Maratha Vidya Prasarak Samaj's

Arts, Commerce and Science College, Nandgaon

Tal – Nandgaon, District Nashik – 423106 (M.S.) India.

E-mail: prinnandgaon@yahoo.com

Website: www.nandgaoncollege.com

Mobile No. 8766876955

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3.2.2. Total number of books and chapters in edited volumes/books published and papers in national/ international conference proceedings during the year (2020-2021)

Sr.no.	Faculty name	Number of Book chapter
1	Dr. V.B. Sonawane	01
2	Dr. B.W. Chavre	01
3	Dr. A.M. Madhane	01
	Total	**03**

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Current Views on

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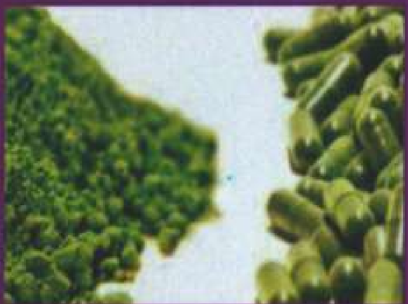

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Rhizosphere Mycoflora: An Over View

Dr. Vitthal B. Sonawane

The German agronomist and plant physiologist Hiltner 1904, first coined the term define of the rhizosphere to describe the plant root interface, a word originating in the part from the Greek word rhiza meaning root and sphere meaning field of influence. Hiltner describe the rhizosphere as the area around a plant root in the inhabited by a unique population of microorganisms influenced, he believed, by the chemicals released from the plant roots. The region of the soil around the roots in which the maximum microbial growth and the activities operate is called rhizosphere. Other simple define of rhizosphere - soil around the root of the plant where microbial activity is high it is called rhizosphere

The concept was discovered by Hiltner. Rhizosphere inhabiting microorganisms participate for nutrients water and space and sometimes improve their attraction by developing a close relationship with plant. The release of organic material provides the energetic force for the development of active microbial populations in a region that includes plant root and surrounds soil. This phenomenon is referred as the rhizosphere effect. This zone is about 1mm wide but has no distinct border. Comparatively, it is an area of intense biological and chemical activity influenced by compounds exuded by the root and by microorganisms feeding on the compounds.

As the plant roots growth through the soil they release water soluble compounds such as sugars organic acids and amino acids that supply food for the microorganisms The food supply means microbiological activity in the rhizosphere is much greater than in soil away from the plant roots and in return the microorganisms provide nutrient for the plants.

The rhizosphere has been developed toconsist of three zones. The endorhizosphere includes portions of the cortex and endodermis in which microorganisms can inhabit the free space between cells. The rhizoplane is the medial zone directly neighbouring to the root including the root epidermis and mucilage. The outermost zone is the ectorhizosphere which extends from the rhizoplane out into the bulk soil. The rhizosphere is not a region of definable size or shape, but instead, consists of gradient in chemical, Biological and physical properties. Tapwal et al., (2003) studies by rhizosphere is a zone of increased microbial activity in the vicinity of plant roots. Increases in microbial community are due to the exudation of plant roots. On the other hand, the micro floras associated with root surface are called rhizoplane. High microbial density in the rhizosphere and rhizoplane is due to the presence of the organic compound exuded from the roots Microorganisms growing on plant root can influence plant growth.

The rhizosphere effects

The improvement of the growth of a soil microorganism resulting from physical and chemical modification of the soil and the involvement of excretions and organic waste of roots within a rhizosphere, when the seed germination and seedling growth, the development of the plant interacts with the microorganisms present in the surrounding soil. As seeds germination take place the roots growth occurs in the soil. The release of organic material provides the driving force for the development of active microbial populations in a zone that contain plant root and surrounding soil in a few mm of thickness. This phenomenon is referred as the rhizosphere effect by Morgan *et al.,* 2001. Mostly there are three distinct components recognized in the rhizosphere – the rhizosphere, the rhizoplane and the root itself.

The rhizosphere region is a highly favourable habitat for the proliferation, activity and metabolism of numerous microorganisms such as bacteria, fungi - rhizosphere effect is selective and significant on specific fungal genera e.g. *Penicillium, AspergillusFusarium* etc. which are stimulated, actinomycetes, protozoa and Algae

Rhizosphere effect on Soil organic matter has been long recognized as one of the most important components in maintaining soil quality, soil fertility and agricultural sustainability. The soil zone strongly influenced by plant roots, the rhizosphere, plays an important role in regulating soil organic matter decomposition and nutrient cycling. Theses process may include exudation of the soluble compounds, water uptake, nutrient mobilization by the roots and microorganism, rhizosphere mediated soil organic matter decomposition and the presently release of CO_2 through respiration. Rhizosphere processes are major gateways for nutrients and water theses process utilize approximately 50 % of the energy fixed by photosynthesis in terrestrial ecosystems and mediate almost all aspects of nutrient cycle. Plant root and their rhizosphere interactions are at the centre of many ecosystem processes.

Root exudation

The outer epidermal layer of living root hair and all plant roots are covered with mucilage and cuticle. Organic and inorganic compounds accumulated in cytoplasm of root cells are diffused out. This loss occurs probably due to the unfavourable conditions external to the root known as root exudation. Root exudation is the release of organic compound from living plant roots into the surrounding soil. The root exudates are affected by various environmental factors including ph, soil type, soil temperature, nutrient availability, oxygen status light intensify and the presence of microorganisms rates of exudation vary widely among species and environmental condition.

