



## RESEARCH ARTICLE

## Effect of Physicochemical Factors on Cyanobacteria Biodiversity in Some Agricultural Soil of Al-Diwaniyah City during Spring Period

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### Abstract

The present study investigated the effect of some physicochemical factors on the biodiversity of Cyanobacteria in the agricultural soils of some areas in the city of Diwaniyah, where six areas are selected: Ghammas, Al-Shamiya, Al-Saniya, Afak, Al-Daghara, Al-sadeer with five farms per region during spring. Physical and chemical factors of the soil range between 21-23.5 °C and pH between 7.72-7.33, electrical conductivity between 233.8-3072  $\mu\text{s}/\text{cm}$ , salinity between 0.268-1.730%, Nitrate between 7.46-20.0400 ppm, and phosphate between 1.340-5.260 ppm while the soil texture, the percentage of sand ranges between 12.08-15.68%, the Silt between 50.112-53.216%, and the clay between 34.208 -35.5%, the organic matter is between 3.350-6.202%, potassium 23-57ppm, calcium between 125.2-1320 ppm, magnesium between 51.46-557 ppm, and sodium between 1.3040-12.3580 ppm. Cyanobacteria species identified in this study are about 26 species. The dominant species of cyanobacteria represented by *Oscillatoria* sp. with percentage 50% followed by *Phormidium* sp. 19.230%, then *Chroococcus* sp. and *Spirulina* sp. 7.692%, Finally, *Gleocapsa* sp., *Microcoleus*, sp. and *Shizothrix* sp. reach to 3.864%. Some species of Cyanobacteria record in all soil areas like *Oscillatoria acuta*, *O. Laetevirens*, *O. tenuis*, *Phormidium anomala*, and *P. pachydermiticum*. The lowest number of Cyanobacteria is 2 in Afak and in Al-Sanyia and the highest number is 8 in Gammass. The Shannon Diversity index values of ranged between 2.350-2.685. While Simpson index Diversity values range between 0.935-0.960 in Afak and Ghammas, respectively. The results of the statistical analysis showed significant differences and a positive, negative correlation between physicochemical factors and to the cyanobacteria numbers of some agricultural areas at  $p < 0.05$ .

**Keywords:** *Cyanobacteria, Biodiversity, Soil, Physicochemical factors, Spring.*

### Introduction

The soil is a major reserve for organic and mineral raw materials and it is an essential for plant stability, providing food and water for its growth and development, as well as being habitat for all flora and fauna, which are more abundant in wet soils [1]. Algae is one of the most common organisms lives in soil, Cyanobacteria one of the most abundant organisms which is negative gram bacteria a prokaryotic distributed in all habitats such as hot springs and northern, southern polar regions, trees bark, and soil surface.

It is photosynthetic organisms and provides high values of oxygen. It is the oldest groups on Earth since the volcanic age, the lifetime of it are more than 2.5-3.5 million years ago [2]. Cyanobacteria have certain qualities and characteristics that make them resistant

inappropriate environmental conditions such as temperature, pH, nutrients availability [3]. They live free or in a symbiotic relationship with plants, fungi, and animals [4]. Algae play an important role in ecosystems especially Cyanobacteria, in oxygen supplying the atmosphere which is important to all forms of life [5]. Song, *et al.* [6] remembered that role of Cyanobacteria in the soil is increase the porosity of it especially filamentous forms of their species.

They have secreted growth-enhancing substances such as hormones (auxin and gibberellin), vitamins and amino acids. [7]. Also, reduce soil salinity, inhibits the growth of harmful herbs, and also increase phosphates in soil by secretion of organic acids [8]. They increase the ability of soil to

keep water via its gelatin structure [9]. Cyanobacteria are used as bio fertilizers in agriculture because of their ability to nitrogen fixation from the atmosphere [10]. The present study aims to know the effect of the physicochemical factors on biodiversity of Cyanobacteria in some agricultural soil Al-Diwaniya city.

## Materials and Methods

### Study Area Description

Study Area locates in the province of Al-Diwaniyah, one of the southern cities of Iraq in the region of the Middle Euphrates, which is part of Iraq's plain sedimentary flood, which is located between latitudes 17.31, 2432N and longitude 44.24, 45.49E. Six areas are selected from Al-Diwaniya, which was Ghammas, Al-Shamiya, Al-Daghara, Afak, and Al-Sadeer (Figure 1). Soil samples collected from this agricultural field by five replicates for each field during spring 2017.



