

An Overview of Flowering Pot Plants for Tropical and Subtropical Climate

Rupali Thakur¹, Babita Kanwar², Choudhary Nandini Chandermohan³, Sourav Sharma⁴

¹Department of Floriculture and Landscape Architecture, Dr YSP UHF, Solan, Himachal Pradesh, India

²Department of Floriculture and Landscape Architecture, Dr YSP UHF, Solan, Himachal Pradesh, India

³Department of Floriculture and Landscape Architecture, Dr YSP UHF, Solan, Himachal Pradesh, India

⁴Department of Floriculture and Landscape Architecture, IGKV, Raipur, Chhattisgarh, India

Abstract: *With ever - increasing standard of living, the demand for pot plants has increased manifold. With decrease in outdoor areas and more urbanization, the living or working area has decreased or we can say people are now confined to smaller apartments or offices. For them pot plants are the cheapest and best method of gardening. So, the demand of potted plants in houses, buildings, offices, hospitals and shopping malls is increasing. Flowering pot plants have shown numerous benefits for both the environment and human health. As they will provide a revitalizing environment and will help in restoring their mental and physical health. In tropical areas, where the temperature can be high and air quality can be poor pot plants can be source of decreasing the temperature, improving air quality and promoting a sense of well - being among residents. The flowering pot plants which have their origin and commercial growing areas in the tropics and sub - tropics with a limited degree of frost resistance are called tropical and subtropical pot plants. Important flowering pot plants includes anthuriums, pot mums, spathiphyllum, poinsettia, ixora, gloxinia, mussaenda, jacobinia, species of begonias, bulbous flowering pot plants and many annuals, which can thrive well in tropical and subtropical climate. For production of a beautiful flowering pot plant the growth and development factors like light, humidity, temperature, potting media are very important and should be carefully considered. As desirable characteristics are incorporated into these pot plants including proper stem length, flower size and color, durability, shipping ability and others for quality production of these pot plants. This paper provides an overview of flowering pot plants that are well suited for tropical and subtropical climates. It discusses the characteristics, growing conditions and the commercial significance of various plant.*

Keywords: Flowering Pot Plants, Tropical Climate, Subtropical Climate, Growing conditions, Commercial Significance

1. Introduction

Tropical flowers, a general term used to designate a group of species native to tropical and subtropical areas of the world and which are different from traditional flowers such as roses, chrysanthemums and carnations. Basically, this category of ornamentals includes, Anthuriums, Poinsettia, Amaryllis, some species of Begonias, Fuchsias and many bulbous flowers (Warren, 1996). Tropical climates are characterized by monthly average temperatures of 18°C or higher year - round and feature hot temperatures with humid conditions. Annual precipitation is often abundant in tropical climates, and shows a seasonal rhythm to varying degrees. Whereas subtropical climates are often characterized by hot summers and mild winters with infrequent frost. Subtropical climates can occur at high elevations within the tropics. With increased urbanization, container gardens continue to enjoy popularity and brighten up patios and balconies. For many reasons, tropical plants have become a staple in container gardens traditionally filled with herbaceous annuals, bulbs, succulents, perennials and woody plants. Tropical flowers are perceived by many flower consumers as exotic and unusual, have an excellent market potential whether as cut or pot plants, particularly in temperate countries. The global pot plant market has valued at \$978.70 million in 2020 and it is projected that by 2030 it will reach \$1.5 billion. This is due to the surge in adoption of pot plants in households, commercial places and also inclination of consumers towards interior decorations which further add value to this industry. Pot plants are utilized for getting

instant color in garden and beautification of homes and work place. Cultivation of plants in pots is useful in several ways, but it is most advantageous to those people who live in small places or flats where there is no space for growing plants in ground. Potted plants provide easy mobility, have various benefits as they purify the air, beautification of area, improves health and gives refreshing feeling, add greenery to urban area and also reduces temperature (Warren, 1996). This is particularly required in areas where air conditioning is not readily available or affordable. Pot plants also helps in reducing risk of respiratory problems and other health issues. So, for growing a beautiful pot - plant one must take care of the all the necessary requirement and conditions that will enhance the growth and development of the plant. Major flowering pot plants that can be grown in tropical and subtropical areas are Anthurium, Spathiphyllum, Begonias, Potted Chrysanthemum, Poinsettias, Geraniums, Beloperone, Jacobinia, Fushcia, Bougainvillea, Species of Orchids, Bulbous Plants like Clivia, Football Lily, Hippeastrums, Spathiphyllum and flowering annuals such as Vinca, Pansy, Ivy Geranium, Bacopa, Calibrachoa, Torenia, New Guinea Impatiens, Regular Impatiens, Verbena, Portulaca, Petunia, Ranunculus, Daisy and many more.