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Healthy roots exude various organic compounds. Including more than 100,000 different types of low molecular weight Secondary metabolites called root exudates. Root exudates are carbonaceous substance containing a wide range of amino acids sugar organic acids water soluble and various vitamins and enzymes and other compounds. Sugars and amino acids in the roots exudates stimulate the germination of resting spores of fungi. Root exudates are transported across the cellular membrane and secreted in to the surrounding rhizosphere. Plant products are also released from roots border cells and root border like cells which separate from the border as they grow. The efficiency of the exudation process may thus be enhanced by stress factors affecting membraneintegrity such as temperature extremes nutrient deficiency.

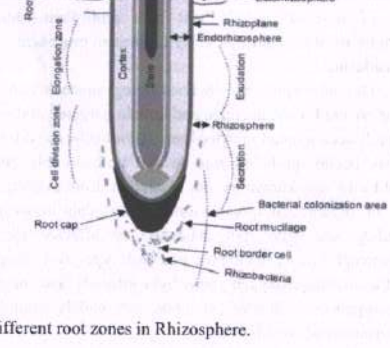

Fig.1: Different root zones in Rhizosphere.

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Mycorrhizal fungi

Mycorrhiza is a general term describing a symbiotic relationship between a soil and fungus and plant root. Unlike rhizobia and their legume partners'mycorrhizal association are ubiquitous and relatively non selective occurring **80%** of angiosperm and in all gymnosperm.

There are two types of mycorrhizal associations with plant roots ectomycorrhiza and endomycorrhiza, which are differentiated by how they physically interface with the plant.

a) **Ectomycorrhizae** occur mainly in the roots of woody plants and form a dense hyphal covering over the root tip from which hyphae grow into the intercellular spaces forming a net of hyphae around the root cortex cells, but do not penetrate the cell walls.

b) **Endomycorrhizae** fungal hyphae grow into the root cortex and enter the cells forming fan like highly branched structure known as an arbuscule that remain separated from the cytoplasm by the plant plasma membrane. The endomycorrhiza can be further divided into the more wide spread arbuscularmycorrhiza and the specialized orchid and ericoid mycorrhizas which, as the name implies, are colonizers or orchids and ericoid e.g. cranberry plant species. The arbusculesmycorrhiza association in both cases the Hartignet of hyphae and the arbuscules increase the contact area between the fungus and the plant through which the transfer of nutrients to the plant and carbon to the fungus occurs.

The endomycorrhiza are wholly dependent on the plant for their carbon and when associations occur, both endomycorrhiza and ectomycorrhiza can demand up to 20 to 40 % of the total photosynthetically fixed the carbon, plant produces. Amusingly, the dense, intertwined network of fungal hyphae forms a common mycorrhizal network, in which hyphae from mycorrhizae infecting two or more plants are interconnected.

Role of rhizospheric microbes

The rhizosphere microbes also play very important role in improving medicinal values of plants. The large variety of fungi and bacteria is recognized in the rhizosphere soil of medicinal plants that showed significant effect in secondary metabolite alteration and uptake of plant nutrient.

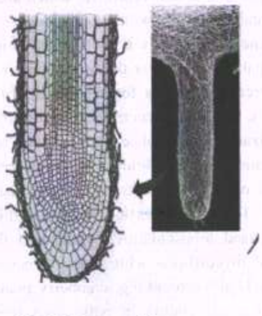

Fig.2: Ectomycorhiae

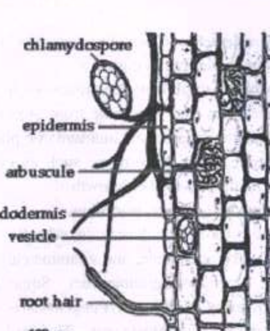

Fig. 3: Endomychorhizae

Rhizospheric microbes affect the plant physiology by imparting several useful effects such as nitrogen fixation, nutrient uptake, and production of secondary metabolites in the medicinal and aromatic plants. Many rhizospheric fungi are associated with plant root in the form of mycorrhiza. Mycorrhizal fungi promote plant growth by various ways. Rhozospsheric microbes induce development of lateral root, root hairs development and mucilage secretion from plant root. Microorganism also increasesthe rate of exudates secretion. Exudates secretion from the plant root helps in formation of soil aggregative that improve soil fertility. Rhizospheric microbes induce development of lateral root, root hairs. Development and mucilage secretion from plant root

Rhizospheric microorganisms are important for plant growth. They promote plant growth. Some rhizospheric bacterial such as R*hizobium,Azotobacter, Clostridium* etc. Fix atmospheric nitrogen and make it available for plant growth.

Many phosphate solubilising microbes such as bacillus found in rhizosphere release free phosphate from inorganic salt of phosphate. Free phosphate is important nutrient for plant growth. Several microbes produce growth hormone such as Gibberellins, Indole acetic acid etc that promote plant growth

Effect of plant root on rhizospheric microbes

The Plant root produces exudates containing carbohydrate, amino acids, nucleotide, and vitamins etc. that serves as food for growth of rhizosphericmicrobes. Some plant root produce chemical that bring fungistasis. Fungistasis is referred to the incapability of spore to germinate e.g.. The root of Allium produces alkylcystin sulfoxide that inhabits germination of sclerotic (spore) of *scelrotium capivarum.* Some plant root produces antimicrobial chemicals such as glycosides and antifungal agents that inhibit growth of rhizospheric microorganisms.They promote plant growth by carrying out various biogeochemical transformations in soil and hence increase amount of plant nutrient in soil. They also produce plant growth hormone and protect plant against from pathogens.

