International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Geographical Variation in Morphological Traits of Catharanthus Roseus [L.]: A Comparative Study Across Five Distinct Ecological Niches from Southern Tamil Nadu, India

Jershia Hadrin J.[1], Bojaxa A. Rosy[2]

[1]Holy Cross College (Autonomous), Department of Plant Physiology and Biotechnology,
Holy Cross colg Road Kurusady, Nagercoil – 629002 Kanyakumari, India
Email: *jershiahadrin[at]gmail.com*

[2]Holy Cross College (Autonomous) - School of Life Sciences, Department of Plant Physiology and Biotechnology
Holy Cross colg Road Kurusady, Nagercoil – 629002 Kanyakumari, India
Email: *bojaxaabs[at]gmail.com*

Abstract: ***Medicinal plants have been vital in human history for their therapeutic benefits, offering a sustainable and accessible alternative to synthetic drugs. Among these, Catharanthus roseus [L.] G. Don stands out for its pharmacological significance, producing bioactive compounds such as vincristine and vinblastine, which are critical in cancer treatment. This plant's adaptability across diverse ecological zones highlights its resilience and underscores the influence of environmental factors on its morphology and physiology. Morphological variations in plants, particularly those growing across altitudinal and climatic gradients, can reveal insights into their adaptive strategies and evolutionary trends. However, limited research has been conducted on the relationship between environmental gradients and the phenotypic diversity of C. roseus. This study focuses on the morphological characterization of C. roseus collected from the distinct agro-climatic zones in the Kanyakumari district. By analysing variations in traits such as leaf dimensions, stem structure, and inflorescence, this research aims to understand how environmental conditions influence morphological expressions. Exploring these variations not only aids in species identification but also enhances our understanding of how environmental and genetic factors interact to shape plant adaptability. Such insights can further inform the conservation and optimized cultivation of medicinal plants, emphasizing their role in traditional medicine and modern pharmacology.***

Keywords: Morphological patterns, pharmacology, Climatic Gradients, Ecological, Environmental.

1. Introduction

Plants may change their morphological and physiological properties in response to environmental changes [Sultan, 1995 & Robakowski *et al.,* 2003], and they can also regulate the expression of these traits to accommodate their adaptability across diverse settings [McIntyre, 2009]. Plant development, structure, function, and metabolism are all affected by altitude [Berli *et al.,* 2013 & Dogra *et al.,* 2013]. Environmental adaptation is reflected in a species' morphological and physiological properties over particular altitudinal gradients [Pellissier *et al.,* 2013]. As a result, current plant ecologists have focused on these plant features in various biological and ecological zones in order to better understand their adaptation mechanisms [Wright *et al.,* 2004; He *et al.,* 2006]. The visual identification of plants is aided by plant architecture. Recent molecular biology research has begun to look at the molecular processes involved in influencing plant morphology conservation and diversity.

Cai *et al.,* 2012; Grytnes and Vetaas, 2002 & Schmidt *et al.,* 2008] suggest that plant species have an optimum altitude for biomass production and net photosynthetic rate, and that deviation from this optimum altitude can cause enzymatic activity to increase or decrease [Cai *et al.,* 2012; Grytnes and Vetaas, 2002 & Schmidt *et al.,* 2008]. However, [Jump and Penuelas, 2005] the adaptation process in response to altitude variation and climate change is little unclear.

Since the birth of medicine, natural products, particularly those derived from plants, have been employed to aid in the maintenance of human health. Traditional medicine has existed since the beginning of time, and it has been widely acknowledged and used by people throughout history. Plants have been used as a source of medicine since the dawn of humanity. For many years, plant-derived therapeutic medicines have piqued the interest of experts all over the world due to their low risk of side effects and good impacts on human health.

Plants having a long history of ethno medicine usage can be a rich source of chemicals for the treatment of a variety of maladies and infectious diseases in the pharmaceutical environment. Medicinal plants are thought to be a storehouse of a variety of bioactive chemicals with various medicinal qualities. Anti-inflammatory, antiviral, anticancer, antimalarial, and analgesic activities are among the therapeutic effects linked with medicinal plants [Mya *et al.,* 2019]. *Catharanthus roseus* L. [G.] Don is a dicotyledonous angiosperm that produces the terpene indole alkaloids vinblastine and vincristine, which are used to combat cancer [Ajaib *et al.,* 2010]. It's one of the most well-researched medicinal herbs [Van Der Heijden *et al.,* 2004 & Verpoorte *et al.,* 2007]. It's an upright, bushy herb that's evergreen and blooms all year.

It generates essential alkaloids such as vincristine and vinblastine, which are mostly found in the leaves, and antihypertensive alkaloids like as ajmalicine, serpentine, and reserpine, which are mostly found in the roots [Mishra *et al.*, 2001]. Menorrhagia, rheumatism, dyspepsia, indigestion, dysmenorrhea, diabetes, hypertension, cancer, menstrual problems, skin illnesses, bleeding, diarrhoea, and antiviral qualities are all treated using C. roseus leaves [Farnsworth *et al.*, 1968 & Holdsworth, 1990].

Plant taxonomy and identification rely primarily on morphological features. The bulk of the measured attributes showed significant differences in the analysis of variance, showing that there was heterogeneity among the taro accessions [Pitoyo *et al.*, 2018]. Changes in shape, anatomy, gene expression, cell metabolism, and growth and productivity are all triggered by environmental factors [Anjum *et al.*, 2011 & Pantilu *et al.*, 2012].

The impact of several ecological factors in terms of latitude and longitude on a few morphological features of the medicinal plant *Catharanthus roseus* were investigated in this study.

Objectives

The objectives of the present investigation were:

- The collection and identification of the selected medicinal plant from the five different locations.
- To carry out the variation in the morphological parameters from the selected study areas.

