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Diversity of Arbuscular Mycorrhiza (AM) in medicinal plants of Ri-Bhoi District, Meghalaya

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Abstract

Medicinal plants traditionally occupied an important position in rural and tribal lives of India. Increase in population and extensive need of medicine has created inadequate supply of drugs and human resistance to the currently used drugs for infectious diseases have focused on the use of plant material as a source of medicine for wide range of human ailments. Therefore attempts are made to explore and to develop cultivation technologies for large scale plantation. Inoculation of Arbuscular Mycorrhizal (AM) fungi during an early stage of plant growth has become an alternative strategy for improved plant survival and growth. AM association have been reported to have function in improving the growth of medicinal plants and productivity of medicinal plants and medicinal compound. Meghalaya is home to very rich floral diversity because of its favourable climatic condition, leading the availability of a wide range of medicinal and aromatic plants. So our study emphasizes the use of native AM fungal strain for the conservation of rare endangered medicinal plants of Meghalaya. We have studied the mycorrhizal diversity and its association on six selected medicinal plants *Alternanthera brasiliana, Ageratum conyzoides, Zingiber montanum, Curcuma zedoaria, Ricinus communis* and *Crinum asiaticum*.

Key words : Medicinal plants, Arbuscular mycorrhiza, spore count, root infection, soil physiochemical properties, *Glomus* sp.

Mycorrhiza is an intimate association between the branched, tubular filaments (also known as hyphae) of a fungus and the roots of higher plants. Mycorrhiza as a mutualistic symbiosis between plant and fungus localized in a root or root like structures in which energy moves primarily from plant to fungus and inorganic resources move from fungus to plant[24,30,35,38]. "Mycorrhiza" literally means "fungus root". They are found in 80% of

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vascular plant species and also some bryophytes[4]. AM (arbuscular mycorrhizal) fungi have gained significant attention in recent years because of their role in soil fertility, nutrient uptake, bio-control of plant diseases and growth of plants[5,16,32,35]. The diversity and community composition of AMF in different ecosystems and plant communities in India have received increasing interest over the past few decades[26,33,34,40]. Vesicular Arbuscular Mycorrhizae(VAM) or Arbuscular Mycorrhizae (AM) are mutualistic symbioses formed between the roots of most plants and fungi in the order Glomales. Currently Glomales are placed in class Zygomycetes[36]. VAM or more commonly, AM are Endomycorrhizae, formed by non-septate zygomycetes of phycomycetous fungi in the roots of the members of most of the families of angiosperms as well as gymnosperms, pteridophytes and bryophytes[4]. In case of Arbuscular Mycorrhiza (AM), the major benefit is probably an enhanced of uptake of phosphorus from soil[23,28,29,37]. Ectomycorrhiza and Ericoid mycorrhiza are also found to facilitate nutrient uptake. Mycorrhizal plants are more efficient in use of mineral nutrients by making fuller use of soil mineral reserves[9,17,43,46].

The arbuscules are the main transfer site of mineral nutrients from the fungus to the plant and of carbon compounds to the fungus. Mycorrhizal fungi provide protection to plants against the attack of soil borne plant pathogens and also against heavy metals[3,18,30, 2,8,20]. Meghalaya is home to very rich floral diversity because of its favourable climatic conditions[7], including the availability of a wide variety of medicinal and aromatic plants[14,22]. Indifferent medicinal plants, the occurrence of AMF has been studied previously by many researchers[22,32]. Several studies show that AM fungi can improve water and nutrient uptake abilities[6,19,27]. AM also enhance the survival capacity of host plant[3,10,38,42,45]. AMF improve the quality of soil by influencing its structure and texture, and hence, plant health. The primary advantage of VAM fungus to plants is improved uptake of poorly mobile ions from the soil. According to a plausible theory, the exterior hyphae and plant roots create a framework for aggregation, while bacterial polysaccarides bind the soil particles together for the improved soil stabilization caused by VAM fungus[2,8,20,29,44,45]. This strategy still needs to be refined, though. One of the main limitations when researching the taxonomy of AM fungi is the obligate biotrophic nature of these organisms. When AM fungi associate with living roots, they produce hyphae, arbuscules, vesicles, and spores both inside and outside the cortex of the roots. Instead of vesicles, fungi in the family Gigasporaceae AM generate auxiliary cells. It has been demonstrated that arbuscular mycorrhizal (AM) fungi are essential for nitrogen cycling and can lessen nutrient losses following rain-induced leaching episodes. This was further supported by the discovery of spores from various VAM fungus species in the soils of the rhizosphere[39]. The uptake of N,P, and, most noticeably, P were all greatly boosted by VAM injection[37,47]. Plants benefit from AM fungus because they help them produce and endure in mineral-rich environments. Therefore, under nutritional conditions, roots that colonised AM fungi may have a better uptake of immobile micro- and macronutrients[28,31,36,43,46].

Location of the study area :

Ri Bhoi is an administrative district in the state of Meghalaya in India. The district headquarters are located at Nongpoh. The district occupies an area of 2378 km² and has a population of 258,840. The district lies be The District lies between 90°55'15 to 91°16' latitude and 25°40' to 25°21' longitude.

