*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. 2(**1**), 12-18, January (**2013**) *Int. Res. J. Environment Sci.*

Incidences of Arbuscular Mycorrhizal Fungi (AMF) in Urban Farming of Mumbai and Suburbs, India

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Available online at: www.isca.in
Received 27th November 2012, revised 25th December 2012, accepted 10th Januray 2012

Abstract

Mumbai, economical capital of India is its true sense is Mayanagari, where the major problem is of space for accommodation and so as land under cultivation is rare in occurrence. The Local train is a life-line of Mumbai. It passes from the major part of Mumbai city and its suburbs. Near the tracks some area of land might be available for urban agriculture. To support day today needs of fresh vegetables, majority of the time such land near railway tracks are utilized. It is the waste land near tracks utilized for cultivation of leafy vegetables like fenugreek (Trigonella longiceps), chavali (Vigna unguiculata), fruit vegetables like bhindi (Abulmoschus esculantus), and some Chenopodiaceae members. Such soils are often of very poor quality for cultivation practices. Irrigation is often done from gutters and waste water from washing and garage water. In such disturbed habitats incidences of mycorrhizal fungi are more in terms of percent colonization. In present investigation, roots of such commonly cultivated crops like bhindi, chavali, and fenugreek were collected from different locations from Central Railway side tracks and screened for % colonization by mycorrhiza fungi. Similarly, rhizospheric soil samples were also collected and detail investigations were carried out like physical parameters such as soil pH, soil moisture, and organic matter. Samples were screened for Arbuscular Mycorrhizal Fungi (AMF) spores also and spore density was calculated for each sample. Lastly, all such parameters were analyzed for any correlation present amongst them.

Keywords: Disturbed habitats, urban agriculture, AM fungi, AMF spores, bhindi (Abulmoschus esculantus), chavali (Vigna unguiculata), and fenugreek (Trigonella longiceps) % root colonization, AM spore density.

Introduction

Mumbai, economical capital of India is its true sense is Mayanagari, where the major problem is of space for accommodation and so as land under cultivation is rare in occurrence. The Local train is a life-line of Mumbai. It passes from the major parts of Mumbai city and its suburbs. Near the tracks some area of land might be available for urban agriculture. Such areas are generally utilized by slum people for the accommodation, for garbage disposal and for as their backyards. Railway stations of Mumbai suburbs like Thane, Dombivali are quite large stations and much more such spaces are observed, whereas in Mumbai area like Masjid railway station is hardly having such space. In short more we move towards Mumbai Chattrapati Shivaji Terminus Railway platforms, the availability of space is problem whereas if we go to opposite direction of it like Parel, Bhandup, Thane, Mumbra etc the available land for urban agriculture becomes larger.

To support day today needs of fresh vegetables, majority of the time such land near railway tracks are utilized. It is the waste land near tracks utilized for cultivation of leafy vegetables like fenugreek (*Trigonella longiceps*), chavali (*Vigna unguiculata*), fruit vegetables like bhindi (*Abulmoschus esculantus*), and some Chenopodiaceae members. Such areas are managed hardly for such cultivation. No proper irrigation system and resource is available hence in such practices any water source is utilized for irrigation purpose. Such soils are often of very poor quality for cultivation practices. Irrigation is often done from gutters and waste water from washing and garage water.

The word mycorrhiza means fungal root derived from two Greek words as mycos meaning fungus and rhiza meaning root. Mycorrhiza can be defined as a symbiotic association for one or both partners between a fungus and a root of living plant that is primarily responsible for nutrient transfer[1]. The mycorrhizal fungi proliferate in both roots and soil. The soil borne extra radial hyphae take up the nutrition from the soil and transport them to the root system of the plant. It helps in increasing the surface area of absorption of the plant root system. In the soil with low moisture and low nutrient contain, this process leads to improve the plant growth and reproduction. The plant showing mycorrhizal association has more ability to tolerate the environmental stress than the non mycorrhizal plants[2].

Exceptionally wide range of plants in different ecosystems shows association with AM fungi. The latter play a major role in better nutrition, species diversity and survival. Amongst the Angiosperms, about 90 per cent of the families develop AM association. The occurrence of AM fungi differs qualitatively

and quantitatively with the change in edaphic factors and type of vegetation[3]. Ecological factors which influence the colonization of AM fungi in the soil are soil pH, temperature, moisture, organic matter content in the soil and soil pollutants. Changes in the soil pH greatly affect the development and functioning of AM fungi. Different species and strains of AM fungi show different responses to soil pH. Higher fungal spore density in acidic soil, while in alkaline soil the spore density is low has been reported[4]. Higher temperature results into high root colonization in temperate zone whereas it can be just a reverse in tropical region. AM fungi prefer optimum soil moisture for sporulation and growth. Because of it, during winter and summer spore density is low as comparing to rainy season in which it is quite high. Organic matter and soil fertility also play an important role in growth and sporulation of AM fungi. In low fertile soil, AM fungi spore density is higher to that of high fertile soil where it is quite low. Changes in soil fertility due to amendments with mineral fertilizers or organic matter markedly affect the activity and survival of AM fungi. They can grow saprophytically around decaying root fragments and other organic matter[5]. Nitrogen can stimulate or suppress root colonization by AM fungi and sporulation by changing the soil pH. In the presence of sufficient amount of Nitrogen in the soil, addition of Phosphorus suppresses root colonization. More amount of AM colonization is observed in P deficient soil[6].

