
Mycorrhizal Association of Verbenaceae and Lamiaceae Plants: A Systematic Study

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Abstract: The growth of medicinal plants is assisted by mycorrhizal techniques to employ Arbuscular Mycorrhizal (AM) fungus to boost the quantity and quality of pharmaceuticals made from indigenous medicinal plants is an area of interest. In the present work mycorrhizal occurrence was evaluated in the roots of medicinal plants *Stachytarpheta jamaicensis*, *Lantana camara*, *Duranta erecta*, *Vitex Negundo*, *Ocimum tenuiflorum*, *Coleus amboinicus*, *C. zeylanicus*, *Leucas aspera*, and *Clerodendrum infortunatum*. *Coleus zeylanicus*, *Lantana camara*, and *Stachytarpheta jamaicensis* plant roots showed the highest levels of colonization of AM fungi.

Keywords: Lamiaceae, Verbenaceae, mycorrhizal fungi, systematic study

INTRODUCTION

Two significant families of angiosperms that contain blooming plants are the verbenaceae and lamiaceae. Both exhibit physiological traits that are largely comparable. Trees, shrubs, and plants belong to the verbenaceae family. It has 77 genera and 3,020 species, of which India is home to 21 genera and 125 species. The family includes residents of temperate and subtropical areas as well as tropical and subtropical areas. The majority of flowers have inflorescences that smell pleasant and most of them have medicinal qualities. The bilabiate corolla and persistent calyx of this family demonstrate its close kinship with the Lamiaceae (Labiatae).

The mint family (Lamiaceae) is an important medicinal plant family. There are around 6000 species in it, distributed among 236 genera. By having square stems and opposing leaves, this family's species are simple to identify. The zygomorphic, often bisexual and verticillaster blooms have five united petals and five united sepals. The majority of plants in this family are fragrant and have essential oils. Despite being present in all of the plant's above-ground components, fragrant essential oils are more frequently detected in leaves. They are valuable in the pharmaceutical, flavouring, fragrance, and perfumery industries in addition to the cosmetic and beauty care sectors (Arijit and Arpita, 2013).

Verbenaceae is very important in the field of medicine for treating a variety of illnesses, including eczema, skin conditions, rheumatism, etc. Additionally, it helps with recurrent fever, ulcers, ophthalmia, pleurisy, etc. Children are treated for colic and stomach aches with milk and powdered roots of *Lantana camara* var. *aculeata*; bronchitis and catarrh are treated with whole plant infusion; and constipation and febrifuge are treated with leaf decoction (Srivastava and Choudhary, 2008). Over the past few decades, there has been an increase in the use of medicinal herbs and the cultivation of medicinal plants is steadily expanding to keep up with the rising demand.

Vesicular arbuscular mycorrhizal (VAM) fungi are most commonly arbuscular mycorrhizal fungi. The association of VAM with host plant play essential role in enhancing plant growth (Van der Heijden et al, 2015). Through this relationship, mostly potassium uptake happens where hyphae create sheath inside by piercing the

cortical cells of plants' roots or outside the root to exchange nutrients. The colonisation of VAM fungus is found to be affected by temperature change. The manner and intensity of root colonisation rate, as well as the ability of VAM fungus to produce propagules. Along with the host plant's growing season, the number of spores also varies (Supriya and Purshotam, 2012). Arbuscular mycorrhizae (AM) fungi are present in most natural settings and offer a variety of significant ecological functions, including enhancing plant nutrition, stress resistance, and tolerance, soil structure, and fertility. Arbuscules and vesicles, two distinct structures that distinguish arbuscular mycorrhizae, form within them (Fiddermann, 2010; Sing et al, 2011).

The current study focuses on the systematic examination of plants from the Verbenaceae and Lamiaceae families as well as their mycorrhizal associations.

MATERIALS AND METHODS

Plant Sampling: Various field collections are carried out between November and March 2021 to gather soil samples and roots from local regions in Kerala's Ernakulam district. A small amount of soil and the root hairs from plants belonging to the Lamiaceae and Verbenaceae families are dug out and placed in sample vials for future research.