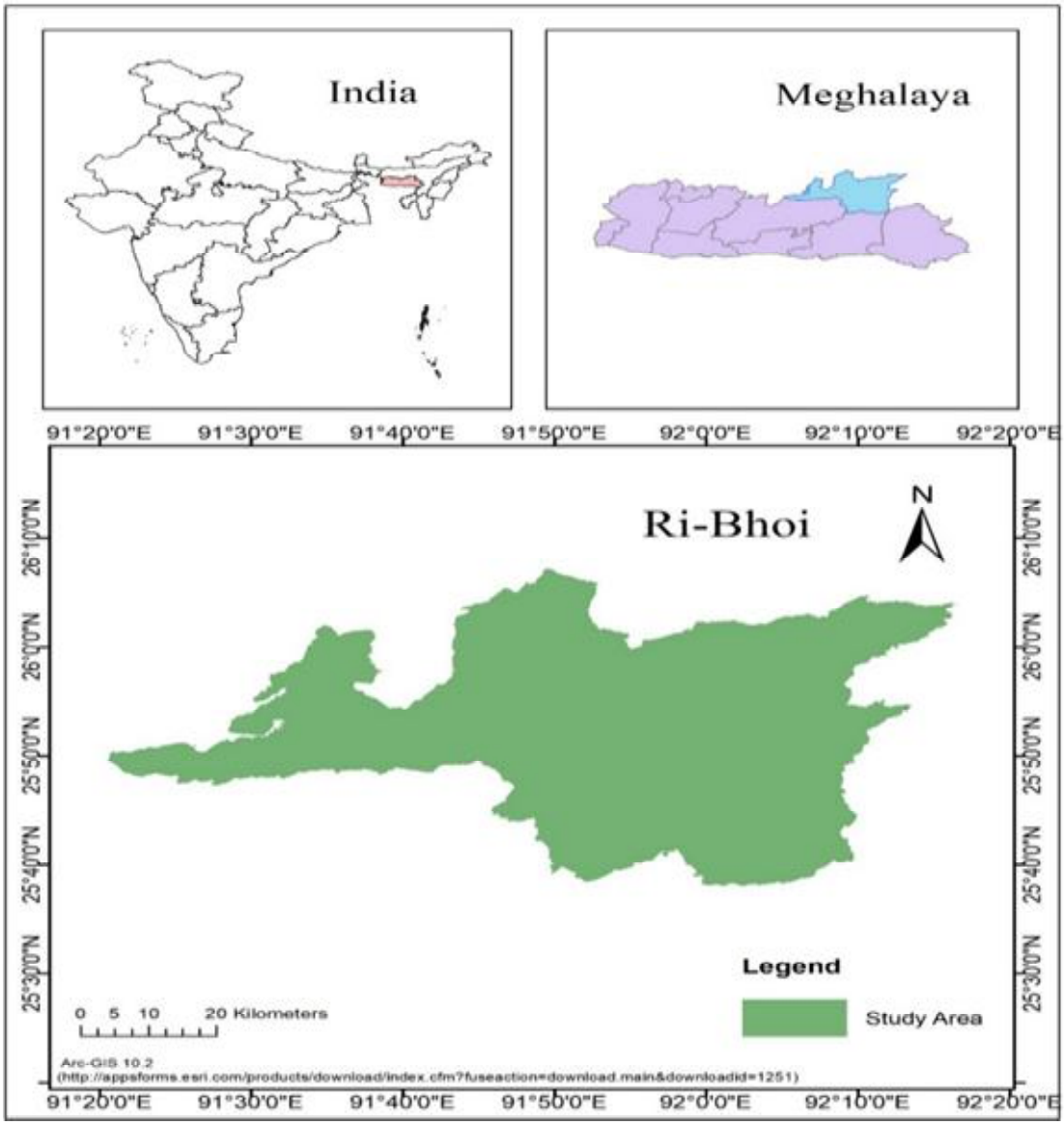


Figure 1. Location of the study area (Courtesy: Google source)

Table 1. List of selected medicinal plants with economic importance

Local name of the medicinal plants	Scientific name	Medicinal uses
1. Samarang	*Alternanthera brasiliana* (L.) Kuntze, Amaranthaceae	Useful in rheumatic fever, dysentery, wounds and eye trouble
2. Sambanguri	*Ageratum conyzoides* (L), Asteraceae	has wound healing property, treat wounds, burns and skin infection
3. Dekhichuphal	*Curcuma zedoaria* (Christm.) Roscoe, Zingiberaceae	Treats various ailments and metabolic disorders like leukoderma, asthma,tumours, piles, bronccities, etc. its paste may provide relief from painful and stiff joins. It has antioxidant and antifungal properties, help fighting inflammation in the body, keeps infection away.
4. Ahuda	*Zingiber montanum* (J. Koenig) Link ex A. Dietr, Zingiberaceae	it has many bioactive compounds including antimicrobial, antioxidant, antiulcer, antibacterial, antitumour, anti HIV, antifungal, anti-inflammation, anti allergic and antidiabetic.it is believed to be rich source of iron, sodium, and vitA and C. it is also believed to have anti- inflammatory and antioxidant properties. It is great for beauty reigime, makes hair silky and shiny, giving it volume and healthy radiant look.
5. Khoronda	*Ricinus communis* L., Euphorbiaceae	It is widely used in traditional medicine such as abdominal disorders, arthritis, backache, muscle aches, chronic backache, sciatica, chronic headache, constipation, expulsion of placenta, gallbladder pain, period pain menstrual cramps, rheumatism, sleeplessness and insomnia.
6. Raja muri	*Crinum asiaticum* L., Amaryllidaceae	In ethnomedicine ,it is employed to relieve anguish from a plethora of ailment conditions such as boils, earache, edema, fever, fractures, gastrointestinal complaints, hernia, mumps, rheumatism, tonsillitis, urinary difficulties, vomiting.

