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MYCORRHIZA NEWS

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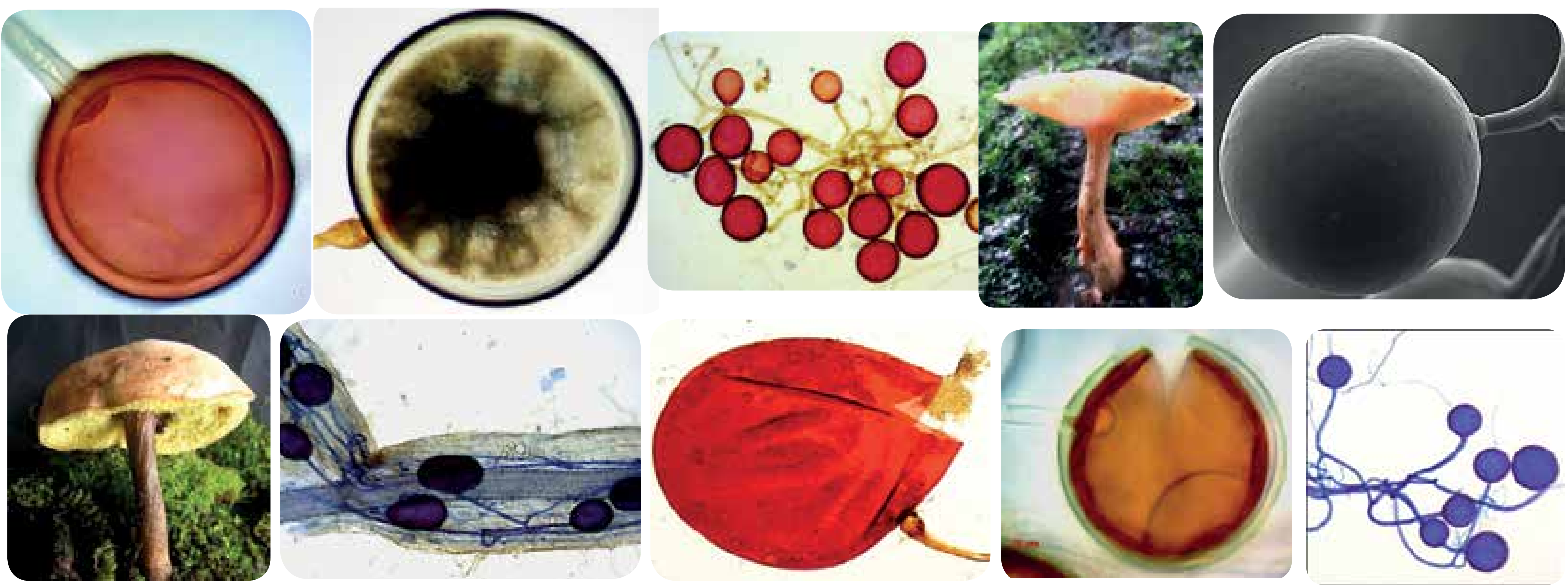

About **TERI**

The Energy and Resources Institute (TERI) is a dynamic and flexible organization with a global vision and a local focus. TERI's focus is on research in the fields of energy, environment, and sustainable development, and on documentation and information dissemination. The genesis of these activities lies in TERI's firm belief that the efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development towards the goal of sustainability.

TERI's **Mycorrhiza Network**

TERI's Mycorrhiza Network is primarily responsible for establishing the Mycorrhiza Information Centre (MIC), the Centre for Mycorrhiza Culture Collection (CMCC), and publishing *Mycorrhiza News*. The Network helps scientists carry out research in mycorrhiza and promotes communication among mycorrhiza scientists.

Mycorrhiza News

The *Mycorrhiza News* provides a forum for the dissemination of scientific information on mycorrhiza research and activities; publishes state-of-the-art papers from eminent scientists; notes on important breakthroughs; brief accounts of new approaches and techniques; publishes papers complied from its RIZA database; provides information on forthcoming events on mycorrhiza and related subjects; lists important research references published during the quarter; and highlights the activities of the CMCC.

