

widely used by pharmaceutical industry due to its wide range of therapeutic effects. The main feature of forskolin is in its roots having unique mechanism of generating cyclic adenosine monophosphate in the cells through direct activation of the catalytic unit of adenylate cyclase enzyme (Yanagihara et al., 1996). For commercial cultivation of this crop optimization of plant population per unit area, method of planting and type of cutting are the prime factors in terms of root yield of medicinal coleus.

The most important problem to the commercial growers of coleus is optimum plant density, appropriate type of cutting, method of planting and selecting suitable cultivar. The species is known well for its pharmacological importance.

2 Botanical and Phytochemical Background

2.1 Taxonomical classification

The plant belongs to the family Lamiaceae and the order Lamiales. Commonly known as the mint family, it includes a number of potent medicinal plants. It consists of 236 genera and 7,000 species, it is the largest family of the order Lamia. The genus *Coleus* was first described in 1790, with *C. forskohlii* classified under the family Lamiaceae, highlighting its botanical significance. This classification underscores the plant's historical use in traditional medicine and its potential for further research in phytochemistry.

2.2 Phytochemistry and medicinal relevance

A Biologically active compound labdane diterpene present in the root tubers called 'forskolin' a key compound extracted from the roots, activates adenylate cyclase, leading to increased levels of cyclic adenosine monophosphate (cAMP) in the cells (Seamon and Daly, 1981). These cAMP plays a key role in various body functions, including heart muscle contraction, smooth muscle relaxation, insulin secretion, and thyroid function and has various physiological effects (Kavitha et al., 2010). The study identifies several minor diterpenoids and other phytochemicals present in *C. forskohlii*, emphasizing the complexity and potential of its chemical profile.

3 Conventional Propagation Methods

3.1 Rooted cuttings with different planting methods and varieties

The yield of medicinal coleus is influenced by plant density, cutting type, and planting methods (Chandrasekhar et al., 2016). Chintapalli local and K-8 varieties were planted using ridge and furrow and flatbed methods, with ridge and furrow methods yielding the highest dry root yield. Genetic factors also significantly impact root yield performance.

3.2 Role of leaves and cutting type in rooting

The physiological status of the cutting is vital for successful rooting. Semi-hardwood stem cuttings that retain apical leaves show significantly higher rooting percentages and quality (Belniaki et al., 2018). Studies found that cuttings with leaves produced an average of 16 roots, compared to only 5.7 roots in leafless cuttings, suggesting that endogenous auxins or carbohydrates from the leaves facilitate better establishment.

3.3 Ex situ propagation through stem cuttings

The methodology involved selecting disease-free, mature stem cuttings from the mother plant are grown in prepared beds and poly bags in a combination of sand, soil, and manure was used to create optimal growing conditions for the stem cuttings (Patel, 2016). A well-structured water and drainage system is crucial for the successful growth of *Coleus forskohlii*, preventing water logging and plant damage. Results indicated that the mixed media in poly bags facilitated rapid root and shoot development, supporting the plant's propagation and contributing to its ex-situ conservation efforts.

4 In vitro Regeneration and Micropropagation

4.1 In vitro shoot induction using MS medium

Leaf explants were collected and subjected to thorough surface sterilization using running water, antifungal agents, and detergents to ensure aseptic conditions (Murashige and Skoog, 1962). After sterilization, explants were cut into smaller pieces and inoculated in MS media with varying concentrations of hormones 2,4-D (0, 0.01, 0.02,