Ageratum conyzoides L., Asteraceae

Alternanthera brasiliana (L.) Kuntze, Amaranthaceae

Zingiber montanum (J. Koenig) Link ex A. Dietr, Zingiberaceae

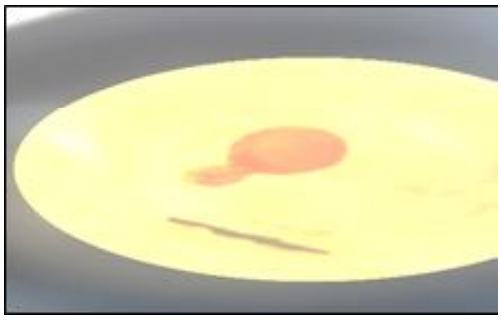
Crinum asiaticum (L), Amaryllidaceae

Curcuma zedoaria (Christm.) Roscoe, Zingiberaceae

Ricinus communis L., Euphorbiaceae

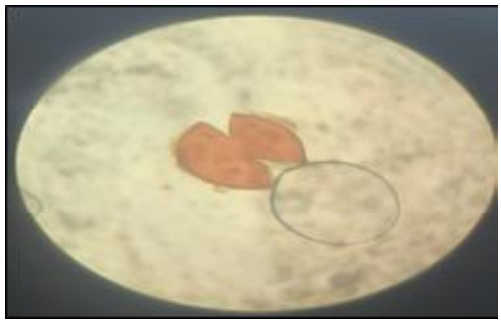
PHOTO PLATE 1: Morphological pictures of the six selected medicinal plants.

Rhizospheric soil samples were aseptically taken from a depth of 5-10 cm below the surface. During the sampling process, the plant's fine roots were also gathered. To avoid contaminating the soil, the sampling was done in polypropylene plastic containers. After being properly Transferred to the laboratory and kept there at 4°C for further analysis following collection from the appropriate areas. The microbiology lab at the University of Science and Technology of Meghalaya's Department of Botany is where the laboratory tests were carried out. Physico-chemical properties of soils were estimated by following the procedures of Jackson[15].

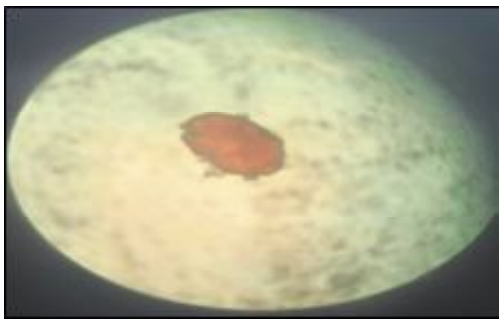


Glomus sp 1

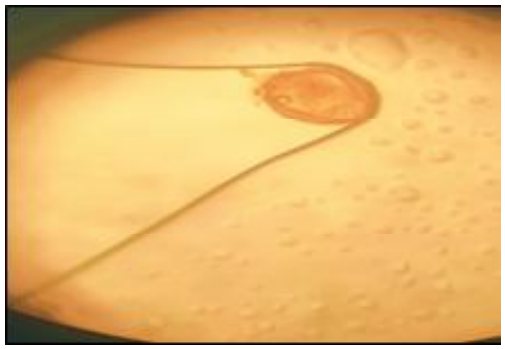
Glomus sp 2



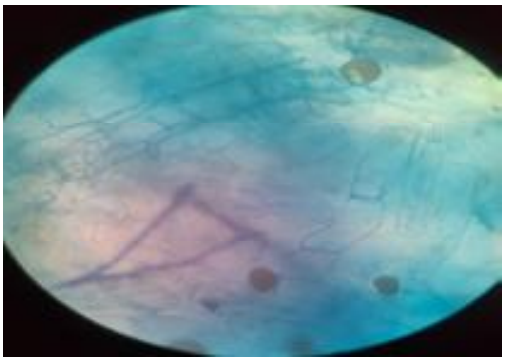
Glomus sp 3



Glgaspora sp 1



Scutellospora sp 3



Root infection by AM spores

PHOTO PLATE 2. Microphotographs showing the dominant AM spores isolated from selected medicinal Plants and root infection with arbuscules and vesicles

