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Rhizospheric Fungal Diversity in the Medicinal Plants of Alibag Taluka of Raigad District, Maharashtra, India

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Abstract : *Rhizospheric fungi play a significant role in maintaining soil health, promoting plant growth, and modulating the production of secondary metabolites in medicinal plants. The rhizosphere represents a complex and diverse microbial niche in which fungal communities interact with plants and may contribute to the biosynthesis of biologically active compounds, including alkaloids, peptides, steroids, phenols, quinones, flavonoids, and terpenoids. The present study aimed to isolate and identify the soil fungi associated with the rhizosphere of two medicinal plants, Ocimum sanctum and Rauwolfia sarpentina, collected from Alibag taluka of Raigad district, Maharashtra, India. A total of thirteen fungal species were isolated from the rhizospheric soil of the selected plants. The highest fungal diversity was recorded in the rhizosphere of Ocimum sanctum. In Ocimum sanctum eight fungal species were identified in contrast to six species from Rauwolfia sarpentina. Cladosporium sphaerospermum, Rhizoctina sp., Aspergillus niger, Cephalosporium roseo-griseum, Fusarium oxysporum, Rhizopus stolonifer, were the most frequently isolated taxa and occurred in association with both the examined plants. The findings demonstrate considerable variation in rhizospheric fungal abundance and diversity among medicinal plants and suggest that these fungal communities may contribute to plant health and have potential applications in sustainable agricultural practices.*

Key Words: Medicinal plants, Fungal diversity, Rhizosphere, Colony-forming unit.

1. INTRODUCTION

The rhizosphere is a region adjacent to roots of plants. It is a house of different microbes, including fungi, which are beneficial for plant growth and yield. Soil represents a complex ecosystem where various microbial communities have significant roles in soil functionality and health (Khan and Singh, 2024 and 2026). Among them, fungi have significant roles in nutrient cycling and organic matter decomposition via their enzymatic activities (Gaddeyya et al., 2012). The study of rhizosphere has become very much interesting to soil microbiologists, agronomists, and soil chemists all over the world. Many researchers like Katznelson, Lochhead, Timonin (1948) , Clark (1949) , Harley and Waid (1955) Ordin(1961) studied the different aspects of rhizosphere. Clarke suggested the term rhizoplane for external root surface and closely adhering particles of the soil debris . The term rhizosphere has a wider acceptance than that of any other term. Therefore, most of the workers are using this term for the soil around the root system. The diversity of rhizospheric fungi is very affected by non-living factors, such as the physical properties of the soil, like pH, water levels, and airflow, and farming methods like changing crops and using fertilizers (Khan et al., 2024 and 2025; Dubey et al., 2026). These factors all together influence the population and diversity of microbes and their abilities for plant growth promotion.

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Medicinal plants are a large group of commercially important plants. They are commonly used in drugs and pharmaceuticals, cosmetics, perfumes, and the essential oil industry. The abiotic factors may deteriorate the soil health and rhizosphere microbiome. All plant roots, including medicinal plants, have a strong and healthy association with different microbes (bacteria and fungi), which enhances plant growth and yield. Their role is like a biofertilizer and biocontrol agent. Rhizospheric fungi also improve soil texture and nutritional value (Vasudha et al., 2013). Hence, there is a need for isolation, identification, and estimation of rhizospheric fungi associated with medicinal plants. Rhizosphere fungi showed healthy interactions between plants and soil, where fungal diversity is much higher and fungal abundance is about 10-20% more than in the rhizoplane (Lynch, 1990; Morgan et al., 2005). Different bioactive compounds secreted by the plant roots that perform many functions. A large number of important organic compounds secreted by plant roots provide nutrition and enhance the microbial population of the rhizosphere (Ortíz-Castro et al., 2009).

The native fungi associated with plant roots enhance nutrient absorption by degrading organic matter (Shah et al., 2021). These microbes not only improve plant health but also improve the production and quality of bioactive compounds in many medicinal plants. The indigenous rhizospheric fungi can be used as beneficial bioinoculant to boost medicinal plants growth without very sophisticated biotechnological processes. This study aims to investigate the population, diversity, isolation, and identification of rhizosphere fungi associated with selected medicinal plants of the Alibag Taluka of Raigad district in Maharashtra.

II. MATERIALS AND METHODS

A systematic survey was conducted at Alibag taluka of Raigad district, Maharashtra, India.