For further information, visit www.mycorrhizae.org.in

CONTENTS

RESEARCH FINDING PAPER

Mycorrhizal Association of Some Medicinal Plants Which are Antimicrobial

C. Manoharachary[*]

Introduction

Nature is bountiful of microbes, fungi, and plants. The medicinal plants have been the traditional source for raw material and finished herbal drugs. Since ancient times the use of such medicinal plants has been documented in many works of scholars. It is estimated that around 2.7 lakh plant species are known to exist on the planet Earth, of which 30,000 plants have been considered medicinally important. Approximately, 15,000 plants are utilized to produce drugs. Plants are known to harbour a number of known and unknown chemical molecules which are important in pharmaceuticals. Therefore, efforts have been made to protect the medicinal plants through *in-situ* and *ex-situ* conservation strategies. The science of life and its related knowledge has been an indigenous system of medicine (Ayurveda) which dates back to 1500–800 BCE. Since that time people have been worshiping natural resources, especially plants. Yajurveda notable emphasizes many plants that are used in rituals. Atharvana veda has mentioned the role of medicinal plants in treating diseases. Ayurveda is the oldest scientific treatise on medicine and disease treatment. The majority of medicinal plants yields qualitative herbal drugs. However, the raw materials suffer from overexploitation, extinction, storage problems, identification and marketing. Dashmool is one of the oldest drugs, made up of 10 roots. Taxol, an anti-cancer drug has been derived from *Taxus baccata*, the first of its kind herbal drug, worth of million dollars, was developed in the USA. Jeevani, an energy tonic was prepared from *Trichopus zeylanicus,* which became first patent of tribals in India. Charaka Samhita has mentioned the utility of around 4000 medicinal plants for maintaining human health. Since time immemorial herbal drugs have been source of general and traditional medicines in most of the developing countries (UNESCO 1996). Africa is a major source of medicinal plants, followed by India. In Europe, some 1500 medicinal plants are widely used in treating humans. The world market for natural drugs, pharmaceuticals, fragrance, flavours, and colour ranges in several billion dollars per year. Examples include Taxol, Vincristine, Vinblastine, Colchicine, Artemisinin, and the Indian Ayurvedic drug – Forkolin. Trade, market, and export of medicinal plants are growing in volume. It is estimated that the global trade in medicinal plants is around US$ 800 million per year. Keen interest in medicinal plant is the re-emerging health aid, which has been fuelled by rising costs of drugs used in the maintenance of personal health and wellbeing.

Based on the current research, it can be established that medicinal plants will continue to play an important role in human health management (Manoharachary and Nagaraju 2016). It is a known fact that several plants are known to cure diseases caused by pathogenic bacteria like *Streptococcus, Bacillus, Staphylococcus, E.coli, Salmonella,* and several others. Similarly there are number of medicinal plants which can cure viral diseases such as Spanish flu, swine flu, dengue fever, HIV, and others. In recent times, COVID-19 has been found responsible to cause Corona Disease which is pandemic, infecting people in 216 countries. Its origin has been traced in China. Its spread to other countries mainly occurred through infected human beings who were the travellers from one region to other region by different means and agencies. It is important to mention that the United States of America, United Kingdom, Brazil, Italy, Switzerland, India and other countries are severely affected, resulting in large-scale health damage. There

[*] Department of Botany, Osmania University, Hyderabad - 500007
Email: cmchary@rediffmail.com

is a need to establish health disaster management system in every ministry of health of each country. It is important to mention that lot of research has been going on microbes including viruses and there is a possibility that several mutants and clones may originate from different countries, which may become more pathogenic than the existing ones. In this context, a mention has been made in Charaka Samhita and other ancient Indian medical systems that medicinal plants and traditional knowledge can boost up the immunity and hence it is likely that these plants may serve as drugs in due course of the time. Several of such plants are mycorrhizal. Mycorrhizae are the symbiotic organisms found in plants which may be ectomycorrhizal in woody plants and endomycorrhizal in many other land plants. Nearly 70%–80% of plants are colonized by arbuscular mycorrhizal fungi (AMF). It is noticed in the literature that the chemical constituents of many of the medicinal plants get increased when treated with addition of mycorrhizal fungi.