Identification of plants: Plants were identified with the support of local name and morphological observation

Isolation and identification of mycorrhizal roots: We use the Philips and Haym(1970) technique to determine if arbuscules and vesicles are present or not. According to protocol, the herbaceous plant was gently uprooted. Only a portion of the root system needs to be cut off and collected in polythene bags if the plant is woody. To get rid of the connected dirt particles, the harvested roots are thoroughly rinsed with tap water. After that, it made 1-2 cm-long cuts. The test tube was then filled with the root fragments, which were subsequently treated with a 10% potassium hydroxide solution. After that, the test tube's roots were autoclaved at 15 lb of pressure for 10 minutes. The test tube was rinsed three times with tap water after the KOH solution was emptied off, leaving the roots inside.

RESULTS AND DISCUSSION

In total, nine plants were gathered for this investigation (Figure 1), five of which were Verbenaceae species and four of which were Lamiaceae species. The taxonomic category of the plants is determined by the morphological features of the leaf, stem, and flower. A more thorough description of each plant can be found below.

1. Stachytarpheta jamaicensis

Local name: Blue porter weed

Habit : Woody herb

Habitat : Grows on moist fertile soils

Stachytarpheta jamaicensis is a woody perennial or sporadically annual herb with a strong tap root and tall, erect annual shoots that culminate in several thin, upright flower spikes. From the plant's base, a large number of woody stems emerge that are initially green, 4-angled, cylindrical, and frequently purplish with swollen nodes. The leaves are opposite, paired, elliptic, somewhat leathery, highly nerved, and either hairless or have extremely fine hairs that blend into the short petioles. The margins are also consistently serrated. Lilac, lavender, blue, or purple flowers appear in clusters of one to three at a time on long spikes at the ends of branches. Each bloom is partially buried in the spike and has five uneven petals.

2. *Vitex negundo*:

Local name : Chinese chaste tree

Habit : Shrub

Habitat : Common, by riverbanks, along roadsides as hedges.

A tiny tree or shrub with a height range of 2 to 8 metres, *Vitex negundo* is classified as a taxon. Reddish brown describes the bark. The plant has five, occasionally three, lanceolate leaflets on its digitate leaves. With the exception of the central leaflet, which is the largest and has a stalk, each leaflet ranges in length from 4 to 10 cm. Both the bottom surface and the leaf margins are hair-covered and toothed or serrated. In panicles 10 to 20 cm in length, the many flowers are produced. They each measure about 6 to 7 cm length and range in colour from white to blue. The centre lower lobe of each petal has the largest length out of all of them. There are thick hairs on the calyx and corolla. The fruit is a succulent drupe, rounded to egg-shaped. It is black or purple when ripe.

3. *Lantana camara*

Local name : Common lantana

Habit : Shrub

Habitat : Occurs in forest, forest-edge, riparian or riverine, staff villages, roadsides, and other disturbed areas.

Lantana camara is a perennial shrub that normally grows to be around 2 metres tall and forms dense thickets in a range of situations, according to its taxonomic classification. It features tiny, four-petalled tubular flowers that are clustered in clusters towards the terminal parts of the stems. Among the many colours of flowers are red, yellow, white, pink, and orange. The flower has a peppery undertone to its tutti frutti scent. The fruit of *L. camara* is a drupe that resembles a berry and matures from green to dark purple.

4. *Duranta erecta*:

Local name : Golden dewdrop

Habit : Shrub

Habitat : Grown in waste areas, roadsides, open woodlands and densely forested areas.

The erect *duranta* is a tiny tree or a widespread shrub. It has an equal width and a maximum height of 6 m. Axillary thorns are present in mature specimens but are

frequently lacking in younger ones. Light-blue or lavender flowers are produced in small clusters on terminal and axillary stems, occasionally resembling panicles, commonly recurved or pendulous, and flowering throughout the summer. The leaves are opposite, light green, elliptic to oblong, and up to 7.5 cm long and 3.5 cm broad. The fruit is a tiny, globular berry that might be yellow or orange and has numerous seeds.

5. *Clerodendrum infortunatum*

Local name : hill glory bower

Habit : shrub

Habitat : Moist evergreen forests, along river banks

Clerodendrum infortunatum is a flowering shrub or small tree, and is so named because of its rather ugly leaf. The stem is erect with no branches and produces circular leaves with 15 cm diameter. Leaves are simple, opposite; both surfaces sparsely villous pubescent, elliptic, broadly elliptic, ovate or elongate ovate inflorescence in terminal, peduncled, few-flowered cyme; flowers white with purplish pink or dull-purple throat, pubescent. Fruit berry, globose, turns bluish-black or black when ripe, enclosed in the red accrescent fruiting-calyx. The stem is hollow and the leaves are long, borne in whorls of four on very short petioles. The inflorescence is huge, consisting of many tubular snow white flowers in a terminal cluster up to 0.6 m long. The tubes of the flowers are about 10 cm long and droop downward, and the expanded corollas are about 5 cm across.

