

Investigations on the rhizosphere microorganisms of two commonly grown fodder crops in Oman.

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The microbial inhabitants of Omani soils in the rhizosphere of the two major fodder crops in Oman; Rhodes grass (*Chloris guyana*) and alfalfa (*Medicago sativa*) were investigated in this study in an attempt to know the numbers and identity. The total count of the microbial population was generally found to be low in contrast to other agricultural soils of the world (10^4 /g soil). The counts of bacteria, fungi, & actinomycetes in the outer rhizosphere of alfalfa and Rhodes grass were found to be different assumingly due to differences in root secretions of the two crops, although the outer rhizosphere of both depressed actinomycetes growth. Both crops however encouraged bacterial growth in their inner rhizosphere while encouraging fungal growth in their outer rhizosphere. The inhabiting microorganisms were further identified using suitable recommended media in order to study their practical significance in mediating the different soil beneficial processes. Three genera of bacteria were found to dominate the rhizosphere of both tested crops irrespective of the location; whether outer or inner rhizosphere. These genera are represented by *Azotobacter*, *Pesudomonas*, and *Bacillus*. Fungi was dominated by five genera; *Aspergillus*, *Fusarium*, *Mucor*, *Penicillium*, and *Phoma*. The Actinomycetes genera were dominated by *Actinomyces*, *Chroococcus* and *Nostoc*.

Key words: Rhizosphere *Chloris Guyana Medicago sativa* Actinomycetes Fungi Bacteria.

Microorganisms capable of mediating useful processes in soils were early recognized (Hamdi and Yousef, 1979). The number of the soil inhabitants & their identity, however vary greatly with soil types, prevailing climatic conditions, and cropping history (Parkinson et.al. 1971). The rhizosphere being an important site of microbial activity in soils, since it provides ample carbon substrate in an otherwise organic matter poor arid soil (Elwan and Diab 1970). The rhizosphere effect is therefore more pronounced both, qualitatively and quantitatively than in other soils. Despite this, rhizosphere and rhizosheaths in arid soils have been studied only scantily in spite of their practical significance to agriculture as regarding the fertility status of soils, as they mediate most of the beneficial processes in agricultural soils (Bhatnagar and Bhatnagar, 2005). Such processes include organic matter decomposition, nutrient transformations,

nitrogen fixation (symbiotic & associative), and sulfur oxidation. All such processes are of immense importance to the status of soils regarding their fertility among other important aspects of practical application including their ability to degrade added pesticides.

Such information is lacking in Omani soils. Their availability is of vital practical significance since the total counts of microorganisms and their identity is beneficial in studying their present and potential role in improving soil fertility. The high rates of applied fertilizers could be kept minimal through initiation of a biofertilization program based on the availability of data about beneficial microorganisms native to the soils of Oman.

This work was therefore initiated to investigate the soil microorganisms dominating the rhizosphere of two of the commonly grown fodder crops in Oman i.e. alfalfa and Rhodes grass and identify them

in an attempt to isolate the beneficial ones so as to propagate them in the future in order to use them for facilitating useful soil processes that may improve the fertility status of the poor sandy soils of the country.

MATERIALS AND METHODS

The soils used to grow two of the important fodder crops; namely Rhodes grass & alfalfa were used in this study. The site chosen represented the typical soils of the most potential areas of crop production in Oman; Batinah Coast (Table1).

A composite sample was taken in duplicate as described by Wollum (1982) for taking rhizosphere soils. A composite soil sample was also taken from a nearby bare soil as a control. The outer rhizosphere samples were taken at 4-6 cm distance from the plant roots, while the inner rhizosphere samples were taken at 2-4 cm distance. Both samples were taken at 15-cm depth. The samples were kept cooled at 4°C in the laboratory until use. The methods described earlier (Wollum, 1982) were followed in sample processing, preparation of media. A soil extract agar was also made and used in the counts to compare the growth of microorganisms with the known described media in the literature. After incubation at 30°C, counts were made after 3 days & 7 days using a colony counter. An initial attempt was made to characterize the isolates at the genus level.

RESULTS AND DISCUSSION

Table1 summarizes the meteorological data during the month of May 2010 when the study was conducted. Table 2 shows the physical & chemical properties of the soils used to grow the two fodder crops, which are typical of the Batinah soils. The results are presented in table 3 and 4.

Rhizosphere counts:

The counts were generally low. The bare soil was mostly dominated by bacterial colonies giving 1.6×10^4 CFU/g soil. Both crops outer rhizosphere (alfalfa & Rhodes grass) was dominated by fungal colonies; 6.6×10^4 & 1.6×10^4 , respectively. These numbers, however, increased when samples were taken from the inner rhizosphere giving 3 & 1×10^6 for alfalfa and Rhodes grass, respectively. Alfalfa, on the other hand showed no actinomycetes growth in contrast to the bare soil which gave 1×10^2 , and the rhizosphere of Rhodes grass which seemingly encouraging actinomycetes growth and gave 1.3×10^4 /g

soil, and 2×10^4 for the outer and inner rhizosphere, respectively.

Microorganisms Identity

The medium as describe by Wollum (1982) was used to know the identity of the microorganisms dominating the rhizosphere of both rhodesgrass and alfalfa.

