INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-3, Issue-2, April-June-2013 ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

Received: 04th Feb-2013 Revised: 24th Feb-2013 Accepted: 27th Feb-2013

*Research article*

# AM FUNGAL POPULATION IN POLLUTED SITES OF JODHPUR REGION

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**ABSTRACT:** Indian Thar Desert have very diverse flora because of its adverse conditions. This unexplored flora may have varied characteristic features which can be used for the bioremediation purposes, as the polluted sites also have adversities in its ecology. Addition of exogenous microflora in the ecosystem of contaminated sites would enhance rate of biodegradation. AM fungal plant- microbe interaction is found in almost 99% of the desert plants. Four genera of Arbuscular Mycorrhiza were found in contaminated sites of Jodhpur region. *Glomus deserticola* was found in abundance, followed by *Gigaspora margarita*, *Scutellospora calospora*, *Glomus mossae* These AM fungi can be mass cultured by using *Cenchrus ciliaris* as host. The roots of the grass can be used as inoculants for addition as exogenous microflora for the purpose of microbial bioremediation and rhizoremediation to the polluted sites.

**Keywords**: bioremediation, micro flora, AM fungi

## INTRODUCTION

Industrialization, urbanization and increased population has increased environmental pollution rapidly. Soil is the uppermost layer of earth crust which supports all the flora and fauna of the mother Earth. It also regulates the global biogeochemical cycles. Soil environment has been polluted with toxic materials from fossil fuel burning, mining and smelting of metalliferous ores, disposal of sewage, fertilizer, pesticides etc.. There is need for sustainable development that means social, economical and environmental factors go hand in hand with the need of controlling emissions of pollutants in the environment. The Thar desert is characterized by scarce and irregular rainfall which leads to low moisture, high wind velocity which causes huge shifting and rolling of sand dunes, high diurnal variation of temperature(minimum 5°C to maximum 47°C),intense solar radiation and high evapotranspiration rate and scanty vegetation. Soil here is generally sandy to sandy-loam in texture. The soil is alkaline and pH varies from 7 to 9.5. The desert soils occupy the districts of Jodhpur, Bikaner, Churu, Ganganagar, Barmer, Jaisalmer and Jalore.

The microbial diversity in desert soil is highly dependent on characteristic such as temperature, moisture and nutrient availability. Due to these reasons more microbial population is found in the rhizospheric region of the desert plant. Due to extreme weather conditions like extreme variations in temperature and moisture , organically poor soils,with limited amounts of bioavailable inorganic nutrients, the plants are highly adaptable to dry as well as physiologically dry conditions (salinity). So it is possible that the under explored microbial flora also has high adaptability to cope with frequent droughts and various stresses such as starvation, high osmolarity, high temperature, and dessication and variation according to the ecosystem of the desert. There is very little knowledge on rhizosphere microbiology of the desert plants. Some previous reports have described the isolation and physiological characterization of specific microorganisms, viz., antibiotic producers or specific plant–microbe relationships [1].
Soil remediation can be done by processes like soil excavation, soil leaching, flushing, stabilizing vitrification, thermal desorption, encapsulation.[2].These processes are applicable to very small areas and are very costly and the main problem is that contamination is just passed on from one location to another it does not end. Moreover, they result in biologically dead soil, i.e. soil looses indigenous flora fauna and microbes. Thus, to tackle the problem of contamination of organic and inorganic pollutants the use of presently available biological resources is found more appropriate rather. So, today bioremediation is a well known and highly ethical process to treat pollution.