2. Some of the Flowering pot plants

Anthuriums: Anthurium (*Anthurium andreaum* Lind) belongs to family Araceae is a tropical flowering, perennial herbaceous indoor plant of great beauty and grown for its colorful long - lasting spathe, spadix and attractive foliage. It

is native to Central and South America. The name Anthurium is derived from Greek word 'Anthos' which means 'flower' and 'oura' which means 'tail' refers to spadix. The spadix is a cylindrical spike with an enormous number of flowers and the spathe is a modified bract. There's a wide range of spathe color - red, dark red, brick red, salmon red, pink, lavender, light white, creamy or multi-color. These differences are due to genetic diversity of different varieties. Anthurium ranks 2nd after orchids among tropical flowers in world trade market. There are different species of anthurium that are categorized under two groups i. e., flowering group and foliage group. *Anthurium ornatum* and *Anthurium aminata* belongs to both flower and foliage group. *Anthurium andreanum* (painter's palette) and *Anthurium scherzerianum* (Flamingo flower) are two important flowering species. In India, some growers of Kerala, Karnataka, Tamil Nadu, Maharashtra and West Bengal has already started growing anthurium on a large scale. Interspecific hybrids, such as Anthurium 'Lady Jane' (Kamemoto and Kuehne, 1996); Anthurium 'Southern Blush' (Henny *et al.*, 1988), and Anthurium 'Red Hot' (Henny, 1998), are produced as flowering pot plants because they are very floriferous and possess a compact, freely branching growth habit suitable for pot production. These hybrids inherited their smaller size and branching growth habit primarily from the dwarf species. The ideal condition of growing anthurium is 25 - 35^o temperature, 80% RH and shade upto 75%. In pots the excessive growth of roots should be checked from time to time, they should not get exposed. For this repotting, covering with moss or compost can be done. Propagation can be done through seeds, node cuttings and pieces of rhizomes or division. Chowdhuri *et al.* (2021) investigated the varietal performance of 14 *Anthurium andraeanum* cultivar on growth and flowering in the subtropical zone of West Bengal by maintaining in the pots. The experiment was laid out in Complete Randomized Design (CRD) with fourteen anthurium cultivars and replicated thrice. From the pooled data of three years, it was observed that "Tropical" variety had the best vegetative as well as flowering characters among the fourteen varieties when grown in subtropical area of West Bengal. Anthurium has air purifying properties, as in 1989 NASA itself has released a detailed study on ability of houseplants in removing toxins (mold, spores, pollutants - cigarette smoke) from the air and also filters odors. These plants have fantastic ornamental value and add a tropical aesthetic to any space. Some studies also prove that they reduce stress and improves mental health.

Chrysanthemum morifolium commonly known as Glory of East, Crown Daisy, Guldaudi and as Mums in short in USA. National flower of Japan. It belongs to family Asteraceae and originated from Europe and Asia. It ranks 2nd in the international cut flower trade and 6th among the potted plant. It is popular due its wide range of flower color, shape, size, form & long-lasting quality. Chrysanthemum is annual or perennial herb, sometimes woody with alternate leaves entire to much dissected. Its flowers are also used for making garlands, venis, gajaras and religious offerings. Growing chrysanthemums in pots is a perfect garden solution for apartments and small gardens. Generally, when grown for pots they are known as pot mums. Pot mums are small - dwarf flowers with 6 - 9'' height used to decorate

places indoor as well as outdoor. Temperature and light are important factors. On the basis of temperature responses, they are divided into three groups. Thermo - positive cultivars - Low temperature between 10 - 13^oC inhibit or delay bud initiation. Which occur more consistently at 16^oC. High temperature over 27^oC accelerates bud initiation but delay flowering. Thermo - negative cultivars - Bud initiation occurs at low to high temperature (10 - 27^oC) but high temperature delays development of bud. Thermo - Zero cultivar - Flowering occur at any temperature between 10 - 27^oC more consistently at 16^oC temperature. Higher temperatures during the short days resulted in more leaves below the flower leading to delay in flower initiation (Karlson *et al.*, 1989). The optimum temperature for flowering in chrysanthemum is in the range of 18^oC - 21^oC (De Jong, 1978). The best temperature for growing chrysanthemum is 20 - 28^oC for day and 15 - 20^oC for night. For pot culture varieties like Sharad Singar, Shoba, Sweta Rita, Hemant Singar, Sonali Tara can be grown (Mahopatra *et al.*, 2000). Potted chrysanthemum requires maximum light intensity of 5000 - 6000 fc. Commercially they are propagated through terminal cuttings. Cuttings are taken from healthy stock plants. 5 - 7 cm long cuttings are made by shearing the basal leaves. Cutting treated with 500ppm NAA /IBA for 5 sec have better rooting. Treated cuttings are planted in bed, pot or sand in partial shade. Water is sprayed for 4 - 5 time a day. Rooting take place within 3 - 4 weeks. To avoid rotting of cuttings, Captan (0.3 %) or Bavistin (0.1 %) should be applied in irrigation water once a week. The use of peat - moss substrate for pot chrysanthemum culture shows better results (Bunt, 1998). It thrives best in slightly acidic soils with pH ranging between 6.2 - 6.7. Nitrogen at 100, 150 or 200 mg/L in combination with at least 10 mg/L of Sulphur yielded plants of commercial quality (Macz *et al.*, 2001). There are three different types of blooming mums: early bloomers, early fall bloomers and late fall bloomers. Early bloomers often begin flowering in late July, early fall bloomers show off blooms in September and late fall bloomers start their stunning display of colors in October. Pruning in chrysanthemum is also very important as regular pruning of faded flowers during flowering period helps the plant to produce more flower buds. Chrysanthemum is also a source of essential oil. The essential oil contains chrysanthenone, which acts on the brain center affected by Parkinson's disease.

