



ISSN 1814 – 5868 Basrah J. Agric. Sci., 32(Spec. 2): 337-351, 2019 E-ISSN: 2520-0860

Changes in Some Soil Properties and Available P Under Phosphorus Integrated management of Sunflower Plant (*Helianthus annuus* L.)

Mohammed J. Mustafa* & Mohammed A. Abdulkareem

Department of Soil Sciences and Water Resources, College of Agriculture, University of Basrah, Iraq

*Corresponding author e-mail: mohammedjm1979@gmail.com

Received 15 December 2018; Accepted 15 February 2019; Available online 28 December 2019

Abstract: Field experiment was conducted in Mohajaran region, Abu-Al-Khaseeb district, Basrah province during the growing season 2018. The study was aimed to evaluate the effect of integration of chemical fertilizer (triple superphosphate) with manure (cattle residue) and/ or biofertilizer (*Aspergillus niger*) on some soil properties and phosphorus availability to sunflower during growing season. Samples were collected at seedling, vegetative growth, flowering and post-harvest stage. pH, EC, moisture content and available P were determined. Results showed that application of chemical fertilizer significantly affected soil pH, EC, and available P, but showed no effect on soil moisture content. Soil pH decreased and EC increased at seedling stage, while EC was decreased at harvest. Available P values were increased at all growing stages. Incorporation of manure at rate of 30 Mg ha⁻¹ considerably decreased the soil pH and increased EC at seedling stage, soil moisture, and available P at all growing stages.. Inoculation the seeds with *A. niger* showed no significant effect on soil pH, EC, and soil moisture but significantly increased available P, at vegetative growth and flowing stages . Results showed that the effect of biofertilizer on available P was in bar with the application of manure at rate of 15 Mg ha⁻¹ .Highest value of available P was associated with combination of 120 Kg P ha⁻¹ + 30 Mg ha⁻¹ + inoculation with fungus.

Key words : Integrated management , Soil pH, EC, Available P, Sunflower.

Introduction

Phosphorus is an essential nutrient for the plant. It contributes to the formation of ATP and nucleic acids, phospholipids and important enzymatic accompaniments in photosynthesis and respiration as well as cell division, seed formation, and fruit reproduction, therefore, it significantly affects the yield quantity and quality (Barker & Pilbeam, 2007). Available

phosphorus presents in agricultural soils only in a low concentration, especially in calcareous soils due to the immobilization with some soil ingredients such as calcium carbonate, clay minerals, and calcium and magnesium ions, resulting in a recovery of only 15-20% of the added fertilizer (Prasad & Power, 1997). Application of chemical phosphorus fertilizers

can compensate the deficiency of this element in such soils, but the continuous use of these fertilizers caused an imbalance of nutrients, pollution hazard to soil, crop and environment as well as escalating costs (Rathore *et al.*, 2011; Sumalatha & Jebarathnam, 2018). The use of biological sources of nutrients is one of the important systems for sustainable agriculture. Through this system organic fertilizers and biofertilizers are added as sources of nutrients such as nitrogen and phosphorus and their addition along the chemical fertilizer (Integrated Nutrients Management (INM)) can reduce the amount of chemical fertilizer, causing decreasing in the inputs of production and maintaining the crop yield (Berecz *et al.*, 2005). Organic fertilizer improves the physical properties of soil, such as bulk density, water retention and soil heating, as well as increases phosphorus availability by formation of organo-metal complex compounds and reduce pH of the soil (Mengel & Kirkby, 2001). Phosphate biofertilizers play important role for change the available form of phosphorus for crops by increasing enzyme activities and / or reducing soil pH (Chaichi *et al.*, 2015). Furthermore, biofertilizers have a direct effects on root development and improved seed germination by producing a beneficial products such as auxines, gibberellins, cytokinines, vitamins and amino acids (Fakirah & Alshabi, 2015).