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Dr. Kirankumar Khandare

attacking herbivore, the cost to the plant in putting up its defenses and to the fungus in transporting the message is high and unnecessary. So, in an environment where there are many different plant species, species-specific signals may be selected for over time; in areas where there are few plant species, a generic signal would suffice.

As research continues, the mysteries of "defense-related" interplant communication via CMN's will be revealed. Field studies are particularly important because they can paint a more accurate picture compared to "highly simplified laboratory conditions." One exciting thing about this type of communication is that it may mean that some plants are communicating with each other across great distances, since "some species of fungi can be vast." CMNs can also target specific plants, and compared to communication via aerial VOC's, the signal will not be diluted by the wind.

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Mycoremediation: An Effective Tool to Decontaminate Environment: A Review

Dr. Bhagwat Chavare

Fungi are the most diverse group of living organisms having a wide adaptability in variety of environmental conditions. Fungus successfully made a way in the life of human being through its wide range of applications in food processing, drug production, enzyme technology and many more fields. They are widely being used in each and every aspect of human life and having a huge role fulfilling needs of growing population. In the present article an attempt is made to discuss one more novel application of fungi, Mycoremediation. It is evident from the literature screening that, they plays very important role in the biodiversity and productivity of plants which is ultimately leads to regulation of different food chains in nature. A variety of fungal species has a capability to degrade different types of pollutants from environment by using their metabolic products like lignin degrading enzymes. In the present situation ever polluting environment can be decontaminated by using fungus which is a cost effective and eco-friendly way.

Fungi are ubiquitous, achlorophyllus, spore-bearing eukaryotes composed of chitin containing cell wall. Over 120,000 species were identified till today. Fungi are considered as one of the most adaptable groups of organisms and also as an essential component of soil because they decompose organic matters and provide nutrients to plants. Apart from this, they are plays important role for the production of various environmental products such as antibiotics, drugs, pigment production, food industry and bioremediation. In the present article, the special application of various fungi is discussed. Author gone through many articles based on fungal bioremediation and an effort is taken to gather information about use of various fungi to decontaminate soil.

Different types of Metals are present in the soil in different forms including free metal ions, oxalates, carbonates and hydroxides. The degree of their toxicity on living organisms is based on their relative availability. Their availability is depends on pH, organic matter and clay content of the soil. Soil micro fungi are able to tolerate concentration of various metals and restrict entry of metals into the cells by extracellular metal sequestration.

Population explosion and rapid development in the developing countries resulted in the loading of large quantum of contaminants and recalcitrant compounds like Polyaromatic hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs), Polychlorinated dibenzp-dioxins (PCDDs) and heavy metals in the environment. To treat such contaminated environment some physicochemical methods can be effectively used but are not feasible in large scale. Bioremediation is one of the important, efficient and feasible solutions to treat and remove pollutants from the environment and soil.Fungi act as decomposer and symbionts in all ecosystems including soil due to their robust morphology and diverse metabolic capacity. So, Mycoremediation is a form of bioremediation in which fungus are well suited for the purpose of treatment of contaminated soils.

Xenobiotic compounds are produced in high amount annually and remains persistent in the environment. Wastewater, landfill leachates and solid wastes are the main sources of xenobiotic compounds. Different types of xenobiotic compounds are phenols, plastics, hydrocarbons, paints, dyes, pesticides, insecticides, paper and pulp mill wastes pharmaceutical remains etc. Xenobiotic compounds can show some carcinogenic and mutanogenic effects. The treatment on such compounds can be done by using different biological processes which is also referred as bioremediation.

Different Types of fungal species reported for various types of waste bioremediation

Shivanand *et al.* (2019) carried out an excellent study on fungal isolation and its applications in possible bioremediation. They isolated fungi from different sources including forest, coastal, mycorrhizal, and endophytic ecosystems. It is clear that, different types of habitats contain diverse fungal species. It is evident from the study that, forest ecosystem contains common fungal species like, *Aspergillus, Penicillium, Trichoderma and fusarium, Penicillium, Cladosporium* etc. The fungal species commonly observed from coastal areas are *Scutellospora, Glomus, Gigaspora, Sclerocystis*etc and from freshwater river contains species like *Aspergillus, Penicillium, Thielavia, Fusarium*, etc.Many mycorrhizal fungi also isolated from different higher plants including orchids. Endophytic fungal strains like *Alternaria, Fusarium, Pestalotiopsis* are also found grownabundantly in the tissues of different higher plants. It is reported that, different species of fungi are highly beneficial for degradation of pollutants including oil spills and different types of alkanes. Coastal fungal species including, *Alternaria alternate, Aspergillus flavus, A. niger, Penicillium chrysogenum, Trichoderma harzianum* are most common species involved in it. Anthracene is completely degraded by*Penicillium oxalicum.*

Fusarium oxysporium shows major bioremediation efficiency. Sashirekha and Usmani (2016) with their research proved it. Fungus can tolerate the pH range from 5 to 11 means it can adapt itself to acidic and basic pH conditions. It has metal tolerance index for zinc 3.7 % to 51 % ppm and 1% to 53% for lead (Sashirekha and Asra, 2016). *Scedosporiuma piospermum, Penicillium spp*and *Aspergillus spp.* have proved experimentally to be effective to degrade polychlorinated biphenyl (PCB) present in historically contaminated soil (Varese *et. al.*, 2009).