Materials and Methods

All the medicinal plants mentioned in Table 1 are collected from in and around Hyderabad, both wild areas and gardens including medicinal plants gardens of Agriculture University and Osmania University, Hyderabad. The plants were brought to the laboratory along with rhizosphere soil samples. The soils were analysed for mycorrhizal fungi following the techniques of Mukerji, Manoharachary and Chamola (2002). The AMF were estimated as for wet sieving and decanting technique (Manoharachary and Kunwar 2002) followed by root-clearing technique and quantification of AMF.

Results and Discussion

The medicinal plants, known to possess antibacterial and antiviral properties, listed in Table 1, are of great use in day-to-day life and also utilized by Ayurvedic doctors in the form of drugs. These medicinal plants have been found colonized in the roots in 40%–90% range. The AMF associated with these medicinal plants include *Acaulospora terricola, Entrophospora* sp., *Glomus etunicatum, Glomus mosseae, Glomus tenuis, Gigaspora margarita, Rhizophagus fasciculata,* and *Scutellospora nigra.* The above AMF have been found constantly in the soils supported by various medicinal plants.

Many mycorrhizal plants show high productivity, growth, immunity and defence against pests and diseases. In recent times, attempts are made to culture these mycorrhizal fungi and inoculate the medicinal plants on a larger scale to boost their production and market them as drugs (after synthesizing).

Table 1: Medicinal plants

Name	Activity
Allium cepa	Antioxidant, antimicrobial, antiviral
Alternanthera sessilis	Antimicrobial, antidote, antiviral
Baccharis trimera	Antibacterial, antiviral, antioxidant
Catharanthus roseus	Anticancer, antimicrobial
Cassia tora	Antimicrobial, antidessentry, antiviral
Curcuma longa	Antidiabetic, anticancer, antimicrobial, antiviral
Cymbopogon martini	Antimicrobial
Cinnamomum aromaicus	Antibacterial, antiviral
Cinnamomum zeylanicum	Antibacterial, antiviral, antioxidant
Dillenia indica	Antidiabetic, antibacterial
Dicerocarym senecioides	Antimicrobial, antiviral
Eucalyptus citridora	Antimicrobial
Foeniculum vulgare	Antimicrobial, digestive, antiviral
Fabiana densa	Antimicrobial, antioxidant, antiviral
Gymnema sylvestra	Antidiabetic, antibacterial, antiviral
Heliotropium indicum	Antitumor, antimicrobial, antiviral
Lantana camara	Antimicrobial, fungicidal

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Table 1 *Contd...*

Name	Activity
Moringa oleifera	Antimicrobial
Momordica charantia	Antidiabetic, antimicrobial
Mentha piperata	Antimicrobial, antidiabetic, antiviral
Ocimum sanctum	Antidiabetic, antifungal, anticancer, antiviral
Psidium guajava	Antihyperglycemic, antimicrobial, antiviral
Punica granatum	Antimicrobial, antiviral
Ruta sp.	Antidiabetic, antimicrobial
Rosmarinus sp.	Antibacterial, antiviral
Tinospora cordifolia	Arthritis, antimicrobial, antiviral
Zingiber officinale	Works against cough, improves digestion, antidiabetic, antimicrobial, antiviral

Mycorrhizal association of higher plants and medicinal plants has gained importance in recent times. Since 1950, there has been an attempt in understanding the advancement of mycorrhizal fungi. After 1970, there occurred a marked accumulation in experimental evidences on the role of AMF. After 1990, practically, growing medicinal plants on a large scale by applying the AMF mycorrhizal association gained importance. It is in this context, work has been done by the author on AMF associated with medicinal plants which are antimicrobial and antiviral. During the survey of 2019–20, the plants listed in Table 1 were found to be mycorrhizal, mainly under the light of the author's observation of AM spores in the soil, mycorrhizal colonization in the roots of the mentioned medicinal plants and also in the soil supporting the medicinal plants (Figures 1, 2, and 3). Later the conducted pot experiments were carried by inoculating the mycorrhizal fungi in Ocimum, Catharanthus, and a few other plants which showed maximum productivity and increase in alkaloid content. Most of the alkaloids present in the medicinal plants were antimicrobial and antiviral. The conduction of experiments are on the way and in future the results will be published regarding plants' efficiency as antimicrobials and antivirals. A collaboration has been established at present with some medical universities and well- known researchers in the field of medical pathology and microbiology. An attempt is also now in progress to prepare biofertilizers for boosting the growth of medicinal plants and their increase in naturally occurring alkaloids.

