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## Effect of soil physico-chemical properties and plant type on bacterial diversity in semi- arid parts in central Sudan. Part ii. Sharq El-neel region, Khartoum state

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## Abstract

Total viable counts of bacteria and bacterial diversity of the different soil samples from three different localities in Sharq EL-Neel region: Soba, AL-Aelafoon and Um Dawan Ban sub-regions were carried out. Soil physical and chemical characteristics (pH, EC,SP,solublecations: Na, K, Ca, Mg and anion P, organic carbon, total nitrogen and soil texture)in each studied sub-regions were measured. Qualitative analysis of microorganisms isolated from the studied soil samples reveal a total of thirteendifferent species of bacteria, of which two are unidentified. The ten species are classified under Bacillus genus. In Sharq EL-Neel regionsoil samples, total bacterial counts ranged from  $9.5 \times 10^4$  cfu g<sup>-1</sup> to  $1 \times 10^3$  with a mean of  $4 \times 10^3$  cfu g<sup>-1</sup>. The quantitative data on microbial population recorded in the present study was analysed using two diversity indices. High Shannon-Weiner diversity Index value for bacteria was obtained in AL-Aelfoon sub-region (1.79361), whereas high Simpson's index value was obtained in Um Dawan Ban sub-region (2.80). Actinomyces Actinomyces spp. and Streptomyces spp. Where the most abundant microorganisms identified in the three subregions. Total bacterial count in Soba soil was positively correlated with pH (r=0.0194) and sand (r=0.3205); the total bacterial count in AL-Aelafoon soilwas positively correlated with EC (r=0.1062), clay (r=0.3816), silt (r=0.1936), SP (r=0.9302), K (r=0.6252), Ca (r=0.1062), Ca (r0.0015) and Mg (r= 0.1556), whereas the total bacterial count in Um Dawan Ban soil was positively correlated with clay (r= 0.2614), silt (r= 0.0216), SP (r= 0.565), K (r= 0.9645), P (r= 0.0197), Ca (r= 0.7377), Mg (r= 0.0267), N (r= 0.5215) and O.C (r= 0.3214). There were obvious differences in correlation coefficients among the selected criteria (46 % from the total number of correlation coefficients were positively correlated between bacterial counts and soil physico-chemical properties whereas 54% from the total number were positively correlated between plant type and bacterial counts).

Keywords: Microbial Diversity; Physico-Chemical Properties; Soils; Semi-Arid Zone; Sharq EL-Neel Region; Central Sudan.

## 1. Introduction

Continuing our research works on the relationships between soil physico-chemical properties, plants and soil microorganism's populations in semi-arid parts in Sudan [1], we have study correlationsbetween these parameters in Sharq EL-Neel region, Khartoum State, Central Sudan.

Soil is a complex habitat, inhabited by a large number of different organisms. Among these, bacteria and fungi are the most important since they are responsible for the vast bulk of decomposition, and also make up the largest part of the biomass in soil. Many of the essential transformations in the nitrogen, sulphur, phosphorus and other element cycles are mediated by microbes.Bacteria are the most abundant microorganism group in soil and can attain concentrations of more than  $10^8$  cells per gram of soil, or  $10^{11}$  per gram organic material [2]. The activity of soil organisms can be divided into four functions: (1) regulation of organic matter turnover and nutrient cycling,(2) biological degradation, (3) maintenance of soil structure, and (4) interaction with plants.

The main factors contributing to the soil environment are: (1) soil texture and structure (2) nutrient status (3) soil pH (4) moisture and temperature (5) surface plants (6) Inputs and (7) compaction. Different soil environments will support different types and num-

bers of microorganisms. Different plant residues contain varying quantities and availability of carbon and nutrients. This influences the soil biological activity.

The objectives of this study were: (i) to obtain a better understanding of the correlations between microbial population and physicochemical properties of different soil types in the study area. (ii) to study how plant type and soil type affects the microbial diversity and abundance. (iii) to explain the differences between the tested habitats.

## 2. Materials and methods

### 2. 1. Study site description and soil sampling

Soils were collected from three different sub-regions (Soba, AL-aelafoon and Um Dawan Ban sub-regions in the Khartoum State, in arid/semi-arid parts in Central Sudan. Soil samples were collected from 0 - 5 cm d 5-15 cm depths and kept in plastic bag. After collection, soil samples were brought to the laboratory and separated into two sub samples; one for bacteriological analysis that was kept in a refrigerator and the other one for the analysis of soil physico-chemical properties. Soil sampling was done in December, 2011.

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#### 2.2. Bacteriological analysis

Nutrient agar medium was used for the enumeration of bacteria present in soil samples [3]. The pH was adjusted before addition of agar and sterilization. Serial dilution plate technique was used for the isolation of microorganism. One gramsoil sample was diluted (1: 100) with 100ml distilled water in a sterile conical flask and shaken well. One ml of this suspension was transferred to 9ml of sterile water for tenfold (1: 10) dilution and by following serial dilution further diluted up to 10<sup>5</sup> times. Plating in duplicate plates was made for each diluted sample. One ml of each of the diluted sample was taken in a sterilized petri dish by pipette. Then, molten agar medium was poured and mixed thoroughly by rotating the petri dish, first in one direction and then in the opposite direction.After setting the medium, the plates were inverted and incubated at 37°C for 48h in an incubator then, the plates having well discrete colonies were selected for counting. The selected plates were placed on a colony counter (Digital colony counter, DC-8OSK1000086, Kayagaki, Japan) to count the number of colonies.

#### 2.2.1. Tests

Motility test was determined according to Cruickshank et al, 1975 [4].Catalase Catalase test Oxidation-Fermentation test (O/F), Oxidase test,Sugar fermentation test,Voges-Proskauer test,Nitrate reductiontest, Indole production test,Urease test,Citrate utilizationwere determined according toBarrow and Feltham 1993 [5]. Casein hydrolysis was determined by method described by Williams and Cross, 1971 [6]. .Starch hydrolysis was performed according to Collins et al., 1995 [7]. Total a viable count of bacteria was determined [8].

#### 2.2.2. Isolation of Streptomyces

Isolation of Streptomyces was performed by the soil dilution plate technique [9]. In this technique; 1g of each soil sample was taken in 9ml of sterilized distilled water in pre-sterilized test tube. Serial aqueous dilutions (10<sup>-2</sup>-10<sup>-7</sup>) were prepared by transferring 1ml of the soil suspension into 9ml of sterilized distilled water in sterilized test tubes. Different aqueous dilutions  $(10^{-4}-10^{-6})$  of the soil suspensions were applied separately into sterilized Petri-dishes and 20ml of Starch-Casein Agar salt medium, SCKNO3, was added, mixed thoroughly and the plates were incubated at 28°C for 7-14 days. SCKNO3 medium was prepared by dissolving 10g soluble starch, 2g dipotassium hydrogen ortho-phosphate, 2g potassium nitrate, 2g sodium chloride, 4g casein, 0.05g hydrated magnesium sulphate, 0.1g calcium carbonate; 0.01g hydrated ferric sulphate, 15g agar in one liter of distilled water. The medium was sterilized by autoclaving at 121°C for 15 minutes. Colonies characteristic of Streptomycetaceae (rough, chalky, powdery and with earth odour) that appeared on the incubated plates were selected,

repeatedly sub-cultured for purification and stored at 4°C onto slants of SCKNO<sub>3</sub> medium until further examinations.