The diversity of habitat and ability for secreting multitude of enzymes makes fungi potential candidates for bioremediation.

White rust fungi like *Phanerochaetechy sosporium, Tramtes versicolor, Bjerkandera adjusta* and *Pleurotus sp.* can produce various lignolytic enzymes can be used for the bioremediation of pharmaceutical and personal care products which can result in effects such as bioaccumulation, acute and chronic toxicity. The lignolytic enzymes from white rust fungi have been applied for transformation of organic pollutants such as pesticides using biopurification system. Some species of white rust fungi such as *Coriolus versicolr, Hirschioporus larincinus, Inonotus hispidus* etc. are used for decolourization of dye effluents. Many species of white rust fungi have been reported to be used in reduction of total phenolics, cresolate, petroleum hydrocarbons and high molecular weight PAH fractions. Marine fungus, *Trichoderma harzianum*has, the capacity to transform pentachlorophenol whereas the *Mucor, Aspergillus* and *Penicillium* show bioremediation potential for water soluble crude oil fractions (Deshmukh *et.al.* 2016). Different types of enzymes secreted by white rust fungi are also causes degradation of different types of xenobiotic compounds present in the soil and environment. Such enzymes include lignin peroxidase, manganese peroxidase, oxidase, laccases etc. (Mariem and Sayadi, 2016).

Young (2012) reported that, extracellular enzymes secreted by white rot fungi during lignin decay can be used as promising agent for oxidizing pollutants. He used *Punctularias trigosozonata, Irpexlacteus, Trichaptum biforme, Phlebia radiate, Trametes versicolor* and *Pleurotus ostreatus* species of white rot fungi. All species tested have degraded C 10 alkane, C 14 alkane and polycyclic aromatic hydrocarbon phenanthrene. Bioremediation and detoxification of wastewater originated from textile industry have been practiced by using white- rot fungus to make water reusable (Hossain *et.al.* 2016). The decolonization capacity of white rot fungus *Coriolus versicolor* was confirmed by them through agar plate and liquid batch studies. *Phanerochaete chrysosporim, Pleurotusostreatus, Trametes versicolor,*

Bjerkandera adusta, Lentinula edodes, Irpexlacteus, Agaricus bisporus, Pleurotus tuberregium and *Pleurotus pulmonarius* are some mushroom white rot fungi used for the purpose of bioremediation and to degrade different xenobiotic compounds (Christopher, 2014).

Fungal laccases are blue multicopper oxidases which catalysze the monoelectric oxidation of a broad spectrum of substrates like polyphenols, aromatic and aliphatic amines etc. can be used as a tool for bioremediation. Laccase fro white rot fungus *Trametes hirsute* is used to oxidize alkanes. Laccase from *Flavodon flavus* is useful in decolourization of several synthetic dyes, (Viswanath *et.al.* 2014). Fungal laccases are applicable in variety of fields like paper and pulp industry, textile industry, xenobiotic degradation and bioremediation.

Ligninolytic fungi are highly useful in the bioremediation of contaminated soils. The most important role of ligninolytic fungi in nature is to regulate global carbon cycle. Naturally the ligninolytic fungi produce some extracellular enzymes which degrade wood material, plant litter as well as soil humic substances. Same enzyme can be utilized to degrade other recalcitrant organic compounds such as toxic metals. By using lignolytic fungi, it could be possible to widen the applicability of bioremediation even to persistent Organic Pollutants (POP), PAHs, and PCDD rich soils.

Seguel *et. al.* (2017), concluded by their research that, arbuscular mycorrhizal fungi such as *Claroideoglomus claroideum* along with *Oenothera picensis* plant contributes to phytostabilize the copper in the contaminated soils. Autochthonous filamentous fungi are highly useful in bioremediation of a soil historically contaminated with aromatic hydrocarbons. Petruccioli *et. al.* (2006) isolated nine fugal strains from an aged and heavily contaminated soil to study their degradative potential. It was observed that the strains like *Allescheriella sp., Stachyobotrys sp. and Phlebia sp.* fungi led to a significant decrease in soil toxicity by removing different types of aromatic hydrocarbons including naphthalene, dichloroaniline,o-hydroxybiphenyl and 1,1-binaphthalene.

