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# *Nephrolepis undulata* J Sm: The fern morphology, development and reproduction

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**Abstract**
A survey of ornamental ferns with potentials for environmental protection and improvement was carried out at the department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere (Under University of Agricultural and Horticultural Sciences, Shivamogga) during 2018-20. Fern *Nephrolepis* were collected from different vegetation zones of Chickmanglore district, Karnataka, India. This was with a view to creating awareness of the importance of ornamental ferns for environmental management and economic values. The beauty of offices of corporate organizations like banks, industries, schools, shopping complexes and religious buildings are enhanced by the ornamental plants such as ferns, flowers of different varieties, shrubs and trees planted within their surroundings. This has, therefore, made the demand for ornamental plants to be on the increase. Collected plants were raised. Morphological, growth and reproductive parameters were observed, documented for their ornamental value and for their relevance in environmental protection and improvement management. The result showed that there were a lot of variations in the shape, frond length and diameters, pinnae(leaflet) texture, size and shapes in all the ferns studied. They have shoot and root biomass which are directly involved in checking wind and soil erosion by covering and holding soils together. These ornamental ferns were found to have much value for landscaping and aesthetic purposes but they were found in few villages with little or no attention.

**Keywords:** environmental management, morphological studies, ornamental ferns and reproduction

## 1. Introduction
In India with changing life style and increased urban affluence, floriculture has assumed a commercial status in recent times, particularly during the past 2-3 decades. Availability of natural resources like diverse agro-climatic conditions permit production of a wide range of temperate and tropical flowers and cut greens, almost all through the year (Ladha and Gunjal, 2011) [4]. In India, flower crops are being grown in 3,24,000 ha with the production of 27,85,000 MT. The total area under flower crops in Karnataka is about 31,000 ha with a production of 2,30,000 MT and 92,000.36 MT of cut flowers (Anon., 2018). A cut foliages occupy an important position in the local and international markets and constitute an important section of floral industry. It is either used alone in large quantities as a source of decoration or in association with flowers and other accessories for value addition. These attractive plant parts are known differently as cut greens, cut foliages and florists greens. The commercial interest in one such foliage is fern, highly valued in the international florist greenery market because of their beautiful and varied foliage, long post-harvest life, low cost, low investment, year-round availability and versatile design qualities in form, texture and colour. Usually these cut foliage of ferns is harvested when the uppermost leaves are fully expanded to avoid postharvest wilting of the immature shoot tips (Safeena, 2013) [10].
The global diversity of pteridophytes is yet not very clear, however the estimated number of species of world pteridophytes is between 9,000-15,000. On the other hand, there are approximately 13,600 species of pteridophytes, which have been named globally. Similarly, the exact number of Indian species of pteridophytes is also yet not clear due to certain factors like misidentifications, dubious species, new species syndrome *etc*. (Smith *et al.*, 2008) [11]. On scrutiny of various enumerations, checklists and recent publications, it came to notice that the number of Indian pteridophyte species is between 950- 1000. The maximum diversity of ferns in India is observed in the Himalayas, Eastern and Western Ghats. Amongst 32 families occurring in India, almost 25 families are represented in Sikkim *i.e*. 78.12(%) Indian families (Chandra *et al.*, 2008) [2].

Ferns were traditionally classified in the class Filices, and later in a division of the plant kingdom named Pteridophyta or Filicophyta. A fern is a member of a group of vascular plants (plants with xylem and phloem) that reproduce *via* spores and have neither seeds nor flowers. They differ from mosses by being vascular *i.e*. having specialized tissues that conduct water and nutrients and in having life cycles in which the sporophyte is the dominant phase. Like other vascular plants, ferns have complex leaves called Megaphylls, that are more complex than the microphylls of clubmosses. The ferns are homosporous, leptosporangiate ferns, sometimes referred to as true ferns found mostly in humid areas.

Besides the economic values, a large number of them are cultivated for their ornamental value either in indoors of the houses or outdoors in the botanical gardens due to their delicate beauty and grace, used as a hanging basket, greenhouses and conservatories and we find them in the smallest apartments to the largest homes (Poole *et al*., 1984) [9]. They are often seen on shady places during spring and summer months. These are usually sold as hanging baskets or potted plants in a variety of container sizes, depending upon market demand and the growth habit of each cultivar. These are also suitable for use around water bodies. Growing ferns as borders and foundations in shade gardens can also be effective (Muthukumar and Prabha, 2012) [5].