Rhizospheric soil sample collection :

The rhizospheric soil samples were collected from the medicinal plants growing in gardens and from the forest area like Karlekhind , SIddheshwar near Alibag of Raigad district, Maharashtra. The rhizospheric soil was taken from a depth of 10-15 cm according to the habit of the plants. Collected samples were placed in a sterile polyethene bags and brought to the laboratory for the further investigations. Samples were collected in al three seasons throughout the year.

Analysis of rhizospheric fungi :

The rhizospheric fungi were isolated by dilution plate technique (Timonin, 1940). The collected Rhizospheric soil was serially diluted three times with sterile distilled water. 1 ml of final diluted soil solution was placed onto previously prepared PDA plates. 1% streptomycin was mixed in PDA to avoid the bacterial growth in the plates. . The plates were incubated for 4 to 5 days at 25°C ±2 in BOD. After 4-5 days Petri plates were examined for the growth of fungal colonies. The fungal colonies in each plate were counted and identification of the fungal species were carried out. For each sample, three plates were plated.

Identification of fungal species :

Fungal colonies were examined both microscopically and macroscopically. In macroscopic observations colony characteristics like colour, growth pattern, texture, etc. was observed. Slides were prepared for the microscopic observations. Hyphae from the colonies were mounted in glycerine and stained in cotton blue. Slides were observed under 10X and 40X lenses of the microscope. During microscopic examination, Characters of shape, size, colour, hyphae, and conidia, etc. were noted under microscopic observations. The fungi were identified with the help of Manual of Soil Fungi (Gillman, 1956).

Total 2 medicinal plants (Ocimum sanctum and Rauwolfia sarpentina) were analysed during the study. The sampling was taken in 3 replicates for each plant, and for each sample, three plates were plated.

Fungal populations were estimated in terms of colony formation unit (CFU). It was calculated with the help of the following formula.

$$CFU/mL = \text{Number of colonies} \times \text{Dilution factor} / \text{Volume of sample (mL)}$$

Where:

Number of Colonies: The count of individual colonies/total number of colonies visible on the single agar plate.

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Dilution factor: Times of dilution (1000)

Volume of sample: The amount of volume used during plating (1 ml)

Table 1. Physico-chemical properties of rhizospheric soil of selected medicinal plants

Parameters/ Plants	Ocimum Sanctum	Rauwolfia sarpentina
Soil texture	Sandy - loamy	Loamy
PH	7.3	7.6
EC (m. mhos.cm-1)	1.40	1.46
Organic Carbon (%	0.78	0.65
Nitrogen (%)	0.292	0.298
Phosphorus (mg kg-1)	44.0	41.0
Potassium (mg kg-1)	46	49

Table 2. Rhizospheric fungal diversity in the selected medicinal plants

Sr. No.	Fungal species	Ocimum sanctum	Rauwolfia sarpentina
	Aspergillus fumigatus W. Fresenius.	+	+
	Aspergillus niger van Tieghem, ,	+	+
	Aspergillus terrcus Thom.,	+	--
	Cephalosporium roseo-griseum Saksena	+	+
	Cladosporium sphaerospermum Penz.	+	+
	Curvularia lunata (Wakker) Boedjin,	--	+
	Fusarium oxysporum, Schlet.ex .Fr.	+	+
	Fusarium roseum Link.,	+	--
	Macrophomina phaseolina (Tassi) Goid	+	--
	Rhizoctina sp.	--	+
	Rhizopus stolonifer (Ehrenb,ex. Fr.),	+	+
	Sporotrichum chlorinum Link.	+	--
	Trichoderma virdie Per. Ex. Gray, .	+	--

Table 3. Macroscopic and microscopic characteristics of identified rhizospheric fungi

Fungal species identified	Colony morphological features	Microscopic characters
Aspergillus fumigatus W. Fresenius.	Velvety, blue- green colonies with white margins	Conidiophore unbranched with foot cell, vesicle flask shaped or globose, conidia mainly globose, green or grey in colour, uniseriate phialides on conidiophores
Aspergillus niger van Tieghem.	Black, powdery colonies with white margins; fast growing	Conidiophore unbranched with foot cell, conidial heads radiate, biseriate, dark brown or black conidia
Aspergillus terrcus Thom.	Pinkish cinnamon to deeper brown colour colonies, pale to bright yellow from reverse.	Conidiophores more or less flexuous, non-septate and smooth walls. Phialides in two series and closely packed. Conidia globose, smooth in long parallel adherent chains.
Cephalosporium roseo-	Colonies spreading	Hyphae are of two types- submerged assimilative