Fifty grams of rhizospheric soil from the sample were first weighed. From these 50gm samples, the spores were collected. AMF soil sample were isolated by wet-sieving and decanting method[13]. After measuring 50gm of soil in the weight machine, the soil is homogenized in beaker with around 1000ml of water and mixed very carefully with the help of a glass rod for 15 minutes and kept in a safe place in laboratory for 1 hour in order to allow the heavier soil particles to settle down in the container. During this time of mixing, the spores move to the upper surface of the water with the foaming of soil particles. After 1 hour, the soil suspension was decanted through a series of sieving method using different measurement of the sieves such as1st position (250µm), 2nd position (125µm), 3rd position (60µm), and 4th position (37µm). The first sieve is used for separating the debris particles of the soil. The remaining sieve's suspensions were transferred to separate beaker (100ml) by using wash bottle with minimal amount of distilled water or tap water. After transferring into the beaker (2nd,4th respectively) the suspensions were filtered using Whattman's filter paper. Then the filter paper was transferred to the large petridishes (around 12-15cm) and observed forspores under stereo-microscope. The spores were separated from the debris in the filter paper by using bamboo needle and the spores were mounted on clean slides using a drop of PVLG (Polyvinyl alcohol + Lactic acid + Glycerol) or PVLG + Melzer's reagent (1:1) and observed under compound microscope followed) and carefully covered with the cover slip and care was taken to protect from air bubbles[37] (Photoplate 2).

Enumeration and identification of AM Fungal spores :

The AMF spores were then counted under a light microscope, and the number of spores on each slide was estimated. A high-quality photograph of the spores was then taken using a camera at various resolutions. After the spores had been counted, they were classified based on their size, shape, colour, wall structures, surface ornamentation, presence or absence of bulbous suspensors, hyphal attachment to the wall and its structure and type,straight, curved, or recurved among other characteristics[36,39]. The identification was carried out using the manual identification A handbook of arbuscular mycorrhizal fungi and the online descriptions provided by the International Culture Collection of Vesicular Arbuscular Mycorrhizal Fungi (http://invam.caf.wvu.edu), AMF phylogeny (www.amf-phylogeny.com).

Estimation of root colonisation (%) :

Using a needle and forceps, the fine roots of each plant were removed from the soil sample. Before the root colonization test, the obtained fine roots were carefully cleaned with tap water to remove any soil or other adhering materials and then preserved in FAA (Formalin-Aceto-Alcohol) solution according to a slightly modified version of the procedure[36]. After being well cleaned with tap water, the root segments are chopped into small pieces (about1 cm) using fresh blades and placed in a conical flask filled with 100 ml of 10% KOH. The flask is then autoclaved at 15 lb pressure for15 minutes. Following autoclaving, the liquid was removed from the flask and the root segments were separated by sieving and washed twice or three times with tap water.

The root segments were rinsed with tap water to get rid of any remaining KOH after 5minutes. The segments were then bleached in alkaline H_2O_2 for 10 to 30 minutes before being rinsed with tap water once more. The roots were acidified for 10–20 minutes in 20–30ml of 1% HCl. Then, for 10 to 60 minutes, they were stained with 0.05% trypan blue. The root segments were then de-stained and kept in acidic glycerol until their mycorrhizal structures were examined. Four to five pieces of each treated root segment from each plant were put on glass slides and covered with cover slips.

Percentage of root infection was calculated by the following formula:

$$\% \text{ of root colonization} = \frac{\text{Number of AM positive segments (1)}}{\text{Total no of segments studied}} \times 100$$

Maintenance and storage of AM fungal spores :

The AM fungal spores can be maintained and stored by applying two methods for short term (for temporary maintenance and storage)and for long term (for permanent maintenance and storage). In the present project work, the temporary method was used by using the Ringer solution (NaCl-8.6g, KCl-0.3g, CaCl2-0.3g and distilled water-1000ml).

Fungal root colonization(%) and spore count :

The infection of AM fungi in roots were studied by the method of root colonisation[35]. The main infections are characterized as hyphal attachment, vesicles and arbuscules. In the present project work, the hyphal attachment, vesicles, arbuscules and AM fungal spores are found. The result of root colonisation (%) and spore count have been shown in Tables-2 and 3. The spore density is different for the different samples of 50gm of soil.

Table-2. Mycorrhizal Spore Count ($50gm^{-1}$ soil) in the selected medicinal plants in the year, 2023

Name of the selected Medicinal Plants	Mycorrhizal Spore Count in $50gm^{-1}$ soil		
	Summer Season, 2023	Rainy season, 2023	Winter season, 2023
Alternanthera brasiliana	280±.4 (250±.3)	400±.2 (375±.2)	140±.4 (120±.3)
Ageratum conyzoides	350±.4 (230±.3)	380±.3 (250±.3)	130±.3 (110±.3)
Curcuma zedoaria	330±.3 (320±.3)	350±.4 (300±.3)	190±.4 (150±.3)
Zingiber montanum	140±.3 (150±.2)	190±.2 (180±.2)	95±.2 (90±.3)
Ricinus communis	220±.4 (100±.4)	260±.4 (230±.3)	130±.2 (100±.2)
Crinum asiaticum	200±.2 (100±.2)	240±.4 (160±.3)	170±.4 (110±.3)

Value in parenthesis represents the data of subsurface soil layer (15-60cm)

Table-3. Percentage of root Infection (%)of Selected Medicinal Plants in the year, 2023