#### 2.3. Analysis of soil physico-chemical properties

The pH of the soil was measured in a soil water suspension (1: 2, soil:water). The electrical conductivity (EC) analysis was measured in the saturated extract. Na+ and K+ were determined photometrically. The exchangeable cations (Ca<sup>++</sup> and Mg<sup>++</sup>) were determined by Atomic Absorption Spectrophotometer (AAS, Perkin-Elmer, 047-1705.Saturated percentage (SP) were also determined [10]. Organic carbon content of the soil was determined by Wakely and Black method(Cited by Moghimi et al., [11]. Total nitrogen (%) was determined by Kjeldahl method following extraction from 2g soil with conc. H<sub>2</sub>SO<sub>4</sub>.The particle size analysis was carried out by the Pipette method(Cited by Moghimi et al., 2013 [11].

Once the percentage of sand, silt, and clay is measured, the soil may be assigned a textural class using the Table of textural soil types (Cited by Subrahmanyam and Sambamurty [12].

#### 2.4. Bacterial diversity measures

 $\begin{array}{l} \label{eq:shannon-Weiner Biodiversity Index:} \\ \mbox{Species diversity (H) = - (P_i)(log_2P_i)} \\ \mbox{Where: P = the proportion of all individuals in the sample which belongs the species i.} \\ \mbox{2/ Simpson Index: D= } 1 - \sum_{i=1}^{N} S(P_i)^2 \\ & i=1 \end{array}$ 

Where: D is the index number; S= the total number of species; P = the proportion of all individuals in the sample which belongs to species i

(Cited by Subrahmanyam and Sambamurty [12].

#### 2.5. Statistical analysis

Correlation coefficient was performed in order to detect the relationships between soil physic-chemical parameters and microbial populations [13].

## 3. Results and discussion

### 3.1. The soil characteristics in Shaq EL-Neelregion

The results concerning soil physical and chemical characteristics (pH, EC, SP, soluble cations: Na, K, Ca, Mg and anion P, organic carbon, total nitrogen and soil texture) in three differentstudied sub-regions are presented in Tables 1-3.

												0		<u> </u>		
Sample No.	Soil Depth	Bacterial count (CFU/g)	рН	EC	N %	O.C %	SP	Na	К	Р	Ca	Mg	Clay %	Silt %	Sand %	Textural Soil Types
SO1	0-5	$1X10^{4}$	7.71	0.53	0.056	0.47	26.3	3.019	0.076	1.482	2	0.75	30	17	53	Sandy clay loam
SO2	5-15	5X10 <sup>3</sup>	7.63	0.88	0.035	0.32	28.4	6.431	0.047	1.729	1.5	0.5	34	25	41	Clay loam
SO3	0-5	$1.5X10^{3}$	7.70	0.99	0.105	0.86	28.8	5.676	0.195	1.032	5	2.3	34	33	34	Clay loam
SO4	5-15	$1X10^{4}$	7.51	0.70	0.028	0.36	26.3	3.080	0.098	0	3	1.5	21	33	46	Loam
SO5	0-5	$1.7X10^{4}$	7.62	0.35	0.049	0.40	28.8	1.57	0.106	1.066	2	0.75	21	30	49	Loam
SO6	5-15	$1.4X10^{3}$	7.71	0.35	0.070	0.46	31.8	2.959	0.057	1.100	2.5	1	37	22	41	Clay loam
SO7	0-5	1.5X10 <sup>5</sup>	7.63	0.35	0.042	0.32	25.9	1.257	0	0	0	0	21	22	56	Sandy clay loam
SO8	5-15	1.8X10 <sup>3</sup>	7.49	0.35	0.049	0.61	25.1	1.419	0.096	1.872	4	1.5	19	25	56	Sandy loam
SO9	0-5	1.8X10 <sup>3</sup>	7.55	0.776	0.042	0.32	25.3	1.978	0.147	1.445	4	1.75	19	25	56	Sandy loam
SO10	5-15	7.5X10 <sup>3</sup>	7.71	0.367	0.049	0.48	27.7	2.478	0.041	1.623	2	0.5	24	17	59	Sandy clay loam

Table 1:Some Soil Physico- Chemical Properties of Different Samples from Sharq EL-Neel Region- Soba Subregion

	Table 2: Some Soil Physico- Chemical Properties of Different Samples from Sharq EL-Neel Region- AL-Aelafoon Subregion															
Sample No.	Soil Depth	Bacterial count (CFU/g)	pН	EC	N %	0.C %	SP	Na	К	Р	Ca	Mg	Clay %	Silt %	Sand %	Textural Soil Types
AL1	0-5	1.2X10 <sup>5</sup>	7.66	0.788	0.046	0.48	36.4	2.630	0.109	0	5	1.5	24	32	44	Loam
AL2	5-15	$1X10^{4}$	7.70	0.617	0.063	0.64	26.3	1.510	0.052	0.628	2.5	1	28	24	51	Sandy clay
AL3	0-5	$2.8X10^{3}$	7.73	0.40	0.063	0.72	22.1	0.804	0.119	0.628	4.5	1.5	22	34	44	Loam
AL4	5-15	1.3X10 <sup>3</sup>	7.69	0.37	0.042	0.63	30.1	1.963	0.039	1.031	2	0.75	20	27	54	Sandy loam
AL5	0-5	$1.2X10^{4}$	7.73	0.40	0.042	0.64	26.3	1.522	0.112	1.273	3	0.5	21	35	44	Loam
AL6	5-15	1X10 <sup>3</sup>	7.73	0.32	0.035	0.45	28.0	1.522	0.036	0	1.5	0.5	35	37	29	Clay loam
AL7	0-5	$1X10^{3}$	7.44	0.857	0.042	0.46	31.8	4.456	0.081	0	2.5	1.5	21	35	44 41	Silt loam
ALO	5-15	1.1710	7.51	0.350	0.035	0.23	23.4	2.415	0.020	1.342	1.5	0.5	22	51	41	Clay
AL9	0-5	2X10 <sup>5</sup>	7.40	0.95	0.028	0.31	38.9	3.080	0.195	0.930	4.5	2	35	37	29	loam
AL10	5-15	$7.5X10^{3}$	7.58	0.43	0.021	0.40	27.6	1.691	0.053	5.179	2	0.75	30	32	39	Clay loam
AL11	0-5	$1.2X10^{4}$	7.61	0.35	0.028	0.64	25.5	1.268	0.077	1.135	3	1	25	27	49	Loam Sandy
AL12	5-15	$1.6X10^{4}$	7.42	0.45	0.056	0.40	27.6	1.721	0.045	0.594	2.5	1	24	20	56	clay
																loam
AL13	0-5	$1.7X10^{4}$	7.36	2.00	0.035	0.45	25.5	4.63	0.178	0	20	4	35	27	39	Clay
AL14	5-15	$7.5 \times 10^{3}$	7.69	2.434	0.035	0.46	27.5	12.05	0.104	0	19	4	20	39	41	Loam
	1	Fable 3: Som	e Soil P	hysico- C	Chemical	Properties	of diffe	erent Sam	ples fron	n Sharq E	EL-Nee	l Regio	n- Um I	Dawan I	Ban	
Sample No.	Soil Depth	Bacterial count (CFU/g)	рН	EC	N %	O.C %	SP	Na	К	Р	Ca	Mg	Clay %	Silt %	Sand %	Textural Soil Types
UD1	0-5	4X10 <sup>5</sup>	7.49	2.30	0.042	0.45	37.7	7.043	0.188	0	23	4	24	38	39	Loam
LIDA	- 1-	4371.04	7.40	4.00	0.020	0.46	20.0	21.40	0.070	1 (22)	24		01	22	~~	Sandy
UD2	5-15	4X10 <sup>-</sup>	7.48	4.00	0.038	0.46	30.9	31.40	0.070	1.623	24	4	21	23	55	clay
UD3	0-5	3X10 <sup>5</sup>	7.70	0.44	0.056	0.61	31.4	1.956	0.154	0	2.5	0.5	19	13	69	Sandy loam
UD4	5-15	9.5X10 <sup>4</sup>	8.09	0.94	0.056	0.64	25.9	6.891	0.07	0	2.5	0.5	31	15	54	Sandy clay loam
UD5	0-5	6.5X10 <sup>5</sup>	7.81	1.12	0.07	0.65	30.9	5.405	0.224	1.412	5	1.50	35	19	46	Sandy clay loam