2. Review of Literature

Geographical diversity in morphological features may indicate evolutionary patterns of morphological adaptation along environmental gradients, according to [Miaoli *et al.*, 2020]. To investigate morphological diversity and evolutionary trends in widespread Bermuda grass, comprehensive information on longitudinal patterns of morphological trait variation is essential. They discovered that physical features varied significantly between longitudes, and that within-population variation was smaller than between-population variance for the majority of the traits studied. Various combinations and interactions of environmental conditions along a longitudinal gradient may have a significant impact on one or more morphological features of Bermuda grass.

[Aaron *et al.*, 2020] found that seedling leaves were bigger and fine root networks were thicker with fewer root points in older, unlogged rainforest on Hainan Island, China, than in historically logged regions. They discovered that root morphological features were more conservative in primary forest than secondary forest, but leaf morphologies were more acquisitive. There was no difference in leaf thickness or root tissue density. Root and leaf morphological changes between forest types were constant throughout the examined plant groups. & at the end Root and leaf morphological variation within the lineage displayed distinct patterns. Intraspecific variation in root diameter and individual root length was influenced by local-scale variations in soil phosphorus and base saturation.

The morphology and inheritance of the double-flowered phenotype in the periwinkle *Catharanthus roseus* mutant TYV1 were examined by [Chin *et al.*, 2012]. TYV1 features an outer salver-shaped whorl of petals and an inner funnel-shaped whorl of petals that emerges from the corolla's apex. The corolla tube's tip generates a tiny aperture. Hairs are seen under the apex aperture. This mutant's stigma is located below the anthers. The single flowered trait was caused by a single dominant gene expressed in homozygous or heterozygous form. Before the sixth pair of leaves developed, all immature seedlings of self-pollinated TYV1 and double-flowered offspring exhibited deformed leaves.

[Naser *et al.*, 2020] investigated the morphological features of C. roseus, including the length and dry weight of rootlets, plumules, and seedlings, as well as the leaf relative water content [RWC]. The results showed that different priming approaches had a positive effect on C. roseus development under natural salt stress. Rootlet dry weight rose as salinity increased, indicating that more carbon was allocated to the roots under stress. The priming procedures used in their research can be used to grow C. roseus in salty regions.

[Alexandra *et al.*, 2021] Microscopy methods were used to analyse the morphological and anatomical characteristics of the Vinca leaf. Interspecific differences were found in both outdoor Vinca minor and V. herbacea plants and greenhouse-grown Vinca major and V. major var. variegata plants. The leaves of all Vinca species are hypostatic. Only a few stomata were found on the top epidermis, with the exception of the V. minor leaf. The greatest stomatal index was found on V. minor leaves, while the lowest was found on V. major leaves, and the distribution of trichrome on the top epidermis was species-specific. This might be a response to the unpredictability of climatic circumstances, but it could still have an impact on plant chemical composition.

[Siti *et al.*, 2019] explored *Catharanthus roseus* variability using morphological and anatomical features, as well as chlorophyll content. Their goal was to evaluate the variability of C. roseus based on morphological, anatomical, and chlorophyll content, as well as to learn about the variations in morphological, anatomical, and chlorophyll content of C. roseus discovered in Banyumas Regency. A survey approach was employed in conjunction with a purposive sample methodology in this study. C. roseus in Banyumas Regency was divided into eight kinds, according to the findings. There were 21 morphological characteristics detected, 8 quantitative characters, and 13 qualitative characters. The majority of the quantitative morphological and anatomical features have a wide range of variation.

[Mya *et al.*, 2019] chosen 15 medicinal plants from Myanmar, including Dalbergia cultrata, Eriosema chinense, Erythrina suberosa, Millettia pendula, Sesbania grandiflora, Tadehagi triquetrum, Andrographis echioides, Barleria cristata, Justicia gendarussa, Premna integrifolia, The phytochemical components, biological, and pharmacological properties of a number of therapeutic plants have been studied. The goal of this research is to compile a collection of publications on the species of chosen medicinal plants found in Myanmar, as well as a critical analysis of the literature data. Myanmar looks to be a source of traditional medicines that have yet to be properly explored as a country. This assessment will serve as a foundation for future research into the pharmacological activity of Myanmar's medicinal plant species.

[Shal and Deng, 2018] assessed the morphological and anatomical alterations in periwinkle seedlings caused by induced polyploidy. Colchicine was used at four different doses for seedling treatment: 0.0, 0.05, 0.1, and 0.2 percent. The findings revealed that increasing colchicine dosages resulted in an increase in survival percentage and the number of tetraploid plants. When compared to diploid plants, polyploidy demonstrated an increase in leaf thickness, stomatal size, pollen diameter, and pollen viability. Flow cytometry confirmed the presence of tetraploids and mixoploids in various colchicine-treated plants, with the 0.2 percent concentration being the most effective in inducing polyploidy in the plants, followed by the 0.1 percent concentration. By assessing photosynthetic physiology, nutritional content, and growth related with adaptation of plants to circumstances at different altitudes above sea level on the plateau, [Juan *et al.*, 2020] discovered the change in morphological and physiological properties. Elymus nutans, the dominating grass, was obtained from these heights and grew at a test location of 2950 metres. Altitude had no influence on plant height or root depth, according to the findings. Plants originating from 2950 and 3300 m, on the other hand, displayed a parabolic response, with leaf area and total root surface area bigger than those produced from the lowest [2450 m] and highest [3300 m].