Figure 1: Satellite map by Google earth explain study area of sample collections

### Physical and Chemical Properties of Soil

Soil temperature is measured by using a soil thermometer. Ph measured by pH Meter, type-Senso direct, Lovibond Company, and German after calibration with Buffer Solution [11]. Electrical conductivity is measured according to [11] by EC meter, type SM 301, American Milwaukee Corporation. While Salinity is estimated based on the values of electrical conductivity according to the equation [12] [salinity (%o) = electrical conductivity ( $\mu\text{s}/\text{cm}$ )  $\times 640 \times 10^{-6}$ ].

Nitrate is estimated by acidic diphosphate method according to [13]. Phosphate is estimated by [14] method. Soil texture is determined by Hydrometer Method according to [11] method. Organic matter is calculated according to [14] method. Calcium and magnesium and Potassium are measured by the atomic absorption spectroscopy [15]. While sodium measured by [16] method, by Flame photometer.

### Isolation and Identification of Cyanobacteria

Cyanobacteria are isolated, according to [17] method, where samples are collected from the surface layer of the soil depth 5cm, about 40 g of wet soil has cyanobacteria in a petri dish. Then covered by Lens Later, these dishes are exposed to the feeble light in laboratory overnight, and remove lens paper with attached cyanobacteria in tubes with Lugol's iodine Solution for kept, the cyanobacteria examined by optical microscopy under x40, and identified depending on the classification keys, [18, 19].

### Biodiversity Indexes

- Shannon and Weaner Index: The value of diversity has been calculated as follows [20]  $H = -\sum_{i=1}^S P_i \ln P_i$
- Simpson Index of Diversity: Simpson's index calculated using equation mentioned in [21] as the following:  $SI = \frac{1}{\sum(P_i)^2}$

## Statistical Analysis

The variations of the physicochemical factors and cyanobacteria species numbers between six agricultural soils were estimated using one-way analysis of variance (ANOVA one way), and Least Significant differences (LSD), the correlation between physicochemical factors and cyanobacteria species number was done by Pearson's correlation coefficient using SPSS 24 at  $P < 0.05$ .

## Results and Discussion

### Soil Temperature

The average of soil temperature ranges

between 21-23.6 °C in Al-Saniya and in Al-Sadeer regions respectively (Table 1). The results indicate significant differences between some temperature values areas, the difference in values may be due to the time of sample collection [22].

A positive correlation is observed between temperature and cyanobacteria numbers in Ghammas, Al-Shamiya, AL-Daghara, and AL-sadeer (Table 2). This is because some cyanobacteria species can tolerate low temperature less than the optimum temperature for their growth which was 25-33 °C [23].

