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ECO-MICROBIOLOGICAL STUDIES ON THE ROOTS OF PSAMMOPHYTES, COASTAL SAND DUNES, NORTHWESTERN COAST OF EGYPT

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Eight dominant psammophytes were studied, these species are: *Echium sericum, Ononis vaginalis, Euphorbia paralias, Jasonia maritima*, *Pancratium maritima, Lotus polyphyllus, Amophyla arenaria* and *Aeluropus lagopoides*. The root characteristics of each species were estimated in each soil depth including the root length, number of lateral roots, fresh and dry weights, water content, the ratio of specific root length (SRL), the root/shoot ratio (RSR) and root/shoot biomass (RSB). The soil supporting each species from different depths were analyzed physically and chemically. The microorganisms of the rhizosphere of each plant species were isolated and counted. The roots of most deep and shallow-rooted species under study are elongated in the depth of soil (15-30cm) excluding *Echium sericum* and *Amophylla arenaria.* Most of the lateral roots are concentrated in the surface depths of the soil in each of deep and shallow roots. The fresh and dry weights of roots decrease with the increase of soil depth in the deep roots versus the shallow roots where the weight increase with the increase of soil depth. *Jasonia maritima* is charactarized by the highest value of water content of the root reached 54.5 %. The values of SRL and RSR were higher in the deep roots than in the shallow roots versus the value of RSB , which were higher in the shallow roots. In most of the rhizosphere of the plant species invistigated, the total bacterial counts was the highest, while the total number of fungal counts was the lowest.There are clear variations between the total number of microbical types among the rhizosphere of the eight species. The total microbial counts decreased parallel with the increase of soil depth in the most rhizosphere invistigated species execluding the total count of actinomycetes which increased with the increase of soil depth. Eighteen microbial isolates could be isolated from the rhizosphere of deep-rooted species, while seventeen microbial isolates were isolated from the rhizosphere of shallow-rooted species.

Keywords: sand dune, root length, root system, root/shoot ratio, root biomass, soil properties, rhizosphere microflora, *Echium sericum, Ononis vaginalis, Euphorbia paralias, Jasonia maritima, Pancratium maritima, Lotus polyphyllus, Amophyla arenaria, Aeluropus lagopoides*.

Root system have four important functions: absorption, anchorage, storage and the synthesis of various organic compounds (Stone, 1957; Vaadia and Waisel, 1963; Duvdevani, 1964). The effectiveness of roots in absorption depends on the extent of the root systems and on the efficiency of the individual roots. The role of roots in anchorage is generally taken for granted, but the successes of most kinds of plants depend on their ability to remain upright. There are wide differences among plants in resistance to overthrow by wind which are related to differences in extent, depth and mechanical strength of roots. Considerable quantities of food are stored in roots especially those which are used as direct food for human or as a source of medicinal materials. Many of inorganic nitrogen is converted to organic nitrogen compounds in the root before being translocated to the shoots. The root functions and the root system development depend on both their hereditary potentialities and on the environment (Kramer, 1983). Root growth is greatly affected by environmental factors such as soil texture and structure; the presence of toxic elements such as aluminum, lead and copper; competition with other plants; and presence of microorganisms such as batceria and fungi and soil inhabiting animals such as nematodes (Kramer and Boyer, 1995). Few studies discussed the effect of the environmental factors on the root development as the rate of extension of root systems (Weaver, 1925), the size of root systems (Weaver, 1926), the distribution of absorbing roots (Jackson *et al.*, 1997) and the effect of rainfall in the desert on the root growth phonology and competitive interactions (Nobel, 1997). The quantitative evaluation of the horizontal and vertical distributions of roots of individual plants was studied by Fitter (1985) and Lee and Lauenroth (1994). The shape or morphology of root systems and the density distributions of roots by depth in order to make generalization about the importance of root distributions to species and growth form abundance and importance were stuided by Fitter (1985, 1987) and Jackson *et al.* (1996). The use of root length as a quantitative measure of root systems as the best indicators of water and nutrient uptake by plants is discussed by Nye and Tinker (1969) and Amber and Young (1977).

Soil is the natural store of all microorganisms. Microorganisms play a number of important roles in the soil especially in the coastal habitats. Some are agents of disease, others are involved in nitrogen fixation or in de-nitrification, yet more are decomposers which play a vital role in nutrient cycling (Packham and Willis, 1997). Some 117 species have been recorded for the Sands of Forvie and Ythan Estaury NNR, mainly from the dunes (Kramer and Boyer, 1995), but North (1981) points out that 52 of these were listed in a single visit paid by members of the British Mycological Society in 1975.

The coastal sand dune habitat in Egypt is very important because it contains many of medicinal and range plants. This habitat is very sensitive to the human interactions such as the overgrazing and the construction of summer resorts. It is useful to study the behavior and development of root system of some dominant plant species in this habitat and its relation with microorganisms inhabit the rhizosphere of these roots to conserve and sustain their economic resources. Generally, The studies of root microorganisms in relation with the root system development and the environmental factor in the deserts are very few in Egypt.

The objectives of this study were 1) quantify root length and density distribution by depth in the soil profile; 2) evaluate the effect of soil composition and texture on the root system development; 3) describe the relationship between root system development and depth for each species; 4) determine and identify the microorganisms inhabit the rhizosphere of these plants; and 5) describe the relationship between the microorganisms, the root system development and the soil condition.

MATERIALS AND METHODS

The field studies were carried out in the habitat of coastal sand dunes of the Northwestwern Mediterrarian coast of Egypt. Eight dominant species in this habitat were selected: four shrub species represent the deep-rooted species and four grasses and forbs species represent the shallow-rooted species. The deep-rooted species were *Echium sericum, Ononis vaginalis, Euphorbia paralias* and *Jasonia maritima*. The shallow-rooted species were *Pancratium maritima, Lotus polyphyllus, Ammophyla arenaria* and *Aeluropus lagopoides*. The investigation was carried out during spring season of 2003. Ten randomly individual plants represent each species were selected from different random locations. The root characteristics of each individual was investigated in each soil depth including root length, number of lateral roots, fresh and dry weight (oven dry at 70 °C for 24 hr) and the water content of the root were estimated. The ratio of length to dry weight, specific root length (SRL) was calculated according to Fitter (1985), the root/shoot ratio (RSR) was measured using root length : shoot length according to Bray (1963) and root/shoot biomass (RSB) was deteremined using dry weight of root : dry weight of shoot according to Crawely (1997) were calculated. The fresh and dry weight of the shoots of each plant were estimated. Three replicates from the soil supporting each individual plant represents specific species were sampled from different successive depths from the base of the plant into the end of the root. The soil samples of each soil depths were analyzed physicaly and chemicaly according Jackson (1967) and Piper (1947).

To isolate, count and identify the microorganisms of the rhizosphere of each plant species selected, three replicate samples from each depth of the rhizospere of each plant were collected. Each sample was cultivated in four different media by serial dilution methods. These media were nutrient agar, starch nitrate agar, subouraud agar and malt peptone agar. The plates were incubated at 25, 30 and 35 °C for two and four days. The grown colonies are counted in different media after incubation period. Representative colonies were isolated from colonies that appeared on cultivated media in different depths. The isolated colonies were purified by streaking for several times on the same media and subjected for characerization and primary identificatin according to Sneath *et.al.*(1986), Kreger-Van (1984), Krieg and Holt (1984), Holt *et.al.*(1994) and Mac Cartney (1996). The correlation between the root prameters and rhizosphere microflora counts with soil prameters were evaluated by using t-test according Steel and Torrie (1960). The data analysed by using the data analysis in Excel program of windows 2003.

RESULTS

Root Length

The roots of most deep and shallow-rooted species studied usually get longer at 15-30 cm excluding *Echium sericum* and *Ammophylla arenaria* (Fig.1). The primary root of *E. sericum* was the longest root (198.3 cm) in the deep-rooted species followed by the root of *Jasonia maritima* (198.0cm), while the root of *Ononis vaginalis* was the shortest (183.0cm). In the shallow-rooted species the primary root of *Lotus polphyllus* is the longest (39.0cm), while the shortest root was that of *Aeluropus lagopoides* (12.0cm) (Fig.3).

The longest part of the root in the deep-rooted species was 97.0cm observed in the root of *Euphorbia paralias* followed by 81.0cm in *E.sericum* and *J.maretima* in the depth of 15-30cm. The shortest part of the root was recorded in the roots of *O.vaginalis* and *E.sericum* were 15cm and 17.3cm, respectively oocupied the depth of 0-15cm,while in *E.paralias* was 14cm at the depth of 45-60cm, meanwhile in *J.maritima* was 25cm at depth whether 30-45cm and 45-60cm (Fig.1). In the shallow-rooted species the longest part of the root was 22.0cm in the root of *lotus polyphyllus* in the depth of 15-

30cm, while the shortest part was 10cm in the root of *A. arenaria* in the depth of 15-30 cm .

Lateral Roots

Figure (2) showed that most of the lateral roots were concertrated in the surface depths of the soil in each of deep and shallow roots. In the deep roots the lateral roots of *E.paralias* and *J.maritima* increased in the surface depths of soil versus in *O.vaginalis* and *E.sericum* , which increase in the deep depth. The highest number of the lateral roots in the soil depths of the deep roots was 69.0/depth in *O.vaginalis* in the depth of 60-75cm , while the lowest number was 1.0/depth in *E.sericum* in the depths of 15-30cm and 30-45 cm.

In the shallow roots, the number of the lateral roots increased in the depth of 0-20 cm excluding in *Pancratium maritima* , in which the lateral roots concenterated at the end of the root bulb. *Pancratium maritima* which have the highest number of lateral roots (76.0 lateral root/depth) recorded in the soil depth of 15-30cm (Fig.2) in the shallow- rooted species, while the lowest number was 5.2 lateral root/depth occurred in the depth of 15-30cm in the root of *L.polyphyllus*.