6. *Ocimum tenuiflorum*:

Local name : Holy basil

Habit : Herb

Habitat : Tropical and subtropical regions.

Family : Lamiaceae

Sessile glandular hairs on the stem have a rectangular cross section, the leaves are simple, opposite decussate, and have a fragrant sweet scent from the essential oils present; Verticillaster inflorescence; zygomorphic, hermaphrodite, hypogynous, bracteate flowers; persistent gamosepalous calyx; bilabiate corolla; four epipetalous, didynamous stamens; axile placentation; gynobasic style; sitting on lobed disc; fruit; schizocarpic carcerulus.

7. *Coleus amboinicus* :

Local name : Mexican mint

Habit : Semi succulent perennial

Habitat : Cultivate everywhere, commonly in tropics.

Family : Lamiaceae

The height of *Coleus amboinicus* can reach 1 m. About 30-90 cm long and fleshy, the stem has long, rigid hairs. Smooth old stems (glabrescent).

The leaves are broad, egg- or oval-shaped, undivided, and about 5-7 cm long, with a tapered tip. Except for the base, the margins are coarsely crenate to dentate-crenate. They are pubescent, heavily covered with hairs, with the most glandular hairs on the

lower surface, giving them a frosted look. The flavour of the leaves can be compared to a potent blend of oregano's flavours.

8. *Coleus zeylanicus*

Local name : Iruveli

Habit : Semi succulent perennial

Habitat : Cultivate in everywhere, commonly in tropics

Family : Lamiaceae

Coleus zeylanicus is an annual plant that may reach a height of 1 m and is typically found in fertile soil. Its leaves are green, hairy, and heart-shaped, measuring 4 inches long and 2.5 inches wide, and its stems are violet in colour and scented.

9. *Leucas aspera*

Local name : Thumba

Habit : Herb

Habitat: Found throughout the India

An underbrush or annual herb. The leaves are obtuse, narrowing at the base, opposite, sessile or short petioled, linear or narrowly oblong-lanceolate, whole or distantly crenate. Petioles are normally between 2.5 and 6 mm long. The stem is heavily branched and quadrangular. Flowers are produced in highest leaf axils in distant, spherical whorls that are 1-4, about 2.5 cm in diameter, and between 16 and 20 flowers. Flowers are 8–10 mm wide, white, with a short, thickly bearded upper lip and a distinctly longer, protruding lower lip.

Mycorrhizal Assessment of Plants

The goal of the current experiment is to determine the prevalence of mycorrhizal associations in specific plants from the Lamiaceae and Verbenaceae plant families. All of the therapeutic plants that were chosen for study showed signs of AM fungal interaction. In the forms of arbuscules, vesicles, and mycelium, the root colonisation was seen. Mycelia of various shapes, including Y-shaped, H-shaped, coiled, beaded, and parallel mycelia, have been found in the roots of plants (Figure 2). Extensive mycelial development was also seen in some instances. Vesicles are elliptical, circular, globose, oval or elongated in shape. *Ocimum tenuiflorum*, *Coleus* species (*C. amboinicus* and *C. zeylanicus*), *Leucas aspera*, *Clerodendrum infortunatum* belongs to lamiaceae, *Stachytarpheta jamaicensis*, *Lantana camara*, *Duranta erecta*, and *Vitex negundo* belong to verbenaceae all exhibit arbuscular mycorrhizal associations.

Coleus zeylanicus (21±3 number) and *Coleus amboinicus* (18±4 number) of the Lamiaceae are the two species where colonisation is most prevalent followed by *Leucas aspera* and *Ocimum tenuiflorum*. *Clerodendrum infortunatum* has the lowest count (13±2) among Lamiaceae. Both Lamiaceae and Verbenaceae members have AM of the Arum type. Our findings concur with those of Karagiannidis et al. (2010). In the verbenaceae, *Stachytarpheta jamaicensis* had the highest count (22±3) and the lowest count (9±2) in *Duranta erecta* (Table 1).