In present investigation, roots of such commonly cultivated crops like bhindi, chavali, and fenugreek were collected from different locations from Central Railway side tracks and screened for % colonization by mycorrhiza fungi. Similarly, rhizospheric soil samples were also collected and detail investigations were carried out like physical parameters such as soil pH, soil moisture, and organic matter. Samples were screened for Arbuscular Mycorrhizal Fungi (AMF) spores also and spore density was calculated for each sample.

Material and Methods

For the present investigation sample collection was the main fundamental aspect. Since in Mumbai, central railway has sprayed like a network and almost 70 per cent of the stations are having such lands under urban agricultural practices, random sampling was done. The plants with root system along with rhizospheric soil were carefully collected in clean, unused plastic bags of suitable size. The samples are carefully labeled showing the records like date of collection, time, location, name of the host plant etc and were brought in the laboratory. After bringing the samples in laboratory, roots were carefully separated from entire plants, tapped gently to separate soil particles which were adhered to it (which was put in respective soil samples). The root samples were washed under tap water to clean and stored in 70 per cent of alcohol until further use. Soil samples were dried under sunlight and stored in well labeled, sterilized plastic bags. Likewise the samples were collected from different locations with the gap of almost only half a day as all the sites were situated on central railway side areas and there is a practical threat of harvest for day to day consumption and for selling to local distributors by plant growers.

Percentage root colonization was calculated after staining procedure[7,8]. The roots of collected plants were washed thoroughly with running tap water for removal of alcohol which was used as preservative. The properly cleaned roots were subjected to staining procedure. Roots were subjected to 10 per cent of potassium hydroxide and heated in water bath at 90^0 C for one hour to clear the tissue. Such cleared roots were washed with distilled water several times to remove the traces of alkali. In case of dark pigmentation of roots, they were treated with three per cent hydrogen peroxide for bleaching. It took 5 to 30 minutes depends upon the degree of pigmentation. This step was eliminated in the case of roots which are white or non pigmented. Once again roots were washed thoroughly for several times with distilled water. Washed roots were kept in 1 per cent hydrochloric acid for about 18 hours to neutralize the effect of alkali used for cleaning the root tissue. Acidification was followed by washing several time the treated roots to remove traces of acid. The roots were then kept in acid glycerol containing 0.05 per cent aniline blue in test tune. Then it was autoclaved for 15 minutes under the pressure of 15 labs at 121^0 C. After that, excessive aniline blue was drained off and excessive stain was removed from stained roots by using acid glycerol. The stained roots were stored in amber coloured bottle in acid glycerol until further use to avoid destaining. The roots were cut into small pieces approximately 1 cm in length and mounted on micro slides using glycerin as mounting medium. After placing the cover slips, the slides were observed under low power of objective of 10 X magnification to confirm the presence of mycorrhizal hyphae and high power objective of 40 X magnification to observe the presence of vesicles, spores etc. the slides were sealed with nail polish. The per cent root colonization was calculated by following formula [9].

$$\text{Per cent root colonization} = \frac{\text{No. of root pieces showing infection}}{\text{Total no. of root pieces observed}} \times 100$$

Isolation and quantification of AM spores was carried out by wet sieving and decanting method[10]. 25 g of sundried rhizospheric soil of different soil of different plants collected at different localities was taken in separate beakers. Half a litre of water and a pinch of soap powder was added to this. The solution was stirred and was allowed to stand for half an hour. The soil solution was then filtered through sieves of 500, 250, 150, 105 and 55 mm mesh which were kept one above the other. The spores and soil particles which settled on the surface of 150, 105 and 55 mm mesh sieve were washed and collected in separate beakers. The water was again filtered through whatman filter no. 1. This paper was observed under stereoscopic binocular microscope to count the number of spores. Different spores were examined for their taxonomic status by using standard key[11].

Rhizospheric soil sample were analyzed for its various physico – chemical properties like soil pH, organic matter content were estimated. Soil pH was determined by using pH meter model number EQ 614. Organic matter content was estimated[12].