**Table 1: physicochemical factors and cyanobacteria species numbers in agricultural soils during spring period**

Agricultural Soils		Ghammas	Al-Shamiya	Al-Saniya	AL-Daghara	Afak	Al-Sadeer	LSD
		Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	Mean± S.E	
Physicochemical Factor								
Temperature C°		22-23 22.4±0.18 B	21-23 22.±0.44 B	20.-22.5 21.00±0.33 C	22-23.5 22.70±0.33 B	21.5-25 23.2±1.0 A	23-24.5 23.6±1.19 A	1.07
pH		6.88-7.18 7.02±0.08 B	7.20-7.55 7.29±0.06 A	7.02-7.54 7.33±0.11 A	7.03-7.28 7.15±0.05 B	7.02-7.36 7.25±0.04 A	7.23-7.50 7.33±0.48 A	0.54 (N.S)
EC (µs/cm)		512-962 774.2±77.35 C	1100-1700 1336±102.44 B	256-530 330.60±50.61 D	2900-3280 3072±86.87 A	202-282 233.8±13.20 D	1020-1700 1404± 12.75 B	197.8
Salinity (‰)		0.33-0.71 0.536±0.06 C	0.67-1.09 0.802±0.08 C	0.16-0.34 0.268±0.04 D	1.20-2.10 1.730±0.32 A	0.10-1.80 0.552±0.32 B	0.30-1.86 1.16±0.25 B	0.45
Nitrate (ppm)		7.8-8.5 8.080±1.157 D	9.9-26.1 20.0400±27.30 A	4.9-12.3 10.642±14.30 B	7.1-7.8 7.46±3.748 E	12-13.4 12.488±4.50 B	7.1-9.9 8.480±4.50 C	0.311
Phosphate (ppm)		1.5-1.8 1.6600±0.67 B	1.1-1.6 1.340±0.929 C	1.5-2.1 1.7040±1.14 B	1.4-1.8 1.60±0.836 B	1.5-1.8 1.666±0.417 B	4.5-7 5.260±4.445 A	0.48
Soil Texture	Sand (%)	6-22.50 12.1±1.21	12-18.5 14.38±1.11	11-20 13.6±1.66	8.40-22 12.08±2.51	8-22 14.14±2.35	8.50-30 15.68±3.92	6.20 (N.S)
	Silt (%)	50-55 52.846±0.89 A	50-52 50.7±1.19 A	49.60-57 51.52±1.38 AB	50.88-57.60 53.216±1.15 A	45-52.50 50.36±2.05 B	44.80-55 50.112±1.62 AB	7.51
	Clay (%)	25.12-39 34.624±0.97	29.5-37.2 34.92±1.8	29.40-39 34.88±0.36	25-39.12 34.704±1.6	32-39.70 35.5±1.6	25.20-39.30 34.208±1.05	3.530 (N.S)
Total organic matter (%)		2.77-5.68 4.322±0.46 A	2.90-4.90 3.952±0.33 A	4.10-5.00 4.510±0.15 A	3.82-5.79 4.844±0.38 A	2.34-4.14 3.352±0.29 A	4.14-7.58 6.202±0.76 B	1.06
Ca (ppm)		380-540 488±28.009 B	540-600 574±12.4 B	130-140 138±2.0 C	1280-1400 1320±20.4 A	130-160 144±50.4 C	120-132 125.2±2.89 A	233.659
Mg (ppm)		247-453 293.40±400.55 B	287-407 362.20±200.7 B	38-70 55.2 ±64.1 C	470-500 486±60 A	45.3-54 51.46±17.20 C	500-613 557±180.841 A	79.5497
Na (ppm)		2.73-4.32 3.574±0.309 B	3.4-5.42 3.9940±0.394 B	1.21-1.55 1.3040±0.063 C	10.11-15.72 12.358±1.0026 A	1.42-1.55 1.464±0.022 C	6.76-9.88 8.304±0.53 B	1.225
K (ppm)		51-60 56±2.074 A	25-47 32.6±3.75 AB	29-50 41.8±3.904 AB	36-71 57±6.253 A	16-34 23±3.098 B	44.4-55.5 50.18±2.263 A	24.13
Algal number		3-8 6±0.83 A	3-7 5±0.83 A	2-7 5±0.89 A	3-6 5±0.63 A	2-6 4±0.63 B	4-6 5±0.25 A	1.75

Mean± Standard Error

Capital letters refer to significant differences between the physicochemical factors and cyanobacteria species numbers for each area

**Table 2: Pearson's correlation coefficient between physicochemical factors and cyanobacteria species numbers at P < 0.05**

Agricultural areas		spring season						
		Ghammas	Al-Shamiya	Al-Saniya	AL-Daghara	Afak	Al-sadeer	
Cyanobacteria numbers	Factors							
	Temperature C°	0.639	0.267	-0.289	0.466	-0.392	0.271	
	pH	0.882	0.674	-0.027	-0.223	-0.278	0.723	
	EC (µs/cm)	-0.273	0.257	-0.034	0.643	-0.450	-0.124	
	Salinity (‰)	-0.341	-0.044	-0.038	0.263	-0.225	-0.647	
	Nitrate (ppm)	0.568	0.653	0.033	0.907	-0.554	-0.104	
	Phosphate (ppm)	-0.441	0.322	-0.139	-0.094	0.839	-0.178	
	Soil texture	Sand (%)	0.111	-0.287	0.689	0.634	-0.306	0.288
		Silt (%)	0.305	0.184	0.797	-0.582	-0.311	-0.993
		Clay (%)	-0.261	0.652	-0.264	0.496	0.066	-0.594
	Total organic matter %	-0.415	0.308	0.946	-0.311	-0.595	0.037	
	Ca <sup>+2</sup> (ppm)	0.171	-0.574	0.12	0.528	0.658	0.678	
	Mg <sup>+2</sup> (ppm)	-0.883	0.652	0.11	-0.132	0.152	0.437	
	Na <sup>+</sup> (ppm)	-0.514	-0.264	-0.772	0.824	-0.326	-0.930	
K <sup>+</sup> (ppm)	-0.778	0.08	-0.851	0.948	-0.162	0.777		