The high level of AM root colonisation is an indication of improved fungal-root contact and that the AM fungal symbiosis is providing more benefits. The host plant, growing season, edaphic variables, and environmental conditions can all affect the degree of root colonisation. According to reports, seasonal spore generation, seasonal changes, and soil nutrient accessibility all have an impact on the mycorrhizal root colonisation. The results of the current studies showed that the number of mycorrhizal associations varied depending on species. An earlier investigation comparing AM fungal diversity with specific medicinal plants in the Hamirpur district of Himachal Pradesh, India, had made a similar observation (Kumar et al, 2019).

Table 1. The Average Vesicular Numbers of VAM

Sl no	Scientific name	Family	No.of vesicles/arbuscules
1.	<i>Clerodendrum infortunatum</i>	Lamiaceae	13±2
2.	<i>Leucas aspera</i>	Lamiaceae	15±3
3.	<i>Ocimum tenuiflorum</i>	Lamiaceae	15±5
4.	<i>Coleus amboinicus</i>	Lamiaceae	18±4
5.	<i>Coleus zeylanicus</i>	Lamiaceae	21±3
6.	<i>Vitex negundo</i>	Verbenaceae	15±5
7.	<i>Duranta erecta</i>	Verbenaceae	9±2
8.	<i>Lantana camara</i>	Verbenaceae	21±3
9.	<i>Stachytarpheta jamaicensis</i>	Verbenaceae	22±3

There are numerous studies being done right now on the utilisation of mycorrhizae to increase the crop yield and active components of medicinal plants (Zhang et al, 2022). According to ethnobotanical knowledge, Coleus species in the family Lamiaceae have higher therapeutic properties, which may have led to more colonisation. In the same way, the Vebenaceae family includes Lantana species and *Stachytarpheta jamaicensis*, which have higher economic worth and thus exhibit increased colonisation. We can infer from the articles that these species play a dominant role in increasing the solubilization of phosphorus. These plants can also increase soil surface accessibility by penetrating the soil pores and paces and have an impact on phosphorus absorption outside of the depleted zone (Srinivasa Murthy and Narayanamurthy,2015;Aggangan et al,2015).



Figure 1 a. *Clerodendrum infortunatum*, b. *Ocimum tenuiflorum* c. *Leucas aspera*
d. *Coleus amboinicus*, e. *Coleus zeylanicus* f. *Vitex negundo* g. *Duranta erecta*
h. *Lantana camara*, i. *Stachytarpheta jamaicensis*

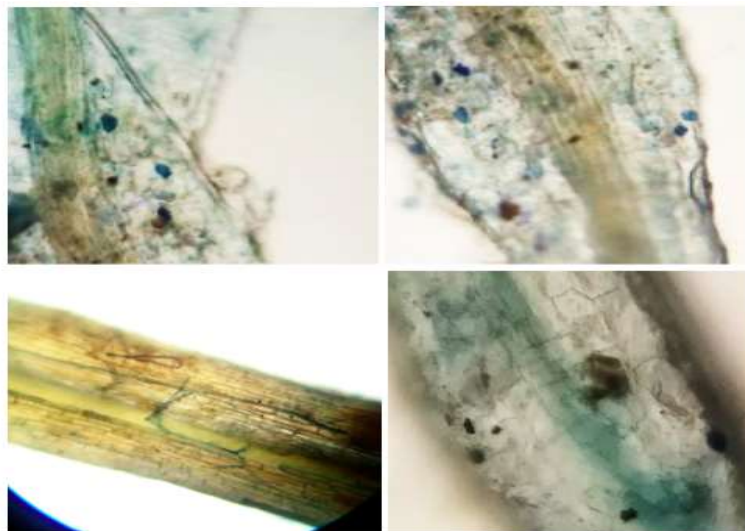


Figure 2 AM fungi observed in various plants

CONCLUSION

The extent of root colonization of mycorrhiza found varied with the plant species. The plant roots of *Coleus zeylanicus*, *Lantana camara*, and *Stachytarpheta jamaicensis* displayed the highest levels of AM fungus colonisation. Arbuscular mycorrhizal fungus inoculation of the roots may be able to boost the vigour and growth of medicinal plants as well as the production of bioactive compounds. In this area, additional in-depth research is required.

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