Euphorbia: *Euphorbia pulcherrima* syn. *Poinsettia pulcherrima*, belongs to family Euphorbiaceae. Native to tropical areas of Central America and Mexico. Poinsettia is among the economically most important ornamental potted plants worldwide (Ecke *et al.*, 2004). It's a tropical to subtropical shrub, varying in height 1 - 4 m. Number one potted flowering plant in US and is sold for Christmas holiday for decoration hence also known as Christmas plant. Poinsettia is a rapid growing sun loving plant with inconspicuous large colored bracts that surrounds the flowers. It can be easily propagated through cuttings. They are very good pot plants in winters. Ideal indoor temperature for poinsettia 18 - 21^oC. Freezing temperature are detrimental to growth and can kill poinsettias. The present days cultivars have special features such as dwarf habits, broader and brighter bracts, maximum number of bracts clustering together and with large clusters, long flowering

season and suitability for planting in gardens and pots (Fry, 1995). Media for pot culture should be well drained, porous, light and with pH of 5.6 - 6.2. Higher light decreases plant height and increases bract color and light less than 3500 FC is detrimental to growth (Islam *et al.*, 2014). In fact, 3500 - 4500 fc should be used with dark foliage cultivars and 5000 - 6000 fc for other cultivars provided greenhouse temperatures are maintained below 32°C (Adams *et al.*, 1998). According to Olosunde and Fawusi (2003) one of the most important criteria for successful rooting is a reliable rooting medium. These plants are also used as both medicinal and dye plants.

Ixora: *Ixora acuminata*, *I. chinensis*, *I. coccinea* belongs to family Rubiaceae commonly known as Flame of the woods, is native to tropical region of India, China, Java, Malayan Archipelago, Moluccas, Madagascar. Other vernacular names are *Raktak* and *Kotagandhal* in Hindi and *Rangam* in Assamese. They are popularly grown as shrubs in the tropics but have various species that can be grown as pot plant as well as trees. They have strong hardy flowers with high commercial value. They have wide range of colors varying from yellow (*I. armeniaca*), orange (*I. chinensis*), pink (*I. chinensis* var. *rosea*), white (*I. undulata*), scarlet (*I. coccinea*) and orange - scarlet (*I. fulgens*). They are used in landscaping projects, garden designing, as house plants and cut flower. Minimum temperature for active growth is 16°C and maximum is 27°C. Humidity requirement is high (>70%) and have moderate drought tolerance capacity (Ingram *et al.*, 1986). It fails to grow in extreme dry and frost prone areas. Prefers full sunlight for growth and development though at flowering some species prefer filtered situation to avoid blossom burn. Well drained moist acidic soil with high organic matter and pH 5 - 6.5. In active growth period (spring to summer) fertilizers should be applied once a week, in autumn - winter once a month. Taller varieties pruned sufficiently after flowering, cutting back about one third of plant. For dwarf varieties light tip pruning when young to promote bushiness is practiced. Fagge in 2011, investigated the effects of sowing media [3 sowing media (Top soil TS, mixtures of Top soil plus Poultry manure TS+PM and Top soil plus Sawdust TS+SD) in the ratio of 2: 1] and Gibberellic acid [GA₃ concentrations (0, 100 and 200ppm)] on the growth and seedling establishment of three ornamental plant species (*Bougainvillea glabra*, *Ixora coccinea* and *Rosa chinensis*). Based on the outcomes of this study, TS+SD and GA₃ 100ppm are recommended for good growth and seedling establishment of these three ornamental plants.

Mussaenda commonly known as Prophet's tears, Virgin tree, Dhobi tree, Red Flag bush, Bangkok Roses and scientifically (*Mussaenda* spp) *M. philippica*, *M. flava*, *M. corymbosa* are native to Asia (Thailand and India). *M. erythrophylla*, *M. frondosa*, *M. luteola* are native to Tropical Africa. It belongs to family Rubiaceae. In tropical climate it is an evergreen shrub but very difficult to grow in frost prone zones. They thrive best in humid localities and can be found up to an elevation of 1200m. They can grow up to 2.5 m depending upon the species so a proper pot should be selected to grow them as pot plants. The blossom color comes from bracts, small flowers are located at center of each bract well in ample sunlight, good rainfall and high

humidity. The most common colors are pale orange, sulphur yellow, white, greenish white, pink and scarlet. Sunny location is must for bract color. Temperature below 15°C slow down plant growth. Dwarf and white *Mussaenda* can be grown in partial shade. Humus rich soil with adequate drainage (Arnold and Boertje, 1975). Pruning is done to shape the plant and produce new branches (Late winters). Dwarf *mussaenda* do well in pots, can be kept indoor (Cramer and Bridgen, 1998). They are commercially propagated through air layering and cuttings of half ripe wood. River sand medium enhanced root growth and development better than the topsoil only or topsoil+ manure or top soil + saw dust (Olosunde and Fawusi, 2003). Fertilizers should be applied at the start of active growth period. The leaves of *mussaenda* can be used as green manure, the flowers are diuretic and used in treatment of cough.

