1. INTRODUCTION

The history of gardening or the effort of man to modulate the nature surrounding him to his will and aspirations might have been developed in par with the human civilization. The earliest known indications of agriculture date back only ten thousand years but an enjoyment of beauty of flowers almost certainly goes back much further. The placing of bouquets of corn flowers, yarrow, grape hyacinths and other flowers around the corps at a Neanderthal burial of sixty thousand years ago shows that they had an aesthetic and possibly ritual role (Laxton, 1991). This shows man's beauty conscious is inseparably blended with the evolution of intellect on him. The earliest gardens recorded were the ones built by the Egyptians around 4000 B.C. (Gordon & Barden, 1979). The Egyptians made formal style gardens enclosed in protection walls in the premises of their dwellings. The 1500 B.C. Persians made beautiful symmetrical, enclosed terrace-gardens focusing the dwellings of aristocrats who preferred living on hills. Later different gardening styles each influenced with the topographic and cultural peculiarities of the regions of their origin were developed in different parts of the world. The Greek and Roman gardens built around the central courtyard or peristyle of the houses and the Japanese gardens with artificially constructed ponds and hills are the major garden styles prevailed in the early centuries of the first millennium A.D. A formality of symmetry was carried out through all these styles and the same was extended to the Renaissance period of Italian gardens and later adapted into the French and early English gardens. All these formal styles were with heavy masonry features like stairs, statues, fountains etc. giving equal or less importance to plant components. The informal style gardens that took its origin during the 18th Century in England (Brown, 1989) and popularized all over the world was a real change from the then existed formal garden style. The plant components subdued the architectural features in these gardens. When the formality of symmetry had lost its popularity, more plant taxa could assure their chance to be employed in garden landscaping irrespective of their variations in physical features. The informal gardens, rich in plant wealth, being provided unity with the surroundings (outward-looking unity) rather made themselves an inseparable part of the ecosystem of the region.

The Indians were also great connoisseurs the beauty of plants and flowers even from the prehistoric time. Even though there is little proof for planned gardens from the Indus valley civilization of third millennium B.C., the seals from Mohan-jo-daro and Harappa hold evidence of people
admired plants that are interpreted to be *Ficus religiosa* and *Salyx babylonica* (Laxton, 1991; Randhawa & Mukhopadhyay, 1986). The Vedic time Arian literature, probably from 1600 B.C. – 500 B.C., like Rig-Veda, Atharva-Veda and epics like Ramayana and Mahabharata have clear account about gardens and ornamental plants and in fact mentioned plants like *Neolamarckia cadamba, Bignonia, Borassus flabellifer, Butea monosperma, Cassia fistula, Ficus benghalensis, F. religiosa, Nelumbium, Oleander, Mesua ferrea, Michelia champaca, Pandanus, Saraca indica, Shorea robusta, Terminalia arjuna* etc. (Randhawa & Mukhopadhyay, 1986). The history of Lord Buddha, born in 563 B.C., is also related to many ornamental trees of that time. The great literature works between the 100 and 600 A.D. such as 'Mrichchakhatikam' (by Sudraka), 'Kamasutra' (by Vatsayana), 'Sundarananda' (by Ashwaghosh), and many works of Kalidasa reveals the influence of ornamental plants and gardens in the life of people. Travelogue of the Chinese traveler Hiuen-Tsang who visited India during 630-645 A.D. also holds clear accounts on the ancient Indian’s interest towards flowers and ornamental plants. But the physical proof of well planned gardens in India is available only from the 16th century Mughal gardens onwards. Adopting the Persian style of gardening they have introduced many plants from their home land in the Middle-East. The Mughal rulers established many a number of well designed symmetric gardens and avenues in India. In fact exotic species of Hibiscus, Oleander, Persian rose, White jasmine, Screw-Pine etc were introduced here by them. The gardens established in the Mughal rule like the Mughal gardens of Kashmir and Pinjore (Hariana) still exist with unfaded glory. Contemporary to the Mughal, the navabs of the Oudh (or Awadh, the 16th century derived name of ancient Ayodhya, now known as Faizabad in Uttar Pradesh) also established a good number of gardens in their empires. One such garden constructed during the period of Wajid Ali Shaw (1789-1814) is the National Botanic Garden in Lucknow which is now maintained by NBRI under CSIR. In the south, the Lalbagh garden in Bangalore, Brindavan garden in Mysore and the Government Botanic garden in Ootacamund are the major gardens established during the 18th and 19th centuries. The arrival of English in India has greatly influenced in garden styles prevailed so far. The formal symmetrical Mughal style was overshadowed by the informal styled nature-friendly English gardens. The concept of Botanic Gardens was also propagated by the English.