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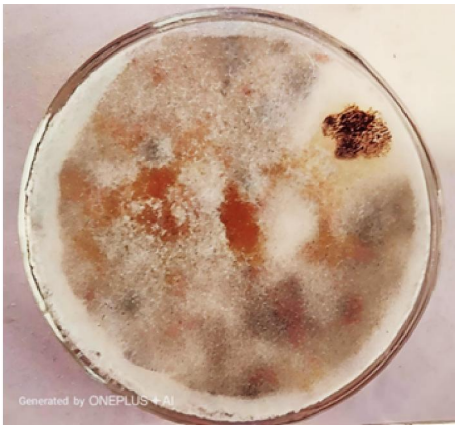
griseum Saksena	broadly and rapidly , floccose white at first, becoming pinkish, pinkish on reverse.	aerial floccose hyphae predominately funiculase with conidiophores. Conidia enclosed in the slime at the tips. Oval to elliptical , pink to deeper red.
Cladosporium sphaerospermum Penz.	Colonies are green to olive green.	Hyphae creeping, septate on the surface. Conidiophores almost tall, erect, dark, branched variously near apex. Clustered or single, floccose, often forming a turf, olive coloured. Conidia dark, one celled then with cross wall, ovoid to cylindrical in shape , in simple or branched, acropetalous chains.
Curvularia lunata (Wakker) Boedjin,	Colonies spreading, subfloccose, dark olive gray in colour.	Hyphae septate and much branched, Conidiophore erect, unbranched, Spores are in whorl at the tip of conidiophore, three septate, curved, brown.
Fusarium oxysporum, Schlet.ex .Fr.	Abundant white colonies.	Aerial mycelium septate, conidiophores arise from aerial hyphae, simple or branched in a bastrycoid manner, septate. Conidia of two types, Microconidia usually one celled , hyaline, oval to oblong, curved, produced singly from the tips of the phialides. Macroconidia dorsiventral, cylindrical to subcylindrical, to fusiform foliate, 2-3 septate, hyaline, singly in mass, pale brownish white to flesh coloured. Narrow towards the tip and the base somewhat conical, apical cell smoothly rounded at the tips.
Fusarium roseum Link.	White to pinkish colonies.	Hyphae aseptate, mycelia. Conidiophore simple or loosely branched, conidia mostly produced in false heads or balls, as sporodochia in gelatinous masses. Conidia long subulate
Macrophomina phaseolina (Tassi) Goid	Colonies are brownish black consists of thick hyphae.	Conidiophores long, conidia one celled, hyaline, elliptical, often curved.
Rhizoctina sp.	Pale brown to brown colour colonies.	Asexual fruit bodies and spores lacking. Sclerotia variable in form, hyphae of mycelium brown with long cells septa of branch set off from main hypha.
Rhizopus stolonifer (Ehrenb,ex. Fr.),	Colonies yellowish in appearance .	Sporangiophores in groups, rarely single. Apophysis wide, sporangia globose, columella prominent, spores catenulate, blackish in mass, spherical, striated.
Sporotrichum chlorinum Link.	Colonies in groups and are of olive green.	Hyphae creeping, branched, septate, branches repeatedly branched. Hyphae in thickness, floccose. Conidia obovate and on the tips of the branches, greenish with one oil drop.
Trichoderma virdie Per. Ex. Gray .	Colonies white at first but ultimately becoming greenish.	Vegetative hyphae septate, conidiophore hyaline, conidia hyaline, one celled ovoid, borne in clusters.

Diagrams of the identified fungal species were prepared from the slides with the help of Camera lucida. Same are presented in the paper.