This technique is of three types; *microbial bioremediation* which uses microbes present in the nature to change form of pollutant to a non harmful chemical or degrade it completely by using it as a source of nutrition. Second is *phytoremediation* where plants are used to remediate the pollution either by phytovolatilisation, phytoaccumulation, phytostabiliization, rhizofilteration, phytodegradation, rhizodegradation, phytoextraction.Third and the most attractive and highly effective technique of bioremediation is *rhizoremediation* which uses both the above types for the purpose of contamination treatment. This technique works on the principle that the microbes are present more near the roots (the rhizospheric soil) as compared to soil without vegetation. The reason behind it is that microbes get nutrition from plants in the form of root exudates and thereby increase their population. While when plant is their source of nutrition they tend to help plant by providing protection against the antagonistic effects of harmful bacteria. This mutual relationship gives us a clue that the process of microbial bioremediation as well as phytoremediation can be fastened by using both the technique together. Plant would be protected from adverse biotic stress while microbe can survive well in contamination due to support by plant. When we move on to a well known symbiotic relationship of mycorrhizae and plant(this relationship is found in more than 95% of plant species) more advantageous system is generated because here the microbe provide hardiness from biotic as well as abiotic stress caused by the contaminants. In addition to MHBs (mycorrhiza helping bacteria), water absorption capacity and phosphate availability is also increased in this symbiotic relationship.
Thus, now due to all the above factors there is need to explore microbial flora of the Indian Thar Desert so that we can enhance the rate of biodegradation of contaminants by adding exogenous microbial population to the contaminated site. *Cenchrus ciliaris* can as a host to mass multiply the fungal spores, the roots of this grass can then be uprooted, cleaned and chopped to 1 cm pieces to use as inoculants for the purpose of rhizoremediation.

## MATERIAL AND METHODS

### Site description

This investigation was conducted at six sites in the Jodhpur, Rajasthan ( industrial area of new power house site, heavy industrial area of Boranada, heavy industrial area of Mogra, Industrial area of Sangaria, Industrial area of Mandalnath and Industrial area at Mandore). An intensive field survey of these sites was undertaken in order to find out occurrence of AM fungal spores in the rhizosphere of *Prosopis cineraria.*

### Soil sampling

Rhizosphere soil samples (soil adhering to the roots) were collected at 30-90 cm depths along with root samples in five replicates from *P. cineraria*. Before sampling, the soils from the upper layer were scrapped off to remove foreign particles and litter. The roots were processed immediately. All the soil samples collected in self locking polyethylene bags from the rhizosphere of a particular plant species were homogenized replication wise before processing by sieving (< 2 mm mesh size) to remove stones, plant material and coarse roots. Sample of each soil was air dried and used for estimation of various physico-chemical properties and to isolate the microbes present.

### Soil parameters

Soil samples were analysed for pH and electrical conductivity on 1: 2.5, soil: water suspension. Organic carbon was estimated by the method of Walkley and Black (1934)[3]. Available phosphorus in soil was determined by Olsen *et al*., 1954[4]. Soil texture was estimated gravimetrically by hydrometer method by Jackson, 1967[5].

### Spore isolation

Spores from the rhizospheric soil were extracted by the Wet- sieving and decanting technique [6] and sucrose centrifugation method [7]. The identification of spores was based on spore size, color, wall layer and hyphal attachment using the identification manual [8] and description provided by the International collection of Vesicular and Arbuscular Mycorrhizal fungi.

## RESULT AND DISCUSSION

An extensive field survey was carried out to evaluate the AM fungal spore population present in rhizosphere of *Prosopis cineraria* which was found commonly in all the six polluted sites. The physiochemical properties of all six sites showed that soil texture varies from sandy gravel to sandy loam. The soil had a pH ranged from 5.01 to 8.32, organic carbon between 0.10% and 0.38% and Olsen P level of 4.1 - 9.3 mg $kg^{-1}$. In general, soils are alkaline in reaction, low in organic matter content and available P status. [Table 1 and 2].