Figure (3) showed that there was no relation between the length of the root per soil depth and the number of the lateral roots in the same depth. Mostly, the total number of the lateral roots in the deep roots was more than in the shallow roots .

The total number of the lateral roots in *O.vaginalis* (108.0/root) was the highest number in the deep-rooted species. *Echium sericum* have the lowest total number of the lateral roots (10.0/root) in each deep or shallow-rooted species. The lowest total number of the lateral roots in the shallow-rooted species was 11.8/root in *L.polyphllus* (Fig.3).

Fresh and Dry Weights of Roots

The fresh and dry weights of the roots decreased with the increase of soil depth in the deep roots versus in the shallow roots, the weights increase with the increase of soil depth (Fig.4). The maximum fresh and dry weights per depth in the deep roots were observed in *O.vaginalis* (131.8 and 94.6 gm, repectively) at the depth of 0-15cm, also the minimum weights (0.9 an 0.6 gm, respectively)were observed in the same species at the depth of 60-75 cm .

The maximum of the fresh and dry weights per depth in the shallow roots were 1215.0 and 905.1gm , respectively at the depth of 15-30cm of *P. maritima* root , while the minimum weights were observed in *L.polyphyllus* (6.0 and 4.4 gm, respectively) at the depth of 0-15cm .

Most of the total fresh and dry weights of the deep roots were higher than in the shallow roots excluding in *P.maritima* , wherease this plant have the highest value of total fresh and dry weights (608.9 and 466.8 gm, respectively) in all root species investigated (Fig.5) . *Ammophyla arenaria* have the lowest value of total fresh and dry weights of the roots (15.0 and 14.7 gm, respectively) . *Jasonia maritima* have the highest value of the fresh and dry weights (96.8 and 44.1 gm, respectively) in deep roots , while *E.paralias* have the lowest value (23.5 and 21.4 gm, respectively).

Water Content of the Roots

The water content percentages of the deep roots were relatively fixed at all depths of soil, but increased in the bottom depth of soil. In the shallow roots most of water content percentages were relatively equal between the first and second depth. So, there is no relation between the water conten of the root and the soil depth (Fig.6).

Jasonia maritima charactarized by the highest value of water content of the root reached 54.5 % at depth of soil from 30 to 45 cm in the deep rooted species, while *L.polyphyllus* have the highest percentage of water content of the root (27.0%) at the depth of 15-30cm of the shallow roots (Fig.6). The lowest percentage of water content of the deep roots was 14.1 % oberved in the root of *E. paralias* at the depth of 30-45cm, while in the shallow-rooted species was 1.2% in the root of *A.arenaria* at the depth of 15-30cm.

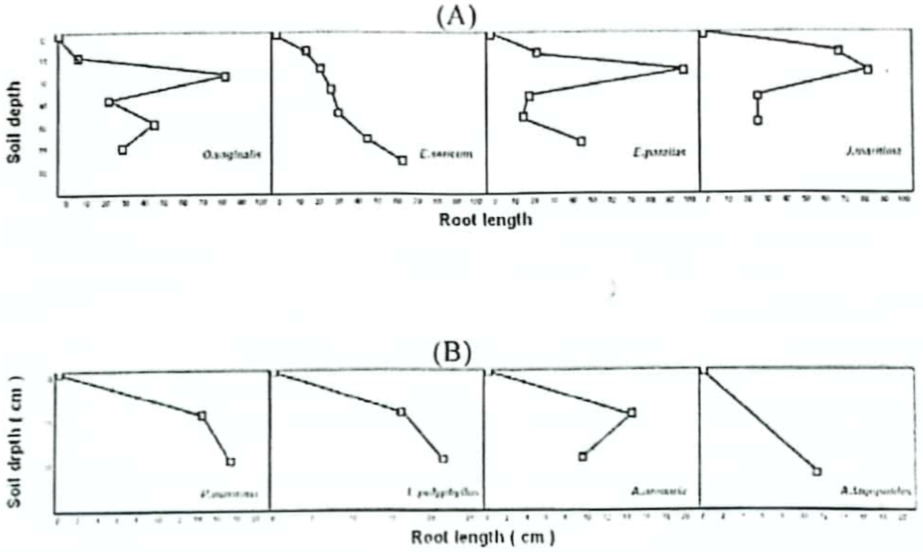

Fig (1). Relationship between soil depth and root length of deep - rooted species (A) and shallow-rooted species (B).

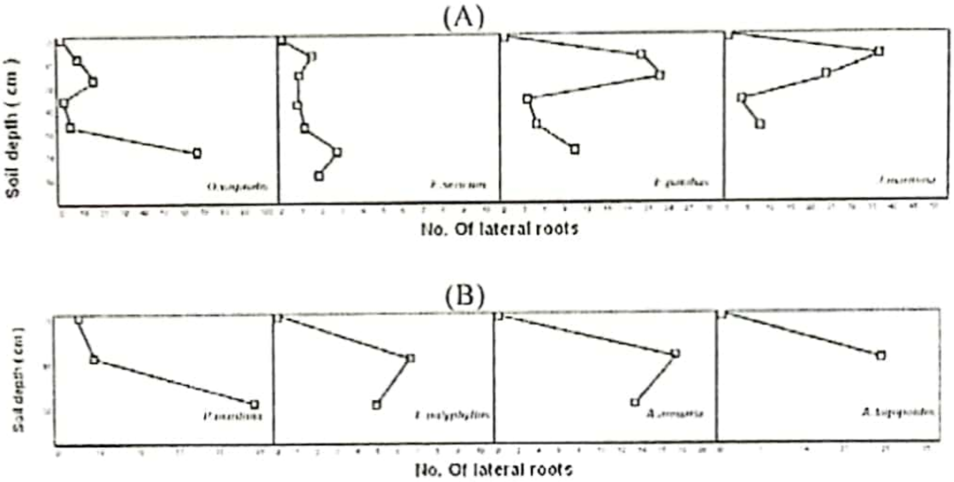

Fig (2). Relationship between soil depth and number of lateral roots in deep - rooted species (A) and shallow-rooted species (B).

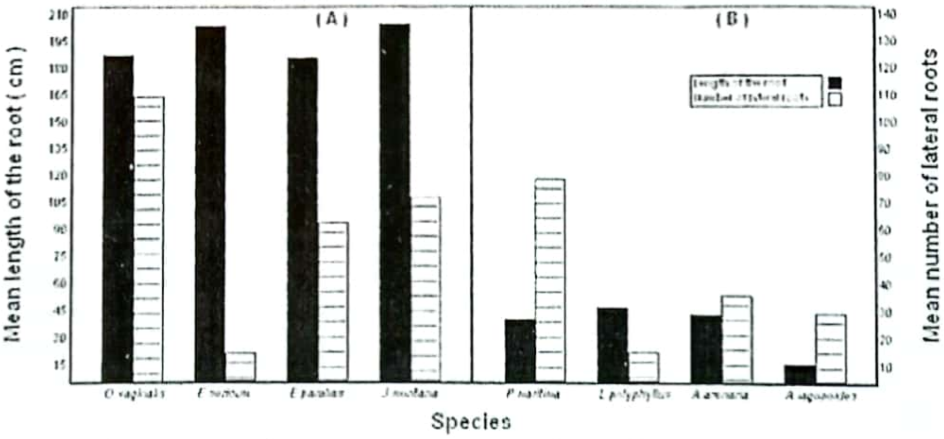

Fig (3). Comparison between the means of root length and number of lateral roots in the deep- rooted species (A) and shallow- rooted species (B).

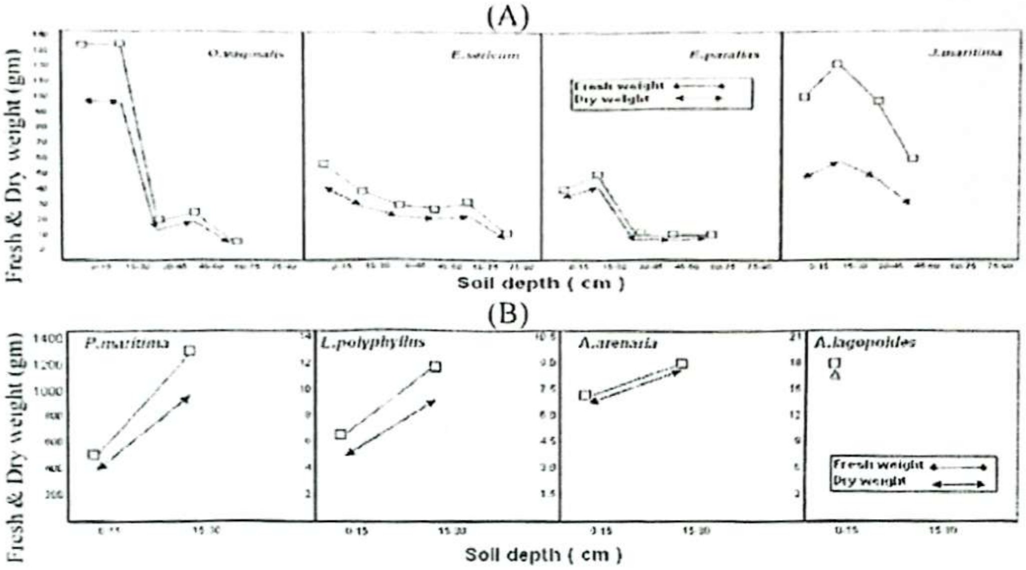

Fig (4). Relationship between soil depth with fresh & dry weight of the roots in deep – rooted species (A) and shallow rooted species (B).