The landscape design mainly functions in preserving and protecting the natural environment (Gordon & Barden, 1979). So the objective of a new design is to preserve, protect and elevate the environment into an enhanced level of beauty. The garden landscape design is also intended to
repair the damages caused to the natural balance by buildings, roads and other artificial features. The plants being the most important landscape component play the major role in defining the landscape functions of both aesthetic and practical nature. Due to changes of several dynasties and subsequent fusion of various cultures over a period of time led to introduce a large number of exotic ornamental plants in Indian subcontinent instead of screening potential ornamentals from the native flora. Most of these exotics were later acclimatized and even subdued the indigenous plant population in the gardens. These garden plants with diversified origin may also play an influential role in the ecosystem of the region as well.

1.1 Systematics

It is strange fact that those who are interested in native floras, especially professional botanists often ignore cultivated plants in gardens (Green, 1973). The horticulturists who directly deal with these plants also pay little attention or less competent for the proper identification and systematic classification of garden plants. Thus the systematics of cultivated ornamental plants still remains unrefined. The present study is therefore, pertained to characterization, identification and classification of the ornamental plants grown in the large and small gardens of Thiruvananthapuram district. The presentation is followed as per the Bentham & Hooker's system of classification with certain modifications suggested by Hutchinson. The purview of the study is restricted on the plants cultivated in purpose of garden-landscaping exempting the green-house and glass-house plants and interior-decoration plants which have little role in garden landscaping. A species / variety level key based on solid morphological characteristics followed by the updated nomenclature with chronological sequence of synonyms are also prepared. The identification at cultivar level is attempted wherever the reliable sources of information are available.

1.2 Landscape design: Principles and Elements

It involves the land form, vertical features (plant and non-plant) and the spaces defined by these elements together constitute the landscape in gardening point of view. As the land form and the non-plant components do not undergo remarkable changes once they have been established, it is the plant component that undergoes periodical and seasonal changes, giving ‘life’ to the garden landscape. The designing and implementing garden landscapes are basically an art form and all the basic principles applicable to other spatial art forms are applicable to landscape design also.
The major basic principles such as unity and continuity, accent, focalization, axis, balance, line, rhythm, scale and proportion, mobility etc applicable to landscape design are discussed below.

1.2.1 Design principles

(i) Unity and Continuity: Unity deals with one-ness, by fitting together of different parts to result a 'harmonious whole'. It is achieved by using components with same/similar physical qualities. The uninterrupted transition from one part to another by balanced repetition of noticeable components is termed continuity. Both 'inward looking unity' [unity within the garden] and 'out ward looking unity' [unity of the garden with its surroundings] have to be maintained in the landscape.

(ii). Accent: The noticeable difference in the physique of components from its surroundings that draw attention to itself is termed accent. The accent breaks the monotony due to unity as well the repeated accents turns to be the basis of continuity and total unity of the landscape.

(iii). Axis and Focalization: Axis is the imaginary line on either side of which, the design elements striking a balance each other. In big landscapes there may be more than one axis. Focus is termed the climactic point of the design on which all other components lead the attention of the viewer. In a formal garden, the focal point is often the terminal feature at the end of the axis or at the crossing of two axes. In an informal design, axis is not necessarily a straight line. The components are deployed in a balanced way to act as a visual which lead to the focal point.