The objective of the integrated fertilization management is achieved by providing the nutrient requirements for plant growth in intensive farming systems and to ensure improved crop production by developing the soil-microbiology-crop system (Sumalatha & Jebarathnam, 2018). Amruth *et al.* (2017) defined the integrated nutrient management as

a practice that facilitates the slow release of nutrients and its replenishment in soil. Rathore *et al.* (2011) noted that the correct selection of the amount of organic and biofertilizers along the chemical fertilizer can reduce the amount of chemical fertilizers, then can provide a suitable solutions to problems such as increase the price of chemical fertilizer and deterioration effect of soil fertility. Dambale *et al.* (2018) reported that the efficiency of integrated fertilization is due to its role in modification of secondary and micro- nutrients, and creating suitable physical conditions in the soil for plant growth.

Based on the above review, the aim of this research is to study the effect of integrated nutrient management of phosphorus on some soil properties and the phosphorus availability to sunflower during different stages of growth.

Materials & Methods

Field and experimental design

A field experiment was conducted to reveal the effect of P integrated management on some soil properties as well as available P to sunflower. The experiment was carried out in a private field at Mohajaran area, Abu Al-Khaseeb district, Basrah province (30° 28'23.21'' North, 47° 52'21.45'' East) in the dry zone during the growing season of 2018. The soil was classified as Typic torri fluvents (Al-Atab, 2008). Some chemical and physical properties of soil were determined according to the standard methods described in Richards (1954), Black (1965) and Page *et al.* (1982) and listed in table (1). Field was leached to reduce salts then plowed twice, level with ladder and divided into three plots.

Each plot representing 24 experimental units of with dimension of 4.00 × 0.9 m with one row at spacing of 1 m among rows and were

Table (1): Some chemical and physical properties of soil.

	Characteristic	Value	Unit
	pH (1:1)	7.90	-----
	Salinity soil paste	10.50	dS m ⁻¹
	CEC	14.13	Cmole ⁽⁺⁾ kg
	Organic matter	2.91	g kg ⁻¹
	Total Carbonates	425.00	
Soluble ions	Ca ⁺⁺	23.12	m mol. L ⁻¹
	Mg ⁺⁺	15.25	
	K ⁺	2.30	
	Na ⁺	57.60	
	CO ₃ ⁼	0.00	
	HCO ₃ ⁻	4.12	
	SO ₄ ⁼	32.51	
	Cl ⁻¹	70.25	
Available nutrients	Phosphorus	12.12	Mg. kg ⁻¹
	Nitrogen	35.90	
	Potassium	158.00	
	Total account of fungus	3.80 × 10 ³	cfu. gm ⁻¹ soil
Particles Size distribution	Sand	46.30	gm. kg ⁻¹
	Silt	538.90	
	Clay	414.80	
	Texture		silty clay

arranged as randomized complete block design (RCBD). Sunflower seeds (Vr. Shomos) were sown in bands at spacing of 0.25 m with three seeds per band on 24 Feb. 2018. Ten days after germination, plants were thinned to one plant per band. Alparin and Nogoze insecticides were used. Tap water was used to irrigate plants whenever needed. The agricultural operations were done as commonly practiced in the region of study.

Fertilization

Cattle residues was used as organic fertilizer source at rates of 0 and 15 Mg ha⁻¹ and was uniformly incorporated in to the soil at depth of 10-20 cm. Table (2) displayed some of the cattle residues characteristics estimated according to the standard methods described by Page *et al.* (1982). Inorganic phosphate fertilizer was added at rates of 0, 40, 80 and 120 kg P. ha⁻¹ as triple superphosphate (20.22

% P) before planting at one dose on the organic fertilizer layer. Nitrogen and potassium were added at rates of 200 kg N. ha⁻¹ and 120 kg K ha⁻¹ in the form of urea (46 % N) and potassium sulphate (43% K), respectively for

all experimental plots and in the same way addition of phosphorus fertilizer. Half of urea rates and 10% of potassium rates were added at sowing time, and the rest of the two fertilizers were added at flowering stage.