Table 5 presents the data obtained.

It is apparent that three genera of bacteria dominate the rhizosphere of both tested crops irrespective of the location; be it bare soil, outer or inner rhizosphere. These genera are represented by *Bacillus*, *Azotobacter*, and *Pseudomonas*. Other genera are found at low numbers. These included *Myxococcus*, *Acinetobacter*, *Micrococcus*, and *Proteus*. Fungal colonies, on the other hand, were dominated by five genera most of which were classified as imperfect fungi. The actinomycetes were represented by three genera i.e. *Actinomyces*, *Chroococcus*, and *Nostoc*.

Rhizosphere bacteria may benefit from access to rich nutrient supplies by root exudates, from opportunities to establish mutualistic or symbiotic relationship & from protection from soil desiccation offered by mucigel. At the same time, rhizosphere bacteria risk exposure to a variety of hazards that include plant defense responses, competition with other rhizosphere occupants, and to exposure to hazards like toxic substances exuded from plant roots.

Similar to the outer rhizosphere counts, the bacteria dominated the bare soil counts although higher numbers were observed in these bare soils. The obvious reason is that the first batches of the soils taken were at a distance from growing plants. The number of actinomycetes is also higher than the numbers encountered with the first batch of bare soils taken. But, unlike the counts made with the outer rhizosphere soils, bacteria instead of fungi in contrast with the outer rhizosphere soils dominated both crops inner rhizosphere. The change in pH of the soils surrounding the crops due to roots exudates could be the cause for such a shift in the nature of the dominating microorganisms. But in consistence with the outer rhizosphere of alfalfa, there was no actinomycetes growth. Rhodes grass inner rhizosphere, on the other hand encouraged both fungi and actinomycetes.

The presented data above clearly showed that the Omani soils is harboring very low population of microorganisms seemingly due to the nature of the soils

Table1: Meteorological Data of the site at the time of sampling

Max. Temp. °C	Min. temp. °C	Mean R.H. %	Wind speed M/sec	sunshine hr-1	Rainfall mm
39.1	26.6	53.8	2.6	11	0

Table 2: Some chemical & physical properties of the soils used in the study

Soil Property	Sample Source		
	Bare soil	Alfalfa rhizosphere	R. grass rhizosphere
EC 1:5(ms/cm)	1.46	2.38	2.76
pH(1:10)	7.37	7.66	7.38

Table 3: Plate counts of microorganisms dominating the outer rhizosphere of the two tested fodder crops

Sample source	Bacteria	Actinomycetes	Fungi
Bare Soil	1.6x10 ⁴	1.0 x10 ²	1.6 x10 ³
Alfalfa	2.2x10 ²	0.0	6.6 x10 ⁴
Rhodes grass	3.1x10 ³	1.3 x10 ⁴	1.6 x10 ⁴

Table 4: Plate counts of microorganisms dominating the inner rhizosphere of the two tested fodder crops

Sample source	Bacteria	Actinomycetes	Fungi
Bare Soil	1.6x10 ⁴	1.0 x10 ²	1.6 x10 ²
Alfalfa	3.8 x10 ²	0.0	3.0 x10 ⁶
Rhodes grass	4.3 x10 ³	2.0 x10 ⁴	1.0 x10 ⁶

Table 5: The identity of soil microorganisms found in the soil samples taken from the experimental site tested (rhizosphere and nonrhizosphere)

Sample source	Dominant bacterial genera	Dominant Actinomycetes genera	Dominant fungal genera
Bare Soil	<i>Azotobacter, Pseudomonas, Bacillus</i>	<i>Actinomyces, Chroococcus, Nostoc.</i>	<i>Aspergillus, Fusarium, Mucor, Penicillium, Phoma,</i>
Alfalfa	<i>Azotobacter, Pseudomonas, Bacillus</i>	<i>Actinomyces, Chroococcus, Nostoc.</i>	<i>Aspergillus, Fusarium, Mucor, Penicillium, Phoma,</i>
Rhodes grass	<i>Azotobacter, Pseudomonas, Bacillus</i>	<i>Actinomyces, Chroococcus, Nostoc.</i>	<i>Aspergillus, Fusarium, Mucor, Penicillium, Phoma,</i>

being sandy in nature and poor in organic matter. The counts did not exceed 10⁴/g soil in contrast to most agricultural soils where the counts usually range from 10⁶- 10⁸/g soil. The exudates of both alfalfa & Rhodes grass are different due to the nature of both; the former being a leguminous crop, while the latter is not. Such variation in the soil ecology should therefore be expected around the growing plants, where the soil samples were taken.

Despite these differences, both crops depressed actinomycetes numbers and encouraged proliferation of bacteria in their inner rhizosphere while encouraging fungi growth in their outer rhizosphere.

The identity of the dominating microorganisms in both the outer & inner rhizosphere need to be determined together with their numbers and correlated to soil properties, both chemical and physical. The

practical significance of such correlation is of immense importance since all the minerals transformations are of biological nature and completely dependant on the activities of such micro flora. Such data are completely missing in Oman soils.

Further investigations are therefore needed to continue such work in field of soil biology with the intention of understanding the basic soil biological processes, which represent the base of any fertility research program to be implemented in the future.

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