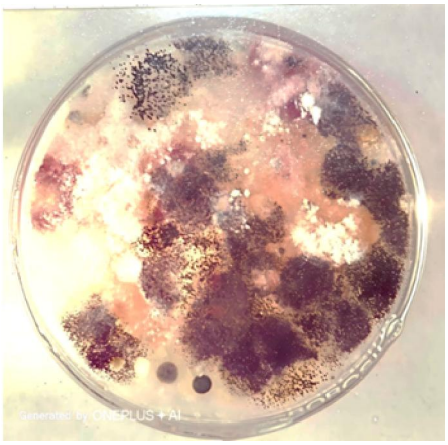
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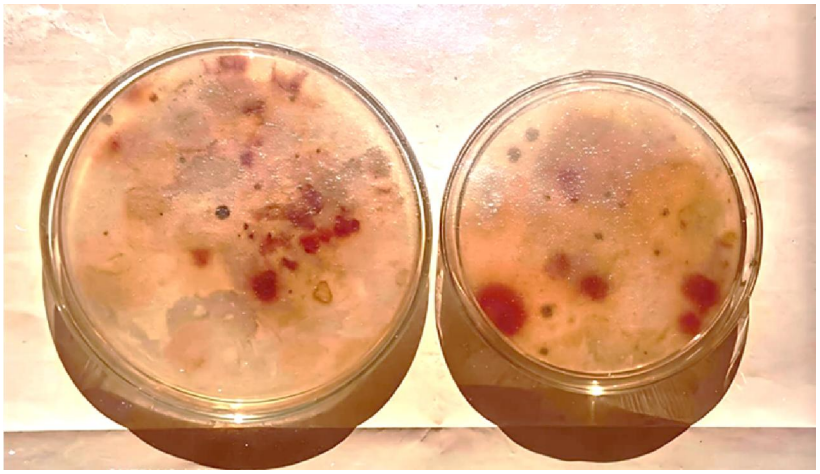
Photo 1 : Petri plates showing the growth of fungal colonies



Fungal colonies from the Rhizosphere of Ocimum sanctum

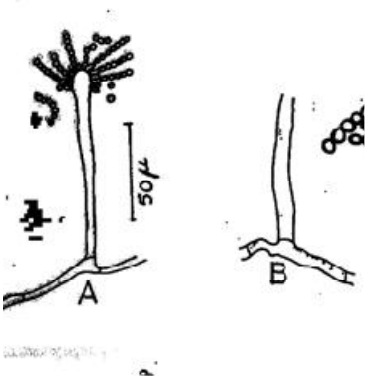


Fungal colonies from the Rhizosphere of Rauwolfia sarpentina

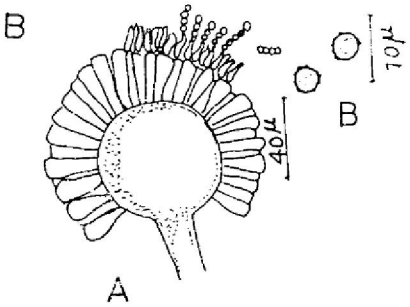


Growth of fungal colonies from the reverse of the Petri plates

Diagram 1: Diagrams of the various fungal species identified during the study

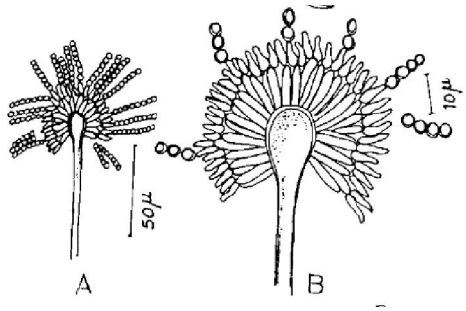


Aspergillus fumigatus W. Fresenius

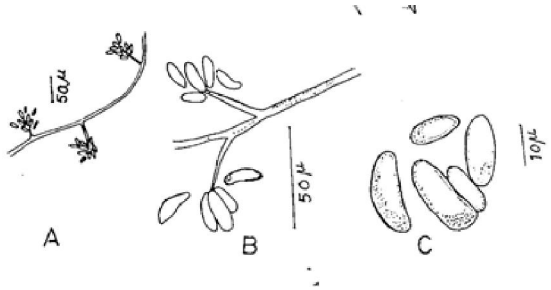


Aspergillus niger van Tieghem

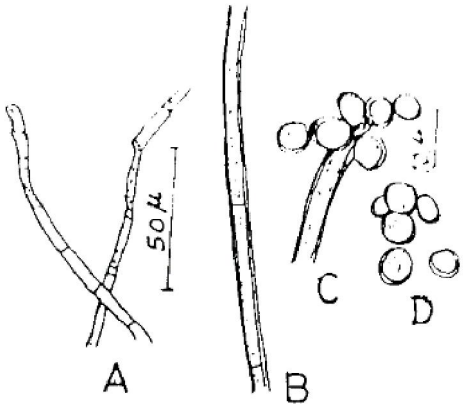
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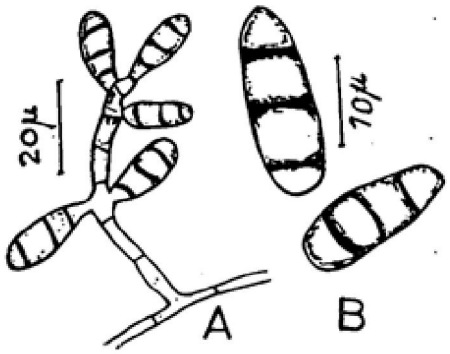
Aspergillus terrcus Thom.



