

# Medicinal plant *Coleus forskohlii* Briq. : Disease and management

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## ABSTRACT

Medicinal coleus (*Coleus forskohlii*) is an important medicinal crop which contains forskolin in their roots. Because of continuous collection of roots from the wild sources, this plant has been included in the list of endangered species. The crop has a great potential in future due to the expected increase in demand for forskolin which is widely used in glaucoma, cardiac problems, eczema, asthma, and hypertension and also used in the treatment of certain types of cancers. With the present annual production of about 100 tons from 700 ha in India, cultivation of *C. forskohlii* is picking up because of its economic potential. However, the crop has not become very popular among farmers because of its susceptibility to many diseases of which root- rot/wilt is the most important, causing serious losses affecting the tuber yield. The present review focuses on various diseases of important medicinal plant *C. forskohlii* and their management. [Medicinal Plants 2011; 3(1) : 1-7].

**Keywords :** *Coleus forskohlii*, diseases, management

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## INTRODUCTION

World Health Organization (2003) estimates that 80% of the world's population depends on traditional medicine for their health needs. In many developed countries, traditional herbal remedies are making a comeback as alternatives to modern medicine. The existence of traditional medicine depends on plant diversity and the related knowledge of their use as herbal medicine. India is one of the twelve mega biodiversity hot spot regions of the world and one fifth of all plants found in India are used for medicinal purpose (Schippmann *et al.*, 2002). Nearly 25,000 effective plant based formulations are used in folk medicine by rural communities in India.

According to a report there was about US \$ 62 billion sales of herbal medicines in the world and it is expected to increase up to US \$ 3 trillion by 2020. Exports from India have increased from Rs. 460 crores in 1995 to 1200 crores in 2000 (Ghosh, 2000). Medicinal plants are

important for pharmacological research and drug development, not only when constituents are used directly as therapeutic agents, but also as starting materials for the synthesis of drugs or as models for pharmacologically active compounds (Mukherjee, 2003). The world market for plant derived chemicals viz., pharmaceuticals, fragrances, flavours and colour ingredients exceed several billion dollars per year. Classic examples of phytochemicals in biology and medicine include taxol, vincristine, vinblastine, colchicine as well as the Chinese antimalarial - artemisinin and the Indian ayurvedic drug -forskolin.

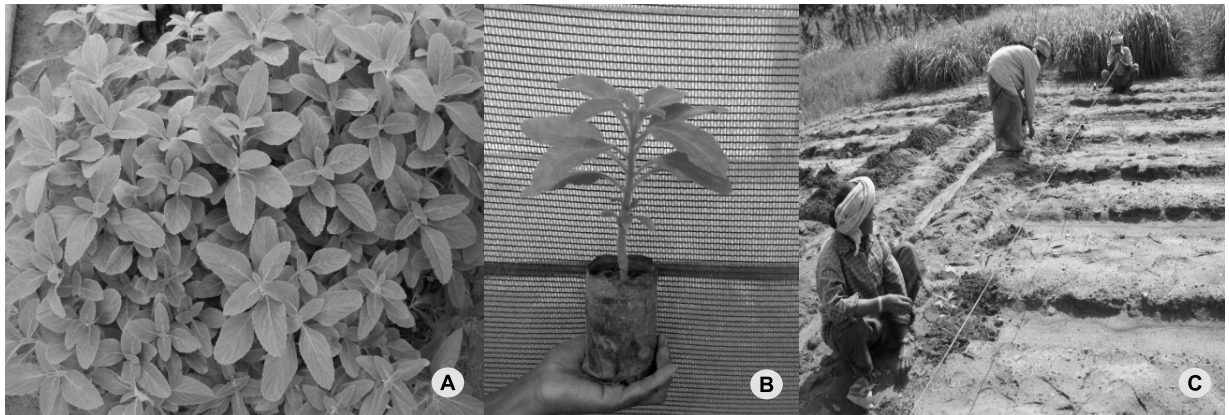
The genus *Coleus* was first described by Loureiro in 1790 and the generic name was derived from the Greek word 'COLEOS' meaning sheath. All the species of *Coleus* have four didynamous, dedinate stamens, and the filaments of the stamens unite at their base to form a sheath around the style. The species name *forskohlii* was given to commemorate the Finnish botanist, Forskel. The genus *Coleus* consists of 150 species and the following species viz., *C. amboinicus*, *C. forskohlii*, *C. spicatus* and *C. malabaricus* occur naturally. *Coleus forskohlii* Briq. [syn: *Coleus barbatus* (Andr.) Benth.]