Ayurveda is an Indian traditional system of medicine that focuses on the medicinal potential of plants, according to [Jai and Navneet, 2017]. They demonstrated that *Catharanthus roseus* is a well-known herb in Ayurveda. Its antitumor, anti-diabetic, anti-microbial, anti-oxidant, and antimutagenic properties are well-known. The blooms can be pink to purple in colour, and the leaves are arranged in opposing pairs. Ajmalcine, vinceine, resperine, vincristine, vinblastine, and raubasin are among the almost 130 alkaloids produced. Hodgkin's disease, breast cancer, skin cancer, and lymphoblastic leukaemia are among the cancers that vincristine and vinblastine are used to treat. It is a threatened species that requires conservation strategies such as micro propagation. It has a lot of therapeutic potential that has to be investigated further.

3. Materials and Method

3.1 Catharanthus roseus [L.] G. Don

Catharanthus roseus is a 1 m tall evergreen subshrub or herbaceous plant. The leaves are grouped in opposite pairs and are oval to oblong, wide, glossy green, hairless, with a light midrib and a short petiole. The blooms have a basal tube and a corolla with five petal-like lobes, and are white to dark pink with a deeper red centre. A pair of follicles make up the fruit.

3.2 Morphological Studies

A total of five accessions, geographically separate genotypes of Catharanthus roseus [L.] G. Don, were obtained from various agro climatic zones in Kanyakumari district for the study. The morphological characteristics of mature leaf length, mature leaf width, number of leaves in a plant, stem length, stem width, number of branches, root length, root width, inflorescence length, and number of flowers were tabulated for all ten plants and the average was computed in excel.

4. Result and Discussion

Because a minimum of 10 samples of a specific plant component are needed to explain the current differences in the population for a given agro-ecological zone, ten plants were randomly collected in each research region. All the morphological parameters are measured using a scale. Using Excel software, the analysis of variance [ANOVA] is used to compare the variation in mature leaf length, mature leaf width, number of leaves in a plant, stem length, stem width, number of branches, root length, root width, inflorescence length, and number of flowers between the five study areas.

The analysis of variances revealed a significant difference [$p \leq 0.05$] between the five distinct *Catharanthus roseus* plant sites in terms of morphological features.

4.1 Changes in Mature Leaf Length

The present study's morphological characterization of *Catharanthus roseus* revealed considerable differences in mature leaf length across the species under varied growing conditions. The location of Duraikudiyruppu [6.91±0.52 cm] has the longest leaf, followed by Mangalakuntu [5.9±1.33 cm], Vyrakudy [5.2±0.69 cm], Ramanputhur [4.06±0.72 cm], and Kannakurichi [4.3±0.64 cm] [Graph 1]. In all of the tested sites, mature leaf colour was found as light green, dark green, and glossy dark green. [Siti *et al.*, 2019] conducted similar research, with leaf lengths ranging from 4.26 to 6.2 cm.

4.2 Changes in Mature Leaf Width

Observable morphological variation existed in the width of the *Catharanthus* leaf studied from five different locations along the various latitudinal and longitudinal gradient, and the five populations showed moderate morphological variation in its width. The term “population” means that all individuals of the same species occupy a certain space in a certain period of time. We considered the samples collected in each site as representative of 10 populations in this study [Graph 2].

4.3 Changes in the number of leaves

The variation in the number of leaves among populations could be related to differences in latitude, longitude, and environmental conditions. Within populations, Vyrakudy had the lowest variance component [13.1±3.53] and Duraikudiyruppu had the highest variance component [39.4±14.20]. [15.3±4.98 and 32.6±5.44] [Graph 3] were the variance components of the other populations. This demonstrates that morphological features can be utilised to distinguish *C. roseus* diversity. Leaf characteristics have been genetically enhanced in order to be used as taxonomic tools [Masungsong *et al.*, 2019].

4.4 Changes in the Length of the Stem

It was found that the longest stem in the selected species was found in Kannakurichi [52.2±9.24 cm], followed by Ramanputhur [49.7±7.04 cm], Duraikudiyruppu [30.01±7.69 cm] and Vyrakudy [19.34±1.28 cm] whereas the shortest stem was found in Mangalakuntu [14.7±4.05 cm]. Morphological features are still commonly utilised for early evaluation because they are quick, easy, and inexpensive, and they can be used to assess plant genetic diversity in a broad sense [Jingura and Kamusoko, 2015]. According to [Pitoyo *et al.*, 2018], various accessions had a wide range of morphological characteristics. As a result, morphological characteristics can be utilised to distinguish across varieties.

4.5 Changes in the width of the Stem

According to the results, changes in stem width may be the consequence of latitude, longitude, and climatic conditions of the selected study areas. The stem width wasn't much different between the various populations studied. At Kannakurichi [0.5±0.18 cm], it was the greatest, while at Vyrakudi it was the smallest [Graph 5].

4.6 Changes in branch number

C. roseus is known to be resilient of abiotic conditions such as dryness and salinity, and it may thrive in a variety of environments including sand, shrubs, dryland, vineyards, roadsides, and beaches. This plant can grow anywhere in the world, regardless of latitude or longitude. The number of branches on the investigated plants was high in those gathered from Kannakurichi [7.2±3.15] and very low in those collected from Ramanputhur [3.1±0.83]. This finding might be owing to the different latitudes and longitudes of the areas surveyed, as well as the environmental circumstances. [Siti *et al.*, 2019], conducted a study that was similar to this one.

4.7 Changes in the length of the Root

The root length of the plant taken from the Ramanputhur areas was extremely long [19.27±3.34± cm]. The root length of the plants taken from the Vyrakudy areas, on the other hand, was very short. [Naser *et al.*, 2020] conducted a similar study in which the length of the root showed substantial differences in the plants investigated.