Begonia commonly known as Blooming fool begonia, Beefsteak geranium, Elephants ear, Fire king begonia and scientifically as *Begonia semperflorens*, *B. bicolor* and many more. They belong to family Begoniaceae. It is originated from subtropical and tropical countries except Australia. More than 900 perennial species under the genus *Begonia*, only about 25% of total number of species describes (up to 1981) are in cultivation *i. e.*, 64 out of 539 from Asia, 33 out of 165 from Africa and 210 of 610 from Latin America (Hoover *et al.*, 2004). *B. alba*, *B. semperflorens*, *B. mettalica* have beautiful flowers and foliage mostly grown in warmer plain areas. The begonias are next to orchids in respect with their diversity. The main groups are Rex begonia, Fibrous rooted begonia, Cane begonias, Tuberous begonias, Rhizomatous begonias and Novelty begonias. Fibrous rooted begonias (*B. semperflorens*) are day neutrals, do not require any specific day length or temperature. 830 fc supplemental lighting for 2 weeks shows more rapid flowering. Growing media should contain high level of organic matter. Soil should be moist, well aerated with pH - 5.2 to 7. Optimum pH - 5.2 for raising begonia cuttings and 4.7 - 5.2 for seed germination. Zhang *et al.*, 2017 studied the effect of different levels of shading (25%, 50%, 75%, 87%, and 93%) to investigate the response of the morphological and physiological characteristics of *B. semperflorens* plant. The number of flowers per plant initially increased and subsequently decreased under 25%–75% shading. As the level of shading increased, the leaf area increased under 25%–87% shading, the chlorophyll content showed an increasing trend too. Thus, shading is very important practice in begonia cultivation. Begonia also contains therapeutic properties like laxative, emetic, anti-inflammatory, digestive and many more.

Beloperone guttata commonly known as Shrimp plant, Synonyms - *Justicia brandegeana* belongs to family Acanthaceae and is native to Mexico. It is a shrub with slender, flexible, 1 - 1.5 m high stems, with ovate - elliptical leaves, pointed at the top, light green and with small tubular white flowers. The inflorescences composed of pink or reddish - brown bracts, overlaid and persistent, scaly in appearance, hence the name of "Shrimp plant" the main decorative elements. *B. guttata* is the only species generally cultivated as house plant. It lasts for 10 - 20 years. Bright light with some direct sunlight is essential for production of

colorful bracts. Recommended winter temperature is 18°C. Fertile, moist, well drained sandy or loamy soil. Soil should be kept moist from spring through fall. Watering can be freely from spring to fall. They can be propagated through cuttings and air layering. Varieties like Fruit Cocktail, Yellow Queen, Red Beloperone are good for pot production. For pot production growth retardant can be used to manipulate the growing habit of plant. The retardant substances are used for producing vigorous plants with smaller size, by reducing the stem elongation (North *et al.*, 2010), stimulating the plant branching and obtaining compact plants, with uniform growth of shoots (Currey & Erwin, 2012).

Hippeastrumhybrida the genus *Hippeastrum*, also referred to *Amaryllis* belonging to family Amaryllidaceae has originated from Subtropical America, from Eastern Brazil to the Southern central Andes of Peru, Argentina and Bolivia. Some of the indoor species are *H. hybrida* (*H. aulicum*, *H. elegans*, *H. reginae*, *H. reticulatum*, *H. straitum*). Many species in this genus and their hybrids have large and showy colorful flowers. Modern hybrids specially the Dutch hybrids, have an array of flower colors including beautiful striping and mottling. The optimum temperature is 18 - 25°C for good growth and development. Well drained, aerated soil with pH ranging from 6 - 7, rich in organic matter is ideal, however can adapt to any type of soil except sandy soil. Propagation can be accomplished by using seed, offsets (bulbs) and twin scaling. In plains bulbs are planted during Sept - Oct or preferably Dec - Jan and flowers during March - April. Siddique *et al.*, 2007 observed that August planting was mostly suitable for profuse growth and flowering. All the selected growth and flower characters except flower scape emergence and days to flower bud appearance showed best results with August planting which was closely followed by the result found with July planting. Late planting that means November planting did not come out with satisfactory results (Bose *et al.*, 1981). There is a view that pot bound *Hippeastrum* flowers better and hence people adhering to this view advise not to use pots more than 5cm in diameter than that of the bulb planted.

Spathiphyllumwallisii commonly as Peace lily, Spathe flower, White anthurium is a tropical, day neutral shade plant. Native to central America, Northern South America, and the Eastern Malayan Archipelago. It's a genus of about 41 species (Bunting, 1960). *Spathiphyllum* cleans indoor air of many environmental contaminants, including benzene, formaldehyde, and other pollutants. It's a terrestrial herb with rhizomatous short stem, erect or creeping. Leaves are loose rosette, simple, long petiole, and the petiole being geniculated at the apex, with long sheath. The optimum temperature is 20°C (night) and 32°C (day) for good growth and development. It can tolerate temperature as low as 7°C and high up to 35°C. Optimum humidity above 50% is required. Light intensities of 9000 - 27000 lux generally required. The ideal soil is pH - 5.8 to 6.8. Potting mixture should have a good drainage and water holding capacity. The media containing only perlite yielded the best results with regard to parameters such as leaf area, leaf number, shoot fresh and dry weight; root fresh and dry weights and root length and root volume. Greater leaf area was observed in 100% perlite and was significantly more than the other

media (Kakoei and Salehi, 2013). Propagation is done through seeds and division of rhizomes (any time of year preferably February). Some of the commonly grown varieties are Power Petite, Emerald Star, High Five, Domino, Jetty, Sweet Dario, Supreme. Flower unavailability in *Spathiphyllum* can be overcome through single foliar spray of 250 ppm GA₃ to stimulate flowering throughout the year, and plant starts flowering within 3 - 5 months of spraying though with seasonal variation. Also, GA₃ induces maximum number of flowering (Henny and Rasmussen, 1981).