Table (2): Composition and characteristics of manure.

Characteristic	Value	Unit
pH(1:5)	7.3	-
EC(1:5)	10.00	dS m ⁻¹
Organic Carbon	249.16	
Organic matter	429.55	
Total Phosphorus	10.93	g kg ⁻¹
Total Nitrogen	18,80	
Total Potassium	9.91	
C / N Ratio	13.25	-
C / P Ratio	22.70	-

A pure *Aspergillus niger* inoculate was obtained from the microbiology laboratory at college of agriculture. The seeds of sunflower were sterilized with sodium hypochlorite, washed with distilled water several times, treated with gum acacia, then mixed thoroughly with *A. niger* at density of 40 × 10³ cfu.

Analysis of soil samples:

A composite soil samples (0-20 cm) were collected at seedling, vegetative growth, flowering, and post-harvest stages. Samples were air-dried, grinded, passed through a 2 mm diameter sieve then pH, EC, and available P were determined. Soil pH and EC were

determined at seedling and post-harvest, while available P was determined at all mentioned stages. Soil pH was measured in 1:1 water suspension according to Page *et al.* (1982). Electrical conductivity (EC) was measured in 1: 1 extract according to Page *et al.* (1982). For available P ,soil was extracted with 0.5 M NaHCO₃ solution, then determined by method of Murphy and Riley (1962) using spectrophotometer at 700 nm wave length. Core samples (20 cm) were collected from the centre of each plot at seedling and post-harvest stages, dried then moisture content was determine by Gardner method described in Black (1965) .

Statistical analysis:

The experiment was laid out in factorial design with three factors. The data was subjected to analysis of variance (ANOVA) using the Gen Stat procedure Library Release PL 18.2. The statistical significance was done at $p \leq 0.05$ using R.L.S.D. test .

Results & Discussion

Soil pH

Data in table (3) showed the effect of chemical fertilization of phosphorus on soil pH value at seedling and harvesting stages. At seedling stage, the pH values decreased by 1, 3 and 3% for rates of 40, 80 and 120 kg P. ha⁻¹ as compared with control . This may be due to the acidic effect of the superphosphate fertilizer. Similar results were also recorded by Mansoor (2014), Alkhader & Abo Rayyan (2015) and Czarnecki & During (2015). Stangev *et al.* (1990) noted that triple superphosphate fertilizer contains 6% of free phosphoric acid during synthetic process.

According to Tisdale & Nelson (1975), when superphosphate fertilizer is added to soil, water entered the fertilizer granules, then a solution saturated with high amounts of monocalcime phosphate and dicalcium phosphate is released. As for harvest stage , there was no significant effect for the addition of chemical fertilizers in soil pH (Table 3). This may be due to the consumption of superphosphate fertilizer added to soil.

Data of table (3) showed a significant effect of adding manure on soil pH at the seedling and the end of the season (table 7). The pH values decreased with increasing manure rates, this is due to the degradation of manure by microorganisms in the soil and release of organic acids and CO₂ as well as a further amount of CO₂ associated with root activity, which turns a large part of it to carbonic acid, leading to the reduction of soil pH seeding and harvest stages, respectively. Similar results were recorded by Mansoor (2014).