Apart from above different types of contaminants, fungi can be used to repair the sites contaminated by acidic radioactive wastes. The radioactive wastes are highly acidic and mixed with heavy metals are continuously leaking in the environment causing contamination of soil as well as groundwater. It is not possible to cleanup such radioactive sites by physicochemical processes due to danger and high expenses. So, some radiation resistant bacterial strains like *Deinococcus radiodurans* can be used to treat such soils but have some limitations. They are very sensitive to low pH and can't survive. So, finally some strains of yeast are reported for bioremediation which are resistant to ionizing radiation. *Rhodotorulatai wanensis* is most specialized fungus applicable for the treatment such a polluted site. Filamentous fungal biomass has a great potential to produce large amount of biomass on the contaminated water with different types of metals with which these are able to absorb metals like Pb, Zn,Cd,Cu, Cr, As and Ni. Many fungal species have been reported such as *Trichoderma autroviride*, *T. harzianum*, *T. virens* and *Aspergillus niger*, that are used for bioremediation of polluted areas. Other fungal species including *Penicillium*, *Rhizopus*, *Mucor*, *Saccaromyces* and *Fusarium* have also shown the capacity to biosorb different types of metals present in the waste water. Polycyclic hydrocarbons (PAHs) are widespread pollutants raising public health concerns because of their chronic toxicity and environmental problems due to their persistence and accumulation in the ecosystem. The filamentous soil fungi like *Talaromyces helices* have shown the capacity to degrade organic pollutants including PAH. Fungus will have some major limitations while bioremediation such as high chemical stability and low bioavailability of PAHs. This limitation has been overcome by Baranger *et. al*. (2018) by the microfluidic approach in which benzo [a] Pyrene (BaP) are used to mimic

polluted soil microenvironment. Sharma and Malvia (2014), reported the bioremediation of tannery wastewater by Chromium (Cr) resistant fungal isolate *Fusarium chlamydosporium*.

Akwaji *et. al*. (2016), reported that, *Penicillium* sp. can biodegrade the hydrocarbons present in spent engine oil. Soil is added with different concentrations of spent engine oil inoculated with *Penicillium* sp. In that soil they seeds of *Telfeira occidentalis* plant was sown and assessed for growth performance. It was observed that, after 28 days of plant growth, the added spent engine oil was no longer detected. The plant began producing pods because *Penicillium sp*. could degrade hydrocarbons of spent oil completely. Teresa (2011) reported that, petroleum substances are the main source of pollutants stored in old waste pits which are responsible for degradation of biological life in the area of storage. The non pathogenic bacteria and fungal species can be used for the biodegradation of such petroleum hydrocarbons. *Aspergillus sydowii*, *Cladosporium cladosporioides* and *Phanerochaete chrysosporium* are some fungal species used for the purpose. *Aspergillus ustus* and *Alternaria alternate* have been tested against diesel fuel by Kaled *et. al*. (2015). According to their study, the two fungal strains can degrade 92-100% diesel after 7 days. The degradation process was enhanced using fungal consortium of both the strains.

Due to resistance to biological process, plastic waste in the environment is a significant threat. Brunner *et. al*. (2018) reported the ability of some fungal strains found on floating plastic debris to degrade plastic. The fungal strains are collected and identified genetically and used to test their ability to degrade polyethylene and polyurethane. Results of the tests have shown that, none of the strain was able to degrade polyethylene however four strains were able to degrade polyurethane. Out of four strains three were litter saprophytic which includes *Cladosporium cladosporioides*, *Xepiculopsis graminea*, and *Penicillium griseofulvum*. One strain that is, *Leptosphaeria sp*. was the plant pathogen. The fungus strains collected from other than plastic source also shows the ability to degrade the plastic. *Agaricus bisporus, Marasmius oreades* and *Pestalotiopsis microspora* are such fungal species.

Podosporaan serina is a special type of fungus which reproduces only by sexual means, non-pathogenic, cosmopolitan species is used for the bioremediation of soils which are contaminated with aromatic amines (Philippe *et.al.* 2011). Fungus has its arylamine N-acetyltransferase 2 enzyme which has ability to detoxify the highly toxic pesticide residues 3,4-dichloroaniline present in the soil. 3, 4 dichloroaniline belongs to the class of aromatic amines.

Use of pesticides and herbicides is an effective method to control different types of pests including weeds. Bout overuse of those can cause harms to environment. The increased concentration of pesticides and herbicides in the soil can be controlled by using bioremediation. Gokhan (2017) carried out a research on the application of some selected fungi on bioremediation of herbicide Chlorsulfuron. According to his study, the fungal species such as *Penicillium thrichoderma, Penicillium simplicissimum, Penicillium talaromyces, Metacordyceps chlamydosporia, Stachybotrys chartarum* and *Alternaria alternata* are effectively involved in the degradation of the herbicide Chlorsulfuron.

Soil and water are the very important components required for the plant growth. Agriculture production is highly affected by quality and quantity of soil and water. Due to industrialization, urbanization, mining, overuse of fossil fuels and modern agriculture different types of contaminants like toxic metals, hydrocarbons, pesticides, herbicides, aromatic amines, plastics, radioactive wastes and many other types of life threatening waste are mixed and continuously being released in soil and water. The treatment of such harmful wastes by using physicochemical methods has some limitations and may gives rise

to secondary pollutants in the environment. Bioremediation is an effective and efficient way to minimize such type of contaminants in the soil. Fungi are cosmopolitan in nature and can grow at acute adverse conditions where other microorganisms cannot grow. Many white rot, filamentous, lignolytic, arbuscular mycorrhizal and other fungal species can be effectively used to reduce concentration of variety of life threatening contaminants saturated in variety of soils and water resources. This approach is very useful to make contaminated soil usable for crop production. Thousands of acres of land contaminated by variety of pollutants may be converted in to fertile land leads to increase agricultural production and important to meets needs of growing population. Water is another necessary component required for living organisms and crop production. Due to various manmade calamities, natural water resources are getting contaminated by different types of wastes. Polluted and contaminated water can be purified by minimizing the concentration of different types of pollutants dissolved and suspended in it. This can be achieved by using different types of fungal species especially, filamentous fungi.