Kaffir lily: *Cliviaminiata* belonging to family Amaryllidaceae is an evergreen pot plant native to South Africa which grows up to 45cm high with bright red, orange or red and yellow flowers in large umbels and sympodial growth. It can survive both in dry and moist region. Its thick, fleshy roots serve as a storage organ to overcome the drought season in their natural habitat (Bailey, 1950). They are excellent house plant tolerating a lot of shade, can be planted in sun or in semi - shade places in Feb - March. The pot - plants could grow even faster when less shading with moderately high air humidity is maintained (Kromdijk *et al.*, 2012). Cultivation of these lilies is easy, keep them in shade and low temperature in open spaces, no fertilizer and just enough water, no moving of pots or repotting when in bud or flower and no repotting until the plant becomes pot bound. In spring, when flowering is over and plant is pot bound, the crown is divided and single crown is planted in 12.5 cm pot at temperature of 16°C (Smedt *et al.*, 1995). After that shifted to other big pots without damaging the roots at any time. By advancing the chilling period in clivia early flowering can be induced. Incomplete chilling results in too little scape elongation due to which the umbel get surrounded by whorl of foliage leaves. Supplementary light can partly compensate for insufficient chilling (Mori and Sakanishi, 1974).

Pelargonium commonly known as Geraniums, Pelargonium, Stork's Bill, Butterfly pelargonium etc. Originated from South Africa. These are herbaceous perennials which belongs to family Geraniaceae, mostly grown as potted plants for their handsome flowers borne in clusters, some species also have showy leaves. Some species that are grown in Sub tropical region as house pot plants are *Pelargonium domesticum*, *Pelargonium graveolens*, *Pelargonium hortorum*, *Pelargonium peltatum*. It prefers shady conditions at temperature >32°C in summers. In plains grown in pots, whereas in temperate climate growing in beds is possible. Rooting media temperature should be between 21 - 24°C. Well drained soil having good air circulation with pH - 5.6 - 6.0, slightly acidic is considered good for growth. The rate of floral initiation and subsequent development depends on intensity and duration of light at appropriate temperature (Langton and Runger, 1985). Other cultural practice like pinching is also affects growth and flowering in pelargonium. For a good display of flowering pot of *Pelargonium zonale*, treat geranium plants with PP333 at 60 ppm as spray with pinching treatment four times in a year this will give plants with formative growth and flowering characteristics from the commercial point of view. These plants thrive best in hill stations and in milder climates of Bangalore and Poona in India.

Saintpaulia ionantha commonly known as African violet, Usambara violet; these belongs to family Gesneriaceae and were originated from Eastern tropical Africa (Tanzania). These are stemless, perennial plants with ovate or subcordate leaves. It is a day neutral, flowering plant with brilliant colors available mostly the new hybrids. A well – drained loose and porous soil with pH - 6 to 6.5 is best suitable for growing this plant. Light duration and intensity major factors for growth and development. Light intensity 600 fc of fluorescent lighting for 18 hours a day causes early flowering with greatest number of flower (Hanchey, 1955). It remains in flowering throughout year under artificial light conditions. Night temperature should be 12 - 18°C and day temperature between 21 - 23°C with optimum humidity level from 50 - 70% is considered good for growth and development. These plants perform exceptionally well in Bangalore under cover. However, in more warmer regions of the country, extra care in shading during summer and shelter from frost in winters should be provided. In regions with heavy rainfall like the eastern part of the country protection should be given.

Gloxinia speciosa (syn. *Sinningia speciosa*) commonly known by names Gloxinia, florist's gloxinias, velvet slipper sinningias belongs to family Gesneriaceae. Native to central and tropical America. It is a very popular house plant with large velvety bright colored flowers. The flower comes in a variety of colors with white edged blooms having contrasting spots and also including pastels. It can reach a height of 25 cm and a spread of 30 cm. Miniature sinningias are (hybrids) with mostly stemless blooms and rosetted leaves that bloom all year in ideal conditions. Best grown as annuals. To produce a large number of blossoms gloxinia hybrids are bred quickly. They produce an outstanding display for about 2 months. *Sinningiapusilla*, the smallest species, has trumpet - shaped solitary violet or lavender flowers that can be ever blooming. Optimum temperature for growth is 18 - 24°C. Increasing supplemental irradiance significantly affects growth and development of the plant (Grimstad, 1987). They perform admirably well under 12 hours of fluorescent lighting. Place them near a sunny window or in bright areas for their better performance. Use of Phosphorous based fertilizer enhances their beauty. Seeds, tubers, stem and leaf cuttings are all methods of propagation. Seeds can be directly sown in 4 - 6 inches pots. Then cover the pots with plastic film to maintain the humidity level. Excessive sunlight can cause scorch. Overwatering can lead to problems like grey mold or crown rot.