Observations: The plants studied for AM fungi colonization are listed below with the locations from where they were collected table 1. Plants were studied for AM fungi association in terms of per cent root colonization figure 3 and no. of AM spores per 25 g of rhizospheric soil figure 4. The observations are tabulated in table-2 similarly, rhizospheric soil samples were analyzed for physico – chemical properties such as pH of soil, organic matter content and shown in table-3.

Table-1
Locations and plants collected for sampling

Location / Site	Name of Plants collected
Thane	*Trigonella longiceps*
	Vigna unguiculata
Mulund	*Trigonella longiceps*
	Vigna unguiculata
	Abulmoschus esculantus
	Spinacia oleracea
Bhandup	*Trigonella longiceps*
	Vigna unguiculata
	Abulmoschus esculantus
	Spinacia oleracea
Kanjur marg	*Spinacia oleracea*
Parel	*Trigonella longiceps*
	Vigna unguiculata
	Abulmoschus esculantus
	Spinacia oleracea
Kari road	*Trigonella longiceps*
	Vigna unguiculata
	Abulmoschus esculantus
	Spinacia oleracea

Table-2
Percent root colonization and no. of AM fungal spores

Location / Site	Name of Plants collected	% Root colonization	No. of AM spore / 25 g sundried rhizospheric soil
Thane	*Trigonella longiceps*	85.2	116
	Vigna unguiculata	90.0	68
Mulund	*Trigonella longiceps*	80.0	108
	Vigna unguiculata	89.12	78
	Abulmoschus esculantus	68.0	65
	Spinacia oleracea	0	35
Bhandup	*Trigonella longiceps*	84.0	99
	Vigna unguiculata	88.0	67
	Abulmoschus esculantus	69.2	66
	Spinacia oleracea	0	31
Kanjur marg	*Spinacia oleracea*	0	39
Parel	*Trigonella longiceps*	88.7	100
	Vigna unguiculata	90.2	78
	Abulmoschus esculantus	65.9	78
	Spinacia oleracea	0	24
Kari road	*Trigonella longiceps*	87.9	109
	Vigna unguiculata	82.0	78
	Abulmoschus esculantus	67.8	67
	Spinacia oleracea	0	29

Table-3
Physico – chemical properties of rhizospheric soil samples

Location / Site	Soil pH	Organic content of soil (%)
Thane	6.2	2.33
Mulund	6.0	2.1
Bhandup	5.7	1.9
Kanjur marg	6.0	2.2
Parel	6.9	3.0
Kari road	6.0	2.77

Figure-1
Map of study area

(http://www.mumbainet.com/images/cityinfo/railmap.gif)

Figure-2

Location map of Mumbai (shows location in map from where samples were collected)