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About Editor

Dr. Kirankumar Khandare is presently working as Assistant Professor in P.G. Department of Botany, Maratha Vidya Prasarak Samaj's K. A. A. N. M. Sonawane Arts , Commerce & Science College Satana, Dist. Nashik, Maharastra (Reaccedited "A" Grade by NAAC) affiliated to Savitribai Phule Pune University, Pune.

He has 20 years of teaching and research experience. After obtaining M. Sc. in Botany from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, he subsequently received Ph. D. from the same University. His area of research is Plant Pathology, Boipesticides and Mycology. He has participated in more than 35 National and international Conferences. He has presented more than 25 research papers at various conferences, seminars and symposia. He has published 43 research papers in national and international journals in the area of Plant Pathology, Biopesticides and management of crop diseases. He is the fellow of society of Life Sciences (F.S.L.Sc.), Fellow of Society of Environmental Science (F.S.E.Sc.). He is the Chief editor of *Scientia Natura,* an international research journal of science. He has worked as Referee for various International Research Journals. He has edited five books in the area of Biodiversity, Life Sciences, Plant Pathology.

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INFLUENCE OF *Chromolaena odorata* (L.) LEAVES EXTRACT ON CARBOHYDRATE AND PROTEIN CONTENT OF *Cajanus cajan* (L.)#

Madane A. N[1], Kenger Y.D [2] and Patel S.I.[3]

Abstract

Carbohydrate status of plants has significant role in improving yield and quality of crop plants. Carbohydrate contents are essential elements for metabolism of plants. Influence of aqueous leaves extract (at 30% and 1% concentration) of *Chromolaena odorata* was studied on carbohydrate contents of seedlings in pigeon pea in Petri plate under laboratory conditions.The total sugar content in *Cajanus cajan* was decreased with increase in soaking periods and increasing concentration percentage. In case of starch content in germinating seeds of *Cajanus cajan* was increased in all treatment ranging from 1 to 30 % and also sprotein content of *Cajanus cajan* the 1% extract concentration responds to increases protein content. The maximum protein content was observed in after treatment of 1% extract treatment after 6 hours soaking period. The leaves extract concentration increased carbohydrate content decrease in seedlings in Petri plate bioassay.

Key words: *Cajanus cajan* , *Chromolaena odorata ,* Carbohydrate

#Research Article

[1]Department of Botany, Arts, Commerce and Science College, Nandgaon, Dist. Nashik (MS), 2Department of Botany,Smt. Kusumtai Rajarambapu Patil Kanya Mahavidyalaya, Islampur, Dist. Sangli, Maharashtra, India, 41540
E-mail:

Introduction

Plant nutrition is one of the most important factors in crop production which have an important role in crop production and improve quality of agricultural products. For suitable plant nutrition, every element should be supplied in enough amount for plant growth and balance and respect the ratio between used nutrients. (Alloway, 2008). In agricultural development programs role of micronutrients is important to increase crop yield and quality. Allelopathy also played important role in various types of stress conditions of environment including soil nutrient inadequacy (Al-Wakeel., 2007). Phenolic compounds are involved in alterations of availability of mineral elements in rhizosphere and organic matter dynamics (Makoi and Ndakidemi, 2007).

Materials and Methods

Carbohydrate

Total soluble sugar and starch content was estimated Nelson (1944). 0.5 gram of seedling were extracted in 80% alcohol and filtered through whatman No.1 filter paper using Buchner' s funnel under suction. The filtrate was condensed on water bath to about 2-3 ml. About 2 g of mixture of lead acetate and potassium oxalate (1:1) was added with constant stirring and then the contents were mixed with 20 ml distilled water. It was transferred into conical flask containing 2 ml concentrated HCL. The flask was plugged with cotton and autoclaved for 30 minutes under 15 lbs pressure. After cooling to room temperature, the contents were neutralized by adding anhydrous Na_2CO_3 and filtered again. The volume of filtrate was recorded, and it was used for estimation of total sugars. The residue left on filter paper during the alcoholic extraction was transferred along with the filter paper into conical flask containing 5 ml concentrated HCL and 15 ml distilled water. It was hydrolyzed at 15lbs pressure for 30min and then cooled to room temperature. The contents were neutralized with anhydrous Na_2CO_3 and filtered. The volume of filtrate was recorded. This filtrate was used for the estimation of starch. Estimation of sugar was carried out calorimetrically one ml of Arsenomolybdate regent was added then after cooling the absorbance was recorded at 560 nm on a spectrophotometer against a blank. Standard curve of carbohydrates obtained by using different concentrations of glucose (0.1 mg ml^{1}) was used to calculate the amount of total sugar and starch present in seeds.