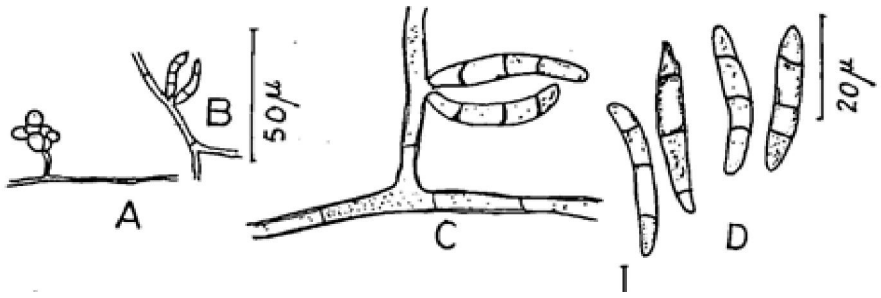
Cephalosporium roseo-griseum Saksena



Cladosporium sphaerospermum Penz



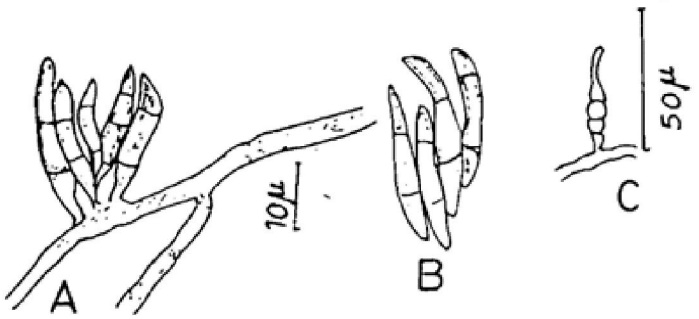
Curvularia lunata (Wakker) Boedjin,



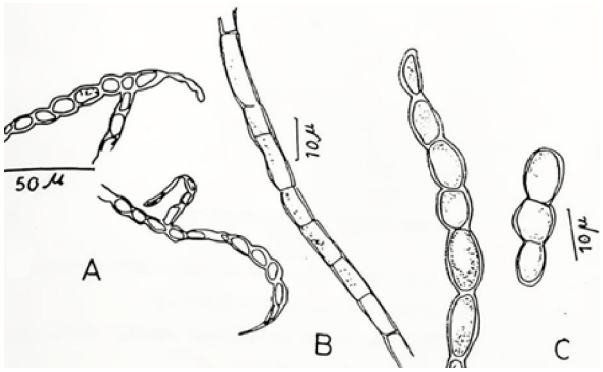
Fusarium oxysporum, Schlet.ex .Fr.

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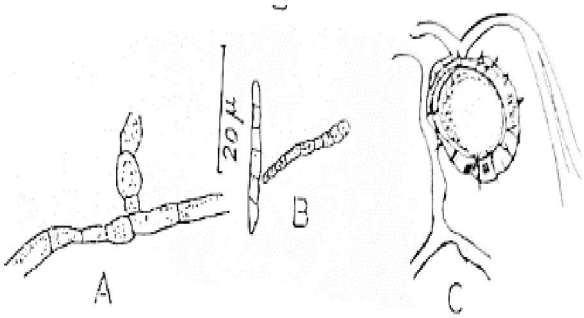
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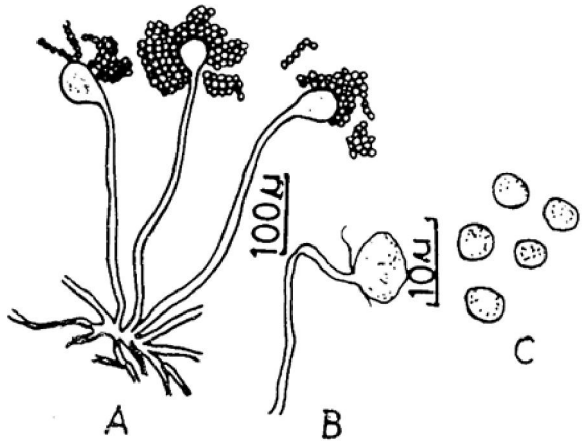
Fusarium roseum Link