Name of the selected Medicinal Plants	Mycorrhizal Colonization (%)		
	Summer 2023	Rainy, 2023	Winter, 2023
Alternanthera brasiliana	50±.4 (30±.2)	68±.3 (45±.3)	30±.3 (25±.3)
Ageratum conyzoides	65±.3 (50±.3)	80±.4 (55±.4)	55±.2 (40±.2)
Curcuma zedoaria	65±.3 (60±.2)	70±.3 (65±.3)	60±.4 (50±.4)
Zingiber montanum	45±.3 (20±.3)	50±.3 (35±.2)	40±.3 (30±.3)
Ricinus communis	40±.2 (30±.2)	55±.2 (40±.2)	40±.3 (35±.2)
Crinum asiaticum	55±.3 (35±.3)	60±.2 (45±.2)	45±.2 (45±.2)

Value in parenthesis represents the data of subsurface soil layer (15-60cm)

Table-4. Physicio-chemical parameters of summer season, 2023

Selected medicinal plants	pH	Soil Moisture content %	Soil Temp. (°C)	Organic carbon (%)	Soil N (mg/g)	Soil P (mg/g)	Soil K (mg/g)
Alternanthera brasiliana	6.4±.2 (6.45±.3)	18.2±.3 (18.55±.3)	30.2±.3 (31.45±.2)	3.3±.2 (2.22±.2)	390.1±.2 (120.32±.3)	46.4±.2 (38.8±.2)	372.4±.2 (357.33±.2)
Ageratum conyzoides	5.23±.4 (6.00±.2)	20.2±.2 (22.7±.3)	30.5±.2 (31.45±.2)	2.65±.2 (2.5±.2)	700±.2 (605.33±.2)	42.6±.3 (50.12±.2)	335.8±.2 (324.4±.2)
Curcuma zedoaria	4.57±.2 (4.58±.2)	22.5±.2 (23.5±.2)	29.95±.3 (31.2±.4)	3.07±.2 (2.46±.2)	863.6±.2 (310.2±.2)	59.52±.3 (30.42±.2)	525.92±.2 (513±.2)
Zingiber montanum	5.8±.3 (5.92±.2)	17.7±.2 (19.8±.2)	30.9±.2 (31.3±.3)	3.1±.3 (1.1±.2)	334±.2 (105.5±.2)	90.8±.2 (50.12±.2)	256.2±.3 (202.43±.2)
Ricinus communis	5.3±.2 (5.40±.2)	18.5±.2 (19.2±.2)	30.2±.2 (31.1±.2)	2.99±.2 (2.12±.2)	420±.3 (190.8±.2)	52±.3 (37.98±.2)	301.1±.2 (250.4±.2)
Crinum asiaticum	5±.2 (6.25±.2)	17.7±.2 (18.7±.2)	30.65±.2 (31.15±.3)	3.33±.3 (3.23±.2)	190±.2 (107.3±.2)	62.1±.2 (51.13±.2)	351.9±.2 (290.78±.2)

Value in parenthesis represents the data of subsurface soil layer (15-60cm)

Table-5. Physicio-chemical Parameters of Rainy Season, 2023

Selected medicinal plants	pH	Soil Moisture content %	Soil Temp. (°C)	Organic carbon (%)	Soil N (mg/g)	Soil P (mg/g)	Soil K (mg/g)
Alternanthera brasiliana	6.5±.2 (6.55±.2)	27.5±.2 (28.27±.2)	32±.2 (32.6±.3)	4.0±.2 (3.5±.2)	450.2±.2 (130±.2)	54.2±.3 (47.31±.2)	376±.2 (355±.2)
Ageratum conyzoides	5.5±.3 (5.52±.2)	23.5±.2 (28.88±.2)	31.1±.2 (32.55±.2)	3.29±.2 (3.4±.2)	887.8±.2 (345±.2)	52.6±.3 (55.35±.2)	550.3±.2 (478±.2)
Curcuma zedoaria	5.82±.2 (5.97±.2)	28.98±.2 (29.12±.3)	30.86±.2 (31.2±.3)	3.19±.2 (3.03±.2)	905.6±.2 (648±.2)	68.8±.3 (52.27±.2)	566±.2 (545±.2)
Zingiber montanum	6.8±.3 (6.97±.2)	23.12±.2 (23.99±.2)	31.13±.2 (31.56±.2)	3.7±.2 (2.47±.2)	800±.3 (504±.2)	150±.2 (70.9±.2)	389±.2 (257±.3)
Ricinus communis	6.32±.2 (6.84±.2)	25.2±.2 (27.53±.2)	32.2±.3 (32.59±.2)	3.5±.2 (2.29±.2)	650.7±.3 (407±.3)	63.5±.2 (42.3±.2)	540.4±.2 (354±.2)
Crinum asiaticum	5.5±.2 (6.17±.3)	18.5±.2 (25.75±.3)	31.5±.3 (31.6±.3)	4.39±.2 (4.2±.2)	420±.2 (160±.2)	72.3±.2 (53.21±.2)	420±.2 (347±.2)

Value in parenthesis represents the data of subsurface soil layer (15-60cm)