Total Protein

Soluble proteins were estimated from seedling of *Cajanus cajan* and *Cicer arietinum* Lowery *et al.,* (1951). 0.5 mg plant material was homogenized in 0.1 M phosphate buffer (pH 7), filtered through moist muslin cloth and centrifuged for 10 min at 5000 rpm, 0.5 ml supernatant was taken in to test tube to prepare an assay, followed by 5ML alkaline copper tartate solution [prepared by mixing of 50 ml of reagent 'a' (2% Na_2CO_3 in 0.1N aqueous NaOH) with 1ml of reagent ' b '(0.5 % $CuSO_4$, $5H_2O$ in 1% Sodium tartate). After 15 min 0.5 ml folinphonol was mixed and it was kept for 30 min at room temperature. Absorbance was recorded at 660 nm against a blank prepared with distilled water. Amount of soluble proteins was calculated with the help of a standard curve obtained using different concentrations of bovine serum albumin, by similar procedure as employed for plant extract.

Result and Discussion

Carbohydrate content

Total Sugar

***Cajanus cajan* L.**

The effect of *Chromolaena odorata* extract was tested on total soluble sugar content of *Cajanus cajan* seedling and depicted in table and fig.

Table: 1. Effect of *Chromolaena odorata* Leaf Extract on Total Sugar Content in *Cajanus cajan* L.

Concentrations	Seed Soaking Period (hr)		
	6	12	24
Control (D.W)	1.6 ± (0.63) [a]	1.4 ± (0.75) [a]	1.3 ± (0.26) [a]
1%	**1.8** ± (0.025) [ab]	**2.1** ± (0.28) [ab]	**2.89** ± (0.74) [ab]
10%	0.4 ± (0.26) [ab]	0.1 ± (0.75) [ab]	0.6 ± (0.42) [a]
20%	0.5 ± (0.85) [a]	0.085 ± (0.36) [a]	0.04 ± (0.14)
30%	0.3 ± (0.75) [a]	0.42 ± (0.35) [a]	0.02 ± (0.23) [a]

Note:

1) Values are mean of three replications and expressed in $mg.100g^{-1}$.
2) Figures in the parenthesis are according to Duncan's multiple range test (DMRT).
3) Same letter on parenthesis is not significantly different ($P < 0.05$).
4) Above values obtained after 96 hours of germination.

The 1% treatment showed stimulatory effect in all soaking periods as compare to control. *i.e.* 1.8, 2.1, and 2.89 $g\text{-}100g^{-1}$. The remaining treatments showed inhibitory effect in total sugar as compared to control. Increasing seed soaking period decreases the total sugar value expect in 1% treatment. Total sugar content in 6-, 12- and 24-hour seed soaking period was highly reduced in 20 and 30% treatment. Das *et al*. (2012) examined allelopathic potentialities of leachates of leaf litter of some selected tree Species on chickpea seeds. They observed that reduction in total soluble sugar content in chickpea seedlings with the treatment of 100% (v/v) leaf leachates of *Acacia auriculiformis*, *A. occidentale, A. lebbek, Eucalyptus citridora, Emblica officinalis, Shorea robusta etc.* El-Shora *et al*. (2015) reported that allelopathic potential of aqueous leaf extract of *Trichodesma africanum* on germination, growth, chemical constituents and enzymes of *Portulaca oleracea*. The finding of results that aqueous leaf extract of *T. africanum* reduced soluble carbohydrate, insoluble carbohydrate and total carbohydrate contents.

Tripathi *et al*. (1998) was determined the allelopathic action of *Tectona grandis, Albizia procera* and *Acacia nilotica* on biochemical development of soybean. The lower concentration three species showed stimulatory impact on protein, sugars, and proline substance of soybean. (fig-1) The report of these scientists supports to the present work.

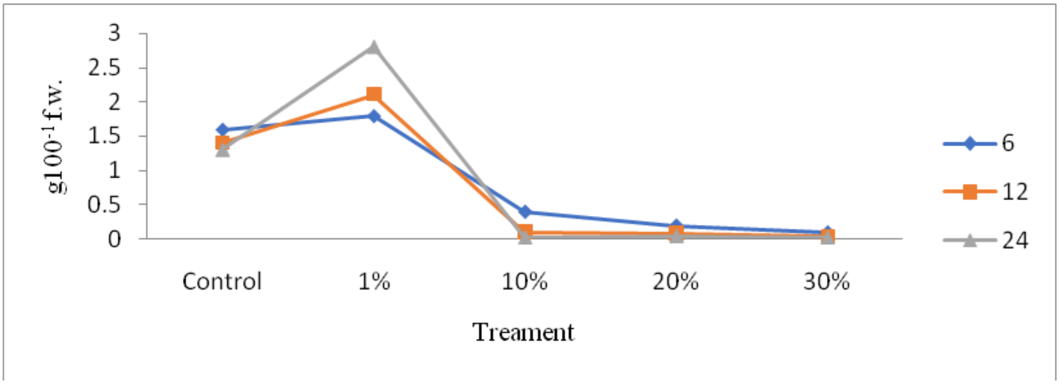

Fig.:1. Effect of Leaf Extract of *Chromolaena odorata* on Total Sugar Content *Cajanus cajan*.

Total Protein

a) *Cajanus cajan*

The total protein in *Cajanus cajan* after seed treatment with *Chromolaena odorata* extract was tested.

Table: 2. Effect of Leaf Extract of *Chromolaena odorata* on Total Protein Content in *Cajanus cajan* L.