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is a plant of Indian origin (Valdes *et al.*, 1987) belonging to mint family Lamiaceae (Fig. 1a,b) and grows perennially over tropical and subtropical regions of India, Pakistan, Sri Lanka, East Africa and Brazil at 600-1800 m elevation. In India, the crop is cultivated in the parts of Gujarat, Maharashtra, Rajasthan, Karnataka and Tamil Nadu and is being grown in an area of more than 2500 hectares for its tuberous roots. The common name of *Coleus* are Pashan Bhedi in Sanskrit, Patharchur in Hindi, Makandiberu in Kannada, Coleus in English, Garmalu in Gujarati, Maimnul in Marathi. Traditionally, the roots have been used as condiments in pickles, for preparation of pickles and also for medicinal purposes by the ayurvedic schools of medicines (Ammon and Muller, 1985). Root juice is given to children suffering from constipation (Singh *et al.*, 1980). Kothas, the native tribes of Trichigadi in Nilgiri, South India consider the decoction of tuberous roots as tonic (Abraham, 1981).

The crop has a great potential in future due to the expected increase in demand for forskolin widely used in glaucoma, cardiac problems and also used in the treatment of certain types of cancer (Shah *et al.*, 1980). It has ethnomedicinal uses for relief of cough, eczema, skin infections, tumors and boils have been recorded (De Souza *et al.*, 1986). Its roots (Fig. 2c) are the source of a labdane diterpene compound called forskolin having a unique property to stimulate adenylate cyclase. Forskolin is also a potent vasodilatory, hypotensive and inotropic agent (Seamon *et al.*, 1984). Like certain drugs used for asthma, the novel feature of forskolin is its unique mechanism of generating cyclic adenosine monophosphate (AMP) in the cells through the direct activation of the catalytic unit of adenylate cyclase enzyme, which made the pharmaceutical industry to recognize the plant as most medicinally and economically important (Seamon *et al.*, 1981).



**Fig. 1.** (A,B) Nursery plants; (C) Transplanting of *C. forskohlii*



**Fig. 2.** (A,B) Cultivation of *C. forskohlii*; (C) Healthy root

Because of continuous collection of roots from the wild sources, this plant has been included in the list of endangered species (Boby and Bagyaraj, 2003). Recently, its cultivation has picked up as a crop because of its economic potential (Vishwakarma *et al.*, 1998).

The crop is cultivated through 55-day-old rooted cuttings (Fig. 1b) which are generally planted on ridges at a spacing of 60 × 45 cm (row to row 60 cm and plant to plant 45 cm) (Fig. 1c). Transplanting is done into planting holes having a depth of 10-12 cm and dia of 8-10 cm. The crop responds well to organic and inorganic fertilizers. A combination of 40 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 50 kg K<sub>2</sub>O per ha is optimum dose of chemical fertilizers.

The crop is ready for harvest in 4 to 5 months after planting (Fig. 2b). The plants are uprooted, the tubers separated, cleaned and sun dried. On an average, an yield of 800 to 1000 kg/ha of dry tubers may be obtained. However, if proper cultivation practices are applied, an yield of up to 2000 to 2200 kg/ha of dry tubers can easily be obtained (Rajamani and Vadivel, 2009).

## DISEASES

Like other crop plants *C. forskohlii* plant is susceptible to many diseases like leaf spots, leaf blight, root rot and wilt and root knot. Of these root- rot/wilt and root knot are the major diseases, affecting complete damage to tubers.

### Leaf spot disease of *C. forskohlii*

Leaf spot lesions are initially brown and punctiform, becoming elliptic, subcircular to irregular and pale brown in colour. They were well delimited with a dark brown rim (up to 5 mm in diameter), distributed on the lamina, sometimes coalescing and leading to extensive necrosis and yellowing. A dematiaceous fungus (*Corynespora cassiicola*) was consistently found sporulating in the centre of the lesions (Fernandes and Barreto, 2003). Leaf spot caused by *Botryodiplodia theobromae* has also been reported (Ramprasad, 2005).

### Blight disease of *C. forskohlii*

Blight disease is common during monsoons or during period of high humidity. Symptoms include water soaked leaf spots that increased rapidly in size becoming light tan to brown and later necrotic. Severe infection results in defoliation and death of the plants. *Rhizoctonia solani* has been reported to cause the leaf blight of *C. forskohlii* (Shukla *et al.*, 1993). Ramprasad (2005) reported stem blight caused *Phytophthora nicotianae* var. *nicotianae*.