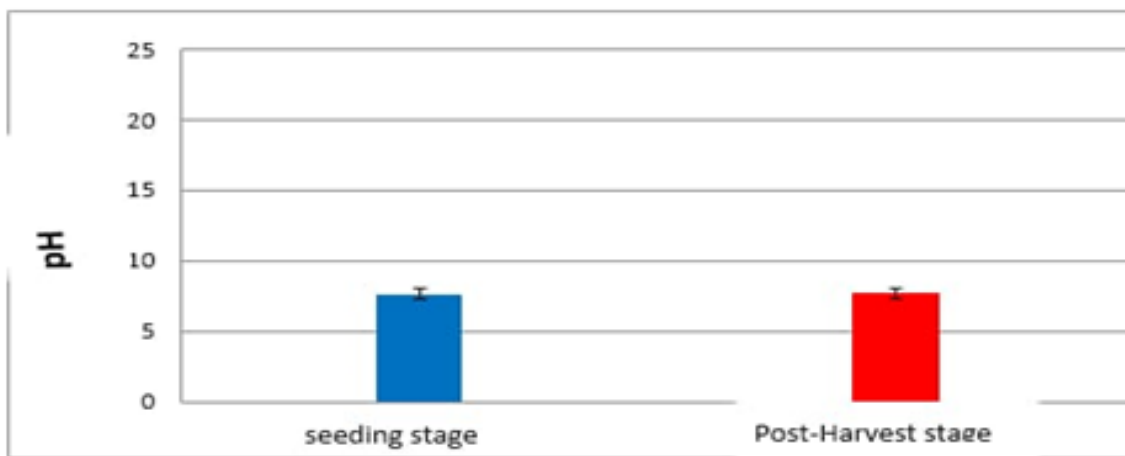


Fig. (1): Soil pH values during the sunflower growing season.

Decrease in pH by application of manures was also recorded by Al-Maliky (2010), Al-Delfi (2013) and Fincheira-Robles *et al.* (2016). Soil pH was not affected by using *A. niger* at the two stages of growth (table 7). The means values were 7.62 and 7.60 at seeding stage and 7.71 and 7.65 at harvest stage, for inoculation and non-inoculation treatments, respectively. This may be attributed to the high soil content of calcium carbonate (425 g. kg⁻¹), which regards as a regulator for changing pH within the alkali range of soil. It should be noted here that the inability of the biofertilizer for change soil pH under study conditions means there is another mechanism for the effect of fungus on soil phosphorus availability (table 6). Such

mechanisms are secretion of metabolites in the root zone associated with the presence of fungus to improve the availability of phosphorus, hydroxyl acids produced by phosphate solubilized organisms can be complex with calcium, increasing the phosphorus availability or phosphatase enzymes produced by microorganisms (Foerster, 1984; Kundu *et al.*, 2009; Ann, 2010). Data in fig. (1) showed no significant development of soil pH at season progressed of sunflower plant, with means of 7.62 and 7.69 for seeding and harvest stages, respectively. Similar results were recorded by Mansoor (2014).

Table (3): Effect of integrated nutrient management of phosphorus on soil pH (± SD) at various growing stages of sunflower.

chemical Fertilizer rate (Kg p. ha ⁻¹)	Manure rate (Mg. ha ⁻¹)	Seeding stage			Post-Harvest stage		
		inoculation	non inoculation	Mean	inoculation	non inoculation	mean
0	0	7.79±0.08	7.76 ± 0.16	7.77±0.11	7.79±0.31	7.66 ± 0.03	7.72±0.21
	15	7.75±0.06	7.75 ± 0.14	7.75±0.10	7.77±0.00	7.68 ± 0.28	7.72±0.18
	30	7.74±0.07	7.74 ± 0.00	7.74±0.04	7.68±0.06	7.70 ± 0.03	7.69±0.05
40	0	7.73±0.04	7.70 ± 0.03	7.72±0.03	7.77±0.04	7.66 ± 0.04	7.71±0.07
	15	7.64±0.03	7.70 ± 0.10	7.67±0.07	7.74±0.06	7.61 ± 0.03	7.67±0.08
	30	7.58±0.08	7.63 ± 0.08	7.60±0.08	7.70±7.60	7.60 ± 0.10	7.65±0.10
80	0	7.61±0.10	7.61 ± 0.60	7.61±0.72	7.66±0.75	7.76 ± 0.21	7.71±0.15
	15	7.59±0.05	7.54 ± 0.06	7.57±0.05	7.64±0.05	7.64 ± 0.11	7.64±0.07
	30	7.46±0.06	7.49 ± 0.05	7.47±0.05	7.60±0.10	7.51 ± 0.09	7.55±0.09
120	0	7.57±0.04	7.52 ± 0.02	7.54±0.03	7.81±0.18	7.79 ± 0.19	7.80±0.17
	15	7.51±0.51	7.38 ± 0.10	7.44±0.10	7.77±0.08	7.76 ± 0.11	7.77±0.08
	30	7.51±0.05	7.39 ± 0.04	7.45±0.07	7.65±0.06	7.51 ± 0.18	7.58±0.14
Mean		7.62±0.11	7.60±0.15		7.71±0.12	7.65±0.14	