Jacobiniacarne commonly known as Brazilian plume flower, flaming flower; family Acanthaceae is native to tropical regions of America, comprises of 300 species of glabrous perennial sub - shrubs and shrubs, have showy raceme or spikes. Height ranges from 30cm to 2m. *J. Carne* (*J. pohliana*; King's crown, pink acanthus) grows up to 2m tall with about 1m spread though their height and spread is reduced to 60 cm. *J. pauciflora* (*J. floribunda*, *Libonia floribunda*) grows upto 60 cm, have nodding scarlet flowers 2.5 cm long and tipped yellow, are produced from autumn to late spring. Grows well in moist, well - drained soil of any type. Tubular red, orange, purple, white, or yellow flowers are cultivated. They make excellent pot

plants. Pots with diameter 20cm, filled with good mixture of fertile soil, peat and sand with proper dose of good fertilizers enhances the growth. It requires at least 5 hours of filtered direct sunlight per day. They thrive at room temperature. In the winter, the temperature should not fall below 13°C. In summers abundant watering should be done with regular application of fertilizers. Propagation is done by cuttings of young shoots taken spring and planted in pots for rooting in sand at 20°C and then cover the pots with transparent film or place them in greenhouse. In proper production of jacobinia the temperature plays an important role. It is not possible to advance the flowering of *Jacobiniacarne* by treating the plants with low temperature at low light intensity for a shorter or longer period. For production of a desirable pot plant the use of paclobutrazol in jacobinia is effective as it will create a balance with the pot. The ornamental value of a pot plant of *Jacobiniacarne* was best produced when paclobutrazol was applied at 20 ppm as a foliar spray and 2.0 mg/pot as a soil drench, as well as according to user preference (El - Bably and Zaky, 2009).

Bougainvillea (*B. glabra*, *B. spectabilis*, *B. peruviana*) is very common and most popular ornamental shrub, sometimes a climber, bougainvillea was first collected by Commerson, French Botanist from Rio - de - Janeiro and was named after the famous French navigator Louis de Bougainvillea. It belongs to family Nycataginaceae and its origin is Tropical and subtropical South America. It's a quick growing plant, varies in height according to different species and cultivars. It can flower all year round in hot climates with mild winters. The leaves are simple and alternate, roundish ovate, or elliptical. It is armed with stout spines in the stem with the help of which the shrub is able to climb. Bracts are deeper in color during hot and dry climate though under shade color remains dull and blooming shyly or nil. It is facultatively short - day plant. Optimum temperature for flowering under short day condition is 21 to 24°C (Hackett and Sachs, 1966). High light intensity of 4000 - 5000 fc encourages rapid compact growth with shining flowers (Dole and Wilkins, 1999). It thrives well in any type of soil provided there is no water logging. They grow very well in pots. Planting them in ceramic pots, clay or terracotta pots of atleast 12 inches ensures their good performance. Plastic pots can sometimes prevent even soil drying as they are impermeable and also unnecessary heat stress during hot days. A place which receives the sun throughout day or at least up to 12 noon, should be selected. Potting mixture containing 80% compost to 20% grit or perlite provides good drainage. Some of the cultivars are Cherry Blossom, Shubhra, Begum Sikander, Sonnet, Cypheriare cultivars of *B. glabra* with free flowering large bracts (purple, slightly towards red when old); Dr. B P. Pal – a vigorous floriferous white bracted bud sport of Mary Palmer (cultivar of *B. peruviana*); Lady Mary Baring is best cultivar amongst the yellows, vigorous growing Mahara (syn. Million Dolar, Manilla Magic Red, Manila Red) have large flower clusters with double bracts. Thimma is a variegated cultivar, red scarlet in color. In northern and east India planting time is July - August whereas in southern parts (Bangalore) planting can be done at any time of the year except during March - May. Potted bougainvillea and their bonsai are also used to adorn the landscape (front gate, the balconies and terraces). For production of a quality pot plant of bougainvillea, use of

plant growth regulators has now become very common. Growth retardants like daminozide, paclobutrazol, chlormequat have been reported effective in controlling plant height in bougainvillea although the effectiveness of growth retardant depends on cultivar (Kobayashi *et al.*, 2007).

Fuchsia xhybrida commonly known as Dancing lady, Lady's eardrop, Earring flower. It belongs to family Onagraceae and is native to Tropical and subtropical regions of Central and South. It is used as ornamental purposes such as colorful house and conservatory plants, containers (upright or spreading), hanging baskets, trellis, standard and specimen plant etc. These flowers thrive in a warm – cool subtropical climate regime. Prefers shade (not too much as produces fewer flowers) for the hottest part of the day and even grows in filtered sunlight. Two parts ordinary garden soil, one part fairly coarse sand, one part well decomposed leaf mould, ½ part completely decomposed or dried cow manure, plus little of bone meal is considered good for pots (Pizzetti and Cocker, 1975). Commercial and best propagation method is through cuttings, 3 to 4 cuttings can be inserted in 7 - 8 diameter pot having moist growing media. Top cuttings of fuchsia (Dollar Princess) were grown in greenhouse from February through April (Mariska *et al.*, 1992). Mostly semi - upright varieties are used for pot culture. Some of them are Border Queen, Pink Lena, Rose of Denmark, White Spider, Red Spider, Flying Cloud, Fascination etc. In large containers upright growing varieties can be used like Prodigy, Morning glory, Snowcap, Tennessee Waltz and many more. Pinching is an important operation in successful production of quality blooms of fuchsia. These flowers add vibrance to our garden and our excellent house plants. They bring contrast to dull places when kept indoor.