### Root-rot/wilt disease of *C. forskohlii*

Root rot/ wilt is the major disease of *C. forskohlii* causing heavy losses (>50%) in south India. Root rot is a disease caused by a variety of fungi/bacterium species that love standing water. Disease show various symptoms like yellowing and wilting of leaves, brown to black roots, oozing, putrefaction and decaying of roots and unhealthy plants (Fig. 3). The disease has been reported to be caused by the following :

- The fungal pathogen causing the disease has been identified as *Fusarium chlamydosporum* (Shyla, 1998; Singh *et al.*, 2009). The symptoms include gradual yellowing marginal necrosis and withering of leaves followed by loss in vigour and premature death. Such plants show discoloration of roots and complete decaying of tap and lateral root system. The bark of such plants is easily peeled off. Such affected plants are finally killed due to severe root and collar rots. The infected tubers show rotting and emit bad odour.
- *Fusarium solani* causing root-rot of *C. forskohlii* has also been reported by Bhattacharya and Bhattacharya (2008).
- *Ralstonia solanacearum* was reported to be causing vascular wilt of *C. barbatus* (Coelho Netto and Assis, 2001; Chandrashekara and Prasannakumar 2010). The symptoms include initially brown later on becomes black roots due to decaying, oozing and putrefaction of roots.
- Root-rot caused by *Macrophomina phaseolina* has also been reported in *Coleus forskohlii*. The symptoms observed are yellowing and drooping of the leaves, blackening of the stem, rotting of the roots and basal stem and peeling of stem bark and root epidermis. The presence of black sclerotia is observed on the rotted portion (Kamalakaran *et al.*, 2006).

### Root knot disease of *C. forskohlii*

The disease is caused by microscopic, parasitic, soil-inhabiting nematodes also known as eelworms, belonging to the genus *Meloidogyne*. These nematodes burrow into the soft tissues of root tips and young roots and cause nearby root cells to divide and enlarge (Fig. 4). Four different type of *Meloidogyne* species are common: *M. javanica*, *M. incognita*, *M. hapla* and *M. arenaria*.

Affected crops may show slow/stunted growth, yellowing of leaves, wilting of the plant despite adequate soil water content and finally leading to collapse of



**Fig. 3.** Root-rot and wilt of *C. forskohlii*

individual plants. Severely infested seedlings produce few roots and usually die rapidly. Heavy infection of older plants causes the plant to wilt unexpectedly and die off early. Swelling or galls develop on the roots of the infected plant, as the result of nematode induced expansion of root cells. The galls vary in size from slight thickenings to lumps 5 to 10 cm across. All root knot galls damage the vascular tissues of roots and thus interfere with normal movement of water and nutrients. They also increase the susceptibility of the root system to invasion by disease causing fungi and bacteria. Root knot disease in *C. forskohlii* has been reported to be caused by *Meloidogyne incognita* and *Meloidogyne arenaria*. *Meloidogyne incognita* has been reported to cause a yield reduction of upto 86% (Senthamarai *et al.*, 2006), while severe losses also occur in *C. forskohlii* because of *Meloidogyne arenaria* infestations (Bhandari *et al.*, 2007).

#### Complex disease of *C. forskohlii*

- Collar rot complex of *C. forskohlii* involving *F. chlamydosporum* and *Rhizoctonia bataticola* (*Macrophomonia phaseolina*) as reported by Kulkarni *et al.* (2007).
- Complex disease of *C. forskohlii* has also been reported involving both fungal and nematode pathogens (Senthamarai *et al.*, 2008).

#### MANAGEMENT OF DISEASES

Water stagnation in *C. forskohlii* fields may lead to severe infections of *Fusarium* and *Ralstonia*, therefore water stagnation in the planted fields should be avoided.



**Fig. 4.** Root-knot disease of *C. forskohlii*

#### Chemical

##### 1) Fusarial /Bacterial wilt control

Dipping the terminal cuttings in carbendazim solution (1 gram per litre) before planting protect *C. forskohlii* from fungal pathogens. Application of streptomycin solution (300 ppm) around the roots of transplanted cuttings protects the crop from bacterial infection (www.indg.in). The chemical Emisan (0.2%) has been found to protect the plants against *Fusarium* wilt to some extent but the protection provided to plants inoculated with biocontrol agents was found to be higher (Boby and Bagyaraj, 2003). Chemical fungicides (benomyl) reduced the disease incidence (54.54%) caused by *Fusarium chlamydosporum* (Singh *et al.*, 2009) during field study of *C. forskohlii*. Paramasivan *et al.* (2007) reported that the use of chemical fungicide (Carbendazim) reduced the disease incidence by 18%. Kulkarni *et al.* (2007) reported that the lowest population (cfu/g soil) of *F. chlamydosporum* and *R. bataticola* was observed with the use of carbendazim.