The relation between water content of the root and soil moisture content was diferentiated from one species to the other. For example the soil supporting *E.paralias* have the highest percentages of soil moisture nevertheless , the precentage of water content of the root was the lowest in the deep-rooted species versus in *j.maritima* , where the soil moisture content was low, while the water content of root was high .The same case repeated in the shallow-rooted species with *A.arenaria* (high soil moisture and low water content of the root) versus in *L.polyphyllus* (low soil moisture and high water content of the root).

Specific Root Length ; Root/Shoot Ratio and Root/Shoot Biomass

The highest value of specific root length (SRL) in the deep-rooted species was 5.3 in *E.paralias* , while the lowest value was 1.8 in *J.maritima.* In the shallow-rooted species the highest value was 4.5 in *L.polyphyllus*, while the lowest value was 0.05 in *P.maritima* (Fig.7). The values of root length/shoot length (RSR) were high in most of the deep-rooted species. The higest value was 5.2 in *E.sericum* follwed by 4.5 in *J.maritima*, while the lowest value was 2.3 in *E.paralias*. In the shallow-rooted species *L.polyphyllus* have the highest value (5.5) of RSR, while *A.lagopoides* have the lowest value (0.7).

Figuer (7) showed that the values of root biomass/shoot biomass (RSB) were very low in all the deep and shallow-rooted species excluding *P.martitima* having very high value (19.1). The highest value of RSB in the deep-rooted species was 0.4 in *E.sericum* , while the lowest value was 0.7 in *A.arenaria* in the shallow-rooted species.

In general , the values of the SRL and RSR were higher in the deep-rooted species than in the shallow-rooted species versus the value of RSB, which were higher in the shallow-rooted species (Fig.7).

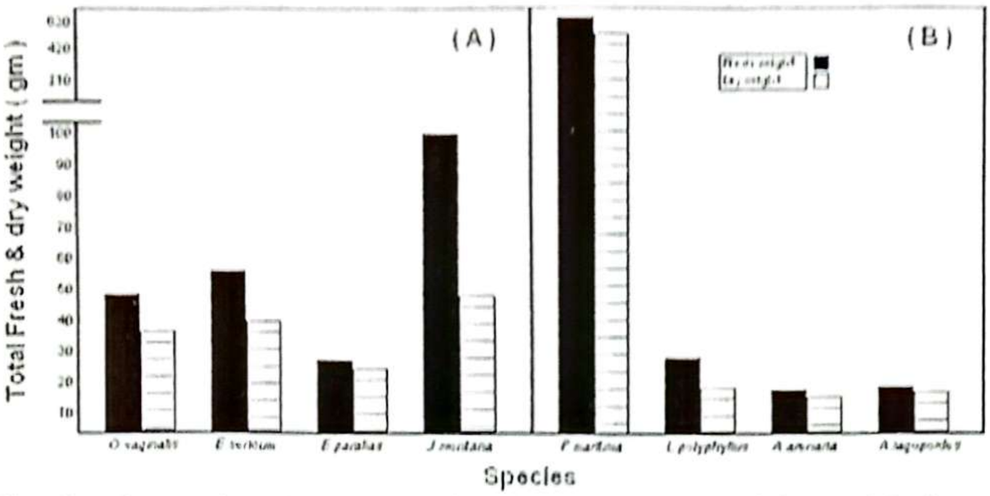

Fig (5) . Comparison between total fresh weight and total dry weight in deep rooted species(A) and shallow rooted species(B) .

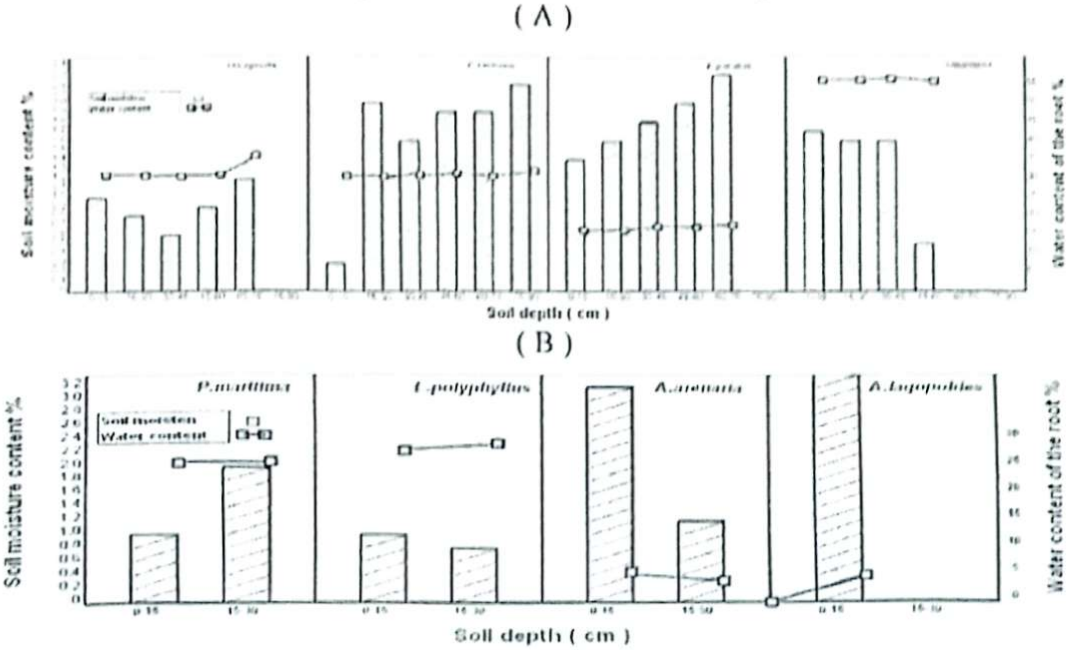

Fig (6). Relationship between soil depth with soil moisture content (%) and water content of the roots (%) in the deep- rooted species (A) and shallow rooted- species (B).

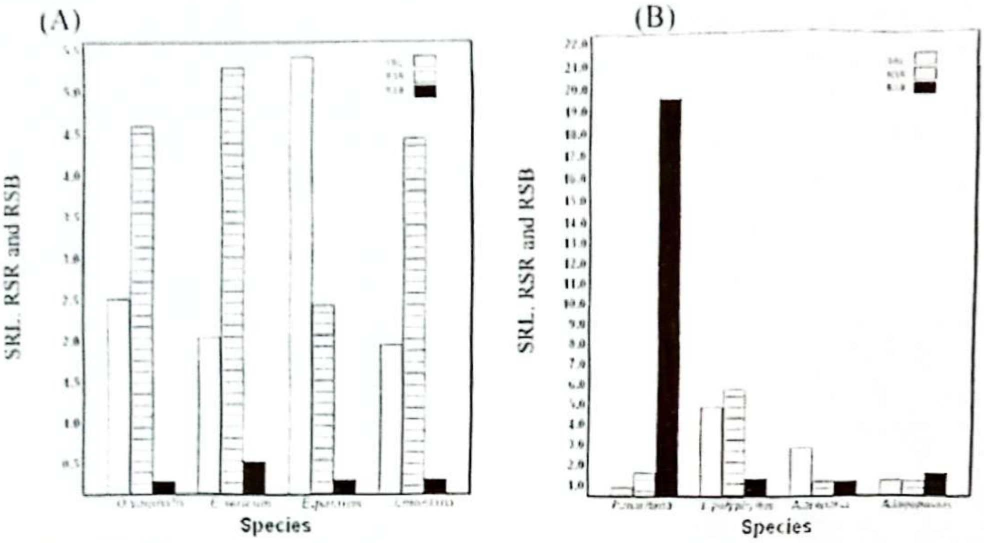

Fig (7). Comparison between specific root length (SRL) , root / shoot length ratio (RSR) and root / shoot biomass ratio (RSB) in the deep rooted- species(A) and shallow-rooted species(B).

The Rhizosphere Microflora

In most of rhizosphere of the plant species invistigated the total of bacterial counts was the highest, while the total number of fungal counts was the lowest (Fig.8). There were clear variations between the total number of microbical types among the rhizosphere of the test eight species. The total of microbial counts decreased with the increase of soil depth in most species of rhizosphere investigated execluding the total count of actionomycetes which increased with the increase of soil depth.

In the deep-rooted species , the highest value of bacterial plate count was 298×10^5/gm fresh rhizosphere recorded in the rhizosphere of *J. maritima* at the depth of 15-30cm. The rhizosphere of *E. sericum* had the highest value of actionomycetes and fungal count 157×10^5/gm and 14×10^5/gm, respectively recorded at the depths of 75-90 cm and 0-15 cm respectively. The lowest values of bacterial count were recorded in the rhizosphere of *E.sericum* (124×10^5/gm) at the depth of 75-90cm, while the lowest value of actinomycetes was 84×10^5 /gm detected on rhizosphere of *O.vaginalis* in the depth of 15-30cm. The values of fungal counts reach to 1×10^5/gm or dissappeared on the rhizosphere of *E. sericum, O.vaginalis* and *E.paralias* in the last depthes of soils (Fig.8). The highest value of yeast count was recorded in rhizosphere of *O.vaginalis* (59×10^5/gm) in the depths of 0-15, while the lowest value was 2×10^5/gm recorded in rhizosphere of *E.paralias* at the depth of 60-75cm.

Most of total microbial count detected on rhizospheres of shalow-rooted species were less than those in the deep-rooted species excluding in *A.arenaria*. The rhizosphere of *A.arenaria* characterized by the highest value of bacterial and actinomycetes count (257×10^5/gm and 164×10^5/gm, respectively) at the depths of 0-15 and 15-30cm and the lowest values of yeast and fungi (118×10^5/gm and 77×10^5/gm, respectively) at the depths of 15-30 and 0-15 respectively. The highest values of fungi and yeast were recorded in rhizosphere of *A.lagopoides* (9×10^5/gm and 22×10^5/gm, respectively) at the depth of 0-15cm (Fig.8). Nineteens microbial were isolated from rhizospheres of eighteen plant species.