#### 3.1.1. Soba sub-region

5-15

 $3.5X10^4$ 

UD6

The soil of this sub-region is predominantly sandy clay loam. The pH of soil samples ranged from 7.49 to 7.71. The EC values varied from 0.35 - 0.99 mmohs/cm. The total nitrogen was in range 0.028 - 0.105. Organic carbon range between 0.32 and 0.86 %. C:N ratio range between 8:1 and 13:1. The SP ranged from 25.1 – 31.8 %. Sodium contents ranges between 1.257 and 6.431 Meq/L. As for K it varies between 0.0 and 0.195 Meq/L. Calcium contents was found to vary between 0.0 and 2.3 Meq/L.P contents ranged between 0.0 and 1.872 ppm.

7.82 0.94

0.056

0.54

23.9

4.438

0.097

#### 3.1.2. Al-aelafoon sub-region

The soil of this sub-region is predominantlyclay loam. The pH of soil samples ranged from 7.36 to 7.73. The EC values varied from 0.32 - 2.434 mmohs/cm. The total nitrogen was in range 0.021 - 0.063. Organic carbon range between 0.23 and 0.72 %. C:N ratio range between 7:1 and 23:1.The SP ranged from 22.1 - 38.9 %. Sodium contents ranges between 0.804 and 4.63 Meq/L. As for K it varies between 0.026 and 0.195 Meq/L. Calcium contents was found to vary between 1.5 - 20 Meq/L. Magnesium contents was found to vary between 0.5 and 4.0 Meq/L.P contents ranged between 0.0 and 5.179 ppm.

#### 3.1.3. Um dawan ban sub-region

0.896 4

1

31

28

41

The soil of this sub-region is predominantlysandy clay loam. The pH of soil samples ranged from 8.00 to 7.48. The EC values varied from 0.44 - 4.0 mmohs/cm. The total nitrogen was in range 0.038 - 0.07. Organic carbon range between 0.45 and 0.65 %.C: N ratio range between 9:1 and 12:1. The SP ranged from 23.9 - 37.7%. Sodium contents ranges between 1.956 and 31.043 Meq/L. As for K it varies between 0.070 and 0.224 Meq/L. Calcium contents was found to vary between 2.5 - 23 Meq/L. Magnesium contents ranged between 0.0 and 1.623 ppm.

Clav

loam

From the 30 collected soils, five different textural soil classes (sandy clay loam, clay loam, loam, sandy loam and silt loam) were detected (Tables 1 -3). The data of soil pH values range between 8.09 (in Um Dawan Ban) to 7.36 (in AL-Aelafoon) among different soil textures. Sandy clay loam (in Soba and Um Dawan Ban)and clay loam (in Soba and AL-Aelafoon) soils showed highest bacterial populations.

# **3.2.Bacterial diversity and total counts of different soil samples from study region:**

The diversity of soil microorganisms of the study habitat is presented in Table 4. Thirteen organisms were isolated from collected soil samples; Actinomyces spp., Streptomyces spp., Bacillus lentus, Bacillus badius, Bacillus pantothenticus, Bacillus mycoides, Bacillus alvei, Bacillus circulans, Bacillus subtilis, Bacillus cereus, Bacillus marcerans, Bacillus thruingiensis, Micrococcus varians. Actinomycetes spp. have highest frequency in the three studied sub- regions and next are Streptomyces spp. tomyces spp. were found in the three habitats. These species are habitat generalists and are well adapted to change in environmental conditions.

ied suc regions and nent are sucpromyces spp.	
Bacteria species like Bacillus lentus, B.circulans, B. cereus, B	
mycoides, B. badius, B. thuringensis, Actinomyces spp. and Strep-	-

Sample No.	Plant	Soil Depth	Bacterial count (CFU/g)	Type of bacteria isolated
SO1	Acacia ehrenbergiana	0-5	$1X10^{4}$	B. lentus B. circulans Actinomycesspp
				Streptomyces spp B. cereus
SO2	A.ehrenbergiana	5-15	5X10 <sup>3</sup>	B.badius Actinomycesspp Streptomyces spp
SO3	Acacia tortilis ssp. Radiana	0-5	1.5X10 <sup>3</sup>	B. cereus B. subtilis Actinomycesspp
				Streptomyces spp B. cereus
SO4	A.tortilis ssp. radiana	5-15	$1X10^{4}$	B. pantothenticus Actinomycesspp Streptomyces spp
				B. mycoides B. lentus B. circulans
SO5	Capparis decidua	0-5	1.7X10 <sup>4</sup>	B. thuringiensis Actinomycesspp
				Streptomyces spp B. mycoides B. thuringiensis
SO6	C.decidua	5-15	1.4X10 <sup>3</sup>	B. lentus Actinomycesspp Streptomyces spp
				B. mycoides B. thuringiensis B. thuring
SO7	Prosopis chilensis	0-5	1.5X10 <sup>5</sup>	B. circulans Actinomycesspp
				Streptomyces spp B. mycoides B. thuringiensis
SO8	P.chilensis	5-15	1.8X10 <sup>3</sup>	B. pantothenticus B. cereus Actinomycesspn
				Streptomyces spp B. mycoides
SO9	Balanites aegyptiaca	0-5	1.8X10 <sup>3</sup>	B. thuringtensis B. pantothenticus B. circulans
				Actinomycesspp Streptomyces spp
				B. mycoides B. lentus B. thuringiensis
SO10	B.aegyptiaca	5-15	7.5X10 <sup>3</sup>	B. marcerans B. circulans
				Actinomycesspp Streptomyces spp B. mycoides
AL1	Acacia ehrenbergiana	0-5	1.2X10 <sup>5</sup>	B. lentus B. marcerans B. circulans
				Actinomycesspp Streptomyces spp B. mycoides
				B. lentus B. thuringiensis
AL2	A.ehrenbergiana	5-15	1X10	B. marcerans B. circulans Actinomycesspp
				Streptomyces spp B. mycoides B. lentus
AL3	Calotropis procera	0-5	2.8X10 <sup>3</sup>	B. thuringensis B. marcerans B. circulans
				Actinomycesspp Streptomyces spp
				B. cereus B. lentus
AL4	C.procera	5-15	1.3X10 <sup>3</sup>	B. thuringiensis B. marcerans B. circulans
				Actinomycesspp Streptomyces spp