Apart from ornamental value, Ferns are used for food because of their nutritive value and low levels of oxalate, and for remediating contaminated soil. They have been subjected to research for their ability to remove some chemical pollutants from the atmosphere, such as bracken fern (*Pteridium aquilinum*) and also have an important role in bioremediation of waste water and found the Chinese bracken fern namely *Pteris vittata* to be a hyperaccumulator of the toxic arsenic metal. It is used as a medicine in treating the various diseases. The medicinal uses of some ferns and pteridophytes of India have also been described (Nair, 1959) [6].

*Nephrolepis* genus is widely distributed in the world over as one of the important foliage plants. There are approximately 30 tropical species of *Nephrolepis*, many of which are cultivated as potted plants or landscape plants. The best and popular species is *Nephrolepis undulate* J. Sm and is one of the widely cultivated plants in home gardens and is the most popular cut foliage used in India. The plant is epiphyte or lithophyte, rhizome short, erect, scaly, bearing wiry slender roots, stolons and tubers, scales 1 - 2 mm broad, pale brown, soft membranous, frond is long and broad, unipennate, rachis green, grooved on upper surface, minutely scaly above, pinnae 30 – 50 pairs, long and broad, middle ones larger, gradually narrowing from base to acute apex, falcate near apex, dimidiate at lower base, distinctly auricled and embracing the rachis at anterior base, crenate at margin, herbaceous, veins forked, sori submarginal, arranged in one row, indusia 1.3 mm broad, broadly reniform (Patil and Dongare, 2014) [8].

The sword fern requires acidic condition for growth and development. Ferns are highly adaptable to all types of soil but thrive in soil that is well-drained and rich in organic matter. Once established, ferns usually require little maintenance. It thrives in loam/clay types of soils and likes soil conditions which are warm and evenly moist. It should be kept moist but avoid overwatering the plant. The fronds will look lusher if the plant is kept slightly root bound, fertilized regularly, and if there is an ample relative humidity in the atmosphere. The fronds should be trimmed regularly to allow light and air to reach the new growth. The high intensity of light and temperature during summer and low night temperatures during winter appear to be detrimental for the sustained growth and the production of foliage (Stamps, 1992).

## 2. Materials and Methods

The experiment was carried out at the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere (Under University of Agricultural and Horticultural Sciences, Shivamogga) during 2018-20.

**Fig 1:** Experimental plot at college of Horticulture, Mudigere.

Fern *Nephrolepis* was collected (Fig. 1) from different vegetation zones of Chickmanglore district, Karnataka. Morphological features *e.g.,* stipe's colour, hairiness, texture, growth forms such as erect, tall, open, bushy and drooping were recorded on the field. Vegetative characters such as rhizome, crozier, frond fertility, leaflet shape, type, petiole and arrangement, apex type and shape were recorded. Quantitave measurements were done using metric rule for frond length and diameter, leaflet length and breadth as shoot biomass while root biomass was also studied so as to ascertain their ability to hold soil against erosion. Reproductive structures such as spores, sporangia, arrangement of sori on the leaflets, presence or absence of indusia and points of attachment of sori on the leaflets were also recorded.

## 3. Results

### a) Habit and Habitat of *Nephrolepis*

Ferns are extremely diverse in their habitat, form and reproductive methods. The foliage of ferns ranges from dark green to light yellow and others with surprising colors of grey, silver, red and blue-green which increase their utility in different types of floral arrangements. The genus *Nephrolepis* is commonly known as “sword fern” which are evergreen or semi-evergreen, either terrestrial or epiphytic species, distributed in tropical to subtropical regions around the world (Patil and Dongare, 2014) [8].

*Nephrolepis* (Nephros, kidney; lepis, the indusium kidney-shaped and scale like) is represented by about 30 species. These species are distributed in the tropics of the entire world.

### b) External Features of *Nephrolepis*

The mature plant body is sporophytic and can be differentiated into rhizome, roots and leaves.

**1. Rhizome**

It is short, slender, suberect, erect, or wide creeping (Fig. 2). It bears a close tuft of leaves and long, slender lateral branches called runners. The runners spread for a considerable distance and bear roots. Branched adventitious roots arise from the rhizome and runners in acropetal succession.

**Fig 2:** Rhizomes of *Nephrolepis undulata* J. Sm

**2. Crozier**

Leaves emerge as *fiddleheads* (Fig. 3) through a special type of vernation called circinnate vernation. The new leaves typically expand by the unrolling of a tight spiral called as a crozier or fiddlehead of the fern. This uncurling of the leaf is termed circinate vernation and that uncoil and expand into fronds (Olsen, 2007) [7].