Eighteen microbial isolates isolated from the rhizospher of deep-rooted species,while seventeen microbial isolates isolated from the rhizosphere of shallow-rooted species. The highest number of microbial isolates was 13 genera recorded in rhizosphere of *E.paralias* and *J.maritima*, while the lowest number (6 genera) recorde on rhizosphere of *A.lagopoides* (Table 1). The bacterial isolates represented by 46.4% from total microbial isolates isolated from the rhizosphere of deep and shallow- rooted species. These isolates were found to belong to eight genera, *Agrobacterium*, *Bacillus*, *Corynebacterium*, *Micrococus*, *Pseudomonas*, *Streptococcus*, *Azotobacter*, and *Rhizobium*. The *bacillus sp.* and *Pseudomonas sp.* recorded on deep and shallow roots in diferent depths. The fungal isolates represented by five genera *Asperigullus*, *Penicillium*, *Mucor*, *Fusarium* and *Trichoderma* with ratio of 23.2% from total microbial isolates. The recorded actinomycetes isolates found belong to three genera, *Streptomyces*, *Thermoactinomyces*, and *Nocardia* represented by rectangle 16.2% from total microbial isolates. The yeast group represented by three genera, *Candida*, *Rhodotorula* and *Sporobolomyces* with low percentage of 15.1% from total microbial isolates. Two bacterial genera and one genus actinomycetes have the highest presence (100%) in all rhizospheres plants investigated. These genera were *Bacillus*, *Pseudomonas, and Streptomyces*. *Trichoderma* has the lowest percent (12.5%) from all rhizospheres plants investigated.

In the deep-rooted species the highest presence (100%) of microbial genera recorded were in *Bacillus*, *Pseudomonas*, *Asperigullus*, *Rhizobium* and *Streptomyces*. Four microbial genera had the lowest precence,these were *Azotobacter*, *Penicillium*, *Nocardia* and *Sporobolomyces*. *Tricoderma* was not recorded on deep roots. Five microbial genera had the highest presence (100%) recorded on the shallow roots, these were *Bacillus*, *Pseudomonas*, *Mucor*, *Streptomyces and Candida*. Seven genera had the lowest presence (25%) recorded on the shallow roots, these genera were *Corynebacterium*, *Micrococus*, *Streptococcus*, *Penicillium*, *Fusarium*, *Trichoderma* and *Rhodotorular*. Two genera are not isolated from rhizosphere of the shallow roots, *Rhizobium and Thermoactinomyces*.

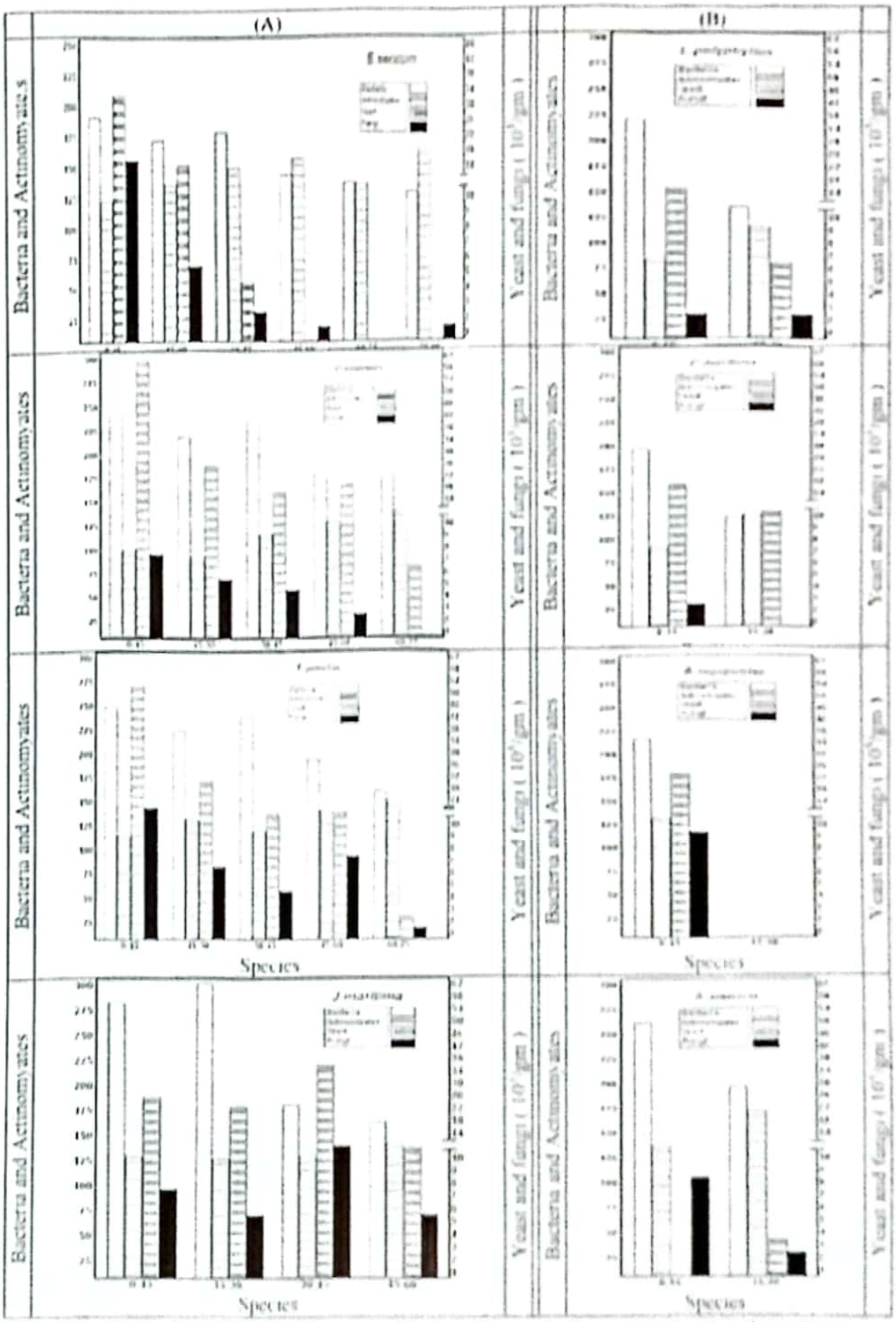

Fig (8). Relationship between soil depth and the count of microflora isolated from rhizosphere of deep- rooted species (A) and shallow- rooted species (B).

TABLE (1). Presence (P%) of microorganisms species isolated from the rhizosphere of deep and shallow-rooted species.

Type of microorganism	Species isolated	Deep-rooted species					Shallow-rooted species					General Presence %
		O.vaginalis	*E.sericum*	*E.paralias*	*J.maritima*	P %	*P.maritima*	*L.polyphyllus*	*A.arenaria*	*A.lagopoides*	P %	
Bacteria	*Agrobacterium sp*	-	+	+	+	75	+	-	+	-	50	62.5
	Azobacter sp	+	-	-	-	25	-	+	+	-	50	37.5
	Bacillus sp	+	+	+	+	100	+	+	+	+	100	100
	Corynebacterium sp	-	-	+	+	50	+	-	-	-	25	37.5
	Micrococcus sp	+	+	-	-	50	+	-	+	-	50	50
	Pseudomonas sp	+	+	+	+	100	+	+	+	+	100	100
	Rhizopium sp	+	+	+	+	100	-	-	-	-	-	50
	Streptococcus sp	+	+	+	-	75	-	+	-	-	25	50
Fungi	*Aspergillus sp*	+	+	+	+	100	-	+	+	+	75	87.5
	Fusarium sp	+	+	-	+	75	-	+	-	-	25	50
	Mucor sp	-	-	+	+	50	+	+	+	+	100	75
	Penicillium sp	-	-	+	-	25	+	-	-	-	25	25
	Tricoderma sp	-	-	-	-	-	-	-	+	-	25	12.5
[illegible]	*Nocurdia sp*	-	-	-	+	25	+	+	+	-	75	50
	Streptomyces sp	+	+	+	+	100	+	+	+	+	100	100
	Thermooctinomyces sp	-	-	+	+	50	-	-	-	-	-	25
Yeast	*Candida sp*	+	-	+	+	75	+	+	+	+	100	87.5
	Rhodotorular sp	+	+	-	+	75	+	-	-	-	25	50
	Sporobolomyces sp	-	-	+	-	25	-	+	-	-	25	25
Total number of species		11	10	13	13		11	11	11	6		

Soil of the Root

The soils of deep and shallow roots were mainly sand (Table.2). In soils of deep roots the percentage of sand increased relatively with the increase of soil depth (Tables 3,4,5 and 6). The percentages of silt and clay decreased with the increase of soil depth. The soil moisture content increased with the increase of the soil depth in the soils of *E.sericum*, *O.vaginallis* and *E.paralias* versus in soil of *J. maritima* it was decrease with the increase of soil depth. The highest value of soil moistur in soils of deep roots was 2.1% at depth of 75-90cm of *E.sericum* root. The soils of the deep roots disposed to the alkalinity. The pH value defrentiated in the soil depth and relatively decreased in the last soil depths of the deep roots excluding in

J.maritima root (Table.2). The highest value of pHwas 9.5 recorded in soil of *E.paralias* at depth of 15-30cm. The value of salinity (EC) decreased slightly with the increase of soil depth of all deep roots excluding *J.maritima* root. The highest value of salinity was 863.0 μ mohs/cm at the depth 45-60cm of *E.paralias* root, while the lowest value was 159.4 μ mohs/cm recorded at the depth 15-30cm of *E.sericum* root. The percentage of organic carbon (O.C) was very low in most of soils of the deep roots. The highest value of O.C (2.2%) was recorded at depth of 75-90cm of *E.sericum* root. The cations were increased slightly prallel with the increase of the soil depth of all deep roots excluding calcium ions decreased with the increase of soil depth in *J.maritima* root (Tables.2,3,4,5 and 6). The percentage of $CaCO_3$ increased with the increase of soil depth of all deep roots excluding in the soil of *O. vaginallis* while decreased parallel with the soil depth. The highest value of $CaCO_3$ (28.8%) was recorded at the soil depth of 30-45cm of *E.sericum* root, while the lowest percentage was 1.0% recorded in depths of 15-30cm and 60-75cm of *E.sericum* root and depth of 45-60cm of *O.vaginallis* root.