##### 2) Nematode control

Chemical methods have been mostly used to control nematodes. Chemical agents such as halogenated aliphatic hydrocarbons (e.g., 1,3-dichloropropene), methyl isothiocyanate mixtures, oxamyl, thionazin and carbofuran have been found effective in the management of nematodes but are not ecofriendly and in the course of time may cause serious threat to the ecological balance. Chemical pesticides have been tested and evaluated for their ill effects such as reproductive toxicity and carcinogenesis in mammals (Sharma and

Pandey, 2009). High doses of these agents have been proved to be fatal to animals. These facts have been reported under 'Food and Environment Protection Act, 1985, Part III. As a last option, apply carbofuron granules at the rate of 20 kg per hectare under wet condition near the root zone (www.indg.in).

## Biological

### 1) Fusarial/bacterial control

Management of diseases of medicinal plants in general and control of soil borne plant pathogens in particular involving organic and biological is being considered as a potential strategy, because chemical methods result in accumulation of harmful chemical residues which may lead to serious ecological problems. Arbuscular mycorrhizal (AM) fungi suppressing the activity of root pathogens are well documented (Mohan and Verma, 1996). *P. fluorescens*, mainly considered as a PGPR, can suppress a wide range of plant pathogens including *Fusarium* (Defago and Hass, 1990; Fukui *et al.*, 1994; Nautiyal, 1997; Johanson *et al.*, 2003). Neem and neem products are effective against the root / soil- borne pathogens (Wajidkhan *et al.*, 1974; Singh *et al.*, 1980; Alam, 1993; Dhanpal *et al.*, 1993).

Some reports clearly indicated that the root-rot/wilt of *C. forskohlii* could be significantly reduced by the application of bio-agents like *Trichoderma viride*, *Pseudomonas fluorescens* and AM fungus like *Glomus fasciculatum* and *G. mosesae* (Boby and Bagyaraj, 2003; Singh *et al.*, 2009) and equivalent yield could be obtained with reference to chemical fertilizers treated plots. Paramasivan *et al.* (2007) reported that the use of bioinoculants like *T. viride* and *P. fluorescens* reduced the disease incidence by 20-21%. Combination of *T. viride* + Neemato (neem based product applied at 500g/5m<sup>2</sup>) resulted in lowest wilt incidence by 12.76% (Kulkarni, 2007).

Some of the botanical extracts (5%) like *Eucalyptus citridora*, *Ricinus communis* (Castor) and *Azadirachta indica* (neem) significantly reduced the bacterial (*Ralstonia solanacearum*) and fungal (*Fusarium chlamydosporum*) growth under *in vitro* condition (Divya *et al.*, 2010). Botanical pesticides like neem cake also reduced the percent disease index (40-60%) and increased the root yield of *C. forskohlii* (Singh *et al.*, 2008, 2009).

Boby and Bagyaraj (2003) and Singh *et al.* (2009) reported that inoculation of bio-inoculants (*T. viride*, *G. fasciculatum*, *G. mosesae* and *P. fluorescens*) significantly increased the forskolin content of the roots.

### 2) Nematode Control

Biological control agents are gaining importance in the field of nematode management. Another importance of these agents is their role as plant growth promoting microorganism (Sharon *et al.*, 2001). *Trichoderma* spp. found in close association with roots contributes as plant growth stimulators (Ousley *et al.*, 1994). Many fungal and bacterial agents have been examined over a period of time for their potential as biocontrol agents. Li *et al.* (2008) evaluated expression of Cry5B protein from *Bacillus thuringiensis* as environment friendly nematicidal proteins. In research performed on fungi, it has been shown that fungi possess appropriate characteristics for biological control of nematodes, for example, fungal enzymes such as chitinases are capable of rupturing nematode egg shells contributing to parasitism of fungi on nematodes (Gortari and Hours, 2008). Also, mutualistic endophytic fungi such as non-pathogenic strains of *Fusarium oxysporum* and species of *Trichoderma* have been evaluated for their activity against plant parasitic nematodes (Sikora *et al.*, 2008).

Soil application with bio-agents like *T. viride* and *P. fluorescens* significantly reduced the nematode population in soil and root and increased the growth and yield of *C. forskohlii* crop (Senthamarai *et al.*, 2008).

Integration of strategies such as stem cutting dipping in *P. fluorescens* + soil application of neem cake @ 400 kg/ha + growing marigold as intercrop followed by their biomass incorporation during earthing up increased the yield (22.7-30.0%) and reduced the root-knot nematode population (71.2-73.8%) superiorly, followed by the integration of *P. fluorescens* + marigold intercrop, which were almost equally effective (Seenivisan and Devrajan, 2008).

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