**Fig 3:** Circinnately coiled crozier

**3. Leaves**

The petiole, or *stipe*, is used as a diagnostic character and in particular the number of vascular strands is important. Leaf blades are highly divided, Leaves are tufted, long, narrow and simply pinnate. Steple (a leaf stalk) is 2.5 to 10 cm long, Pinnae are numerous, crowded, often imbricated, 3 cm long to 20 cm long slightly falcate and articulated at the base.

Margins are entire or slightly crenate (Fig. 4). Fertile leaves bear spore-producing sporangia, which are typically organized in groups, called sori. Usually, sori are on the lower side of the leaf, and some groups have specialized structures associated with their sporangia and sori (Kavana *et al*., 2019) [3]. The veins are free and there are present white line dots over the vein tips. Sori is present on the lower surface. Sori are near the margin.

The indusia are usually round-reniform with a narrow sinus. Sometimes the sinus widens to a broad curved base.

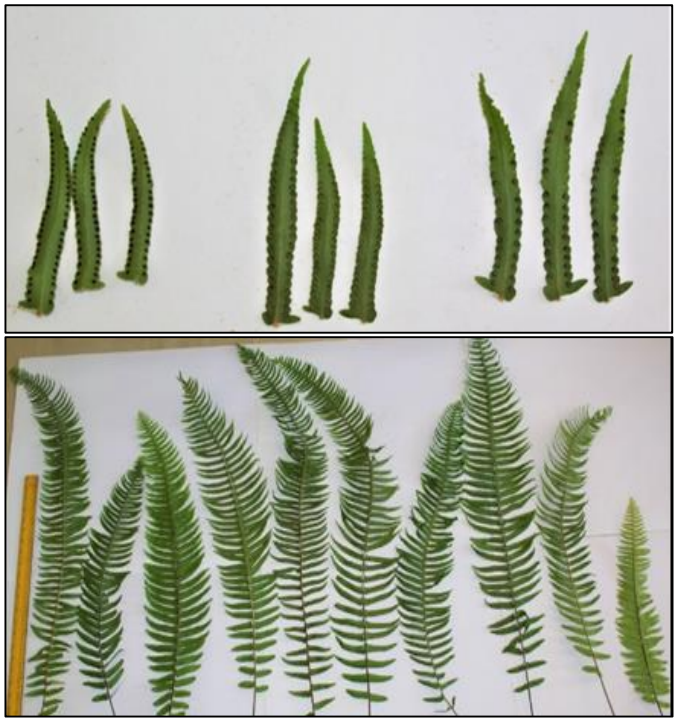

**Fig 4:** Leaflets and fronds of *Nephrolepis*

**c) Reproduction in Nephrolepis**

*Nephrolepis* reproduces by two methods:

(i) Vegetative reproduction.

(ii) Sexual reproduction.

**(i) Vegetative reproduction**

It takes place by the formation of buds. Runner produces buds at some distance from parent rhizome. These buds give rise to fronds and thus help in vegetative reproduction of the plants.

**(ii) Sexual Reproduction**

**d) Structure and Development of Sporangium**

Structure and development of sporangium is similar to Pteridium. Mature spores are brown in colour, with thin exosporium, thick endosporium with small warts.

**e) Structure and Development of Prothallus**

Development of prothallus is similar to Pteridium. A mature prothallus is formed in about fifty days. It is large, green and heart shaped and 0.3 cm x 0.5 cm in diameter. It has a large cushion on the ventral side. It is 4 – 6 cells thick in the region of cushion and one celled elsewhere.

It has a deep notch and 4-7 meristematic cells lie in it. Prothallus is monoecious. At maturity antheridia are first to appear antero posteriorly on the posterior side of the cushion. Development and structure of antheridium is similar to Pteridium.

A mature antheridium is large and spherical. At maturity it consists of 32 spermatocytes. Structure and development (Fig. 5) of the archegonium is similar to Pteridium. Many archegonia are formed and lie in the anterior part of the cushion at maturity. Fertilization and development of sporophyte is also similar to Pteridium.

**Fig 5:** Initiation of indusium and development of spores below the surface of *Nephrolepis.*

## 4. Conclusion

Ferns are good for both indoor and outdoor purposes to beautify offices, homes and for landscaping, aesthetic values and for environmental protection and management. All the ferns collected for this study are perennial plants. They have ability for continuous production of spores, croziers, fernlets (young fern plants) from their stolons and accumulate biomass throughout the year with the availability of moisture and adequate supply of nutrients.

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