were found key factors for their regeneration.

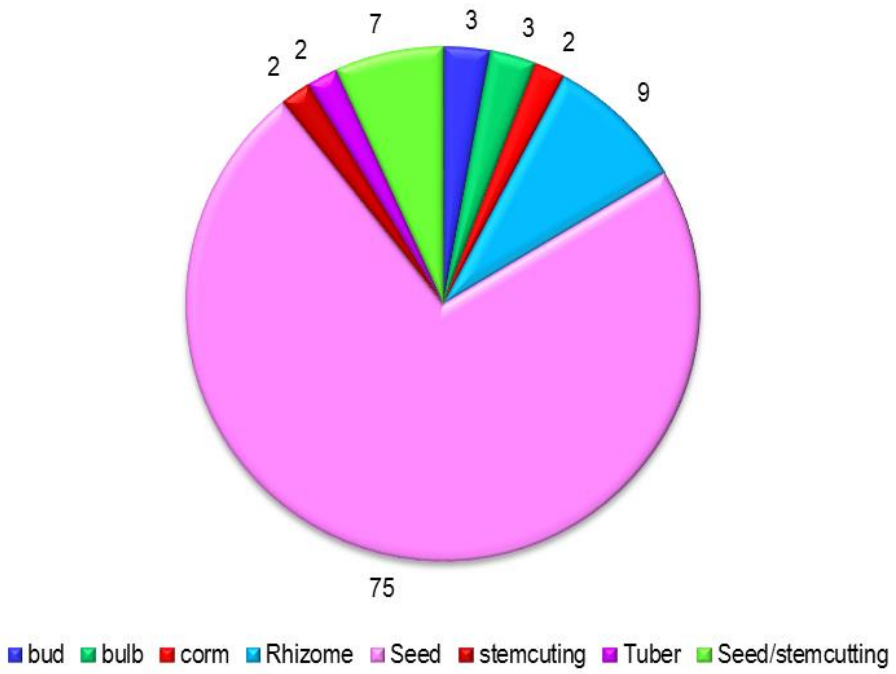


**Figure 5** Propagation method of selected plants in the area

Our results indicate that shrubs can be useful to stabilize vegetation and minimize erosion along roadsides and is supported by results from a study on effects of vegetation on runoff from simulations of rainfall showing that grasses and shrubs in combination protected better against runoff and soil detachment rates compared with grasses *per se* or natural restoration [10]. However, shrubs are disfavored by several natural and human imposed factors, and is anteceded by grasses and forbs in the natural plant succession order. Other functional plant groups, such as graminoids and forbs, tend to spread faster into disturbed areas, as does active management with seeding of graminoids and mowing frequently used to maintain visibility.

In urban areas, biodiversity offers social and biological functions to residents, including ecological balance, ecosystem services, environmental protection, outdoor recreation, aesthetic enjoyment, nature education, and nurturing grounds, shelters, refuges and dispersal centers for wildlife species [11-13]. Roads are man-made urban corridors, an essential part of urban green infrastructure [14]. Roadside trees, as integral part of urban green spaces, are of value to biodiversity, recreation and esthetic [15-17]. They provide home and sustenance for many floral and faunal species. Roadside trees in urban areas have many environmental benefits including removing air pollutants [18-19], improving urban aesthetics and supporting wildlife habitat [20-21], mitigating the "heat island" effect through evapo transpiration and shading sequestering carbon [22], and reducing building energy use for cooling and heating [23].

Roadside trees share similar management concerns and challenges to other urban trees .The specific physical and physiological constraints restrict species selection and affect their management. Usually, the relatively narrow roadside corridor and underground utilities severely confine tree growth in compact city environment. The heavy shading, heat irradiation, pollution, poor soil quality, limited rooting volume and soil compaction would exclude many species from roadside use [24-26]. The need for headroom and lateral clearance for vehicular and pedestrian traffic and adjacent buildings would preclude more species [27]. The high mortality rate of street trees implies that the species with low adaptation to the harsh roadside environment would be eliminated [22]. This in turn would require tree removal and replacement. With increased management cost and reduced funding available, public agency tree managers need tools that will allow them to prolong the service life of public roadside tree populations. The fact that the urban environment is a series of heterogeneous microclimates as Bassuk (1990) stated, the perfect urban tree' that are aesthetically pleasant and can withstand the multitude of environmental stresses encountered by roadside trees does not exist [28]. The differences in environmental variables (drainage, soil fertility, pH, salt and the amount of rooting space) can create so widely differing site conditions that even identical cultivars of street trees possess non-uniform growth. Besides, the lessons of the extensive plantings of a few species in USA proved that this approach is shortsighted [28-29]. Planting monocultures, or extensive plantings relying on only a very few species can create genetic vulnerability by encouraging the build-up of pests and diseases [28]. The cases showed that as most serious pests or problems are specific to certain families, genera, or species of plants, a key to sustainability in urban settings lies not in the selection of any single cultivar

with a particular set of characteristics but in biological diversity within populations. Having a broad diversity of trees in urban roadsides can guard against the possibility of large-scale devastation by both native and introduced insect and disease pests.

However, for many cities, the danger of monoculture plantings remains real with a very few species making up the greatest percentage of the population [28]. To avoid catastrophic losses and pest outbreaks associated with virtual monocultures, we should maintain a broad diversity of trees. Thus, biodiversity in existing street tree population needed to be assessed.