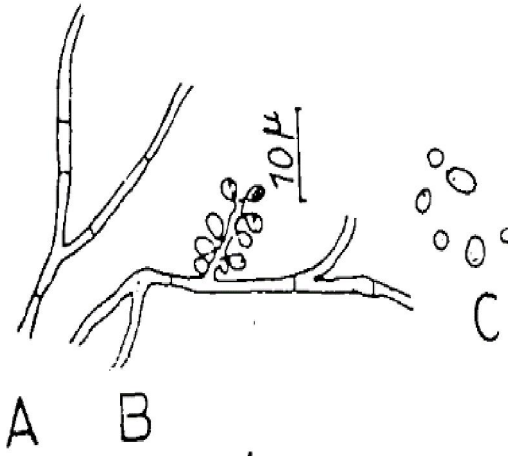
Macrophomina phaseolina (Tassi) Goid



Rhizoctina sp.



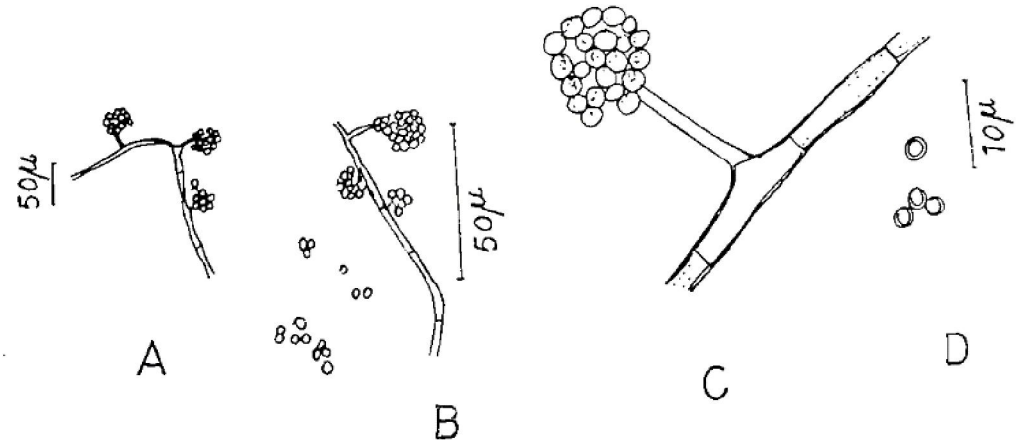
Rhizopus stolonifer (Ehrenb,ex. Fr.)



Sporotrichum chlorinum Link

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Trichoderma virdie Per. Ex. Gray, .

II. RESULTS

The physico-chemical characteristics of the soil of the medicinal plants of Alibag taluka has been presented in Table 1. The pH of rhizospheric soil samples was alkaline (pH 7.1 and 7.8). The soil texture was predominantly loamy sand and loamy. Such soil has good drainage capacity as well as moisture content. Such soil properties provide favourable conditions for the growth of rhizospheric microbes including fungi.

Both the medicinal plants selected for the study were associated with Rhizospheric fungi. Total thirteen fungal species were isolated from the rhizospheric soil of selected medicinal plants viz., Aspergillus niger van Tieghem, Aspergillus fumigatus W. Fresenius, Cladosporium sphaerospermum Penz. Fusarium roseum Link., Macrophomina phaseolina (Tassi) Goid, Rhizoctina sp. , Curvularia lunata (Wakker) Boedjin, Fusarium oxysporum, Schlet.ex .Fr. Rhizopus stolonifer (Ehrenb,ex. Fr.), Aspergillus terrcus Thom., Sporotrichum chlorinum Link. Cephalosporium roseogriseum Saksena , Trichoderma virdie Per. Ex. Gray, . (Table 2,). Fungal species were identified based on macroscopic and microscopic observation. The identifying characteristics have given in Table 3.