4.8 Changes in the width of the Root

The plants studied from the regions of Kannakurichi had the largest root width [0.42±0.12 cm], followed by the plants examined from the regions of Mangalakuntu [0.37±0.09 cm], Ramanputhur [0.33±0.11 cm], Duraikudiyruppu [0.29±0.07 cm], and Vyrakudy [0.26±0.04cm]. [Aaron *et al.*, 2020] investigated the morphological variability of fine root systems and leaves on Hainan Island's primary and secondary tropical forests.

4.9 Changes in the length of the inflorescence

The inflorescence measured 6.76±1.83 cm in length, which was longer than the inflorescence recovered from Ramanputhur's regions. Plants gathered from Vyrakudy locations were evaluated for the next largest length [5.04±0.60 cm] of the inflorescence. The plants gathered from the Duraikudiyruppu districts had the next longest inflorescence [4.35±0.64 cm]. The inflorescences of the plants obtained from Mangalakuntu's locations were somewhat long [3.5±1.02 cm]. The shortest inflorescence length [2.39±0.29 cm] was found in the Kannakurichi region. If environmental variables are not favourable, plants have the potential to respond to their demands, especially during their life cycle. This response might lead to the formation of morphological, anatomical or physiological features. According to [Maghsoudi and Moud, 2008], external conditions that impact alterations include light intensity, air humidity, and CO_2 concentration. As a consequence, differences in inflorescence length across places may be linked to climatic conditions such as air, humidity, and CO_2 levels in the atmosphere.

4.10 Changes in the number of Flowers

The plants investigated from the Kannakurichi districts produced a higher number of blooms [16.8±4.50]. The plants taken from the Vyrakudy districts have the fewest blooms. The number of blooms in all other sites ranged between [3±1.34-12±4.09]. Changes in climatic circumstances like as solar light, soil fertility, and water may cause variations in the quantity of blooms. For effective species identification, morphological features of all plant organs are employed [Chen *et al.*, 2017; Csiky *et al.*, 2013; Ochirova *et al.*, 2013 and Petra *et al.*, 2020].

According to [Adams *et al.*, 2012], maintaining the rate of transpiration is the most effective adaptation of plants in reacting to the effects of environmental conditions. The results revealed that *C. roseus* had minimal variability in features such stem width, root width, and leaf, stem, and flower colour. Leaf length, leaf breadth, number of leaves, stem length, number of branches, root length, inflorescence length, and flower number were all highly variable morphological characters. This demonstrates that morphological characteristics may be utilised to differentiate *C. roseus* diversity.

4.11 Tables

Table 1: Morphological Variations between *Catharanthus Roseus* from Five Altitudes

Location	Matue leaf length [cm]	Mature leaf width [cm]	No of leaves	Stem length [cm]	Stem width [cm]	No of branches	Root length [cm]	Root width [cm]	Inflorescence length [cm]	No of flowers
Ramanputhur	4.06±0.72	2.49±0.73	32.6±5.44	49.7±7.04	0.43±0.11	3.1±0.83	19.27±3.34	0.33±0.11	6.76±1.83	12±4.09
Duraikudiyruppu	6.91±0.52	2.54±0.33	39.4±14.20	30.01±7.69	0.41±0.07	5.1±3.44	7.99±2.72	0.29±0.07	4.35±0.64	3.9±1.51
Mangalakuntu	5.9±1.33	2.62±0.65	15.3±4.98	14.7±4.05	0.43±0.11	3.3±1.1	7.9±1.92	0.37±0.09	3.5±1.02	3±1.34
Vyrakudy	5.2±0.69	1.92±0.38	13.1±3.53	19.34±1.28	0.29±0.10	3.1±0.94	4.27±0.35	0.26±0.04	5.04±0.60	2.2±0.83
Kannakurichi	4.3±0.80	2.44±0.63	37.9±9.42	52.2±9.24	0.5±0.18	7.2±3.15	10.15±1.66	0.42±0.12	2.39±0.29	16.8±4.50

Table 2: Collection Data of Catharanthus Roseus L. from Five Locations

Sl.no	Location	Latitude	Longitude	Date of collection
1.	Ramanputhur	8.1737	77.4212	25/01/2022
2.	Duraikudiyruppu	8.300154	77.81437	27/01/2022
3.	Mangalakuntu	8.220476	77.22434	27/01/2022
4.	Vyrakudy	8.088306	77.53845	27/01/2022
5.	Kannakurichi	8.133292	77.33478	25/01/2022