## PH

The pH affects directly or indirectly the metabolic process of algae [24]. The lowest rate of pH is 7.02 in the Ghammas, and the highest is 7.33 in Al- Saniya and Al-Sadeer (Table1). The pH in the current study tends to be neutral to slightly alkaline. Kaushik, 1994 remembered that pH is an important factor that effects the growth and diversity of Cyanobacteria which was usually preferred neutral to alkaline soil.

A positive correlation between Cyanobacteria and pH was observed table 2 in most areas such as Ghammas, AL-Shamiya, and Al-Sadeer (Table 2). The results of the statistical analysis indicated that there are no significant differences between areas in pH values, the results of the current study are less than the results of [25, 26, 27, 28, 29] In their study on the diversity of cyanobacteria and the physical and chemical factors of soil.

## Electrical Conductivity and Salinity

The average values of electrical conductivity range between 233.8-3072 µs/cm in Afak and Al-Daghara respectively. While average values of salinity range between 0.268-1.730 ‰ in Al- Saniya and Al- Daghara respectively (Table1).It is observed through the results of electrical conductivity salinity values there were significant differences between areas.

The results of electrical conductivity in the current study are higher than those recorded by [30] in India and [27, 31] in China. They results also lower than the results of [32] in India. Also, there is a negative correlation between Cyanobacteria numbers and Salinity in Ghammas, Al- Shamiya, Al-

Saniya, Afak and Al-Sadeer whereas a positive with Al-Daghara area (Table 2) this is because salinity leads to a decrease in growth of Cyanobacteria, but its effect on inhibition of growth varies from one species to another because species differ in morphological and gene diversity [33]. Consequently, the distribution of Cyanobacteria in environments is not equal, due to the ability of Cyanobacteria to adapt in the saline environment [34].

The decreasing of salinity values in the Afak may be due to the existence of the alfalfa plant [35] refer to an inverse relationship between the concentration of salt and the growth of alfalfa plant, which may consume the nutrients which are in the salts form. In addition, the increase of salinity in Al-Daghara may be due to an increase of salinity in irrigation water [36]. Or it may be due to the continuous and irregular process of adding fertilizers; this adds salts to the soil where they accumulate due to continuous evaporation from the soil surface [37].

## Nitrate

The rate of nitrate ranges between the lowest of 7.46ppm in Al- Daghara and the highest rate of 20.04ppm in Al-Shamiya (Table1). The results showed significant differences in the values of nitrate among the areas, this may be due to the role of algae in the soil, or to the adding nitrogen fertilizers [38].

A negative correlation between cyanobacteria numbers and nitrate in the Al-Saniya, Afak, and Al-Sadeer areas where as a positive correlation Al-Shamiya



(Table 2) this is may be due to cyanobacteria and their secretion in these areas, like polysaccharides that are produced by Cyanobacteria, contribute the stability of soil structure, increasing levels of carbon and nitrogen in soil, and enhanced plant growth [39]. The results of the present study are higher than those recorded by [28, 40] in Egypt and lower than the results [30] in India in their study on the biodiversity of algae in agricultural fields.

### Phosphate

The phosphate rate ranges between 1.340-5.260 ppm in Al-Shamiya and Al-Sadeer respectively (Table 1). Also, the results of phosphorus values showed significant differences among the regions. This may due to adding fertilizers, and the presence of Cyanobacteria. Also, a positive and negative correlation showed between cyanobacteria numbers and phosphate values (Table 2). Phosphate forms in the soil determine cyanobacteria composition and their distribution [41].