Aspergillus fumigatus W. Fresenius, Aspergillus niger van Tieghem, Cladosporium sphaerospermum Penz., Fusarium roseum Link, Macrophomina phaseolina (Tassi) Goid, Rhizoctina sp, Fusarium oxysporum, Schlet.ex .Fr Aspergillus terrcus Thom, Sporotrichum chlorinum Link. Cephalosporium roseogriseum Saksena, Rhizopus stolonifer (Ehrenb,ex. Fr.), Trichoderma virdie Per. Ex. Gray, Sporotrichum chlorinum Link. Were recorded only with the plant Ocimum sanctum while Rhizopus stolonifer (Ehrenb,ex. Fr.), Rhizoctina sp. , Fusarium oxysporum, Schlet.ex .Fr. Cephalosporium roseogriseum Saksena, , Aspergillus niger van Tieghem, Aspergillus fumigatus W. Fresenius, Rhizopus stolonifer (Ehrenb,ex. Fr.), Aspergillus niger van Tieghem, Curvularia lunata (Wakker) Boedjin, Fusarium oxysporum, Schlet.ex .Fr. Cladosporium sphaerospermum Penz., were found to be associated with Rauwolfia sarpentina plant.

Aspergillus niger van Tieghem, Fusarium roseum Link, Rhizoctina sp, Cephalosporium roseogriseum Saksena, Fusarium oxysporum, Schlet.ex .Fr, Rhizopus stolonifer (Ehrenb,ex. Fr.), were found to be associated with both medicinal plants.

Maximum diversity was recorded in the rhizosphere of Ocimum. sanctum. The fungal colonies showed notable variations in fungal populations across different plant species. The fungal populations in the root microhabitat of Ocimum sanctum and Rauwolfia sarpentina were 25×103 and 19×103 CFU respectively, dominated by Aspergillus sp. and Rhizopus sp.

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III. DISCUSSIONS

The current study aims to record the Rhizospheric fungal diversity associated with two medicinal plants (Ocimum sanctum and Rauwolfia sarpentina) of Alibag taluka of Raigad district. In the present investigation, thirteen major fungal species have been identified, with a predominance of Aspergillus fumigatus W. Fresenius, Aspergillus niger van Tieghem and Aspergillus terrcus Thom. and Fusarium oxysporum, Schlet.ex .Fr. , Fusarium roseum Link. The wide distribution of these fungi in the rhizosphere of plants is due to their adaptability to the changing ecosystem, as the roots of plants secrete a variety of compounds that control the microbial population and foster symbiotic association with beneficial microorganisms (Walker et al., 2003). In the rhizosphere of the plants, the microfungi are of focal importance in nutrient cycling, as they regulate the biological activity of the soil, responding to the amounts of organic and inorganic content in the soil (Gaddeyya et al., 2012). The highest fungal diversity was found in the plant Ocimum sanctum. This may be related to the complex root exudation pattern of the plant species, as the root system of the plant species is known to release complex mixtures of primary and secondary metabolites as chemical signals for the recruitment of specific microorganisms in the rhizosphere (Badri and Vivanco, 2009; Bais et al., 2006) Rauwolfia sarpentina also show the good biodiversity of rhizosphoric fungi. . The rhizospheric microbes help plant growth and recycle nutrients in the ecosystem's rhizosphere compartment by making different beneficial compounds (Khan et al., 2008). Root exudates are chemical compounds that roots release into the rhizosphere compartment. These chemicals attract organisms, which use them as a source of carbon and energy for development (Badri and Vivanco, 2009; Bais et al., 2006).

Rhizospheric fungi is very important part of soil microbiome and responsible for maintaining soil plant interactions and plant productivity. Similar study was also carried by many researchers, who have suggested the presence of many rhizosphere fungi associated with different medicinal plants and also in different ecosystem across the world (Jena et al., 2015; Caruso et al., 2020; Mir et al 2017). The diversity of fungi associated with the rhizospheric soil of different host plant growing at different locations also differs (Morgan et al., 2005). The rhizospheric fungi help the plant growth promotion through nutrient cycling, nutrient uptake and protect the plant from biotic and abiotic stresses. (Li et al., 2018).

Overall, this study highlights the intricate relationships between soil properties, plant exudates, and fungal communities in the rhizosphere of medicinal plants. It underscores the importance of maintaining diverse and healthy microbial populations to promote plant growth, disease resistance, and the production of bioactive compounds.

IV. CONCLUSION

In this study total thirteen fungal species were associated with the rhizosphere in selected medicinal plants of Alibag taluka of Raigad district, Maharashtra, India. Ocimum sanctum with the highest fungal diversity and Rauwolfia followed by it. Dominance of Aspergillus and Fusarium species indicates their versatility in the plant rhizosphere and their activities in soil fertility and plant well-being. Rhizopus species indicates beneficial fungi with probable agricultural uses, and total overall fungal diversity indicates an active role in nutrient cycling and plant defence. Identification of such fungal communities may improve the cultivation of medicinal plants, soil health, and sustainable agriculture. The native rhizospheric fungi can be used as beneficial bioinoculants to enhance the growth of medicinal plants and production of bioactive compounds without very sophisticated biotechnological processes. Future studies will require investigating their functional roles in plant development and secondary metabolite production.