4.12 Figures

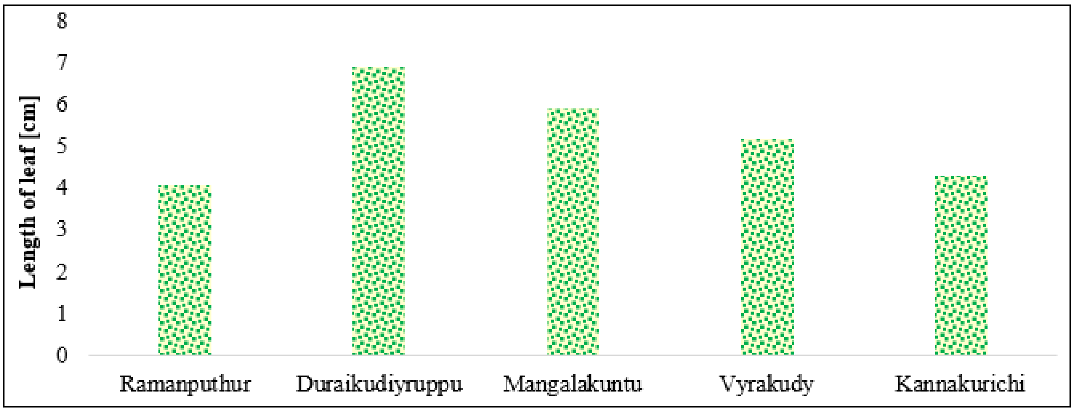

Figure 1: Mature Leaf Length in Catharanthus Roseus from Five Location

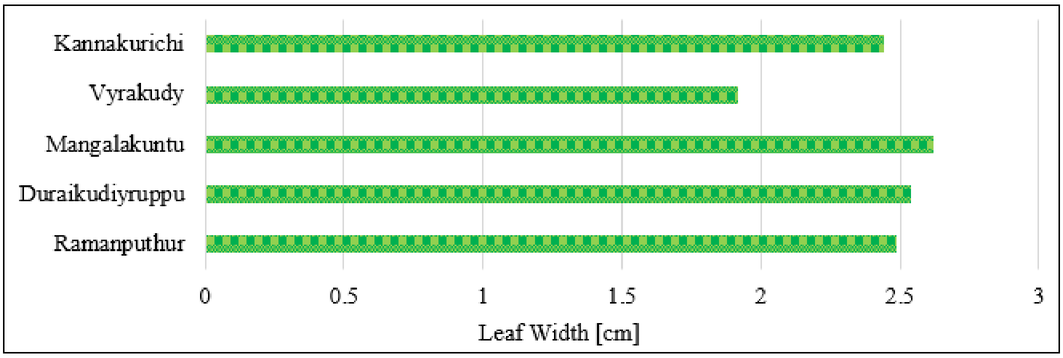

Figure 2: Mature Leaf Width in Catharanthus Roseus from Five Location

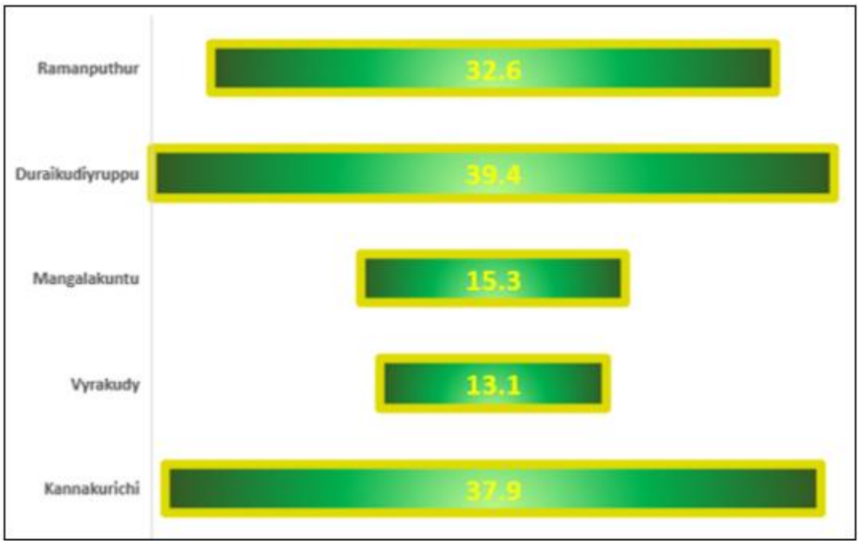

Figure 3: No. of Leaves in Catharanthus Roseus from Five Locations

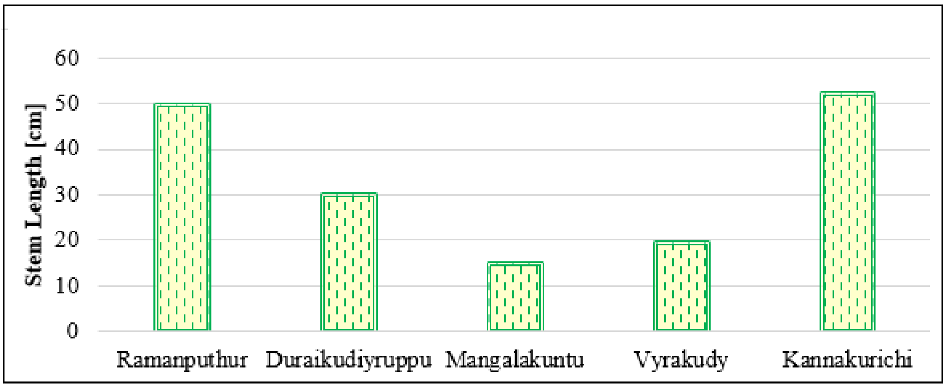

Figure 4: Stem Length in Catharanthus Roseus in five loctions

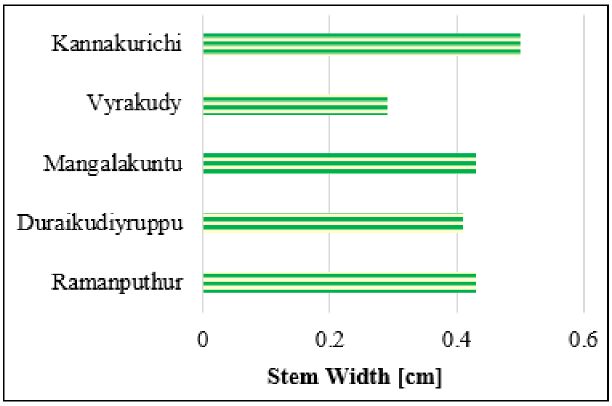

Figure 5: Stem Width in Catharanthus Roseus in five locations

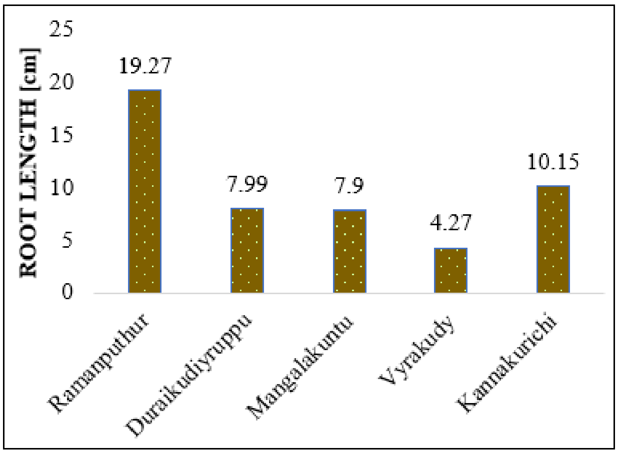

Figure 7: Root Length in Catharanthus Roseus from Five different location

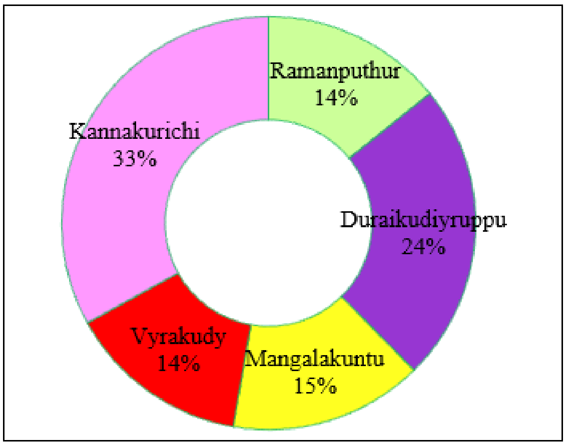

Figure 6: No of Shoot Branches in Catharanthus Roseus in five locations

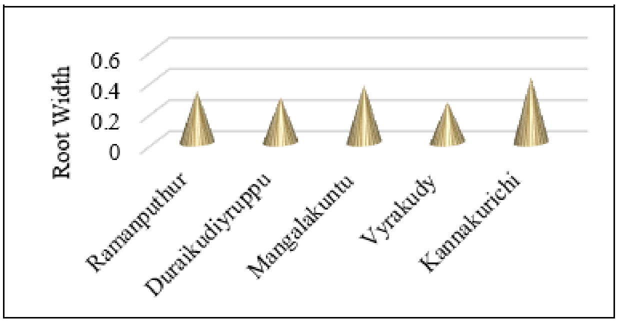

Figure 8: Root Width in Catharanthus Roseus from Five Locations

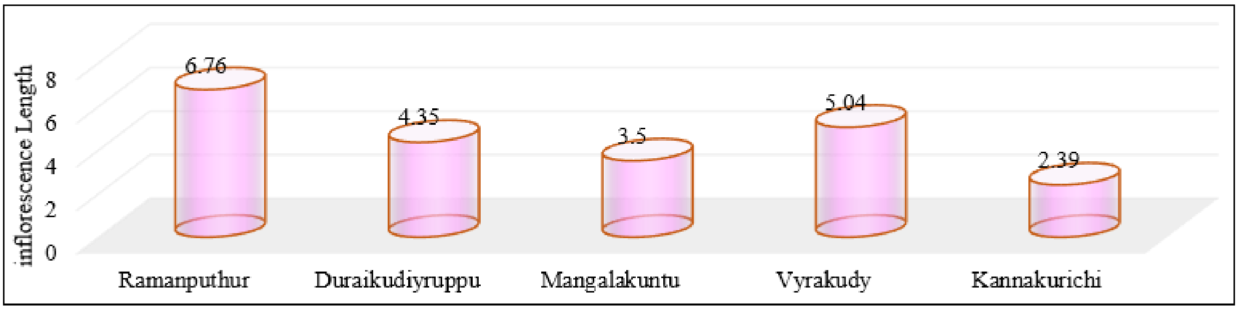

Figure 9: Inflorescence Length in Catharanthus Roseus from Five Locations

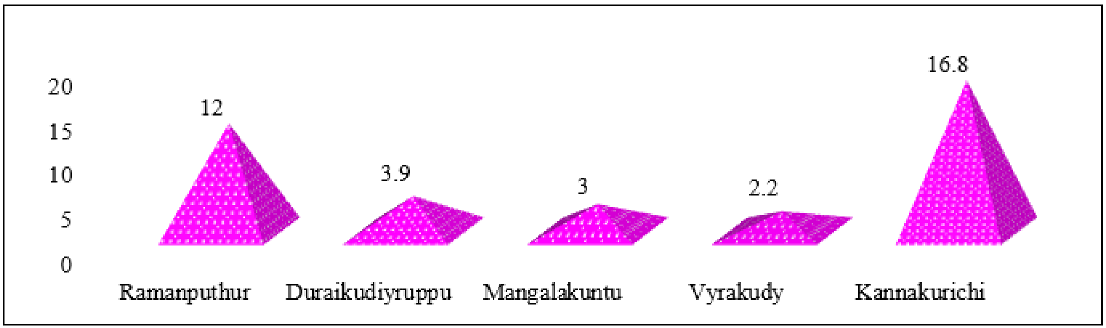

Figure 10: No. of Flowers in Catharanthus Roseus from Five Locations

5. Summary and Conclusion

Medicinal plants have been used to create a variety of unique medicinal compounds that have a strong pharmacological impact on humans. Instead than utilising chemical pharmaceuticals that have adverse effects, ancient medicine might be investigated to find unique drug compositions that are more effective, have less side effects, and are also less expensive. One of the most significant therapeutic herbs identified is *Catharanthus roseus*. It's used to treat a variety of ailments, including diabetes, sore mouth, oral ulcers, and leukaemia. Many alkaloids are produced, including reserpine, vinceine, raubasin, and ajmalcine. Vinblastine and vincristine have anti-leukemic action.

Plant drug research in connection to morphology would help researchers better grasp the link between morphological patterns and function. Drug measures might relate morphological changes to the pressures that plants actually face, allowing researchers to assess the true value of morphological change.