(iv). Balance: The visual equilibrium of the design components in either sides of the axis is termed balance. In a symmetrical balance, a central axis utilizes with an exact repetition of components on its either side. Asymmetrical or informal balance is achieved through the employment of harmonious features or areas of equal attraction on either side of an unstressed axis.

(v). Scale and Proportion: The scale denotes the relative size of the landscape components. The proper relationship in scale between the landscape components and the whole landscape to its surroundings is termed proportion. When plants are the landscape components the designer should be prejudicial on the change in scale happened to them on growing up.

(vi). Line: Line may be perceived as the junction of the adjacent parts in the garden landscape. It could create control pattern of visual movement and attention. That is, the curvy, informal 'lines' may retain the visual continuity of the components one after another where as straight lines give emphasis to a particular component on which the vision may get struck [accent]. The straight lines denote formality and pomp, implying strong solid structural qualities where as curved lines are less
formal, passive and encourage further eye movement. The ‘lines’ also influence the depth of the landscape scene. Thus the straight lines cut short the apparent depth of the scene where as curvy lines extends it further.

(vii). Rhythm: Rhythm is the feeling of regulated movement achieved through the reappearance and transition of identifiable features. Gaining a feeling by rhythmic beat is an added pleasure in the landscape.

(viii). Mobility: In tropical regions the seasons and their impact on plants is not as distinct as temperate countries. This constant state or lack of mobility in a landscape may cause some sort of monotony to regular viewers. But the structural and functional mobility can break the monotony in a landscape and the same could be achieved through prejudicial selection of suitable plants. Structural mobility is achieved by incorporating plants that pass through different physical status such as leaf-covered, leaf-shed, flower / fruit covered stages during the course of the year. The plants that host butterflies, squirrels and birds generate functional mobility in the landscape.

1.2.2 Design elements
Design elements are the structural or functional qualities of the landscape components that turn to be the basic units of the aesthetic totality of a landscape. A landscape designer, therefore, develops a composition by employing or purposefully eliminating any of the elements of design such as form, color, texture, pattern and space while developing a landscape (Gorden & Barden, 1979). The landscape-components (mainly plants) possess with these design elements and the same can be utilized by proper deployment to define the design principles in the landscape. In a design rather than these structural elements, the functional elements such as adaptability, scent, flowering frequency, respond to seasons, tolerance to pruning and trimming and the capacity to attract birds and animals also turns to be the deciding factors of landscape applications of a plant.

1.2.2.1 Structural elements
(i) Form: Form is the shape or architecture of the components (fig. 1). The formal, unique forms can result accents and focal points. The symmetry, balance, continuity or rhythm can be achieved in the landscape through the repetition of same or similar forms.

(ii) Color: Color is one of the most influential landscape elements. When contrasting colors (the colors coming opposite in the color wheel) come side by side the accents are created. On the other
Fig. 1: Typical canopy forms
hand the complimentary colors (the colors coming side by side in the color wheel) maintain continuity among the landscape components. The ‘warm colors’ such as red, orange, and yellow and its hues can foreshorten the apparent depth of the scene where as the ‘cool colors’ like purple, blue and green increases the scenic depth (fig. 2).

(iii) Texture: The surface texture of the components can also contribute to the design values of the landscape. It is the individual size and nature of disposition of leaves/flowers that decides the texture in plants. The texture can be smooth, medium or coarse. The coarse texture provides accent effect to the components and reduces the apparent depth of the landscape. On the other hand the fine texture raises the feeling of depth to the landscape.

(iv). Pattern: Regarding plants as landscape components, the mode of disposition of organelles such as branches, leaves, inflorescence etc. is termed as pattern. The peculiar, unique pattern creates accents in the scene. *Araucaria, Diospyros, Terminalia* etc. with tiered branches, *Plumeria* with dichotomous branches and *Ravenala* with distichous leaves are few examples.

(v). Space: Space is the negative element defined by physical elements surrounding it. Space achieves its form, volume and scale on being defined by the tangible, visual elements surrounding it. Rather than the individual qualities of the components, it is their massive structural deployment that determines the nature of the space. The shape and size of space could create emotional feelings to a landscape.