Table-6. Physicio-chemical Parameters of winter Season, 2023

Selected medicinal plants	pH	Soil Moisture content %	Soil Temp. (°C)	Organic carbon (%)	Soil N (mg/g)	Soil P (mg/g)	Soil K (mg/g)
Alternanthera brasiliana	5.5±.2 (5.8±.2)	11±.3 (11.5±.2)	26±.3 (27±.2)	2.9±.2 (2.1±.2)	175±.2 (69±.2)	31.1±.2 (30.5±.2)	263.2±.2 (260±.2)
Ageratum conyzoides	4.5±.3 (4.9±.4)	17±.2 (18.7±.2)	26.52±.2 (26.92±.2)	1.6±.2 (1.2±.3)	500.7±.2 (140±.2)	18.9±.4 (56.5±.2)	270±.3 (204±.3)
Curcuma zedoaria	4±.3 (4.5±.2)	17±.2 (17.8±.2)	27.5±.2 (27.86±.3)	2.53±.2 (2.5±.2)	501±.3 (100±.3)	45.1±.2 (50.4±.2)	433.3±.3 (403.2±.3)
Zingiber montanum	4.5±.2 (5.1±.2)	14±.3 (15±.3)	30±.3 (30.5±.3)	0.42±.2 (0.4±.2)	150±.3 (65±.2)	28.3±.2 (28±.2)	227.8±.2 (205±.2)
Ricinus communis	4.5±.2 (5.0±.2)	16.7±.2 (21.1±.2)	24.98±.3 (25±.2)	1.65±.2 (1.5±.3)	250±.2 (145.6±.2)	25±.2 (23.9±.2)	245.3±.2 (240±.2)
Crinum asiaticum	4.2±.2 (4.5±.2)	17.5±.2 (22.6±.2)	25.3±.2 (25.5±.2)	1.95±.2 (1.5±.2)	185±.2 (155.3±.2)	19±.3 (17.1±.3)	315.8±.3 (299.8±.4)

Value in parenthesis represents the data of subsurface soil layer (15-60cm)

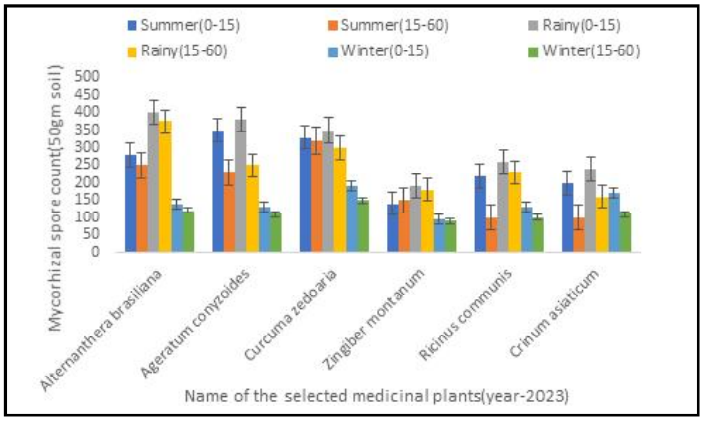


Fig. 2. Mycorrhizal spore count of selected medicinal plant soil (year-2023)

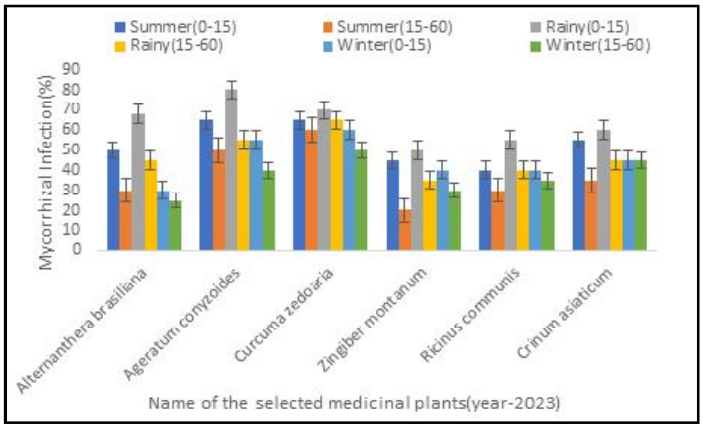


Fig. 3. Mycorrhizal root infection (%) of selected medicinal plant (year-2023)

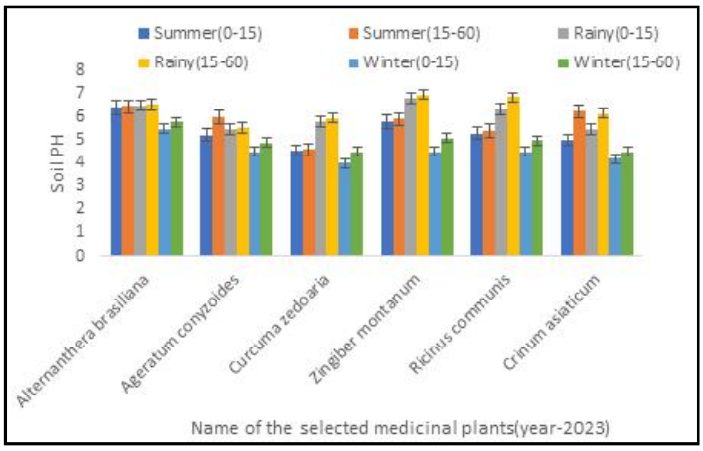


Fig. 4. Soil pH of selected medicinal plant soil (year-2023)