Significant phenotypic connections were discovered between the morphological characters evaluated in Ramanputhur, Duraikudiyruppu, Mangalakuntu, Vyrakudy, and Kannakurichi, which are all located in Kanyakumari district.

To conclude, diverse morphological features were observed in several Kanyakumari district locales. Almost all quantitative morphological features studied have a wide range of variation.

References

[1] Aaron Hogan J, Oscar Valverde-Barrantes J, Qiong Ding, Han Xu and Christopher Baraloto. 2020. Morphological variation of fine root systems and leaves in primary and secondary tropical forests of Hainan Island, China. *Annals of Forest Science*. 77:79.

[2] Adams T D, Hunt L, Franks P J, Beerling D J, Gray J E. 2012. Genetic manipulation of stomatal density influences stomatal size, plant growth and tolerance to restricted water supply across a growth carbon dioxide gradient. *Phil Trans R Soc B*. 367: 547-555.

[3] Ajaib M, Khan ZUD, Khan N and Wahab M. 2010. Ethnobotanical studies on useful shrubs of District Kotli, Azad Jammu & Kashmir, Pakistan. *Pak J Bot*. 42 :1407 -1415.

[4] Alexandra Ciorît, Septimiu Cassian Tripon, Ioan Gabriel Mircea, Dorina Podar, Lucian Barbu-Tudoran, Cristina Mircea and Marcel Pârvu. 2021. The Morphological and Anatomical Traits of the Leaf in Representative Vinca Species Observed on Indoor- and Outdoor-Grown Plants. *Plants*. 10 [622] 1-17.

[5] Anjum S A, Xie X, Wang L, Saleem MF, Man C and Lei W. 2011. Morphological, physiological and biochemical responses of plants to drought stress. *Afr J Agric Res* 6 [9]: 2026-2032.

[6] Berli F J, Alonso R, Bressan-Smith R and Bottini R. 2013. UV-B impairs growth and gas exchange in grapevines grown in high altitude. *Physiologia Plantarum*. 149 [1]: 127–140.

[7] Cai Z Q, Jiao D Y, Tang S X, Dao X S, Lei Y B and Cai C T. 2012. Leaf photosynthesis, growth, and seed chemicals of Sacha Inchi plants cultivated along an altitude gradient. *Crop Science*. 52 [4]: 1859–1867.

[8] Chen Q, Lu X, Guo X, Guo Q and Li D. 2017. Metabolomics characterization of two Apocynaceae plants, *Catharanthus roseus* and *Vinca minor*, using GC-MS and LC-MS methods in combination. *Molecules*. 22, 997.

[9] Chin-Mu Chen, Tzu-Yao Wei and Der-Ming Yeh. 2012. Morphology and Inheritance of Double Floweredness in *Catharanthus roseus*. *Hortscience*. 47 [12] :1679–1681.

[10] Csiky J and Purger D. 2013. Herbaceous periwinkle, *Vinca herbacea* Waldst. et Kit. 1799 [Apocynaceae], a new species of the Croatian flora. *Acta Bot. Croat*. 72, 399–406.

[11] Dogra V, Ahuja P S and Sreenivasulu Y. 2013. Change in protein content during seed germination of a high altitude Robakowski plant *Podophyllum hexandrum* Royle. *Journal of Proteomics*. 78 [78]: 26–38.

[12] Farnsworth N R, Svoboda G H and Blomster R N. 1968. Antiviral activity of selected *Catharanthus* alkaloids. *J. Pharm. Sci*., 57 [12]: 2174–2175.

[13] Grytnes A and Vetaas O R. 2002. Species richness and altitude: a comparison between null models and interpolated plant species richness along the Himalayan altitudinal gradient, Nepal," *The American Naturalist*. 159 [3]: 294–304.

[14] He J S, Wang Z and Wang X. 2006. A test of the generality of leaf trait relationships on the Tibetan Plateau. *New Phytologist*. 170 [4]: 835–848.

[15] Holdsworth D K. 1990. Traditional medicinal plants of Rarotonga, Cook Islands part I. *Int. J. Crude Drug Res*. 28[3]: 209–218.

[16] Jai Narayan Mishra and Navneet Kumar Verma. 2017. A brief study on *Catharanthus roseus*: A review. *International Journal of Research in Pharmacy and Pharmaceutical Sciences*. 2 [2]: 20-23.