1.2. 2. 2 Functional elements

(i). Adaptability: Adaptability of plants to the edaphic and climatic conditions of the site is very important. The aspirations of the designer on the plants could be fulfilled only if the plants he used would grow in to an expected size, shape and form.

(ii). Scent: The emotional feelings generated by fragrance of a plant which provides a lively and pleasing atmosphere in the landscape.

(iii). Flowering-frequency: The duration of beauty of a landscape depends on the flowering frequency of the plants also. It may be once in a year, twice in a year or throughout the year.

(iv). Respond to seasons: It is the plants that are prone to noticeable changes to the seasons and provide structural mobility to a landscape. For example, *Dillenia pentagyna* passes through leaf covered, bare branched, flower covered and fruit covered seasons during the course of the year.
Color, the most influential landscape element
The sudden change in canopy from dark green to deep red in *Mesua ferrea* by the appearance of young branchlets can generate surprise in minds of the viewer.

(v). Tolerance to pruning and trimming: Plants that tolerate pruning and trimming, enabling to be trained into clipped hedges and topiaries are the major components defining the structural framework of formal landscapes.

(vi). Attraction to birds and animals: Plants that host butterflies, birds, squirrels etc. with honey and fruits helps to provide ‘functional mobility’ to the landscape.

1.3 Aesthetic and functional application of plants as landscape components

With no doubt aesthetics is the prime role expected in a plant used in garden landscaping. If the design elements, such as color, form, pattern and texture, in individual plants (landscape components) are properly deployed the design principles and the aesthetic totality of the design can be achieved. In addition to the aesthetic role, the plant can contribute to a number of functional roles also while constructing a landscape which is discussed below (Edmond, 1957; Hudak, 1984; Bridwell, 2002.)

(i) Specimen plants / Accent plants: Plants with solid, unique elements of form, color, texture and pattern that draw attention to it are termed as specimen plants or accent plants. They can be employed properly as focal points or through their regulated recurrence in unity, continuity, rhythm and balance in the landscape. There may be permanent accents, with constant accent qualities that retained throughout the year or seasonal accents with accent qualities during a particular season only. There are trained accents like topiaries and standards to meet our requirements.

(ii) Structural plants: The plants with permanent features that decide the structural skeleton of the landscape, termed structural plants. The plants belonging to accent and avenues are major structural plants and they form the back bones of the garden (Johnson, 1979).

(iii) Avenues: Trees and shrubs bordering/directing a road or foot path are termed Avenue in garden landscaping. Avenues may enact structural frames, emphasize landscape axis and provide a microclimate in the atmosphere. Evergreen trees like with full fledged foliage in the summer have a very important role in a tropical garden landscape. However the deciduous avenues provide liveliness or structural mobility to the scene. Avenues may be homogeneous with a single species repeated through the entire length or heterogeneous.
(iv) Vines (Climbers): Beautiful climbers trained on trellises, arches and pergolas become attractive features in formal gardens. Some times they are trained on frames or through vertically raised pipes into ‘standards’. Climbers may be trained on strings or mesh-works over walls or other projecting scenes as a transition element or screen. In informal landscapes vines planted on trees for providing more natural look to the Arboreta.

(v) Ground covers: Herbs, under-shrubs or shrubs with spreading habits, planted in groups as filler transitive in between the accent plants are termed ground covers. It enacts a background and emphasizes the accents as well as checks weed growth.

(vi) Lawn: Lawn is the ground cover with grass mater.-i. A well kept lawn provides perfect setting for a flower bed, shrubbery, specimen tree or hard focal features such as statues, ponds with fountains etc. The vast lawns that increase very much the apparent depth of the landscape in encounter with the space can create wonderful emotions in a garden landscape.

(vii) Bedding plants: Annual or perennial flowering herbs planted in mass creating beautiful accents by the side of paths and roads or in front of buildings are generally termed bedding plants. Constructing the plant beds by the side of the paths also contribute to the ‘line’ of the landscape. The massive seasonal effect created by the annuals plays an important roll providing mobility or liveliness to the landscape.