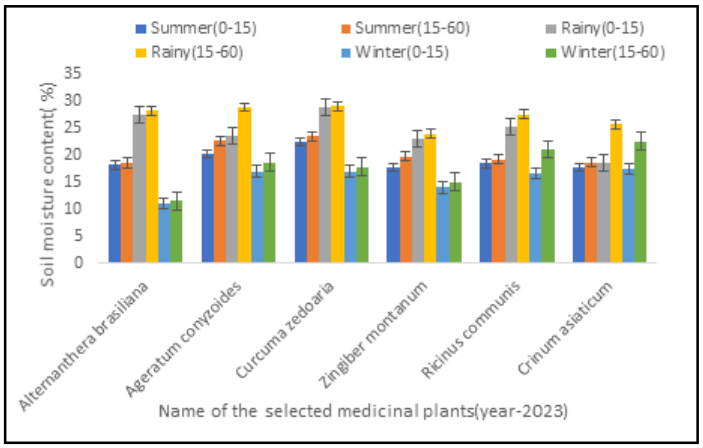


Fig. 5. Soil moisture content of selected medicinal plant (year-2023)

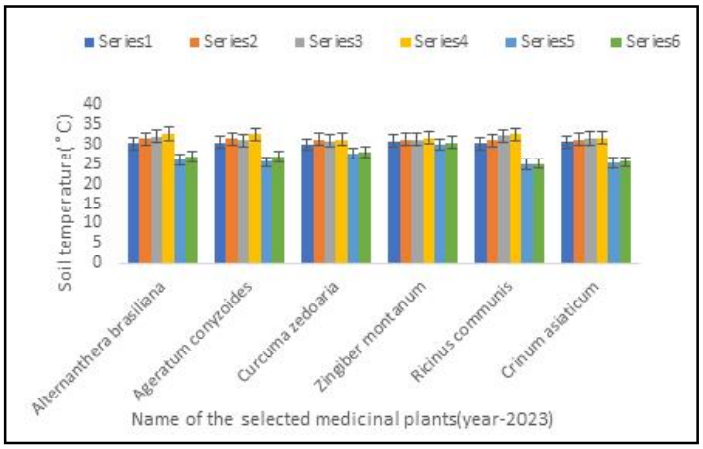


Fig. 6. Soil temperature of selected medicinal plant soil (year-2023)

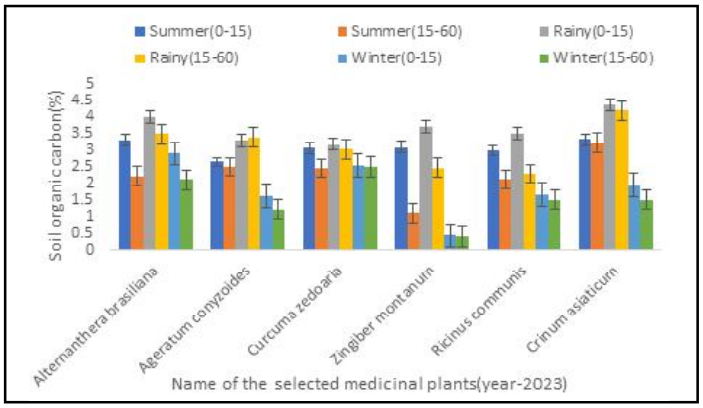


Fig. 7. Soil organic carbon (%) of selected medicinal plant (year-2023)

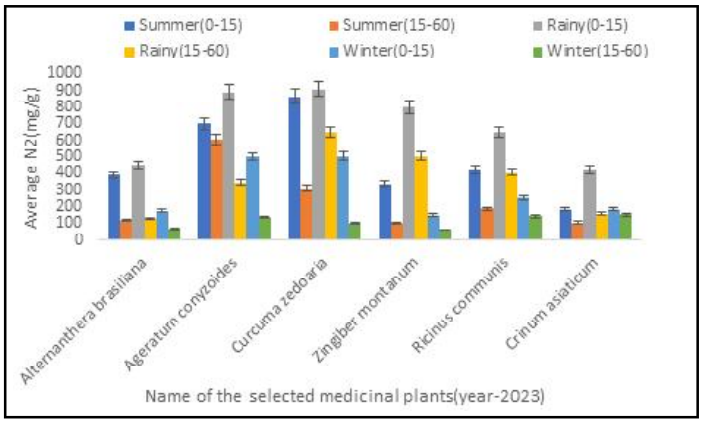


Fig. 8. Average soil nitrogen of selected medicinal plant (year-2023)

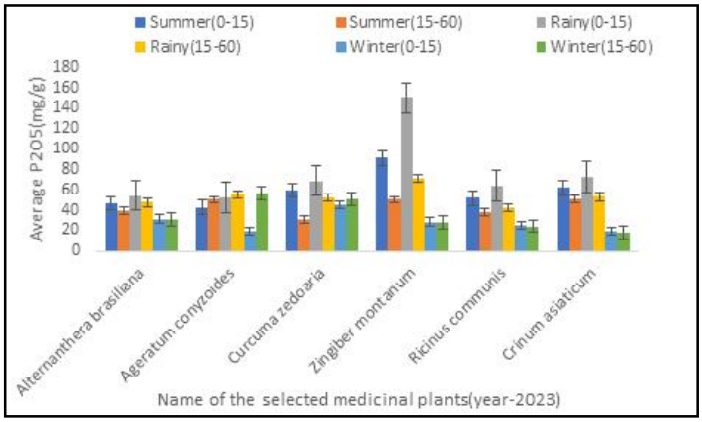


Fig. 9. Average soil phosphorous of selected medicinal plant (year-2023)