In the soil of the shallow roots, the values of most soil properties were relatively similar in both soil depths of 0-15cm and 15-30cm (Table 2). The percentages of clay in soil depth 15-30 cm were less than in depth of 0-15cm of *L.polyphyllus* root. The soil of *P.maritima* charecterized by the highest percentages of clay and organic carbon (1.5% and 0.11%, respectively) in the shallow roots specialy at depth of 15-30cm. The soil moisture content at the depth 15-30cm was less than at the depth 0-15cm of *A.arenaria* and *L.polyphyllus* roots, while it was at depth 0-15cm more than depth 15-30cm in soil of *P.maritima* root. The highest value of soil moisture in the soils of shallow roots was 3.2% recorded in depth 0-15cm of *A.lagopoides* root. The percentage of organic carbon increased with the increase of soil depth of shallow roots (Table, 2,7,8 and 9).

The value of EC was higher at depth 15-30cm than at depth 0-15cm of *P.maritima* root,while in the soils of *L.polyphyllus* and *A.arenaria* roots it was less in depth 15-30cm than in depth 0-15cm. The highest value of salinity in soils of shallow roots was 640.6μmohs/cm recorded in soil depth 0-15cm of *A.lagopoides* root.

DISCUSSION

The smilarities and the differences in the root system of species were studied based upon the quantitative analysis of the environmental conditions of these roots. The deep roots of the studied plants were distributed in the shape of triangle except of *E.sericum* root distributed in the shape of vertical. The shallow roots of the studied plants were concentrated near the soil surface in the shape of rectangle. The concentration of roots near the soil surface for most species in all grasslands types may be important for plant survival.The differences in the shape of roots of the grasses resulting from the adventitious roots, which limit the ability of the change of the root distribution with the change in the recources (Sun *et al.*,1997).

The distribution of absorbing roots determines the location of water extraction in the soil. As a general rule plants have their higher root densities in the top soil, however important changes in root distribution occur across species. The most conspicuous are those between grasses, shrubs, and trees (Jackson *et al.*,1996 and 1997). The results indicated that the deep roots elongate due to the increase of the percentages of sand, soil moisture, organic carbon and the value of pH, in the trend of alkalinity, while the increase of salinity reduces the root elongation (Tables 3,4,5 and 6). For these reasons, the root of *E.sericum* had the highest elongation at the depth of 15-30cm, while *E.paralias* had the lowest elongation at depth of 45-60cm. Kramer and Boyer (1995) found that the rate of root elongation varies widely among species, with the season, with variation in such soil conditions as water content, aeration and temperature. In deep, well-aerated soil, roots penetrate to great depths and spread widely. Vartanian (1981) reported that drying soil reduced root elongation but increased the number of new lateral roots in *Sinapis alba.*

Greacen and Oh (1972) found that wet soil had less resistance to root growth than the same soil at a lower water content and that root growth was more rapid in the witter soil. The roots are the most sensetive organ and affected first under salt stress (Levitt, 1980 ; Okusanya and Unger, 1984). Zidan *et al.*(1990) found that inhibition of root growth in maize under salinity is due to reduction in the length of root tip elongation zone and decline in cell division rate. Accumulation of proline of roots under stress condition is clearly associated with the reduction in root growth and decrease in mitotic index with increase in NaCl condition (Hossain *et al.*, 2004). In the shallow roots, the root elongation was increased parallel with the increase of soil moisture, organic carbon of soil and pH value, while it was injured due to the increase of clay percentage (Tables 7,8 and 9). Kramer (1983) found that the clay soil had inhibitory effect on root penetration of maize

The data analysis (Tables 3,4,5,6,7,8 and 9) indicates that the major reasons causing the increase of lateral roots number in the deep roots were the increase of soil salinity, sand percentage, $CaCO_3$ and the length of root. In the shallow roots the number of lateral roots increased with the increase of soil moisture and salinity. The increase of soil alkainity caused decrease in number of lateral roots in both deep and shallow roots. Sun *et al.*(1997) found that the concentration of roots near the surface is a critical feature that allows for acquistion of below-ground resources and, consequently, plant survival, because both soil water and nitrogen are concentrated near the soil surface (Hayes and Seastedt,1989 ; Sala *et al.*,1992).

The fresh and dry weights of the deep roots were increased as a result of the increase of clay percentages and pH value and decreases parallel to the decrease of soil depth, soil moisture and sand percentage. Montasir and Selim (1956) observed that when the relative saturation of soil water content increase or decrease above or below 60%, the fresh and dry weight of *Helianthemum luteum* root decrease. In the shallow roots the fresh and dry weights were increased due to the increase of soil depth, organic carbon and root length and the decrease of $CaCO_3$. So, the root of *P.maritima* had the highest value of fresh and dry weights. The root of this plant is a huge bulb. Most of the roots of the plants grown in low nutrient soil charecterized by storage tissues (Crawely, 1997). On the other hand the increase of fresh and dry weights of *P.maritima* and *J.maritima* may be due to the increase of water content of these roots as a result of increase of lateral roots, which absorbing a high quantity of water from the soil.

The value of SRL increase in the deep and shallow roots studied due to : 1) increase the length of the root, 2) the plants grown in low nutrient environment, 3) production of lateral roots, and 4) high soil-water utilization. These results agreement with Christie and Moorby (1975), Robinson and Rorison (1983), Fitter (1985), Holmes and Rice (1996) and Crawely (1997). Kramer (1983) stated that the increased of root/shoot ratio (RSR) found in the plants subjected to water stress. In this study *E.sericum* and *L.polphyllus* had the highest value of RSR. The aveage of soil moisture is very low (1.55% and o.8%, respectively)comparable with the other species.Soil water deficits often reduce shoot growth befor root growth is reduced resulting in increased root/shoot ratios in moderately water-stressed plants (Boyer,1970). The mean hieght of *E.sericum* (13.5cm) and *L.polphyllus* (14.8cm) consider the lowest hieght in the deep and shallow-rooted species. The wide variation in the range of RSR resulting from the wide variations in water suply and other environmental factors to which plants are often subjected during the growth season, as well as to genetic variations among plants such as grasses and root crops (Kramer and Boyer, 1995). The plants grown in low nutrient soil charecterized by small volume which causing increase in RSR (Crawely,1997). The ratio of root/shoot biomass (RSB) were very low in all the deep and shallow-rooted species excluding *P.martitima* having very high value (19.1). Bray (1963) reported that an average of 40% of the dry matter of 28 species of herbaceous plants occurs in the roots, the percentage being highest in root and tuber crops. Head (1967) found that the vigorous shoot growth reduced the production of new roots on apple and plum because it leaves little carbohydrate to be translocated to the roots. Development of fruits and seeds sometimes reduces root growth (Kramer, 1983). The data analysis indicated that the water content of the root increases with the increase of soil moisture, Ca, K and $CaCO_3$ and decreases with the increase of pH and dry weight.

The interaction between plants, microorganisms and soil component can be broadly classified into biological and abiological interactions. Biological interactions involve the growth and multiplications of plants, microorganisms and the secretion of organic substances. Abiological interactions involve physical and physicochemical interactions. Physical interaction is related to geometry and cohesion and soil matrix. They include on spore size distributon, water retention, aggregate stability and mechanism properaties of soil physiochmical interactions include in sorption, dissolution, hydrolysis, oxidation, and other prameters such as pH (Chenu and Stotzky, 2002).

The results indicated that the total bacterial, fungal and yeast count increased with the decrease of soil depth versus the total count of actinomycetes increases with the increase of soil depth, that is in agreement with Bolton *et al.*(1993) and Fritze *et al.*(2000). This may be due to deficiencies in the rate of oxgen and carbon dioxid ratios (Burges,1958 ; Richaume *et al.*,1993). The main factors causing increase of total bacterial count in the rhizosphere of deep-rooted species were the increase of pH, fresh and dry weight of the root and the decrease of soil depth, organic carbon, Ca, K and Mg. Kuske *et al.* (2002) found that the total bacterial community and the Acidobacterium division bacteria were affected by soil depth in both the interspaces and plant rhizospheres. They stated that the bacterial abundance affected by the limiting resources of nitrogen and water at different depths. The low number of bacteria in acidic soil is apparently indirect response to their inability to tolerant these pH (Theng and Orchard, 1995). The total bacterial count in the rhizosphere of shallow-rooted species increased with the increase of soil moisture and EC, while it was decreased with the increase of pH. Anter (1976) found that the count of aeropic spore-forming bacteria, gram negative bacteria and the count of Azotobacter were affected by soil salinity level.