(viii) Carpet beds: Two dimensional formal designs depicted using perennial herbs or low trimmed under-shrubs are termed as carpet beds. Letters of messages and logos are also incorporated in carpet beds. Contrasting color shades, uniform growth nature, tolerance to heavy pruning and easy means of propagation etc are the qualities of the carpet bed plants.

(ix) Edges: Perennial herbs or small shrubs bordering the garden parts are termed edge plants. They usually define the horizontal ‘lines’ of shrubberies and mixed plant beds with the roads, foot paths, lawns, etc.

(x) Hedges: Hedges are of both aesthetic and functional applications in the landscape. The clipped, formal hedges define strong horizontal ‘lines’. Hedges turn to be the structural frame in many formal landscapes. Protection is the functional application of the hedges. Dense foliage, tolerance to pruning and high adaptability are the basic qualities of hedge plants.

(xi) Topiaries: The shrubs or trees clipped and trained into imitative shapes is termed topiaries. With their unique forms, topiaries turn to be the major accents in formal gardens. Flexibility of
branches, dense foliage and tolerance to pruning are the essential qualities required for a topiary plant.

(xii) Transition element / softening material: Suitable plants can be used to blend the junction of two dissimilar surfaces or to reduce the over-impact of architectural features and other artificial components in a landscape. The transition plants used against or near the foundation or wall of a building or other structures to merge those artificial structures to the rest of the landscape are termed ‘foundation plants’. Corners of the buildings create strong vertical ‘lines’ that compete for attention with the rest of the landscape features. Shrubs or trees with suitable heights and partly accent nature planted to soften such harsh corners are termed ‘corner plants’.

(xiii) Microclimate material / air conditioner: The plants can create a microclimate in the landscape by regulating air temperature, humidity, solar radiation and air movement. Trees that refresh the air by releasing oxygen and moisture and absorbing back the carbon dioxide can be good air conditioners /purifiers in residential areas. They may filter out dust and regulate the force and direction of wind. Like that a vine covered wall may be cooler than an exposed wall and a lawn surface reflects less heat than an exposed surface.

(xiv) Engineering applications: Engineering applications are lending more support to the role of plants in the landscape. ‘Soil erosion’ due to wind and water can effectively be checked by plants. While the canopy regulates the force of wind or rain fall, the root system holds the soil from getting eroded. Trees may also functions as wind breakers that reduce the wind force. Plants with dark foliage and heavy texture are used to reduce the natural and artificial glares and reflections particularly on city highways, play grounds etc. Plants with high adaptability, uniform growth and some times with guarding spines are also widely used as landscape boundaries.

(xv) Architectural qualities: Plants can act as a screen defining private areas, concealing unpleasant views and partitioning spaces. Ankle-high hedge just ‘line a floor’, knee-high one casually ‘direct or lead’, waist-high hedge ‘controls traffic’ or acts as a ‘partial enclosure’, chest-high wall divide spaces and walls above eye level ‘define private enclosure’.

The ornamental plants used in landscaping public gardens, avenues and home gardens have diversified origin of both indigenous and exotic nature. They have been established and acclimatized and become influential components in deciding the aesthetic and functional qualities of the landscape as well as being an integral part of the local flora. Yet such an important group of ornamental plants, especially of exotic origin, are generally neglected in floristic studies and
sometimes carry wrong names for several years due to miss identity. Against this background, a serious attempt has been made through the present investigation with the following objectives for systematic analysis and evaluation of ornamental potential of cultivated plants in Thiruvananthapuram district of Kerala.

- Survey, collection, identification and documentation of cultivated ornamental plants in Thiruvananthapuram district.
- Critical study on morphological characters based on fresh specimens for taxonomic treatment, preparation of keys for identification which are not available in local floras.
- Assessment of the influence of the exotic plants in the gardens and local flora.
- Evaluation of all the cultivated plants for the aesthetic and functional qualities which make them suitable for landscape components.