Acknowledgement

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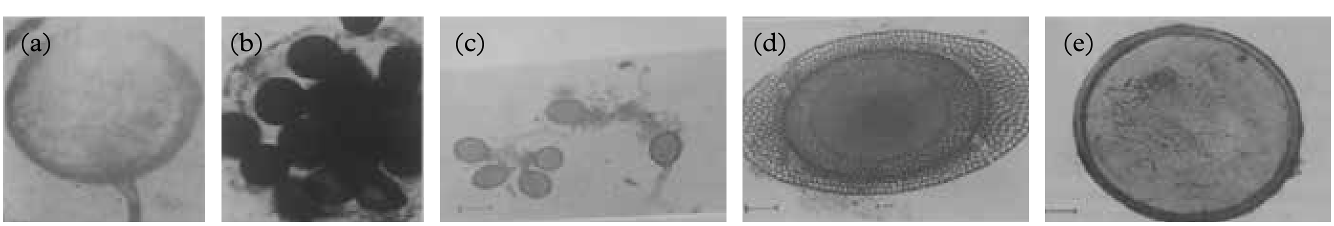

Figure 1: Spores and sporocarps of AMF: (a) Spore of Glomus mosseae showing the distinctive funnel-shaped subtending hypha (b) Intracellular spores of G. tenue in cleared and stained roots of Terminalia sp., (c) Loose sporocarp of G. aggregatum, (d) Spore of Entrophospora sp., (e) Sessile spore of Acaulospora delicata

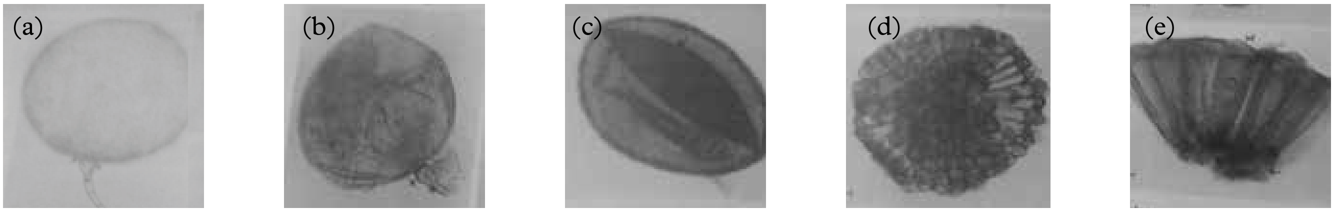

Figure 2: Spores and sporocarps of AMF: (a) Spore of Gigaspora gigantea showing the bulbous and hyphal suspensor-like cells in the septate subtending hypha (b) Spore of Scutellospora erythropa showing germinating shield and bulbous base of subtending hypha (c) Scutellospora sp. spore with germinating shield and subtending hypha (d) Sporocarp of Sclerocystis microcarpus (peridium lacking) (e) Portion of a sporocorp of S. microcarpus showing cylindric-clavate chlamydospores with thickened walls at the apex and central plexus of hyphae at the base

Figure 3: Root colonization

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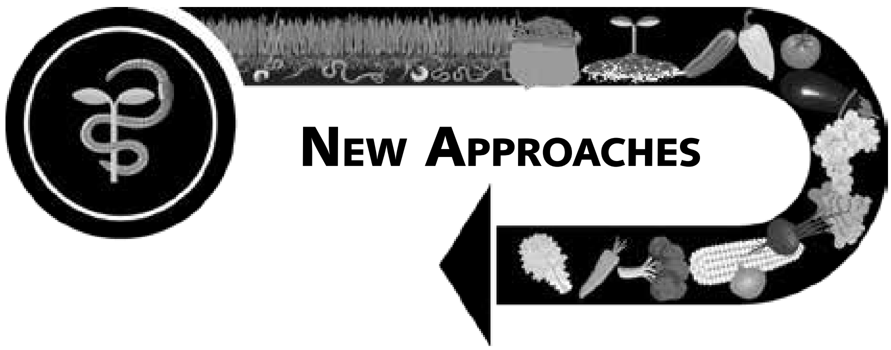