AL3     Bulantic acception     6-3     LX10 <sup>4</sup> Kerning Composition       AL4     Rangening     5,15     IX10 <sup>2</sup> No interpretable in an experiment of the services     Notion Services       AL3     Capports devidual     6,5     IX10 <sup>2</sup> A interpretable in an experiment of the services     No interpretable in an experiment of the services       AL3     Cabeelaa     5,15     IX10 <sup>2</sup> A interpretable in an experiment of the services       AL3     Cabeelaa     5,15     IX10 <sup>2</sup> A interpretable in an experiment of the services       AL3     Cabeelaa     5,15     IX10 <sup>2</sup> A interpretable in an experiment of the services       AL10     An explain experiment in an experiment of the services     5,15     IX10 <sup>2</sup> A interpretable in an experiment of the services       AL10     An explain ex					B. mycoides
A15     Iodames aggebbasi     0.5     1211     Actionsportunity of the second seco					B. cereus
AL5     Bargeyriner     5-15     IXI0 <sup>1</sup> Superside and a second	AL5	Balanites aegyptiaca	0-5	1.2X10 <sup>+</sup>	Actinomycesspp
AL5 $X10^3$ $X10^3$ $X10^3$ $X model of the second $					Streptomyces spp
AL6     Resurgetator     S.15     RU0 <sup>2</sup> Resurce frameworks of the constraints of the con					B. mycoides
A.1.6     Rangepleice     5.15     IX10 <sup>1</sup> Ranzersample (Ranzersample)       AL7     Capport deciduar     0.5     IX10 <sup>2</sup> Ranzersample (Ranzersample)       AL7     Capport deciduar     0.5     IX10 <sup>2</sup> Ranzersample (Ranzersample)       AL8     Cadexiduar     5.15     IX10 <sup>2</sup> Ranzersample (Ranzersample)       AL9     Acacia concilio rap. spinocarpa     0.5     IX10 <sup>2</sup> Ranzersample (Ranzersample)       AL9     Acacia concilio rap. spinocarpa     0.5     IX10 <sup>2</sup> Ranzersample (Ranzersample)       AL10     Acacia concilio rap. spinocarpa     0.5     IX10 <sup>2</sup> Ranzersample)       AL10     Acacia concilio rap. spinocarpa     0.5     IX10 <sup>2</sup> Ranzersample)       AL11     Zipplax spinoc Christi     0.5     IX10 <sup>2</sup> Ranzersample)       AL12     Zuplac christi     0.5     IX10 <sup>2</sup> Ranzersample)       AL13     Pascopic chlimit     0.5     IX10 <sup>2</sup> Ranzersample)       AL14     Pascopic chlimit     0.5     IX10 <sup>2</sup> Ranzersample)       UD1     Acacia concilio rap. toritic     0.5     IX10 <sup>2</sup> Ranzersample)       UD1     Acacia concilio rap. toritic     0.5     IX10 <sup>2</sup> Ranzersample)       UD2     Acacia concilio rap. toritic     0.5     IX10					B. thuringiensis
AL7Caparis deciduar0.5IX10 <sup>10</sup> IACON R deciduarAL7Caparis deciduar0.5IX10 <sup>10</sup> E creat R deciduarAL8Calesiduar5.15IX10 <sup>10</sup> Benovalar R deciduarAL9Access arribits say, spinocurpu arribumous agric0.5IX10 <sup>10</sup> Benovalar R deciduarAL9Access arribits say, spinocurpu arribumous agric0.5IX10 <sup>10</sup> Benovalar R deciduarAL10Access arribits say, spinocurpu arribumous agric0.5IX10 <sup>10</sup> Benovalar R deciduar R arrivolation R arri	AL6	B.aegyptiaca	5-15	$1X10^{3}$	B. marcerans
A.7.2     Copports docidion     0.5     X10 <sup>1</sup> Status (1971)					Actinomycesspp
$AL2 \ Lapharis decidass                                    $					Streptomyces spp
AL7.     Eugenetic decidants     0-5     LX10 <sup>2</sup> Rescalants     Rescalants       AL8.     Calecidant     0-15     LX10 <sup>2</sup> Rescalants       AL9.     Calecidants     0-15     LX10 <sup>2</sup> Rescalants       AL9.     Calecidants     0-15     LX10 <sup>2</sup> Rescalants       AL9.     Accesite intrifis say, spirocurpu     0-5     2X10 <sup>2</sup> Rescalants       AL10     Accesite intrifis say, spirocurpu     0-5     7X10 <sup>2</sup> Rescalants       AL10     Accesite intrifis say, spirocurpu     0-5     7X10 <sup>2</sup> Rescalants       AL10     Accesite intrifis say, spirocurpu     0-5     12X10 <sup>2</sup> Rescalants       AL11     Rescalants     Rescalants     Rescalants     Rescalants       AL11     Rescalants     Rescalants     Rescalants     Rescalants       AL11     Rescalants     Rescalants     Rescalants     Rescalants       AL12     Spinote rescalants     Rescalants     Rescalants     Rescalants       AL11     Rescalants     Rescalants     Rescalants     Rescalants       AL12     Spinote rescalants     Rescalants     Rescalants     Rescalants       AL11     Rescalants     Rescalants     Rescalants     Rescalants       AL12     Rescalant					B. lentus P. thuringiongia
AL7     Capparis decidas     9-5     [X10 <sup>2</sup> ]     R. genordat Actionspression Streptomice spin Election B. Bandar B. Bandar					B. inuringiensis B. careus
A1.8 $\mathcal{L}$ decides5.15 $1.110^3$ $\mathcal{L}$ decides $\mathcal{L}$ decidesA1.9 $\mathcal{L}$ decides $\mathcal{L}$ -basic $\mathcal{L}$ decidencing $\mathcal{L}$ decidencing	AL7	Capparis deciduas	0-5	$1X10^{3}$	B. mycoides
A1.8 $LorestituLiklo2L$					Actinomycesspp
$A18 \ Calculate \left[ \frac{1}{2} \operatorname{Lexture}_{A} + \operatorname{Lexture}$					Streptomyces spp
A1.8 $\mathcal{L}$ elecidur $\mathcal{L}_{12}$ </td <td></td> <td></td> <td></td> <td></td> <td>B.badius</td>					B.badius
AL8     Calceldua     5-15     1.1X10 <sup>1</sup> Amarcana a marcana Bernation Bernatio Bernation Bernation Bernation Bernation					B. lentus
AL9       Acacia torilli squ. spinocarpa       9.5       2X10 <sup>2</sup>	AL8	C.decidua	5-15	$1.1X10^{3}$	B. mycoides
AL9Acakia tortilis sep. spinocarpa $0.5$ $2X10^5$ $10^{10}$ $10^{10}$ R provide R lating instation R lating insta					B. marcerans