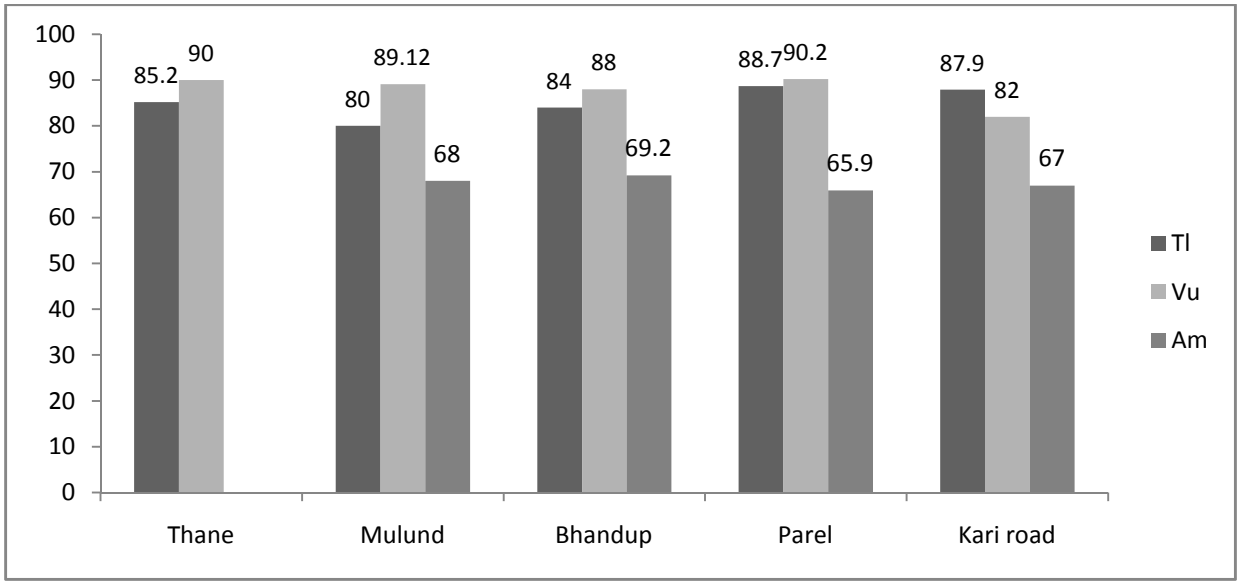

Figure-3

Per cent root colonization of samples according to the locations

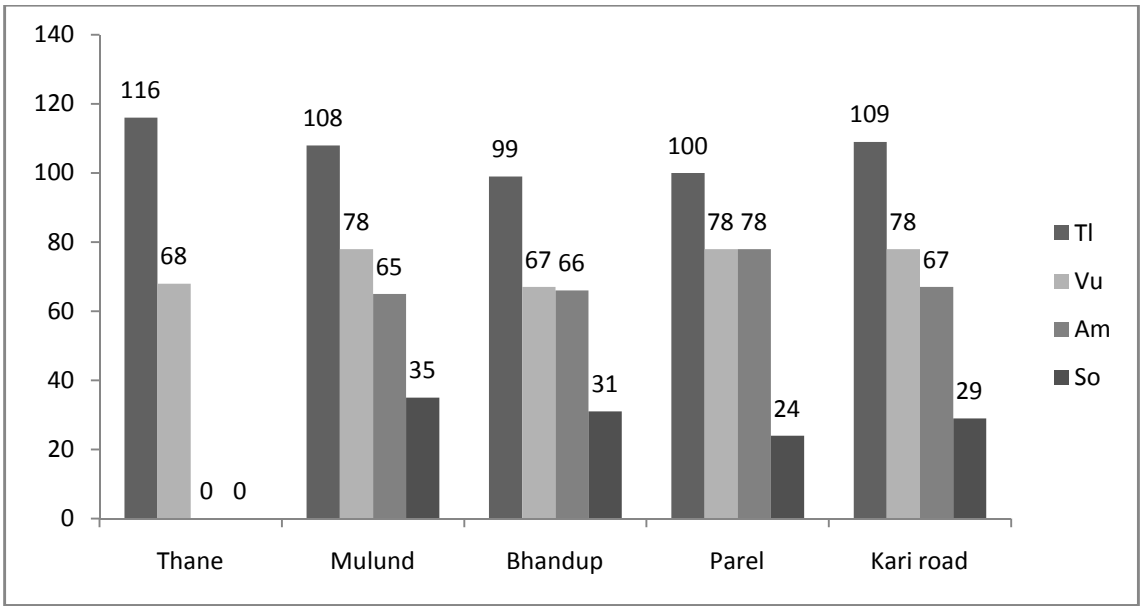

Figure-4
No. of AM fungal spores per 25 g of rhizospheric soil sample location wise

Results and Discussion

All the rhizospheric soil samples collected were showing almost 90 % of the moisture content, hence the detail comparison is not carried out. This must be because of enough amount of irrigation was done in every locations though that water was not of safe and good quality. All soil samples were acidic in pH, whereas all of them show very poor quality in terms of organic matter content. It can be one of the main reasons to have a good quantity of AM fungal spores which ranges from 24 as least in sample of Kanjur marg where as maximum in Thane sample showing 116 AM fungal spores per 25 g sundried rhizospheric soil samples. Very interestingly in all the samples of Kanjur marg which were collected from rhizospheric soils of *Spinacia oleracea*, presence of AM fungal spores though the spore count was very low. This might be because of absence of suitable host. It has been reported by many workers as Chenopodiaceae members don't show AM fungi colonization. In the present investigation it was found that all the samples of *Trigonella longiceps* shows highest root colonization as well as highest spore number in rhizospheric soil, followed by *Vigna unguiculata*, *Abulmoschus esculantus*. This variation in observations from site to site indicates the variation because of physico – chemical parameters which differ slightly. But with respect to species observations are more or less same. No fixed correlation could be drawn since many factors like uneven irrigation, duration of irrigation, unexpected harvest for local markets are operative at same time. *Glomus mosseae* is the most common in occurrence in all soil samples with highest spore density, where as Gigaspora sp and Acaulospora sp were also observed in all soil samples. There occurrence were in comparison less than *Glomus mosseae* in terms of spore density.

Conclusion

Based on the above observations and results conclusion can be drawn that such unused lands which are on sides of railway tracks can be potentially utilized for urban agriculture. Mycorrhizae are proved to be good enough to sustain in very poor fertile soil. So for such growers, ideas are to be provided to use mycorrhizal inoculums for their cultivations. Such commercially produced inoculums are easily available in market. Irrigation system should be developed properly which will supply fresh, pollutant free water for plants.

Acknowledgement

Authors are thankful to DR. V. J. Sirwaiya, Principal, Wilson College, Mumbai for providing lab facilities. They are also grateful to teaching and non teaching staff of Department of Botany for their constant support.

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