Also, some cyanobacteria contain the Phosphatase compound in a response to phosphorus deficiency in the external environment [42]. The results of the current study do not agree with many studies on Cyanobacteria and the physical and chemical properties of the soil such as [30] in India, [28,40] in Egypt, [43] in Saudi Arabia, and [29] in Thailand.

### Soil Texture

According to the soil particles sand, silt and clay the soil of this study classified as silty clayey with fine texture because of the clay percentage higher than sand (Table 1). Soil texture affects the composition and spread of Cyanobacteria, In the present study, it is observed that the highest number of Cyanobacteria is recorded in Clay-Silty soils. This is consistent with the study of [44, 45] it shows that the Silty-clay soil is suitable for the growth of Cyanobacteria. Cyanobacteria highly spread in wet soils that have water retention [46].

This is confirmed by positive correlation in most areas of study (Table 2). The results of the statistical analysis of sand and clay values indicate that there are no significant differences among areas, while there are significant differences among the areas in the

values of the Silt. This may be due to the difference of soil separators in the study areas, where sandy soil has low organic matter while Silty soil has high organic matter [47, 48]. The results of the current study do not correspond to many studies about Cyanobacteria in agricultural soils [25, 41, 49, 50] in Egypt, and [44] in Saudi Arabia.

### Organic Matter

The average of organic matter ranges between 3.352-6.202% in the Afak and Al-Sadeer respectively (Table 1). It is also observed through the results of the organic matter that there are significant differences among the areas; it may due to the existence of plants in most of the months of the year that helps the soil keep permanent storage of organic materials [51].

It is observed also a positive correlation between Cyanobacteria numbers and organic matter in the Al-Sadeer, Al-Shamiya, and Al-Saniya areas (Table 2), this may be due to the presence of cyanobacteria in the soil and its impact on plant growth by adding organic matter to the soil, it helps to bind soil particles and improve soil aeration and nitrogen fixation [52]. The results of this study are disagree with the results of several studies like [53] In Pakistan, [25, 41, 54] in Egypt, [30] in India and [29] in Thailand, and [44] in Saudi Arabia.

### Calcium

The results of the statistical analysis of calcium indicate that there are significant differences among the regions, this may due to different factors such as fertilizer, plants, algae, or may due to dust storms that calcium compounds form from it about 40% [55], they deposited in agricultural soils because of irrigation or other factors such as rain.

The lowest rate of calcium is 125.2ppm in Al-Sadeer area (Table 1), this may due to agricultural activities. Farms are a place for human activities including tillage, fertilizers, pesticides, and herbicides. These activities affect the physical and chemical environment of the soil [56]. A positive correlation between calcium and Cyanobacteria in Ghammas, Al-Saniya, Al-Daghara, Afak, and Al-Sadeer (Table 2), because calcium is necessary for the growth of Cyanobacteria [57]. The highest rate of 1320ppm in the area of Al-Daghara

and this increase may due to the calcareous shells that belong to soil composition and its role in increasing calcium concentration [58]. It may be a result of decomposition of organisms in the soil because of their compositions contain a large amount of calcium [59]. The results of the current study do not match with the results of [49, 28, 25, 60, 61] in Egypt [30]. In India, [29] in Thailand, and [44] in Saudi Arabia in their study on soil algae in agricultural fields.

### Magnesium

Magnesium results showed significant differences among areas according to the existing plant. Where magnesium ion is one of the necessary elements for plant growth and forming chlorophyll [62]. In addition, it is essential to the presence of algae because it composes of transport enzymes in the phosphorylation process in cyanobacteria [63].

The lowest rate of magnesium is 51.46 ppm recorded in Afak (Table 1), It is observed a positive correlation between Cyanobacteria numbers and Magnesium in Afak  $r = 0.152$  (Table 2). Magnesium deficiency causes a decrease in algal density [64]. The highest magnesium rate is 557 ppm in Al-Sadeer, this may due to the degradation of chlorophyll in crop plants which means its liberation as one of the main components of chlorophyll composition [58].