AL9Acada torilli say. spirocarpa $0.5$ $2 \text{K10}^2$ $\left[ \begin{array}{c} \text{R} \ n \ n \ n \ n \ n \ n \ n \ n \ n \ $					Strentomyces spp
A1.9     Acacia torillis sep. spinocarpa     0.5     2X10 <sup>1</sup> Inima     Inima       A1.10     Atorillis sep. Spinocarpa     5-15     7.5X10 <sup>1</sup> Initialization in the sep spinocarpa       A1.11     Tripping spinocarpa     5-15     7.5X10 <sup>1</sup> Initialization in the sep spinocarpa       A1.12     Tripping spinocarpa     6-5     1.2X10 <sup>1</sup> Initialization in the sep spinocarpa       A1.12     spinoc Christi     6-5     1.2X10 <sup>1</sup> Initialization in the sep spinocarpa       A1.12     spinoc Christi     5-15     1.6X10 <sup>4</sup> Initialization in the sep spinocarpa       A1.13     prosopic chilensis     6-5     1.7X10 <sup>4</sup> Initialization in the sep spinocarpa       A1.14     prosopic chilensis     6-5     1.7X10 <sup>4</sup> Initialization in the sep spinocarpa       A1.14     prosopic chilensis     6-5     7.5X10 <sup>5</sup> Initialization in the sep sep spinocarpa       UD1     Acacia norribits sep tornibit     6-5     7.5X10 <sup>5</sup> Initialization in the sep sep spinocarpa       UD2     Acacia torribits sep tornibit     6-5     7.5X10 <sup>5</sup> Initialization in the sep sep spinocarpa       UD3     Acacia torribits sep tornibit     6-5     7.5X10 <sup>4</sup> Initialization in the sep sep spinocarpa       UD3     Acacia torribits sep tornibit     6-5     7.5X10 <sup>4</sup> Initializati					B. mycoides
Al-9     Accia torilli s.p. spinocarpa     0-3     2x10°     A creation       AL10     Anortili s.p. Spinocarpa     8-15     7.5X10°     B marcing and a construction of the second of th					B. lentus
A1.9     Accia torills say. spincarpa     0.5     2X10 <sup>2</sup> Buturingenesis Halformicessay Actionary cossay Bit Maringenessa Bit Maringenessa Bit Maringenessa Bit Maringenessa       AL10     Atorills say. Spincarpa     5-15     7,5X10 <sup>2</sup> Barsecoide Actionary cossay Bit Maringenessa       AL11     Ziphus spina - Christi     0-5     1,2X10 <sup>4</sup> Barsecoide Actionary cossay Bit Maringenessa       AL12     Ziphus - Christi     0-5     1,2X10 <sup>4</sup> Barsecoide Barsecoide Actionary cossay Bit Maringenessa       AL13     Ziphus - Christi     0-5     1,2X10 <sup>4</sup> Barsecoide Barsecoide Barsecoide Barsecoide Barsecoide Barsecoide Barsecoide       AL14     Pressopic chlemis     0-5     1,7X10 <sup>4</sup> Barsecoide Barseco				_	B. circulans
$A1.0 \ A.torills xgs. Spirocarpu  A1.0 A.torills xgs. Spirocarpu  A1.1 A.torills xgs. Spirocarpu  A1.1 Ziphus. spina- Christi  D1.2 Ziphus. spina- Christi  A1.1 Ziphus. spina- Christi  D1.2 Ziphus. spina- Chr$	AL9	Acacia tortilis ssp. spirocarpa	0-5	2X10 <sup>5</sup>	B. thuringiensis
Al.10Atomitic sep. Spirocarpa5-15 $7.5 \times 10^3$ $Atomitic sep. Spirocarpa5-157.5 \times 10^3Atomitic sep. SpirocarpaAl.112irphus spina Christi0^-51.2 \times 10^4BerraisAl.122irphus spina Christi0^-51.2 \times 10^4BerraisAl.122irphus spina Christi0^-51.2 \times 10^4BerraisAl.132irphus spina Christi0^-51.2 \times 10^4BerraisAl.14Persopis chilensis0^-51.7 \times 10^4BerraisAl.14Persopis chilensis0^-51.7 \times 10^4BerraisAl.14Persopis chilensis0^-51.7 \times 10^4BerraisAl.14Persopis chilensis0^-51.7 \times 10^4BerraisAl.14Persopis chilensis0^-53.5 \times 10^5BerraisUD1Aeceis torilis sop. torilis0^-53.10^2BerraisUD2Aetrais persodis1.5^23.5 \times 10^5BerraisUD3Aeceis torilis sop. torilis0^-53.5 \times 10^5BerraisUD3Aetrais persodis1.5^29.5 \times 10^5BerraisUD3Aetrais persodis1.5^23.5 \times 10^5BerraisUD3Aetrais persodis1.5^23.5 \times 10^5BerraisUD3Aetrais persodis1.5^29.5 \times 10^5BerraisUD3Aetrais persodis1.5^29.5 \times 10^5BerraisUD4Aetrais persodis1.5 \times 10^51.5 \times$					B. marcerans
AL10 A torrife sop. Spirocarpa Sciences Spir					Actinomycesspp
AL10Austrills say. Spirecarpa5-157.5X10 <sup>1</sup> $\begin{bmatrix} ReressiHerrosciellsArtinonycostapB. HurringienstsE. CeressiB. HurringienstsB. Hurringiensts$					Streptomyces spp B thuringiansis
AL10     A corrilis sap. Spirocarpa     5-15     7.5X10 <sup>1</sup> Empodes Anionyces sap Actinonyces sap Bergeonyces sap Berg					B. maringiensis R cereus
AL11     Ziphus spina-Christi     0-5     L2X10 <sup>4</sup> Actinonycessp Streptomyces spp B. Hurringientis B. Cerress       AL12     Z. spina-Christi     5-15     1.6X10 <sup>4</sup> B.mycoides Actinonycesspp Streptomyces spp B. Burringientis B. Cerress       AL12     Z. spina-Christi     5-15     1.6X10 <sup>4</sup> B.mycoides Actinonycesspp Streptomyces spp B. Burringientis B. Cerress       AL13     Prosopis chilensis     0-5     1.7X10 <sup>4</sup> B.mycoides Actinonycesspp Streptomyces spp B. Burringientis B. Cerress       AL14     P.chilensis     5-15     7.5X10 <sup>2</sup> B.mycoides Actinonycesspp B. Burringientis B. Cerress       UD1     Acocia torritis sp. torritis     0-5     4X10 <sup>2</sup> B.mycoides Actinonycesspp B. Burringientis B. Cerress       UD2     Actinitis sp. torritis     0-5     4X10 <sup>2</sup> B. ceress B. anycoides Actinonycesspp B. anycoides Actinonycesspp B. anycoides B. a	AL10	A.tortilis ssp. Spirocarpa	5-15	$7.5 \times 10^{3}$	B.mvcoides
Al.11Ziplus spine Christi0.5 $1.2\times10^4$ Steptissions Eccress Revisions Actionationscress Billionscress 		I I I			Actinomycesspp
AL11Ziphus spina-Christi0-5 $2X10^4$ Barrents					Streptomyces spp