New Approaches and Techniques

A Freeware Tool for Measuring Length of Fungal Hyphae

Determining root and fungal hyphal lengths is a basic undertaking in many eco-physiological and ecological studies. Digital Image Analysis has been found to reduce labour and increase data reproducibility in plant fungus phenotyping. Automated and semi-automated image analyses could save time, increasing comparability and consistency of data. For measuring the lengths of hyphae and roots in *in vivo* and *in vitro* systems, *HyLength* – a user-friendly tool assembling functions of the Image Processing Toolbox of MATLAB R2019b that allow skeletonizing objects before counting their total pixel number has been developed and successfully validated against manual measures as well. *HyLength* was validated with four sets of digital images of roots and fungal mycelia grown in *in vivo* and *in vitro* systems. The validation was done by comparing the lengths determined by the *HyLength* against those manually determined using objects traced by either the ImageJ/Fiji or grid-line intersection counting (standard approaches). *HyLength* allowed great reduction of the time needed for length measurement compared with manual methods. It also allowed measurement of length over a whole experimental unit, eliminating the error due to sub-area selection by the user and allowing the processing of many samples. The tool is easy to use and a standard office laptop is sufficient to measure any number of images. Parameters can be optimized by the user and hence one can work with different, heterogeneous and modest-quality images. The tool is freely released together with the source code and expert users can implement additional functions and improve the code if necessary (Cardini, Pellegrino, Dottore, *et al.* 2020).

Reference

Cardini A., Pellegrino E., Del Dottore E., Gamper H. A., Mazzolai B, and Ercoli L. 2020. Hylength: a semi-automated digital image analysis tool for measuring the length of roots and fungal hyphae of dense mycelia. *Mycorrhiza* **30** (2–3): 229–242

Recent references

The latest additions to the network's database on mycorrhiza are published here for the members' information. The list consists of papers from the following journals:

- *3 Biotech*
- *Carbohydrate Research*
- *Chemosphere*
- *China Journal of Chinese Materia Medica*
- *Ecology Letters*
- *Ecotoxicology and Environmental Safety*
- *Frontiers in Microbiology*
- *Frontiers in Plant Science*
- *International Journal of Molecular Sciences*
- *Journal of fungi (Basel, Switzerland)*
- *Methods in Molecular Biology (Clifton, N. J.)*
- *Mycorrhiza*
- *Nature Communications*
- *New Phytologist*
- *Plant Physiology and Biochemistry*
- *Plants (Basel, Switzerland)*
- *PLoS One*
- *Proceedings, Biological Sciences*
- *Scientific Reports*
- *The Journal of Applied Ecology*
- *The Science of the Total Environment*
- *Tree physiology*

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Adamo M*, Chialva M, Calevo J, Rose S D, Girlanda M, Perotto S, Balestrini R. 2020	**The Dark Side of Orchid Symbiosis: can tulasnella calospora decompose host tissues?** *International Journal of Molecular Sciences* **21** (9): 3139 [*Department of Life Sciences and Systems Biology, University of Turin, Viale Mattioli 25, 10125 Turin, Italy]
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Tran C T K*, Watts-Williams S J, Smernik R J, Cavagnaro T R. 2020	**Effects of plant roots and arbuscular mycorrhizas on soil phosphorus leaching** *Science of the Total Environment* **722**:137847 [*The Waite Research Institute and The School of Agriculture, Food and Wine, The University of Adelaide, Waite Campus, PMB1, Glen Osmond, SA 5064, Australia]
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27 September – 02 October 2020	**International Training on In Vitro Culture of Arbuscular Mycorrhizal Fungi** *E-mail: monica.garcesruiz@uclouvain.be* *Website: https://www.mycorrhiza.be/training/in_vitro_culture_AMF/index.php*
Brussels, **Belgium** October 7–8, 2020	**Biopesticides Europe 2020** *Website: https://www.wplgroup.com/aci/event/biopesticides-europe/*
New York, **United States** October 8–9, 2020	**ICMMF 2020: International Conference on Mycology, Mushrooms and Fungi** *Website: https://waset.org/mycology-mushrooms-and-fungi-conference-in-october-2020-in-new-york*
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