The data analysis tabled in tables (3,4,5,6,7,8 and 9) indicated that the main factors affecting the increase of total actinomycetes count on rhizosphere of deep roots were the increase of soil depth and the decrease of fresh and dry weights of the root, number of lateral roots and total count of bacteria. In the shallow roots the total count of actinomycetes increased with the increase of soil depth, organic carbon, fresh and dry weights, while it decreased with the increase of bacterial count. This may be due to the competion between bacteria and actinomycetes. Dormaar and Faster (1991) explained that rhizosphere zone contain high level from organic and inorganic matter compare with ordinary soil. This organic takes many forms such as secretions of roots, muciluyes from root cap, epidermal cells and other organic matter. Therefore this organic effect on types of microorganisms and total number on deep and shallow roots.

TABLE (2). Soil properties supporting the roots of the coastal sand dunes species.

Species	Soil depth (cm)	Soil properties												
		Gravel %	Sand %	Silt %	Clay %	Soil moisture %	pH	EC µ mohs/cm	Na me/l	K me/l	Ca me/l	Mg me/l	O.C %	$CaCO_3$ %
E.sericum	0-15	0.0	96.7	0.6	2.7	0.2	8.1	430.0	0.7	0.1	2.7	4.5	0.01	16.5
	15-30	0.0	98.0	0.9	1.1	1.9	7.9	159.4	0.2	0.1	2.9	3.1	0.06	1.0
	30-45	0.0	98.0	0.6	1.4	1.5	7.8	220.0	1.6	0.9	5.5	4.5	1.9	25.0
	45-60	0.1	98.4	0.6	1.0	1.8	7.4	380.0	1.2	0.5	1.3	1.8	0.09	20.3
	60-75	0.0	98.3	0.7	1.0	1.8	7.4	430.0	0.9	0.2	3.1	3.8	0.5	1.0
	75-90	0.0	99.7	0.2	0.1	2.1	7.8	215.0	1.3	0.5	5.0	13.0	2.2	27.5
O. vaginalis	0-15	1.8	92.6	0.9	4.7	0.9	7.1	379.6	1.4	0.5	2.0	0.8	0.06	27.0
	15-30	5.5	90.6	0.6	3.3	0.7	7.3	320.3	1.3	0.3	1.4	1.9	0.08	2.5
	30-45	6.7	90.9	0.4	2.0	0.5	8.1	240.6	2.2	0.2	2.9	4.0	0.05	16.5
	45-60	1.5	96.9	0.3	1.3	0.8	7.3	350.0	2.0	0.5	1.3	1.8	0.07	1.0
	60-75	0.1	99.7	0.2	0.0	1.1	6.8	330.0	3.3	0.9	2.5	2.5	1.0	19.5
E. paralias	0-15	0.0	99.2	0.1	0.7	1.3	7.1	629.7	9.9	0.5	1.4	1.2	0.06	7.5
	15-30	0.0	98.5	0.1	0.4	1.5	9.5	479.7	2.6	0.2	2.8	1.9	0.3	8.0
	30-45	0.1	98.0	0.2	0.2	1.7	8.2	744.0	13.0	3.6	4.7	7.3	0.3	28.8
	45-60	0.3	96.0	0.3	3.3	1.7	6.2	863.0	9.1	3.9	18	7.0	0.6	26.3
	60-75	0.4	97.7	0.2	1.6	1.8	8.3	613.0	6.5	2.0	4.7	3.0	0.6	15.0
J.mritimi	0-15	0.0	99.3	0.3	0.4	1.6	7.5	640.6	4.0	0.2	3.5	1.2	0.02	2.5
	15-30	0.0	99.2	0.1	0.7	1.5	8.2	520.3	2.6	0.2	1.9	6.5	0.07	14.0
	30-45	0.0	97.7	0.3	2.0	1.5	7.5	490.6	2.9	0.2	3.3	1.5	0.12	13.5
	45-60	0.2	98.3	0.4	0.7	0.4	8.0	809.4	6.7	0.5	2.4	7.0	0.06	16.0
P.mritimi	0-15	0.0	98.1	0.6	1.3	0.8	7.6	359.4	0.6	0.1	3.0	1.6	0.02	2.5
	15-30	0.3	97.9	0.3	1.5	1.9	7.5	370.3	0.6	0.1	3.9	1.2	0.11	2.0
L.[illegible]	0-15	0.0	98.2	0.4	1.4	0.9	7.2	465.6	2.2	0.3	1.8	0.4	0.06	4.0
	15-30	1.0	98.2	0.4	0.4	0.7	7.4	450.0	2.4	0.3	1.8	0.5	0.07	3.0
A.arenaria	0-15	0.0	99.3	0.3	0.4	3.1	6.9	467.0	1.3	0.8	2.3	1.8	0.01	31.3
	15-30	0.0	99.4	0.2	0.4	1.1	7.2	459.4	2.9	0.5	1.7	0.8	0.07	17.5
A.lagopoides	0-15	0.0	99.7	0.1	0.2	3.2	7.4	640.6	3.8	0.5	1.2	1.4	0.05	18.5

TABLE (3). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Jasonia maritima*.

	depth	gravels	sand	silt	clay	moisture	pH	EC	O.C	Na	K	Ca	Mg	CaCO3	r.length	r.fresh	fresh wt	dry wt	water cont	Bacteria	Actinomyc	Yeast	fungi
depth	1																						
gravels	0.707	1																					
sand	-0.755	-0.229	1																				
silt	0.411	0.507	-0.407	1																			
clay	0.030	-0.199	-0.375	-0.152	1																		
soil moist	-0.763	-0.856	0.075	-0.510	0.142	1																	
pH	0.251	0.182	0.283	-0.192	-0.407	-0.352	1																
EC	0.425	0.508	0.044	0.552	-0.455	-0.881	0.192	1															
O.C	0.520	-0.060	-0.788	-0.083	0.813	0.122	-0.043	-0.575	1														
Na	0.653	0.340	-0.168	0.691	-0.025	-0.606	0.150	0.949	-0.304	1													
K	0.656	0.552	-0.104	0.449	-0.195	-0.623	0.307	0.757	-0.100	0.848	1												
Ca	-0.523	-0.324	-0.122	0.045	0.275	0.316	-0.969	-0.171	-0.051	-0.365	-0.245	1											
Mg	0.512	0.575	0.129	-0.114	-0.016	-0.615	0.921	0.431	-0.037	0.410	0.532	-0.935	1										
CaCO3	0.042	0.410	-0.572	-0.259	0.039	-0.452	0.573	0.060	0.050	0.134	0.459	-0.659	0.592	1									
R.length	-0.514	-0.519	0.907	-0.533	-0.508	0.555	0.311	-0.339	-0.511	-0.496	-0.470	-0.262	0.085	-0.448	1								
R.fresh	-0.808	-0.435	0.626	-0.338	-0.529	0.454	-0.047	-0.057	-0.800	-0.245	-0.365	0.117	-0.214	-0.797	0.858	1							
fresh wt	-0.712	-0.535	0.421	-0.720	0.075	0.910	0.011	-0.384	0.114	-0.327	-0.779	-0.055	-0.281	-0.270	0.739	0.470	1						
Dry wt	-0.713	-0.533	0.423	-0.722	0.073	0.912	0.010	-0.383	0.113	-0.326	-0.753	-0.055	-0.281	-0.271	0.740	0.471	1.000	1					
water con	0.000	-0.213	-0.125	0.000	-0.247	0.021	0.000	0.000	0.000	0.135	0.502	0.262	0.000	0.065	0.018	0.038	0.004	-0.004	1				
Bacteria	-0.765	-0.676	0.741	-0.730	-0.256	0.741	0.227	-0.916	-0.221	-0.727	-0.646	-0.240	-0.049	-0.265	0.548	0.773	0.912	0.912	-0.074	1			
Actinomyc	0.791	0.913	-0.255	0.478	-0.173	-0.976	0.482	0.946	-0.084	0.879	0.803	-0.445	0.720	0.684	-0.510	-0.475	-0.862	-0.862	-0.062	-0.684	1		
Yeast	0.672	0.886	-0.152	0.507	-0.313	-0.972	0.362	0.946	-0.284	0.924	0.847	-0.378	0.622	0.583	-0.461	-0.378	-0.929	-0.929	0.079	-0.697	0.986	1	
fungi	-0.754	-0.489	0.717	-0.519	-0.415	0.707	0.175	-0.450	-0.006	-0.557	-0.549	-0.159	-0.067	-0.327	0.856	0.715	0.774	0.776	0.000	0.875	-0.525	-0.510	1

TABLE (4). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Echium sericum.*

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]																							
[illegible]	[illegible]	1																					
[illegible]	[illegible]	[illegible]	1																				
[illegible]	[illegible]	[illegible]	[illegible]	1																			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1																		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1																	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1																
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1															
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1														
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1													
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1										
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1							
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

TABLE (5). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Ononis vulgaris.*

	depth	gravels	sand	silt	clay	soil moist	pH	EC	OC	Na	K	Ca	Mg	CaCO3	R.length	R.lateral	fresh wt	dry wt	water cont	Bacteria	Actinomyc	Yeast	fungi
depth	1																						
gravels	-0.414	1																					
sand	[illegible]	[illegible]	1																				
silt	[illegible]	[illegible]	[illegible]	1																			
clay	[illegible]	[illegible]	[illegible]	[illegible]	1																		
soil moist	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1																	
pH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1																
EC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1															
OC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1														
Na	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1													
K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1												
Ca	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1											
Mg	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1										
CaCO3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1									
R.length	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1								
R.lateral	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1							
fresh wt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1						
dry wt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					
water cont	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1				
Bacteria	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1			
Actinomyc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1		
Yeast	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	
fungi	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1

TABLE (6). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Euphorbia paralias*.