AL11     Ziciphus spina- Christi     0-5     L2X10 <sup>4</sup> Benycoides Actionaryces spin Beniringiensis       AL12     Z spina- Christi     5-15     L6X10 <sup>4</sup> Benycoides Becarina       AL13     Prosopis chilensis     5-15     L6X10 <sup>4</sup> Benycoides Becarina       AL14     Periosopis chilensis     0-5     L7X10 <sup>4</sup> Benycoides Becarina       AL14     Periosopis chilensis     0-5     L7X10 <sup>4</sup> Benycoides Becarina       AL14     Periosopis chilensis     5-15     T5X10 <sup>14</sup> Benycoides Becarina       UD1     Acacia torillis sop. torillis     0-5     4X10 <sup>5</sup> Becarina Becarina       UD2     Acoritis sop. torillis     5-15     4X10 <sup>4</sup> Becarina       UD3     Acacia torillis sop. torillis     5-15     3X10 <sup>4</sup> Becarina       UD4     Acoritis sop. torillis     5-15     3X10 <sup>4</sup> Betrains       UD5     Acacia torillis sop. torillis     5-15     9.5X10 <sup>4</sup> Betrains       UD4     Acoritis sop. radiana     0-5     3X10 <sup>5</sup> Betrains       UD5     Acacia torillis sop. radiana     0-5     3X10 <sup>5</sup> Betrains       UD4     Acoritis sop. radiana     0-5     3X10 <sup>5</sup> Betrains       UD5     Acacia torillis sop. radiana     0-5     5X10 <sup>4</sup> Betrains<					B. thuringiensis
AL11     Ziphus spine: Christi     0-5     1.2X10*     Brigonologics Streptomyces spp Between Bet					B.cereus
$\operatorname{AL12} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	AL11	Ziziphus spina- Christi	0-5	1.2X10*	B.mycoides
AL12Z spine-Christi5-15 $1.6 \times 10^4$ B intrinsignatis B introducts Christipunoves spine B introducts Christipunoves spine B introducts B interview spine B intervie					Actinomycesspp Streptomyces spp
AL12       Z spine-Christi       5-15       1.6X10 <sup>4</sup> Recreas Briegency es Support         AL13       Prosopis chilensis       0-5       1.7X10 <sup>4</sup> Braycoides Actionaryces spin         AL14       Prosopis chilensis       0-5       1.7X10 <sup>4</sup> Braycoides Actionaryces spin         AL14       Prosopis chilensis       0-5       1.7X10 <sup>4</sup> Braycoides Actionaryces spin         AL14       Problemsis       5-15       7.5X10 <sup>3</sup> Braycoides Actionaryces spin         UD1       Acacia toriilis sp. toriilis       0-5       4X10 <sup>9</sup> Braycoides Actionaryces spin         UD2       Acacia toriilis sp. toriilis       0-5       4X10 <sup>4</sup> Braycoides Actionaryces spin         UD3       Acacia toriilis sp. toriilis       0-5       3X10 <sup>4</sup> Braycoides Actionaryces spin         UD4       Acoriilis sp. toriilis       0-5       3X10 <sup>4</sup> Braycoides Actionaryces spin         UD5       Acacia toriilis sp. radiana       0-5       9.5X10 <sup>4</sup> Braycoides Braycoides         UD5       Acacia chenbergiana       0-5       9.5X10 <sup>4</sup> Braycoides Braycoides         UD6       Achenbergiana       0-5       9.5X10 <sup>4</sup> Braycoides Braycoides         Braycoides       Braycoides Braycoides       Brandicheticus Braycoides<					R thuringiensis
AL12     Z spine- Christi     5-15     1.6X10 <sup>4</sup> Empodes Alionmyces spine Streptomyces spine Receress       AL13     Prosopis chilensis     0-5     1.7X10 <sup>4</sup> Envocides Receress       AL14     Pehilensis     0-5     1.7X10 <sup>4</sup> Envocides Receress       AL14     Pehilensis     5-15     7.5X10 <sup>3</sup> Envocides Receress       UD1     Acacia toriilis sp. toriilis     0-5     4X10 <sup>5</sup> Envocides Receress       UD2     Acoriilis sp. toriilis     0-5     4X10 <sup>5</sup> Envocides Receress       UD3     Acacia toriilis sp. toriilis     5-15     4X10 <sup>4</sup> Elemis Receress       UD4     Acoriilis sp. toriilis     5-15     3X10 <sup>4</sup> Elemis Receress       UD3     Acacia toriilis sp. toriilis     5-15     9.5X10 <sup>4</sup> Elemis Receress       UD4     Acoriilis sp. toriilis     5-15     9.5X10 <sup>4</sup> Elemis Receress       UD5     Acacia toriilis sp. radiana     6-5     9.5X10 <sup>4</sup> Elemis Reproduces spine Receress       UD5     Acacia chrenbergiana     6-15     9.5X10 <sup>4</sup> Elemis Reproduces spine Receress       UD6     Achrenbergiana     5-15     9.5X10 <sup>4</sup> Elemis Reproduces spine Reproduces spine Receress       UD6     Achrenbergiana     5-15     9.5X10 <sup>4</sup> Elemis Reproduces spine Reproduces spine Receress </td <td></td> <td></td> <td></td> <td></td> <td>B. cereus</td>					B. cereus
AL13     Prosopis chilensis     Actionarycesspp     Serversas       AL13     Prosopis chilensis     0-5     1.7K10 <sup>4</sup> Benycoides       AL14     Pechilensis     E. Inuringiensis     E. Inuringiensis       AL14     Pechilensis     5-15     7.5K10 <sup>3</sup> Errerus       UD1     Accia torillis sap. torillis     0-5     4X10 <sup>3</sup> Eccreas       UD2     Accinarycessp1     5-15     4X10 <sup>3</sup> Eccreas       UD2     Accinarycessp2     Enversionarycessp2     Enversionarycessp2       UD2     Accinarycessp1     5-15     4X10 <sup>3</sup> Eccreas       UD3     Acacia torillis sap. torillis     6-5     4X10 <sup>4</sup> Eccreas       UD3     Acacia torillis sap. torillis     6-5     4X10 <sup>4</sup> Eccreas       UD3     Acacia torillis sap. torillis     6-5     4X10 <sup>4</sup> Ecreas       UD4     Acacia torillis sap. torillis     6-5     9.5X10 <sup>4</sup> Ecreas       UD5     Acacia torillis sap. radiana     6-5     6.5X10 <sup>5</sup> Ecreas       UD5     Acacia torillis sap. radiana     6-5     6.5X10 <sup>5</sup> Ecreas       Ecreas     Ecreas     Ecreas     Ecreas       Envirol     Ecreas     Ecreas     Ecreas       Ecreas     Ecreas     Ecreas	AL12	Z. spina- Christi	5-15	$1.6 X 10^4$	B.mycoides