It is also observed a negative correlation between Cyanobacteria and magnesium in Ghammas  $r = -0.883$  and in Al-Daghara  $r = -0.132$  (Table 2), this may due to increased Cyanobacteria numbers that consume magnesium as it enters in the structure of the chlorophyll molecule [65]. The results of the current study are higher than those of [29] in Thailand, [49] in Egypt. This study does not agree with [28, 41, 25] in Egypt, and [26] in India.

### Sodium

The results of sodium in the present study show significant differences among the areas, this is due to the difference in the amount of sodium that consumed by plants and algae. In addition, it may due to different in conductivity and salinity values which are associated with sodium that is considered one of salinity ions. The results record the lowest sodium rate of 1.3040 ppm in the Al-Saniya area (Table 1) which may be due to

consumption by plants and algae, where sodium ion is considered a micronutrient that plants and algae need, and it is necessary for enzymatic activity [66].

There is a negative correlation between sodium and Cyanobacteria numbers in Al-Saniya, Ghammas, Shamiya, and Afak (Table 2). The highest sodium rate is 12.3580 ppm in Al-Daghara (Table 1), The results of the present study are higher than those recorded by [28] in Egypt, [26] in India, and [41] in Egypt. They are less than [25] in Egypt while, they do not agree with [61, 60, 49] in Egypt, and [44] in Saudi Arabia.

### Potassium

The results of potassium values indicate significant differences among areas because it is found in the soil in different quantities, due to the difference in the original material and to other factors affected it the distribution of potassium in soil [67]. The lowest rate of potassium is 23 ppm in Afak (Table 1), this may be due to the continuous depletion of potassium by plant because it needs a high concentration of potassium under the agriculture conditions, in addition to, and it is not used as fertilizer. According to studies, Iraqi soils are characterized by a large storage of potassium, but the speed of its liberation is low and does not enough to plants needs of many crops, especially in intensive farming conditions [68].

The highest rates 57ppm in Al-Daghara (Table 1), this may be due to the adding of chemical fertilizer, which affects the nutritional balance in the soil solution because of the competition between potassium ions and other element ions in exchange and absorption sites at plant roots [69].

There is also a positive correlation between potassium and Cyanobacteria species numbers in Al-Daghara, Al-Shamiya, and Al-Sadeer (Table 2), this is because the Cyanobacteria in the soil lead to a significant increase in the dry weight of phosphorus, potassium, and total nitrogen [70]. The results of the present study are higher than those recorded by [41, 28] in Egypt, [44] in Saudi Arabia. They are less than those recorded by [26] in India. While, they do not agree with those by [30] in India, [29] in Thailand [49, 61] in Egypt.

## Cyanobacteria in Soil and Diversity

The soil algae are an effective in the terrestrial ecosystems through its importance to the plant, by nitrogen fixation and have the ability to improve soil quality and fertility [71]. A number of identified species in the current study reaches 26, they belong to 8 genera.

The domination is to the *Oscillatoria* sp. 50 %, followed by *Phormidium* sp. 19.230 %, followed by *Chroococcus* sp., *Spirulina* sp. 7.692 %, and finally *Gleocapsa* sp. and *Microcoleus* sp. and *Shizothrix* sp. 3.864 %.

Some species of Cyanobacteria recorded dominance in all areas represented by *Oscillatoria acuta*, *O. Laetevirens*, *O. tenuis*, *Phormidium anamala*, *P. pachydermiticum* (Table 3).

The dominance of *Oscillatoria* species may be attributed to its ability to tolerate inadequate environmental conditions and its ability to store phosphates and nitrogen [72]. The lowest number of Cyanobacteria is 2 species in Afak (Table 1), it is also recorded the lowest value for diversity indices Shannon and Simpson 2,350, 0.935 respectively in the same area (Table 4), this may due to the reduction of calcium and magnesium in this region, as the lack of these elements leads to a decrease in the number of algae in the soil (Kumar et al., 2010). This is confirmed by the positive link relationship between the

number of algae and magnesium 0.152  $r$ = and calcium  $r = 0.528$  in Afak (Table 2), It may due also to the fact that the roots of the alfalfa plant produce phenolic substances that inhibit the growth of Cyanobacteria. As these compounds act in the defense of plants by inhibiting the growth of neighboring organisms [73].