Concentrations	Seed Soaking Period (hr)		
	6	12	24
Control (D.W)	10.21 ± (0.25)^{a}	12.21 ± (0.29)^{a}	13.11 ± (0.56)^{a}
1%	**11.28** ± (0.28)^{a}	**12.91** ± (0.26)^{a}	**14.16** ± (0.84)^{a}
10%	9.11 ± (0.54)^{ab}	6.23 ± (0.29)^{b}	5.14 ± (0.89)^{b}
20%	6.26 ± (0.28)^{bc}	4.12 ± (0.24)^{bc}	2.96 ± (0.24)^{c}
30%	3.12 ± (0.56)^{d}	1.16 ± (0.22)^{d}	0.89 ± (0.11)^{d}

Note:
1) Values are mean of three replications and expressed in mg.100g^{-1}.
2) Figures in the parenthesis are according to Duncan's multiple range test (DMRT).
3) Same letter on parenthesis are not significantly different ($P < 0.05$).
4) Above values were obtained after 96 hour of germination.

The protein content in *Cajanus cajan* was found to be decreased with increase in concentration and seed soaking periods. The maximum protein content in *Cajanus cajan* was observed in 1% concentration as compared to all other plant extract, treatments, and control. The minimum protein content was observed after 30% concentration. The lower concentration *i.e.* 1% enhances total protein content as per increase in seed soaking period. In control condition protein content increase as per increase in seed soaking period but it is exactly reverse in increase concentration treatment.

Pawar and Rawal, (2014) studied the influence of petal leachate of *Delonix regia* on germination and seedling growth of chickpea, They observed that total soluble protein of chickpea was reduced due to aqueous extract of petal leachate of *Delonix regia.* Padhy *et al.* (2000) and Kavitha *et.al* (2012) allelopathic potential of *Eucalyptus* leaf litter leachates on germination and seedling growth of finger millet noticed that the leachates of *Eucalyptus globulus* reduce the protein content in both the root and shoot of finger millet. The present work correlated investigations.

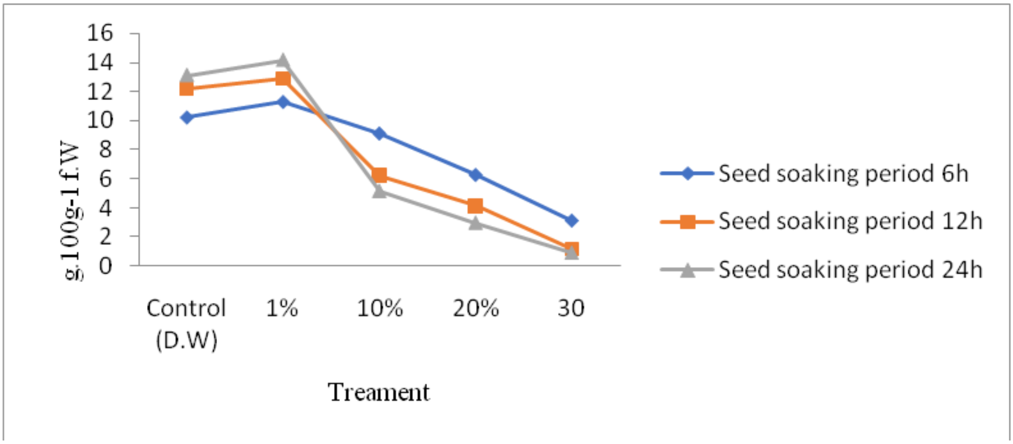

Fig.: 2. Effect of Leaf Extract of *Chromolaena odorata* on Protein Content of *Cajanus. Cajan*.

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Editors Profile

Dr. Uttam Laxman Dethe is a Head of PG- Department of Botany, Shri PanchamkhemrajMahavidyalaya, Sawantwadi. He has more than 30 years of teaching experience and 15 years of Research experience. With over a decade in the field of plant science research, Dr. Dethe has his own identity that shines through his International and national publications. His research area is Marine Botany, Plant Physiology, Mangroves and Phytochemistry. He has participated in many Conferences. His has successfully completed couple of research projects on mangroves. He is also served as a member of Board of Studies. He is author of many book chapters and has edited book.

Dr. Nivas M. Desai, is a Fellow of Association of Plant Science Research (FAPSR). With over a decade in the field of plant science research, Dr. Nivas has a unique identity that shines through his more than 25 International and national publications. His research area is Marine Botany, Plant Physiology, Functional foods and photochemistry. He has more than 26 International and National Publications and participated in 30+ Conferences. His has successfully completed a DST Fasttrack Project on Marine Cyanobacteria. He has been also awarded by couple of Young Scientist Awards and Research Excellence award also. He is a author of many book chapters and has edited couple of books.

Dr. Umesh R. Pawar is a hardcore Botanist and Assistant Professor at PG-Department of Botany, SPK College Sawantwadi. His research area is in the field of molecular characterization of mangroves. He has received his PhD from Annamalai University, Tamil Nadu. He has several publications in his credits and attended many conferences. Dr. Umesh is more interested in the conservation of Mangroves.

Dr. Vishal T. Aparadh has completed his Ph.D. in Physiology from Shivaji University Kolhapur. His research work in botany is reflected through his publications. Dr. Vishal's research area is Phytochemistry of Medicinal Plants. Presently he is working at Shri Pancham Khemraj Mahavidyalaya, Sawantwadi. Along with teaching and research he is active in the Mushroom cultivation and fruit carving.