	depth	gravel	sand	silt	clay	soil moist	pH	EC	OC	Na	K	Ca	Mg	CaCO3	R.length	R.lateral	R.fresh wt.	R.dry wt	water cont	Bacteria	Actinomyc.	Yeast	Fungi
depth	1																						
gravel	0.362	1																					
sand	[illegible]	[illegible]	1																				
silt	0.371	[illegible]	[illegible]	1																			
clay	[illegible]	[illegible]	[illegible]	[illegible]	1																		
soil moist	0.574	[illegible]	-0.765	[illegible]	[illegible]	1																	
pH	[illegible]	[illegible]	[illegible]	-0.379	[illegible]	-0.129	1																
EC	0.743	[illegible]	-0.862	[illegible]	0.547	[illegible]	-0.800	1															
OC	0.394	[illegible]	[illegible]	[illegible]	0.639	0.749	-0.160	0.166	1														
Na	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.138	[illegible]	[illegible]	[illegible]	1													
K	[illegible]	[illegible]	-0.805	[illegible]	0.524	[illegible]	-0.314	[illegible]	[illegible]	[illegible]	1												
Ca	[illegible]	0.528	[illegible]	[illegible]	0.593	[illegible]	-0.368	0.760	0.646	[illegible]	0.736	1											
Mg	[illegible]	0.336	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.300	[illegible]	[illegible]	0.937	0.579	1										
CaCO3	0.525	[illegible]	-0.715	[illegible]	[illegible]	[illegible]	-0.392	0.794	[illegible]	[illegible]	[illegible]	0.546	[illegible]	1									
R.length	[illegible]	-0.367	[illegible]	[illegible]	[illegible]	-0.245	[illegible]	-0.741	[illegible]	[illegible]	-0.574	-0.398	-0.551	[illegible]	1								
R.lateral	[illegible]	[illegible]	[illegible]	[illegible]	-0.452	-0.746	0.461	-0.714	-0.634	[illegible]	-0.590	[illegible]	[illegible]	[illegible]	[illegible]	1							
R.fresh wt	-0.336	[illegible]	0.735	[illegible]	-0.341	-0.308	[illegible]	-0.567	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.866	[illegible]	1						
R.dry wt	-0.338	[illegible]	[illegible]	[illegible]	-0.341	-0.308	[illegible]	[illegible]	-0.673	[illegible]	[illegible]	-0.564	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1					
water cont	0.551	0.470	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1				
Bacteria	-0.379	[illegible]	[illegible]	[illegible]	[illegible]	-0.530	[illegible]	[illegible]	-0.655	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1			
Actinomyc	[illegible]	[illegible]	[illegible]	0.524	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.574	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1		
Yeast	-0.339	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.498	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	
Fungi	-0.376	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1

TABLE (7). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Pancratium maritima.*

	depth	gravel	sand	silt	clay	soil moist	pH	EC	O.C	Na	K	Ca	Mg	CaCO3	R.length	R.area	Fresh wt	Dry wt	water content	Bacteria	Actinomyc	Yeast	Fungi
depth	1																						
gravel	0.313	1																					
sand	-0.776	-0.384	1																				
silt	-0.873	-0.898	0.378	1																			
clay	0.775	0.582	-0.200	-0.330	1																		
soil moist	0.989	0.398	-0.766	-0.369	0.788	1																	
pH	-0.522	-0.704	0.344	0.051	0.105	-0.517	1																
EC	1.000	0.329	-0.772	-0.880	0.777	0.991	-0.519	1															
O.C	0.984	0.384	-0.762	-0.864	0.762	0.947	-0.514	0.982	1														
Na	0.000	-0.263	0.000	0.000	0.000	0.146	0.000	0.011	-0.178	1													
K	0.000	-0.264	0.000	0.000	0.000	0.147	0.000	0.011	-0.179	0.995	1												
Ca	0.994	0.373	-0.943	-0.950	0.875	0.970	-0.352	0.984	0.966	0.000	0.000	1											
Mg	-0.325	-0.758	0.478	0.994	-0.995	-0.315	0.151	-0.327	-0.911	0.000	0.000	-0.978	1										
CaCO3	-0.951	-0.808	0.540	0.983	-0.977	-0.940	0.222	-0.952	-0.935	0.000	0.000	-0.991	0.997	1									
R.length	0.373	0.538	-0.580	-0.771	0.530	0.839	-0.453	0.384	0.779	0.479	0.479	0.864	-0.313	-0.335	1								
R.area	1.000	0.339	-0.781	-0.873	0.788	0.987	-0.531	1.000	0.986	-0.011	-0.011	0.982	-0.922	-0.947	0.373	1							
Fresh wt	1.000	0.334	-0.775	-0.878	0.774	0.989	-0.523	1.000	0.984	-0.001	-0.001	0.984	-0.925	-0.950	0.376	1.000	1						
Dry wt	1.000	0.333	-0.775	-0.878	0.775	0.989	-0.522	1.000	0.984	0.000	0.001	0.984	-0.926	-0.951	0.376	1.000	1.000	1					
water cont	0.000	-0.264	0.000	0.000	0.000	0.147	0.000	0.011	-0.179	0.995	1.000	0.000	0.000	0.000	0.479	-0.011	-0.001	0.000	1				
Bacteria	0.992	0.394	-0.590	-0.831	0.847	0.991	-0.412	0.993	0.975	0.000	0.000	0.999	-0.956	-0.982	0.371	0.991	0.992	0.992	0.000	1			
Actinomyc	0.994	0.366	-0.770	-0.870	0.770	0.987	-0.513	0.993	0.997	-0.103	-0.108	0.973	-0.920	-0.945	0.324	0.995	0.994	0.994	-0.108	0.986	1		
Yeast	0.982	0.349	-0.573	-0.829	0.843	0.991	-0.259	0.984	0.942	0.103	0.104	0.980	-0.880	-0.975	0.326	0.979	0.982	0.982	0.104	0.991	0.982	1	
Fungi	-0.955	-0.854	0.747	0.947	-0.747	-0.992	0.504	-0.988	-0.900	-0.251	-0.260	-0.943	0.993	0.917	-0.570	-0.921	-0.965	-0.965	-0.251	-0.957	-0.927	-0.982	1

TABLE (8). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Ammophylla arenaria.*

	Depth	gravel	sand	silt	clay	soil moist	pH	EC	O.C	Na	K	Ca	Mg	CaCO3	R length	R lateral	Fresh wt	Dry wt	Water conte	Bacteria	Actinomyc	Yeast	Fungi
Depth	1																						
gravel	#DIV/0!	1																					
sand	0.522	#DIV/0!	1																				
silt	-0.522	#DIV/0!	-1.000	1																			
clay	0.000	#DIV/0!	0.000	0.000	1																		
soil moist	-0.997	#DIV/0!	-0.521	0.521	0.081	1																	
pH	0.878	#DIV/0!	0.153	-0.153	0.120	-0.868	1																
EC	-0.999	#DIV/0!	-0.568	0.568	0.017	0.995	-0.820	1															
O.C	0.951	#DIV/0!	0.761	-0.761	0.000	-0.947	0.724	-0.959	1														
Na	0.995	#DIV/0!	0.430	-0.430	0.000	-0.992	0.910	-0.974	0.974	1													
K	-0.878	#DIV/0!	-0.868	0.868	0.000	0.875	-0.500	0.914	-0.983	-0.828	1												
Ca	-0.985	#DIV/0!	-0.280	0.280	0.000	0.982	-0.940	0.929	-0.906	-0.997	0.722	1											
Mg	-0.997	#DIV/0!	-0.553	0.553	0.000	0.984	-0.806	0.991	-0.969	-0.965	0.944	0.910	1										
CaCO3	-1.000	#DIV/0!	-0.522	0.522	0.000	0.997	-0.874	0.990	-0.984	-0.994	0.894	0.982	0.989	1									
R length	-0.951	#DIV/0!	-0.761	0.761	0.000	0.947	-0.724	0.959	-1.000	-0.914	0.983	0.936	0.968	0.984	1								
R lateral	-0.926	#DIV/0!	-0.151	0.151	0.000	0.923	-0.949	0.879	-0.753	-0.869	0.832	0.993	0.863	0.921	0.753	1							
Fresh wt	0.995	#DIV/0!	0.520	-0.520	-0.090	-1.000	0.854	-0.995	0.947	0.991	-0.976	-0.951	-0.983	-0.996	-0.947	-0.922	1						
Dry wt	0.996	#DIV/0!	0.520	-0.520	-0.065	-1.000	0.855	-0.995	0.947	0.991	-0.975	-0.951	-0.981	-0.996	-0.947	-0.922	1.000	1					
Water con	-0.996	#DIV/0!	-0.507	0.507	0.063	0.998	-0.877	0.990	-0.940	-0.993	0.884	0.987	0.979	0.998	0.940	0.931	-0.998	-0.998	1				
Bacteria	-0.998	#DIV/0!	-0.597	0.597	0.000	0.992	-0.842	0.993	-0.976	-0.982	0.918	0.997	0.997	0.997	0.975	0.911	-0.992	-0.990	0.990	1			
Actinomyc	0.995	#DIV/0!	0.597	-0.597	0.000	-0.993	0.842	-0.995	0.975	0.980	-0.918	-0.997	-0.997	-0.997	-0.975	-0.933	0.992	0.991	-0.990	-1.000	1		
Yeast	-0.995	#DIV/0!	-0.458	0.458	-0.074	0.995	-0.806	0.987	-0.910	-0.997	0.838	0.973	0.970	0.994	0.922	0.949	-0.984	-0.985	0.987	0.984	-0.984	1	
Fungi	-0.866	#DIV/0!	-0.151	0.151	-0.354	0.834	-0.930	0.781	-0.713	-0.837	0.892	0.923	0.795	0.862	0.713	0.905	-0.851	-0.830	0.847	0.831	-0.831	0.913	1

TABLE (9). Correlation between the root parameters and rhizosphere microflora counts with soil prameters of *Lotus polyphellus.*