AL13       Prosopis chilensis       0-5       1.7X10 <sup>4</sup> Biopromodes spp Eccreas         AL14       P.chilensis       5-15       7.5X10 <sup>4</sup> Biopromodes spp Eccreas         AL14       P.chilensis       5-15       7.5X10 <sup>3</sup> Eccreas         Maintonycesspp       Streptomyces spp Environyces spp.         UD2       Acoritiis ssp. toritiis       5-15       4X10 <sup>5</sup> Eccreas Eccreas Environyces spp.         UD3       Acacia toritiis ssp. radiana       0-5       9.5X10 <sup>4</sup> Eccreas E paratolenicus Environyces spp.         UD4       Acoritiis ssp. radiana       0-5       6.5X10 <sup>5</sup> Ecreas E paratolenicus E paratolen		•			Actinomycesspp
AL13 Prosopis chilensis 6.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1					Streptomyces spp
AL13Prosopis chilensis $0.5$ $1.7X10^4$ Berewas Actionorycess pp B. huringiensisAL14Pechilensis $5.15$ $7.5X10^3$ Beereus BeereusAL14Pechilensis $5.15$ $7.5X10^3$ Beereus Beretonyces spp B. huringiensisUD1Acacia tortilis ssp. tortilis $0.5$ $4X10^5$ Beereus Benycoides Actinonyces spp B. huringiensisUD2Acoria tortilis ssp. tortilis $0.5$ $4X10^5$ Beereus Beretonyces spp Beretonyces spp 					B. thuringiensis
AL13Prosopis chinensis0-51.7.10Empodes Streptomyces spp Streptomyces spp B. HurringiensisAL14P.chilensis5-157.5X103E.cereus B.mycoidesUD1Acacia tortilis ssp. tortilis0-54X105B.mycoides B.cereusUD2A.tortilis ssp. tortilis0-54X104B.cireus B. inversiones B. inversiones B. inversiones B.cereusUD2A.tortilis ssp. tortilis5-154X104B.cereus B. inversiones B. inversiones B.cereus B.cereusUD2A.tortilis ssp. tortilis5-154X104B. circulans B.cereus B.	11.12	D . 1.1 .	0.5	1 73/104	B.cereus
AL14 P.chilensis 5-15 7.5X10 <sup>3</sup> B.rucioniyces spp B. huringiensis E.cereus B. duringiensis B.	AL13	Prosopis chilensis	0-5	1./X10 <sup>-</sup>	B.mycoides
AL14P.chilensis5-157.5X103B. therpionyces spp B. cereusUD1Acacia torilis ssp. torilis0-5 $4X10^3$ $B. cycoides$ Actinomyces spp Streptomyces spp B. thuringiensisUD2Acacia torilis ssp. torilis0-5 $4X10^4$ $B. cycoides$ B. mycoidesUD2Actoritiis ssp. torilis5-15 $4X10^4$ $B. cycoides$ B. mycoidesUD2Actoritiis ssp. torilis5-15 $4X10^4$ $B. cycoides$ B. cycoidesUD2Actoritiis ssp. torilis5-15 $4X10^4$ $B. cycoides$ B. cycoidesUD3Acacia torilis ssp. radiana0-5 $3X10^5$ $B. cycoides$ B. cycoidesUD4Acacia torilis ssp. radiana5-15 $9.5X10^4$ B. cereus B. partoiners spp. Streptomyces spp.UD5Acacia ehrenbergiana0-5 $5.5X10^4$ B. cereus B. panothenticusUD6Achinomyces spp.B. cereus B. panothenticusB. coreus B. panothenticusUD6Achinomyces spp.B. cereus B. panothenticusB. cereus B. panothenticusUD6Achinomyces spp.S.5104B. cereus B. panothenticusUD6Achinomyces spp.B. cereus B. cereus B. cereus B. cereus B. cereus B. panothenticus B. panothenticus B. cereus B. panothenticus B. panothenticus B. panothenticus B. panothenticus B. panothenticus B. panothenticus B. panothenticus					Streptomyces spp
AL14P.chilensis5-157.5X103Recreas Actinonycesspp B. fluringiensisUD1Acacia tortilis ssp. tortilis0-54X103B.cerens B.cerensUD2Actorialis ssp. tortilis0-54X104B.cerens B.cerensUD2Actorialis ssp. tortilis5-154X104B.cerens B.cerensUD2Actorialis ssp. tortilis5-154X104B.cerens B.cerensUD3Acacia tortilis ssp. tortilis5-153X105B. lentus Actinonyces spp. Streptowyces spp. St					B. thuringiensis
AL14P.chilensis5-157.5X103Ranycoides Actionnycesspp BituringiensisUD1Acacia tortilis ssp. tortilis0-54X105Bererus Bererus BituringiensisUD2Acacia tortilis ssp. tortilis0-54X104Bererus BituringiensisUD2Actorilis ssp. tortilis5-154X104Berlus BituringiensisUD2Actorilis ssp. tortilis5-154X104Berlus BituringiensisUD3Acacia tortilis ssp. radiana0-53X105Berlus BituringiensisUD4Acacia tortilis ssp. radiana0-59.5X104Berlus BituringiensisUD5Acacia ehrenbergiana0-50.5X105Berlus Actionnyces spp. BituringiensisUD6Achirenbergiana0-50.5X105Berlus BituringiensisUD6Achirenbergiana5-153.5X104Bituringiensis BituringiensisUD6Achirenbergiana5-153.5X104Bituringiensis BituringiensisUD6Achirenbergiana5-153.5X104Bituringiensis BituringiensisUD6Achirenbergiana5-153.5X104Bituringiensis Bituringiensis BituringiensisUD6Achirenbergiana5-153.5X104Bituringiensis <b< td=""><td></td><td></td><td></td><td></td><td>B.cereus</td></b<>					B.cereus
UD1Acacia toriilis ssp. toriilis0-54X10 <sup>5</sup> Acinomycesspn B. churingiensis B. cereus B. mycoidesUD2A.toriilis ssp. toriilis5-154X10 <sup>4</sup> B. lentus Actinomycesspn B. mycoidesUD3Acacia toriilis ssp. toriilis5-153X10 <sup>4</sup> B. lentus Actinomycess spn. B. circulansUD3Acacia toriilis ssp. radiana0-53X10 <sup>5</sup> B. lentus Actinomyces spn. B. circulansUD4Actoriilis ssp. radiana0-53X10 <sup>5</sup> B. cereus B. circulansUD5Acacia chrenbergiana0-59.5X10 <sup>4</sup> B. cereus B. panothenicus B. panothenicus B. panothenicus B. panothenicus B. panothenicus B. panothenicus B. mycoidesUD6Achrenbergiana5-159.5X10 <sup>4</sup> B. cereus B. panothenicus B. panothenicus <b< td=""><td>AL14</td><td>P.chilensis</td><td>5-15</td><td>7.5X10<sup>3</sup></td><td>B.mycoides</td></b<>	AL14	P.chilensis	5-15	7.5X10 <sup>3</sup>	B.mycoides
$ \begin{tabular}{l l l l l l l l l l l l l l l l l l l $					Actinomycesspp
UD1 Acaia tortilis ssp. tortilis 0-5 4X10 <sup>5</sup> B. Cercus B. Bacreus B. Bacreus B. Cercus B. Macinomyces.spp Streptomyces.spp B. mycoides B.					Streptomyces spp
UD1Acacia tortilis ssp. tortilis0-54X105B.mycoides Attionyces spp B.mycoides 					B. thuringiensis
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Our results showed that microbial population was different in soil under different plant covers, soil types and depths. The total number of isolated bacteria varied in different samples of studied soils. Among several factors affecting microbial population and activity, moisture, temperature, nutrients and soil depth are important factors.