REFERENCES

1. Badri DV, Vivanco JM. 2009. Regulation and function of root exudates. Plant, Cell & Environment 32(6), 666–681.
2. Bais HP, Weir TL, Perry LG, Gilroy S, Vivanco JM. 2006. The role of root exudates in rhizosphere interactions with plants and other organisms. Annual Review of Plant Biology 57, 233–266.
3. Caruso G, Abdelhamid MT, Kalisz A, Sekara A. 2020. Linking endophytic fungi to medicinal plants

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International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
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Impact Factor: 8.2

therapeutic activity: A case study of Asteraceae. Agriculture 10(7), 286

4. Dubey S, Tripathi T, Tripathi S, Kumar V, Hasan S, Khan S, Singh AP. 2026. Responsiveness of arbuscular mycorrhizal symbiosis in plants during abiotic stress. International Journal of Microbiology and Mycology 22(2), 1–20.
5. Gaddeyya G, Niharika PS, Bharathi P, Ratna , Kumar PK. 2012. Isolation and identification of soil mycoflora in different crop fields at Salur Mandal. Advances in Applied Science Research 3(4).
6. Jena SK, Tayung K, Rath CC, Parida D. 2015. Occurrence of culturable soil fungi in a tropical moist deciduous forest, Similipal Biosphere Reserve, India. Journal of Microbiology 46(1), 85–96.
7. Khan S, Singh AP. 2024. Microbial inoculants: Effective biofertilizers for improving crop productivity. International Journal of Environmental Sciences & Natural Resources 34(3),
8. Khan S, Singh AP. 2026. Beneficial soil microorganisms: Role in plant growth and soil fertility: A review. Indian Journal of Agricultural Research.
9. Khan S, Kharwar PK et al, 2024. A comprehensive review on arbuscular mycorrhizal fungi: Impact on plant growth and nutrient acquisition. Research Communication 2(2), 56–64.
10. Khan S, Kushwaha K, Kharwar PK, Singh AP. 2025. Arbuscular mycorrhizal fungi: An environment friendly approach for sustainable agriculture. Agri Research & Technology: Open Access Journal 29(1).
11. Li X, De Boer W, Zhang Y, Ding C, Zhang T, Wang X. 2018. Suppression of soil-borne Fusarium pathogens of peanut by intercropping with the medicinal herb Atractylodes lancea. Soil Biology and Biochemistry 116, 120–130.
12. Lynch JM. 1990. Introduction: Some consequences of microbial rhizosphere competence for plant and soil. In: Lynch JM (ed.). The Rhizosphere. New York: John Wiley & Sons. pp. 1–10.
13. Mir MA, Sawhney SS, Bhat MY, Jan H. 2017.Studies on the rhizospheric soil fungi associated with Nepeta cataria L. and Rumex dentatus L. in District Kulgam of Kashmir Valley. Indo American Journal of Pharmaceutical Research 7, 8756–8763.
14. Morgan JAW, Bending GD, White PJ. 2005. Biological costs and benefits to plant–microbe interactions in the rhizosphere. Journal of Experimental Botany 56, 1729–1739.
15. Ortíz-Castro R, Contreras-Cornejo HA, Macías-Rodríguez L, López-Bucio J. 2009. The role of microbial signals in plant growth and development. Plant Signaling & Behavior 4(8), 701–712.
16. Shah KK, Singh A et al, 2021. Role of soil microbes in sustainable crop production and soil health: A review. Agricultural Science and Technology 13(2), 83–92.
17. Timonin MI. 1940. The interaction of higher plants and microorganisms. I. Microbial population of the rhizosphere of seedlings of certain cultivated plants. Canadian Journal of Research 18, 307–317.
18. Vasudha S, Shivesh S, Prasad SK. 2013. Harnessing PGPR from rhizosphere of prevalent medicinal plants in tribal areas of Central India. Research Journal of Biotechnology 8(6), 76–85.
19. Vasundhara Singh et al 2026, Rhizospheric fungal diversity in the medicinal plants of Rewa District, Madhya Pradesh, India, International Journal of Microbiology and Mycology