Species richness on roadside margins as revealed in the current investigations underlines the observations of Tansely, (1949) that roadsides are botanically and ecologically significant places [30]. Moreover, unlike the less diverse and regularly managed roadsides of the west with only few species [31-32], the negligibly managed roadsides of South India showed a rich diversity of resistant species. Apart from some studies on vegetation-site relationship of a broader area [33] and comparison according to climatic differences [34], no specific floristic investigations, especially that of the phytosociological details of resistant species close to tar-edge of roads are mentioned in the literature, even in recent vegetation analyses of roadsides of the Indian subcontinent [35]. Ahmad *et al*. (2004) [36] reported 227 species from a broad distance of roadsides; but total species diversity so far reported from roadsides close to tar-edgesis less than 70 species [37, 35, 33]. The significant differences in species richness and certain phytosociological characteristics found over urban and rural roadsides occupying same climatic conditions can be attributed to differences in the degree of anthropogenic disturbance over the zones. Non-climatic differences in species richness of roadside vegetations are known earlier [38]. However, the explanations of the differences in vegetation types on urban and rural roadsides without quantitative analytical details of individual species cannot reveal the ecological potentials of different species [39]. Therefore, the inclusion in the present investigation of such details enabled identification of the degree of hyper-tolerance of very many new species. Phytoremediation is an emerging cost effective eco-technology to deal with heavy metal contaminations and phytomining. These types of plant inventory researches are essential to the preliminary identification of hyper accumulators useful in phytoremediation.

Moreover, many species from the already identified hyper-accumulator plant families such as Poaceae, Asteraceae, Cyperaceae, Fabaceae, Lamiaceae and Euphorbiaceae were found on roadsides in the present studies; the fast growing Poaceae are noted for their tolerance and hyper accumulation capacities [40, 41]. The ecological potentials of the dominant grass species noted on these roadsides may be further explored for their specific ecological indications of tolerance or hyper-metal accumulation. The results of this research thus open up new vistas of ecological opportunities, which the exploration of roadside vegetation provides. Disturbance frequently is implicated in the spread of invasive exotic species [42]. Roads being the ecological corridors of exotic species [43], highly disturbed roadsides are open places where natural communities contain many exotic species. If the percentage of exotic species on roadsides is equated to the degree of disturbing environmental influence on the integrity of roadside communities, the South Indian roads with 53% exotics, (45 species), irrespective of seasons or regions, could be assessed as highly disturbed; however, none of the exotics observed were of nationally notified species for control and prevention of spread. Among the total exotics 78% (35 species) were dicots and only 22% (10 species) were monocots. The high density and relative abundance of a few monocots over that of many dicots revealed that the former are more invasive on roadsides than the latter. The observation of a sharp and significant increase in the total number of species and also exotics in the urban environment over that of rural zone indicated that the competitions between native and exotic species for establishment in the urban environment are an ongoing and continuous process. It may also be noted that the increase in species richness in the disturbed urban environment cannot be a sign of stability; instead, it appeared that an increase in anthropogenic influence in wet tropical urban system of developing countries can be associated with an increase in the number of exotics in general, which contributes to a general increase in species diversity in such places. *Euphorbia indica*, a well-known exotic roadside invader species [44, 45] and *Cynodon dactylon,* a cosmopolitan dominant roadside tolerant species [46] were observed on these roadsides also, in plenty. The overall assessment is that contaminated roadsides botanical expeditions to find out hyper-resilient species against physico-chemical disturbance, which are ecologically significant in many ways. Such inventories of plants in relation to their environmental characteristics can be suggested as the task of botanists and ecologists towards the preliminary identification of hyper accumulators, which are essential to the fast emerging of eco-technologies such as phytoremediation. Systematic phytosociological analyses of vegetations are inevitable to such investigatory expeditions. This suggests roadside verges may play an important role in conserving Cerrado biodiversity, as a stepping stone for isolated animal populations, and as a reservoir of plant genetic diversity. In the light of the focus on roads as a conduit for plant invasions, it is perhaps not unexpected that so little is known regarding the traits of species that manage to persist in roadside habitats [47-48]. Thick bark enhances survivorship of plants exposed to fire [49-50], which is probably the mechanism underlying why plots on roadsides had fewer plants with thin bark than those in reserves. Frequent fires may also be why species and individuals typical of savanna formations were significantly more prevalent in the reserves than in roadsides.

## 4. Conclusion

Roads play a pivotal part in the infrastructure of countries; however, their construction can lead to detrimental effects on the surrounding environment, with local ecosystems being heavily affected. Therefore, as engineers, it is our role to try and minimize these harmful consequences of road building and if possible, eradicate these factors all together. It may even be possible to improve some aspects of the surrounding ecosystems through thorough planning of biodiversity-neutral roads and the implementation of road runoff collection and treatment systems. The present study is a strong first step and warrants further effort, which may pave the way to screen the feasibility of these plants in context of their potentiality to be planted in other urban areas with varying pollution load. In a nutshell, the use of urban roadside plants as bio indicators or biomarkers is an inexpensive and convenient technique and thus offers an eco-sustainable green tool for urban ecosystem restoration.

## Compliance with ethical standards

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*Disclosure of conflict of interest*

We declare that we have no conflict of interest.

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