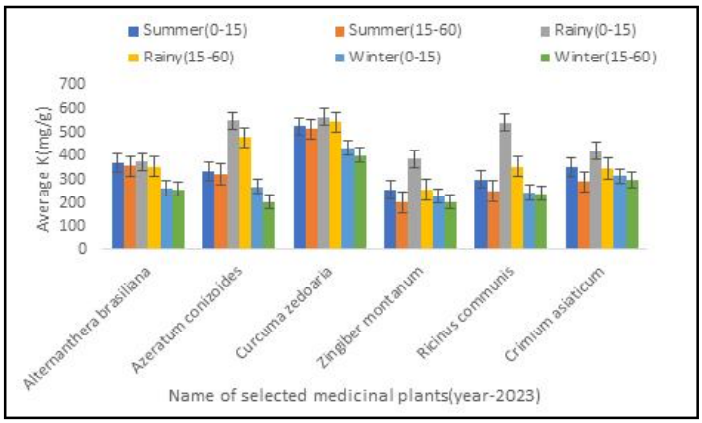


Fig. 10. Average soil potassium of selected medicinal plant (year-2023)

The spores mostly found were of following geners :

Glomus: the spores found were round to oval in shape,the colour of the spores ranged from light yellow,brown to reddish brownand shiny black, spore walls were slippery. Passed throuh 125µm and 250µm.

Gigaspora: the spores found had a bulbulous suspensor. Spores were round and slightly rounded. The colour of the spores was yellow,reddish brown to blackish. Has a smooth,single layered spore wall, has no ornament. The spores are relatively large, passing through a 250µm filter.

Scutelospora: the shape of the spore found were round to irregular, the colour of the spore were clear, dirty, gray to black,the surface of the spores was smooth, the walls are rather thick. There is a germination shield. Pass the 125µm sieve.

The three major types of AM spores *i.e*., *Glomus* sp. *Gigaspora* sp. *Scutelospora* sp have been isolated and *Glomus* sp. was found to be dominant genus isolated from all the selected medicinal plants (Photoplate-2).

It has been found that most of the soil parameters except pH, temperature and moisture content all other properties like organic carbon, nitrogen, phosphorous and potassium in soil decreases with depth. The soil parameters tends to remain highest in rainy season and lowest in winter season, which effects the soil spore count and root infection accordingly. In winters it has been found that the spore count and root infection is found to be highest and lowest in winter season[10,16,23,28,43].

Soil pH has been found to be highest in *Zingiber montanum* during rainy season and lowest in *Curcuma zedoaria*during winter season (Fig. 4). Soil moisture content has been found to be highest in *Curcuma zedoaria* in rainy season and lowest in *Alternanthera brasiliana* during winter season (Fig. 5). Soil temperature has been found to be highest in *Alternanthera brasiliana* during rainy season and lowest in *Ricinus communis* during winter season (Fig. 6). Organic carbon has been found to be highest in *Crinum asiaticum* during rainy season and lowest in *Zingiber montanum* during summer season (Fig. 7). Average nitrogen and potassium has been found to be highest in *Curcuma zedoaria* during rainy season and lowest in *Zingiber montanum* during winter season (Fig. 8,10). Average phosphorous has been found to be highest in*Zingiber montanum* and lowest in *Ageratum conyzoides* during winter season (Fig. 9). Micorrhizal spore count has been found to be highest in *Alternanthera brasiliana* followed by *Ageratum conyzoides* during rainy seasonand lowest in *Zingiber montanum* during winter season (Fig. 2). Micorrhizal root infection has been found to be highest in *Ageratum conyzoides* during rainy season and lowest in *Zingiber montanum* during winter season (Fig. 3).

The identified AM spores can be further used as an inoculum as a biofertilizer[30,33,16] for the cultivation of various medicinal plants of NE India which will be more beneficial for the sustainable development of Socio-economic aspects of this region[5,33,40]. So, future work can be carried out to further undergo single spore culture of these isolated strains on the endangered and rare medicinal plants of NE India for maintaining the Gene bank of

the medicinal plants. AM fungi have been variously studied for their contribution in degraded land as well as their potential application in agriculturally cultivated plants for enhanced production[35,38,40]. The present project work reveals the diversity, colonization, occurence frequency and the morphology of the identified species of AM fungi in the rhizospheric soil of aloe vera, periwinkle, insulin plant, common self-heal plant and Billy goat weed. Further investigation of differences in percentage colonization might be attributed to the initial inoculum of the AM fungi in the field under natural conditions. The differences in root colonization percentage and species richness might be an attribute to change in climatic conditions around the year[1,27,41,42]. In addition, host dependence, age of the host plants and dormancy might play significant role in AM fungi establishment and diversity.

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