Brunfelsia (yesterday - today - tomorrow) belongs to family Solanaceae is a native of Brazil and Peru. It's a genus comprising a group of handsome, free flowering, evergreen shrubs, blooming scented, funnel or salver shaped flowers. Potted *Brunfelsia pauciflora* are little shrubs that grow up to 60cm tall and spread 30cm, with lance - shaped, glossy, yet leathery leaves and spectacular, frequently scented blooms. It gets its popular name, Yesterday - Today - and - Tomorrow, from the way its blossoms change color from one day to the next. Each bloom starts off violet - purple, fades to pale lavender - blue, turns practically white, and dies by the fourth day. The genus is allied to *Franciscea*. They grow in moist tropical conditions and can be grown in semi shaded situation also. Propagate *Brunfelsia pauciflora* in spring with tip cuttings of new growth. They require pinching as well as pruning to keep plant in shape and for good display of flowers. Flowers have short peduncles and grow in a 3 to 5 flowered cyme. High amounts of nitrogen applied during the first part of the low - temperature treatment increased the number of flowers per plant (Pizano, 2005). Use a potting mixture based on soil. Brunfelsia flowers best when its roots are kept in small pots, no larger than 13 - 15cm. Every spring, repot in new potting mixture, but do not increase pot size. Simply replace the old with the new combination. It can be utilized in perfume gardens, construct tropical gardens, hedge or screen beach

landscapes, or as a specimen plant. It's ideal for deck privacy screening or blocking out undesirable vistas.

3. Conclusion

In conclusion it can be stated that this article provides a comprehensive overview of flowering pot plants suitable for tropical and subtropical climates. It has highlighted the characteristics, growth conditions and the commercial significance of various plant species, providing valuable information for horticulturists, botanists and individuals interested in gardening or landscaping in these regions. It also discusses the rise in demand and need for pot plants as people's living standards have risen, number of outdoor spaces shrinking, more urbanization, temperature rise, pollution and about the benefits of having pot plants. Thus, for the production of a healthy pot plant factors like as light, temperature, potting media, and humidity are critical for optimum growth and development and should be carefully considered. Also, as this field of commercial floriculture is underdeveloped due to a lack of knowledge about standardized production methods for these pot plants and lack of defined markets, a combined efforts between producers and marketers are required to expand this blooming pot plant industry.

References

- [1] Adams SR, Valdés V M & Fuller D.1998. The effects of day and night temperature on *Chrysanthemum morifolium*: Investigating the safe limits for temperature integration. *The Journal of Horticultural Science and Biotechnology* **84**: 604 - 608.
- [2] Arnold Bik R & Boertje G A.1975. Fertilizing standards for potting composts based on the 1: 1 ½ volume extraction method of soil testing. *Acta Horticulturae* **50**: 153 - 156.
- [3] Bailey LH.1950. The standard cyclopedia of horticulture. Vol. I. Macmillan, New York, USA.
- [4] Bose T K, Jana B K and Mukhopadhyay T P.1981. A note on the effect of day length on growth and flowering in *Hippeastrum*. *Indian Journal of Horticulture* **38**: 110 - 12.
- [5] Bunt AC.1988. Media and Mixes for Container - Grown Plants, Second Edition. Unwin Hyman Ltd., London.
- [6] Bunting G S.1960. A Revision of *Spathiphyllum* (Araceae). Mem. N. Y. Bot. Gard. **10**: 1 - 53.
- [7] Chowdhuri T K, Sadhukhan R and Ghosh.2021. Varietal performance of *Anthurium* (*Anthurium andreanum*) on growth and flowering in the subtropical zone of West Bengal. *International Journal of Plant & Soil Science* **33**: 32 - 37.
- [8] Cramer C S and Bridgen M P.1998. Growth regulator effects on plant height of potted *Mussaenda* 'Queen Sirikit'. *HortScience* **33**: 78 - 81.
- [9] Currey CJ & Erwin JE.2012. Foliar applications of plant growth regulators affect stem elongation and branching of 11 *Kalanchoe* species. *HortTechnology* **22**: 338 - 344
- [10] DeJong J.1978. Selection for wide temperature adaptation in *Chrysanthemum morifolium* (Ramat.).