[17] Jingura R M and Kamusoko R. 2015. Utility of markers for determination of genetic diversity in *Jatropha*: A Review. *Open Renew Energy J*. 8: 1-6.
[18] Juan Qi, Wenhui Liu, Ting Jiao and Ann Hamblin. 2020. Variation in Morphological and Physiological Characteristics of Wild Elymus nutans Ecotypes from Different Altitudes in the Northeastern Tibetan Plateau. *Hindawi Journal of Sensors*.11.
[19] Jump A S and Penuelas J. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. *Ecology Letters*. 8 [9]: 1010–1020.
[20] Maghsoudi K and Maghsoudi moud A. 2008. Analysis of the effects of stomatal frequency and size on transpiration and yield of wheat [*Triticum aestivum* L.]. *Am Eurasian J Agric Environ Sci*. 3 [6]: 865- 872.
[21] Masungsong L A, Belarmino M M and Buot J R IE. 2019. Delineation of the selected *Cucumis* L. species and accessions using leaf architecture characters. *Biodiversitas*. 20 [3]: 629-635 .
[22] McIntyre S, Lavorel S, Landsberg J and Forbes T D A. 2009. Disturbance response in vegetation–towards a global perspective on functional traits. *Journal of Vegetation Science*. 10 [5]: 621–630.
[23] Miaoli Wang, Jingxue Zhang, Zhipeng Guo, Yongzhuo Guan, Gen Qu, Jianyu Liu, Yuxia Guo and Xuebing Yan. 2020. Morphological variation in *Cynodon dactylon* [L.] Pers., and its relationship with the environment along a longitudinal gradient. *Hereditas*. 157 [4]: 1-11.
[24] Mishra P, Uniyal G C, Sharma S and Kumar S. 2001. Pattern of diversity for morphological and alkaloid yield related traits among the periwinkle *Catharanthus roseus* accessions collected from in and around Indian Subcontinent. *Genet. Resour. Crop Evol*. 48[3]: 273–286.
[25] Mya Mu Aye, Hnin Thanda Aung, Myint Myint Sein and Chabaco Armijos. 2019. A Review on the Phytochemistry, Medicinal Properties and Pharmacological Activities of 15 Selected Myanmar Medicinal Plants. *Molecules*. 24, 293.
[26] Mya Mu Aye, Hnin Thanda Aung, Myint Myint Sein and Chabaco Armijos. 2019. A Review on the Phytochemistry, Medicinal Properties and Pharmacological Activities of 15 Selected Myanmar Medicinal Plants. *Molecules*. 24, 293.
[27] Naser Ghasemi, Heshmat Omidi and Amir Bostani. Morphological Properties of *Catharanthus roseus* L. 2020. Seedlings Affected by Priming Techniques Under Natural Salinity Stress. *Journal of Plant Growth Regulation*. 40 [2]: 550-557.
[28] Ochirova K S, Ovanova E A and Dordzhieva V I. *Vinca minor* L. 2018. Leaf anatomical structure. *J. Pharm. Sci. Res*. 10, 2528–2530.
[29] Pantilu L I, Mantiri F R, Ai N S, Pandiangan D. 2012. Morphological and anatomical responses of the soybean [*Glycine max* L.] Merill] sprouts to the different light intensity. *J Biol* . 2 [2]: 80-87.
[30] Pellissier L, Espíndola A and Pradervand J N. 2013. A probabilistic approach to niche-based community models for spatial forecasts of assemblage properties and their uncertainties. *Journal of Biogeography*. 40 [10]: 1939–1946.
[31] Petra S A, Georgescu M I, Manescu C R, Toma F, Badea M L, Dobrescu E and Popa V I. 2020. Leaves anatomical and physiological adaptations of *Vinca major* 'Variegata' and *Hedera helix* L. to specific roof garden conditions. *Not. Bot. Horti Agrobot*. 47, 318–328.
[32] Pitoyo A, Prameta A A, Marsusi, Suratman and Suranto. 2018. Morphological, anatomical and isozyme variability among taro [*Colocasia esculenta*] accessions from south eastern part of Central Java, Indonesia. *Biodiversitas* 19 [5]: 1811-1819.
[33] Pitoyo A, Prameta A A, Marsusi, Suratman and Suranto. 2018. Morphological, anatomical and isozyme variability among taro [*Colocasia esculenta*] accessions from southeastern part of Central Java, Indonesia. *Biodiversitas* 19 [5]: 1811-1819.
[34] Robakowski P, Montpied P and Dreyer E. 2003. Plasticity of morphological and physiological traits in response to different levels of irradiance in seedlings of silver fir [Abies alba Mill]. *Trees.* 17 [5]: 431–441.
[35] Schmidt S K, Reed S C and Nemergut D R. 2008. The earliest stages of ecosystem succession in high-elevation [5000 metres above sea level], recently deglaciated soils. *Proceedings of the Journal of Sensors 9 Royal Society B: Biological Sciences*. 275 [1653]: 2793–2802.
[36] Shala A Y and Deng Z. Investigation of Morphological and Anatomical Changes In *Catharanthus roseus* [L.] G. Don Due to Colchicine Induced Polyploidy. 2018. *Scientific J. Flowers & Ornamental Plants*. 5[3]:233-243.
[37] Siti Samiyarsih, Nettyani Naipospos and Dian Palupi. 2019. Variability of *Catharanthus roseus* based on morphological and anatomical characters, and chlorophyll contents. 20, [10]: 2986-2993.
[38] Sultan S E. 1995. Phenotypic plasticity and plant adaptation. *Acta Botanica Neerlandica*. 44 [4]: 363–383.
[39] Van Der Heijden R, Jacobs DI, Snoeijer W, Hallard D and Verpoorte R. 2004. The *Catharanthus* alkaloids: pharmacognosy and biotechnology. *Current Medicinal Chemistry*. 11: 607-628.
[40] Verpoorte R, Lata B, Sadowska A and Verpoorte R. 2007. Biology and biochemistry of *Catharanthus roseus* [L.] G. Don. *Phytochemistry reviews*. *Springer* . 6 [2–3]
[41] Wright I J, Groom P K and Lamont B B. 2004. Short communication: leaf trait relationships in Australian plant species. *Functional Plant Biology*. 31 [5]: 551–558.

Author Profile

Jershia Hadrin.J Holds a Bachelor of Science in Plant Physiology from Manonmaniam Sundaranar University, Tamil Nadu and a Master of Science in Advanced Plant Physiology and Biotechnology from Bharathidasan University, Tamil Nadu. With a strong foundation in plant sciences, has actively worked in genetic engineering across various crops, microbiology, nanotechnology, and genetic mutational studies. In doctoral research, continues to explore cutting-edge advancements in plant biotechnology and physiology.

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Bojaxa A. Rosy Assistant Lecturer at Holy Cross College with a strong academic background in plant sciences. Her research interests include plant tissue culture, biochemistry, taxonomy, biotechnology, plant diversity, and ecology studies. With a passion for advancing botanical and ecological research, she actively contributes to scientific studies that explore plant adaptation, conservation, and innovative biotechnological applications. Through her work, she aims to enhance understanding in plant sciences and support sustainable ecological practices.