	Depth	gravel	sand	silt	clay	soil moist	pH	EC	O.C	Na	K	Ca	Mg	CaCO3	R.length	R.lateral	Fresh wt	Dry wt	water content	Bacteria	Actinomyc	Yeast	Fungi
Depth	1																						
gravel	0.990	1																					
sand	0.000	0.161	1																				
silt	0.000	-0.161	-1.000	1																			
clay	-0.337	-0.383	-0.161	0.161	1																		
soil moist	-0.775	-0.327	-0.632	0.632	0.865	1																	
pH	0.775	0.713	0.000	0.000	-0.754	-0.600	1																
EC	-0.337	-0.382	0.057	-0.057	0.975	0.706	-0.802	1															
OC	0.522	0.450	-0.655	0.655	-0.375	0.135	0.495	-0.570	1														
Na	0.775	0.721	0.632	-0.632	-0.365	-1.000	0.600	-0.726	-0.135	1													
K	0.000	0.161	1.000	-1.000	-0.161	-0.632	0.000	0.057	-0.655	0.632	1												
Ca	0.000	-0.161	-1.000	1.000	0.161	0.632	0.000	-0.057	0.655	-0.632	-1.000	1											
Mg	0.522	0.583	0.683	-0.683	-0.583	-0.944	0.495	-0.472	-0.455	0.944	0.353	-0.353	1										
CaCO3	-0.522	-0.583	-0.655	0.655	0.583	0.944	-0.495	0.472	0.455	-0.944	-0.353	0.353	-1.000	1									
R.length	0.951	0.913	-0.010	0.010	-0.388	-0.540	0.736	-0.388	0.751	0.540	-0.310	0.310	0.232	-0.232	1								
R.lateral	-0.394	-0.373	0.027	-0.027	0.577	0.753	-0.621	0.397	-0.542	-0.753	0.027	-0.027	-0.495	0.495	-0.950	1							
Fresh wt	0.578	0.570	0.131	-0.131	-0.387	-0.341	0.559	-0.376	0.099	0.841	0.131	-0.131	0.622	-0.622	0.890	-0.982	1						
Dry wt	0.556	0.595	0.000	0.000	-0.365	-0.774	0.742	-0.594	0.522	0.774	0.000	0.000	0.522	-0.422	0.850	-0.950	0.971	1					
water con	0.374	0.362	0.571	-0.571	-0.361	-0.574	-0.026	-0.205	-0.044	0.574	0.571	-0.571	0.631	-0.631	0.033	-0.195	0.220	0.008	1				
Bacteria	-0.993	-0.937	-0.053	0.053	0.395	0.813	-0.772	0.392	-0.458	-0.813	-0.053	0.053	-0.575	0.575	-0.925	0.990	-0.955	-0.897	-0.310	1			
Actinomyc	0.996	0.957	0.090	-0.090	-0.397	-0.829	0.771	-0.399	0.443	0.829	0.090	-0.090	0.557	-0.557	0.919	-0.983	0.955	0.896	0.325	-1.000	1		
Yeast	-0.225	-0.300	-0.073	0.073	0.375	0.956	-0.717	0.302	-0.181	-0.965	-0.273	0.273	-0.805	0.805	-0.752	0.910	-0.955	-0.925	-0.470	0.943	-0.950	1	
Fungi	-0.962	-0.932	-0.263	0.263	0.995	0.914	-0.747	0.347	-0.230	-0.914	-0.263	0.263	-0.729	0.729	-0.838	0.952	-0.973	-0.964	-0.416	0.979	-0.985	0.960	1

The reduction of fungi in soil is not because most fungi are intolerant to the acidic soil only but also probably because bacteria and actinomycetes are efficient comptitors and prevent establishment and proliferation of fungi. The results indicated that the main factors causing increase of total fungal count on the rhizosphere of the deep roots were the increase of fresh and dry weights, while the increase of soil depth, organic carbon and the number of actinomycetes causing decrease in the total count of fungi. In the rhizosphere of the shallow roots, the main reasons of the increase of fungi were the increase of $CaCO_3$ and the decrease of soil depth, organic carbon, and fresh and dry weights of the root.

The percentage of silt was the main factor causing the increase of total count of yeast on rhizosphere of the deep-rooted species, while the increase of soil depth causing decrease of this count. In rhizosphere of shallow-rooted species the increase of soil moisture and the number of lateral roots causing increase in the total count of yeast.

The result obtained from microbial isolation and identification revealed that microorganisms on rhizosphere zones studied belong to four groups of bacteria species represented by high percentage (46.4%), fungi represented by 23.2%, actinomycetes represented by 16.2% and yeast represented by low percentage (15.1%). The *Bacillus* and *Pseudomonas* species represnted by high percentage from other bacterial species. Nagao *et al.*(2001) obtained macrolactins antibiotic from *Bacillus sp.* and Lampis *et al.*(1996) isolated Karalicin a new biologically active compound from *Pseudomonas sp.* On the other hand the bacterial species play important role for fertilization of soil such as *Azotobacter* and *Rhizobium*. The *Aspergillus sp.* represented high percentage from fungal isolates. Suzuki *et al.* (1997) isolated novel antitumor antibiotics from *Aspergillus sp.*

In the actinomycetes group, *Streptomyces sp* had the highest percentage; It is known that *Streptomyces* genus. Only produce more than 60% from total antibiotics produce by microorganisms.

The interaction between different types of microorganisms on rhizosphere zone may be effect on appear certain types of microorganisms by comptators processes and prevent establishment and proliferation or stimulation of the other plants and microorganisms.

In general it is concluded that the part of the root in the soil depth of 0-30cm conseder the active and important part of the roots in both deep and shallow-rooted species investigated in coastal sand dune habitat. This may be due to the following: 1) the highest elongation of the root recorded in this depth, 2) the highest number of lateral roots of most plant species, 3) the highest value of fresh and dry weights of all roots, and 4) the highest number of bacteria, fungi and yeast isolated from all rhizospheres investigated. This conclusion is in agreement with many authers e.g. Walter (1971) who suggested that grasses with adventitious roots intensively acquire recources from relatively shallow layers whereas shrubs with horizontaly and vertically spreading roots can also acquire resources from deep and shallow layers. Sun *et al.* (1997) found that the peak of root density in the grasses in North America at depth of <15cm. Jackson *et al.*(1996) reported that grasslands had some of the shallowest rooting profiles with 80-90% of the roots in the upper 30cm of soil. Shrublands were reported to only have 60-70% of the root in the upper 30cm of soil. Grasses as functional group had 44% of their roots in the top 10cm of the soil and shrubs had only 21% of the roots in the same upper soil level.

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دراسات بيئية وميكروبيولوجية لجذور الأنواع النباتية النامية في الكثبان الرملية في الساحل الشمالي لمصر

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تمت دراسة جذور ٨ أنواع نباتية تنمو في الكثبان الرملية وهي كالآتي: حنا الغول والزينة وشجرة الحنس وصدر الحمار والبوصيل والزيقني والجازوف والحلبة. تم التقييم الكمي للصفات الخاصة بجذور كل نوع من الأنواع المذكورة في كل عمق للتربة مثل :- طول الجذر - عدد الجذور الجانبية - الوزن الغض والجاف للجذر - المحتوي المائي للجذر - معدل استطالة الجذر - النسبة بين الجذور والسيقان - النسبة بين الكتلة الحيوية للجذور والسيقان. كما تم تحليل التربة التي تنمو بها هذه الجذور فيزيائيا وكيميائيا في أعماق مختلفة. وقد تم أيضا عزل الكائنات الدقيقة النامية علي هذه الجذور وحولها في أعماق مختلفة من التربة وتم عدها وتعريفها. أوضحت الدراسة أن معظم الجذور السطحية والعميقة تستطيل في عمق التربة من ١٥ إلي ٣٠ سم فيما عدا نوعي حنا الغول والجازوف، كما تتركز الجذور الجانبية في الأعماق السطحية من التربة.

وأوضحت الدراسة أن الوزن الغض والجاف لجذور الانواع ذات الجذور العميقة يقل بازدياد عمق التربة عكس جذور الأنواع ذات الجذور السطحية التي يزداد وزنها الغض والجاف بازدياد عمق التربة. تبين من الدراسة أن جذور نبات صدر الحمار تتميز بارتفاع قيمة محتواها المائي والذي يصل إلي ٥٤,٥%. كما تبين من الدراسة أن النسبة بين الجذور والسيقان ومعدل استطالة الجذر ومعدل الجذور إلي السيقان تكون عالية في الأنواع ذات الجذور العميقة عن الأنواع ذات الجذور السطحية عكس النسبة بين الكتلة الحيوية للجذور والسيقان التي تكون عالية في الأنواع ذات الجذور السطحية عن الأنواع ذات الجذور العميقة.

لوحظ من الدراسة أن عدد البكتيريا هو الأعلى في الكائنات الدقيقة التي تم عزلها من علي جذور جميع الأنواع المدروسة، بينما كان عدد الفطريات هو الأقل. وقد ظهر من الدراسة الفروق الواضحة في العدد الكلي للكائنات الدقيقة المعزولة بين الأنواع النباتية الثمانية موضوع الدراسة. وتبين من الدراسة أن عدد الكائنات الدقيقة يقل بالتوازي مع زيادة عمق التربة لمعظم النباتات المدروسة فيما عدا عدد الأكتينوميسيتات التي تزيد بالتوازي مع زيادة عمق التربة. وقد تم فصل ١٨ جنس من الكائنات الدقيقة التي تنمو علي جذور النباتات ذات الجذور العميقة، بينما تم فصل ١٧ جنس من الكائنات الدقيقة التي تنمو علي جذور النباتات ذات الجذور السطحية.