- Netherlands Journal of Agricultural Science* **26**: 110 - 118.
- [11] Dole JM and Wilkins HF. *Floriculture: Principles and Species*; Prentice - Hall: Upper Saddle River, NJ, USA, 1999.
- [12] Ecke P, Faust JE, Williams J and Higgins A. 2004. The Ecke Poinsettia Manual. Ball Publ., Batavia, Illinois.
- [13] El - Bably S M Z and Zaky AA. 2009. Efficacy of paclobutrazol on the growth and flowering of *Jacobiniacarne* (Lindl.) Nicholson. The Bulletin of Faculty of Agriculture - Cairo University **60**: 86 - 98.
- [14] Fagge A A and Manga A A. 2011. Effect of sowing media and gibberellic acid on the growth and seedling establishment of *Bougainvillea glabra*, *Ixora coccinea* and *Rosa chinensis* on root characters.
- [15] Fry JT. 1995. The introduction of the poinsettia at Bartram's Garden. Bartram's Broadside (Winter).
- [16] Grimstad SO. 1987. The effect of supplemental irradiation with different light sources on growth and flowering of gloxinia (*Sinningiaspeciosa* (Lodd.) Hiern). *Scientia Horticulturae* **32**: 297 - 305.
- [17] Henny R J and Rasmussen E M. 1981. Inducing flowering of spathiphyllum with gibberellic acid. *Foliage Digest* **4**: 7 - 9.
- [18] Henny RJ, Poole R T and Conover C A. 1988. 'Southern Blush' Anthurium. *HortScience* **23**: 922 - 923.
- [19] Hackett W P and Sachs R M. 1996. "Flowering In Bougainvillea San Diego. " *Proceedings of the American Society for Horticultural Science* **88**: 701.
- [20] Hanchey RH. 1955. Effects of fluorescent and natural light on vegetative and reproductive growth in Saintpaulia. *Proceedings of the American Society for Horticultural Science* **66**: 378 - 382.
- [21] Hoover WS, Karegeannes C, Wiriadinata H and Hunter JM: Notes on the geography of South - East Asian *Begonia* and species diversity in montane forests. *Telopea* 2004 **10**: 749-764.
- [22] Ingram DL, Ramcharan C and Nell TA. 1986. Response of container - grown Banana, *Ixora*, Citrus and *Dracena* to elevated root temperatures. *HortScience* **21**: 254 - 255.
- [23] Islam M A, Kuwar G, Clarke J L, Blystad D R, Gislervød H R, Olsen J E and Torre S. 2014. Artificial light from light emitting diodes (LEDs) with a high portion of blue light results in shorter poinsettias compared to high pressure sodium (HPS) lamps. *Scientia Horticulturae* **147**: 136-43.
- [24] Karlsson M G, Heins R D, Erwin J E, Berghage R D, Carlson W H and Biernbaum J A. 1989. Irradiance and temperature effects on time of development and flower size in chrysanthemum. *Scientia Horticulturae* **39**: 257 - 267.
- [25] Kakoei F and Salehi H. 2013. Effects of different pot mixture on spathiphyllum (*Spathiphyllum wallisii* Regel) growth and development. *Journal of Central European Agriculture* **14**: 140 - 148.
- [26] Kobayashi K D, McConnel J & Griffis J. 2007. *Bougainvillea*. Cooperative Extension Service. College of tropical Agriculture and Human Resources. University of Hawai'i at Monoa, OF - 38.
- [27] Kromdijk J, van Noort F, Driever S and Dueck TA. 2012. An enlightened view on protected cultivation of shade - tolerant pot - plants: benefits of higher light levels. *Acta Horticulturae* **956**: 381 - 388.
- [28] Langton F A and Runger W. 1985. *Pelargonium*. In: A. Halevy (ed.). Handbook of flowering. CRC Press, Boca Raton, Fla **4**: 9 - 2.
- [29] Mori G and Sakanishi Y. 1974. Effect of temperature on the flowering of *Cliviaminiata* Regel. *Journal of the Japanese Society for Horticultural Science* **42**: 326 - 332.
- [30] Mohapatra A, Arora J S and Sindhu G S. 2000. Evaluation of chrysanthemum varieties for pot culture. *Journal of Ornamental Horticulture (New Series)* **3** (2): 78 - 82.
- [31] Macz O, Paparozzi E T & Stroup W. 2001. Effect of nitrogen and sulfur applications on pot chrysanthemum production and postharvest performance. I. Leaf nitrogen and sulfur concentrations. *Journal of Plant Nutrition* **24**: 111-129.
- [32] Mariska T, Zande G and Baclquire T, 1992. Effect of day extensions with different light qualities on the morphogenesis of Fuchsia. *Acta Horticulturae* **305**: 86 - 9.
- [33] North JJ, Laubscher CP and Ndakidemi PA. 2010. Effect of the growth retardant Cycocel® in controlling the growth of *Dombeya burgessiae*. *African Journal of Biotechnology* **9**: 4529 - 533.
- [34] Olosunde OM and Fawusi M O A. 2003. Effect of growing media on rooting of Queen of Philippines (*Mussaendaphilippica*). *Proceedings of the 21st Annual Conference of Horticultural Society of Nigeria*. pp 121 - 126.
- [35] Pizano M. 2005. International Market Trends - Tropical Flowers. *Acta Horticulturae* **683**: 79 - 86.
- [36] Pizzetti I and Cocker H. 1975. *Lantana*. J L Hochmann, ed. Flowers, a guide for your garden. Volume II. Harry N Abrams, Inc, New York, NY. 720 - 723pp
- [37] Siddique M N A, Sultana J, Sultana N and Hossain M M. 2007. Effect of planting dates on growth and flowering of hippeastrum (*Hippeastrum hybridum*). *Int. J. Sustain. Crop Prod.* **2**: 12 - 14.
- [38] Smedt V, Huylenbroeck J M and Debergh P C. 1995. Influence of temperature and supplementary lighting on growth and flower initiation of *Clivia miniate* Regel. *Scientia Horticulturae* **65**: 65 - 72.
- [39] Kakoei F and Salehi H. 2013. Effects of Different Pot Mixtures on spathiphyllum (*Spathiphyllum wallisii*) Growth and Development. *Journal of Central European Agriculture* **14** (2): 140 - 148.
- [40] Kamemoto H and Kuehnle A R. 1996. Breeding anthuriums in Hawaii. Univ, of Hawaii Press, Honolulu.
- [41] Warren W C. 1996. Tropical flowers of Malaysia and Singapore. Singapore: Periplus Editions HK. pp 12.
- [42] Zhang Y, Liu A, Zhang X and Huang S. 2018. Effects of shading on some morphological and physiological characteristics of *Begonia semperflorens*. *Pakistan Journal of Botany* **50**: 2173 - 79.