Bacterial count tends to decrease with increase in soil depth. Decrease in the bacterial count with increasing soil depth could be related to the organic carbon content of the soil as nutrients are declining with the increase in soil depth. The higher bacterial count at the surface layer might be due to the presence of litters, twigs, herbs and tree canopy which render a moist environment in the soil and favor high microbial activity and hence high microbial populations [14].

# **3.3.** Quantitative data on microbial populations using diversity indices

The quantitative data on microbial population recorded in the present study was analysed using two diversity indices. High Shannon-Weiner diversity Index value for bacteria was obtained in AL-Aelfoon sub-region (1.79361), whereas high Simpson index value was obtained in Um Dawan Ban sub-region (2.80). Table 5.

Table 5: Diversity of Microorganisms in the Study Area						
Sub marian	Shannon-Weiner Diversity	SimpsonDiversity				
Sub-region	Index	Index				
Soba	1.3453	1.78				
AL-Aelafoon	1.79361	2.7213				
Um Dawan Ban	1.5408	2.80				

# **3.4.** The correlation effects between the soils characteristics on bacterial count:

The correlation effects between the soils parameters on bacterial count were studied (Tables 6 - 8).

### 3.4.1.Soba

Total bacterial count was positively correlated with pH (r= 0.0194) and sand (0.3205) and negatively correlated with EC, clay, silt, SP, Na, K, P, Ca, Mg, N, and OC. Table 6.

#### 3.4.2. AL-aelafoon sub-region

Total bacterial count was positively correlated with EC (r= 0.1062), clay (r= 0.3816), silt (r= 0.1936), SP (r= 0.8302), K (r= 0.6252), Ca (r= 0.0015), and Mg (r= 0.1556). Table 7.

#### 3.4.3. Um dawan ban sub-region

Total bacterial count was positively correlated with clay (r= 0.2614), silt (r= 0.0216), SP (r= 0.565), K (r= 0.9645), P (r= 0.0197), Ca (r= 0.7377), Mg (r= 0.0267), N (r= 0.5215) and OC (r= 0.3214) and negatively correlated with pH, EC, sand and Na. Table 8.

All the relationships between the total viable bacterial counts and soil physico-chemical properties or plant types are compiled in Tables 6 - 8. There were obvious differences in correlation coefficients among the selected criteria (46 % from the total number of correlation coefficients were positively correlated between bacterial counts and soil physico-chemical properties whereas 54 % from the total number were positively correlated between plant type and bacterial counts).

 
 Table 6:Correlation Coefficients of the Physico-Chemical Properties with the Viable Bacterial Count (Cfu G<sup>-1</sup> Soil) In Soba Sub-Region

Soil Physico-chemical Properties	R	$\mathbb{R}^2$	Correlation
pH	0.0194	0.0004	Weak +ve
EC	-0.332	0.1102	-ve
Clay	-0.2685	0.0721	-ve
Silt	-0.1444	0.0209	-ve
Sand	0.3205	0.1027	+ve
SP	-0.2621	0.0687	-ve
Na	-0.3722	0.1385	-ve
K	-0.5597	0.3133	-ve
Р	-0.6273	0.3935	Moderate -ve
Ca	-0.6766	0.4578	Moderate -ve
Mg	-0.577	0.3329	Moderate -ve
N	-0.2104	0.0443	Weak -ve
0.C	-0.3295	0.1086	Weak -ve

Table 7:Correlation Coefficients of the Physico-Chemical Properties	with
the Viable Bacterial Count (Cfu G <sup>-1</sup> Soil) in AL-Aelafoon Sub-Region	

Soil Physico-chemical Properties	R	$\mathbb{R}^2$	Correlation
pH	-0.3094	0.0957	-ve
EC	0.1062	0.0113	+ve
Clay	0.3816	0.1456	+ve
Silt	0.1936	0.0375	+ve
Sand	-0.4129	0.1705	-ve
SP	0.8302	0.6892	Strong +ve
Na	-0.0014	0	-ve
K	0.6252	0.3909	Moderate +ve
Р	-0.0983	0.0097	Weak -ve
Ca	0.0015	0	Weak +ve
Mg	0.1556	0.0242	Weak +ve
N	-0.1926	0.0371	Weak -ve
0.C	-0.3388	0.1148	Weak –ve

**Table 8:** Correlation coefficients of the physico-chemical properties with<br/>the viable bacterial count (cfu  $g^{-1}$  soil) in Um Dawan Ban sub-region

Soil Physico-chemical Properties	R	$\mathbb{R}^2$	Correlation
pH	-0.1219	0.0149	-ve
EC	-0.2512	0.0631	-ve
Clay	0.2614	0.0683	+ve
Silt	0.0216	0.0005	+ve
Sand	-0.1771	0.0314	-ve
SP	0.565	0.3192	Moderate +ve
Na	-0.4126	0.1702	-ve
K	0.9645	0.9303	Strong +ve
Р	0.0197	0.0004	Weak +ve
Ca	0.7377	0.5442	Moderate +ve
Mg	0.0267	0.0007	Weak +ve
N	0.5215	0.272	Moderate +ve
0.C	0.3214	0.1033	Weak +ve

## 4. Conclusion

Qualitative analysis of microorganisms isolated from the studied soil samples reveal a total of thirteen different species of bacteria, of which two are unidentified. The ten species are classified under Bacillus genus, and one species is classified under Micrococcus genus.

The quantitative analysis of the isolated microorganisms was also carried out by considering individual colonies as separate units (CFUs). The quantitative data on microbial population recorded in the present study was analysed using two diversity indices. Soil Actinomyces spp. and Streptomyces spp. were the most abundant microorganisms identified in the three habitats.

Current biotechnolgy research is needed for developing new microbial pesticides from these studied microorganisms.

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