Their concentration varies in cultivated plants depending on plant species and circumstances of plant growth [74]. The highest number of Cyanobacteria is 8 species in Ghammas (Table 1) and the highest values of Shannon and Simpson diversity indices was 2,685, 0.960 respectively in the same area (Table 4). It may be due to that the previously planted in these soils are rice which considered a suitable environment for the growth of Cyanobacteria through the providing their needs such as the appropriate temperature and nutrients and characterized by increased soil fertility and these species providing nitrogen and vitamins and other metabolites can increase soil fertility [75].

The values of the Shannon Index recorded in the present study are higher than those recorded by [32, 76] in India. The results of the statistical analysis showed significant differences between areas because of changes in soil cyanobacteria species usually was a quantitatively, this is due to fluctuation in water availability while the composition of species is constant [77].

**Table 3: cyanobacteria species distribution in agriculer soil during spring period**

Agriculture soil Cyanobacteria species	Ghammas	Al-Shamiya	Al-Saniya	AL-Daghara	Afak	Al-sadeer
<i>Arthrospira mass artii</i> Kuffareth	-	-	+	-	-	+
<i>Chroococcuscohaerens</i> (Bareb)	+	-	-	-	-	-
<i>C. montanus</i> Hansgirg.	-	+	+	+	-	+
<i>GleocapsaFuscolutea</i> Nag.	+	+	-	-	-	-
<i>Microcoluessubtorulosus</i> (Breb) Gomont	-	-	-	-	+	-
<i>Oscillatoriaacuta</i> Bruhlet Biswas	+	+	+	+	+	+
<i>O. animalis</i> Ag.ex.Gomont	+	+	-	-	-	-
<i>O. curviceps</i> Ghose	-	-	+	-	+	-
<i>O. foreaui</i> Fremy	+	+	-	-	+	-
<i>O. formosa</i> Bory	+	-	-	-	-	-
<i>O. laetevirens</i> Biswas	+	+	+	+	+	+
<i>O. limosa</i> Ag.ex.Gomont	-	+	-	+	+	+
<i>O. nigroviridies</i> Thwaites	+	-	-	-	-	-
<i>O. perornata</i> Skuja	-	-	+	+	+	+
<i>O. subbrevis</i> Schmidle	-	-	-	+	-	-
<i>O. tenuis</i> Ag.ex.Gomont	+	+	+	+	+	+

<i>O. terebriformis</i> Ag.ex.Gomont	+	-	-	-	-	-
<i>O. williei</i> Gardner	+	-	-	+	-	+
<i>Phormidium</i> Ambiguum Gomont	+	+	+	-	+	+
<i>P. Anomala</i> Rao, C.B.	+	+	+	+	+	+
<i>P. fragile</i> (menegh) Gom	+	+	-	+	+	+
<i>P. Luciduis</i> Kutz	-	+	+	+	+	+
<i>P. pachydermiticum</i> Fremy	+	+	+	+	+	+
<i>Schizothrix</i> Vaginata (Nag) Gomont)	+	+	+	+	-	-
<i>Spirulina laxissimawest</i> , G.S	-	+	-	-	+	-
<i>S. meneghiniana</i> (zanard) Gom	-	-	-	-	-	+

**Table 4: Shannon's and Simpson's diversity of cyanobacteria species in agricultural soils**

Agriculture lands	Ghammas	Al-Shamiya	Al-Saniya	AL-Daghara	Afak	Al-sadeer
Shannon	2.685	2.548	2.359	2.565	2.350	2.658
Simpson's	0.960	0.957	0.938	0.954	0.935	0.958

## Conclusion

This study showed that agricultural soil of Al Diwanayah city/ Iraq has cyanobacteria species diversity, were registered 26 species, the dominant species of cyanobacteria was *Oscillatoria* with percentage 50 %, followed by *Phormidium* 19.230 %, then *Chroococcus* and *Spirulina* 7.692 %, Finally, *Gleocapsa*, *Microcoleus*, and *Shizothrix* reach to 3.864%. The diversity of cyanobacteria species was affected by physiochemical factors were found positively correlated between them. Shannon

and Simpson's diversity indices of cyanobacteria recorded highest values in Ghammas area and the lowest in the Afak area that richness of species in these areas was affected by crop cultivation.

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