**Table 1: Physiochemical characteristics of site soils.**

| S.No. | Industrial sites | pH | EC(dSm-1) | OC (%) | Olsen P (mg kg-1) | Texture |
|---|---|---|---|---|---|---|
| 1. | New Power House | 5.22 ± 0.01 | 0.13 ± 0.02 | 0.13 ± 0.01 | 8.4 ± 0.01 | Sandy gravel |
| 2. | Boranada | 5.24 ± 0.02 | 0.15 ± 0.01 | 0.15 ± 0.01 | 8.6 ± 0.02 | Sandy loam |
| 3. | Mogra | 8.32 ± 0.03 | 0.25 ± 0.04 | 0.38 ± 0.01 | 4.1 ± 0.04 | Sandy |
| 4. | Sangaria | 5.01 ± 0.01 | 0.11 ± 0.01 | 0.10 ± 0.01 | 7.6 ± 0.01 | Sandy loam |
| 5. | Mandalnath | 5.25 ± 0.02 | 0.15 ± 0.03 | 0.16 ± 0.01 | 8.6 ± 0.01 | Coarse loam |
| 6. | Mandore | 5.06 ± 0.01 | 0.12 ± 0.01 | 0.11 ± 0.01 | 9.3 ± 0.03 | Sandy loam |

± Standard error of mean

**Table 2: Distribution of AM fungal species associated with Prosopis cineraria found in Polluted regions of Industrial areas of Jodhpur**

| AM fungal species | New Power House | Boranada | Mogra | Sangaria | Mandalnath | Mandore |
|---|---|---|---|---|---|---|
| *Acaulospora leavis* Gerdmann & Trappe | – | + | – | – | + | + |
| *Gigaspora margarita* Becker& Hall | ++ | + | ++ | ++ | ++ | ++ |
| *Gigaspora rosea* Nicol & Schenck | + | ++ | + | + | – | + |
| *Glomus aggregatum* Schenck & Smith | + | + | + | – | ++ | ++ |
| *Glomus constrictum* Trappe | + | + | ++ | + | – | + |
| *Glomus deserticola* Trappe Bloss & Menge | +++ | +++ | +++ | ++ | +++ | ++ |
| *Glomus mosseae* Gerdmann & Trappe | ++ | ++ | + | +++ | + | ++ |
| *Scutellospora calospora* Walker & Sanders | ++ | + | ++ | + | ++ | +++ |

**- =** Absent, + = Low (< 20%), ++ = Moderate (20-50%), +++ = High(> 50%)

In all the replicates from at each of six polluted soil( industrial area of new power house site, heavy industrial area of Boranada, heavy industrial area of Mogra, Industrial area of Sangaria, Industrial area of Mandalnath and Industrial area at Mandore) four genera of Arbuscular Mycorrhizal fungi were commonly present. These were *Glomus*, *Acaulospora*, *Gigaspora* and *Scutellospora*. It is reported that genus *Glomus* has been the most common AM fungi distributed globally and it is also known to dominate in tropical areas [9] as well as temperate regions [10] of the world. Four species of *Glomus*, two of *Gigaspora* and one of *Acaulospora* and *Scutellospora* each were found in the polluted regions. Four species being *Glomus deserticola*, *Gigaspora margarita*, *Scutellospora calospora* and *Glomus mossae* were present in all six sites. Other species being *Acaulospora leavis*, *Gigaspora rosea*, *Glomus aggregatum* and *Glomus constrictium* were also present. In all the sites *Glomus deserticola* was the most abundant species, followed by *Glomus mossae* and then *Scutellospora calospora*. Maximum spore population was found in Mandore industrial area followed by Boranada area. All the eight species were found commonly in these two areas. The area with least AM fungal spore population was in Sangaria industrial area.

## CONCLUSION

The rhizospheric soil of legume *Prosopis cineraria* from the polluted areas of Jodhpur show the presence of eight species belonging to four genera. The studies showed that the *Glomus deserticola* was found more dominantly in the polluted region. All these species, thus are capable to survive and propagate in the polluted region and are therefore can be an important tool for rhizoremediation when used with leguminous species for decreasing the adversities (abiotic stress). The AM fungi also increase surface area of roots of plant and thus can be stabilize pollutants of greater area. These can thus increase availability of pollutants with less solubility to the phytoremediating plant.

## ACKNOWLEDGEMENT

We thank council of scientific and industrial research for providing financial support by granting Junior Research Fellowship.

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