Soil salinity

At the seedling stage, the salinity of soil was significantly increased by 7% with increasing the rate of chemical fertilizer from 0 to 120 kg P.ha⁻¹ (table 4). However, a significant decrease (26%) in soil salinity was obtained with increasing fertilizer rate at harvest stage. The application of superphosphate fertilizer at sowing time may add different ions to the soil

solution after it analysis as well as the high acidity of this fertilizer can dissolve some of soil components resuming free ions to soil solution increases soil salinity. Ahamad *et al.* (2006) showed an increase in the concentration of Ca⁺², SO₄⁻² and HCO₃ in soil solution after addition of phosphate fertilizers, resulting in an increase in soil salinity. This result was similar to that of Mohammed (2013).

Table (4): Effect of integrated nutrient management of phosphorus on soil salinity (dS m⁻¹ ± SD) at various growing stages of sunflower.

chemical Fertilizer rate (Kg p ha ⁻¹)	Manure rate Mg ha ⁻¹	Seeding stage			Post-Harvest stage		
		Inoculation	non inoculation	Mean	Inoculation	non inoculation	Mean
0	0	6.58±0.50	5.70 ± 0.52	6.14 ±0.66	24.07±3.49	19.76 ± 1.04	21.92±3.30
	15	8.90±0.90	6.26 ± 0.00	7.5 ±1.55	22.27±3.14	18.08 ± 3.46	20.18±3.74
	30	8.95±0.28	8.00 ± 10.50	8.47 ±1.12	20.26±1.33	16.25 ± 1.37	18.26±2.50
40	0	7.23±0.62	5.52 ± 0.30	6.38 ±1.03	21.87±1.85	26.09 ± 4.55	23.98±3.87
	15	8.06±0.00	6.72 ± 0.53	7.39 ±0.80	18.15±1.77	24.80 ± 1.44	21.48±3.91
	30	8.14±1.06	9.30 ± 0.80	8.72 ±1.05	19.87±1.80	18.97 ± 1.08	19.42±1.42
80	0	7.48±1.52	7.28 ± 0.65	7.38 ±2.04	20.99±3.00	21.47 ± 0.81	21.23±1.98
	15	7.45±0.84	7.85 ± 0.85	7.65 ±1.61	18.26±3.24	15.38 ± 0.41	16.82±2.60
	30	7.53±0.66	7.95 ± 1.45	7.74 ±1.21	13.41±0.88	14.80 ± 1.00	14.11±1.13
120	0	8.17±0.52	7.00 ± 0.40	7.58 ±0.76	15.50±1.91	16.26 ± 3.79	15.88±2.72
	15	7.55±0.71	7.36 ± 0.88	7.45 ±0.72	14.12±3.74	15.00 ± 1.24	14.65±2.54
	30	8.57±0.44	9.90 ±0.54	9.23 ±0.94	13.19±1.03	15.00 ± 0.47	14.09±1.22
Mean		7.88±1.15	7.40±1.15		18.50±4.01	18.49±4.18	

At the harvest stage, the significant decrease in soil salinity may be due to plant absorption of ions from soil solution as well as there is no further additions of chemical fertilizers at this time, resulting in decrease soil salinity. These observations are confirmed by findings of Patil & Sheelavantar (2000) who stated that absorption of nutrients from soil solution can reduce the escalating effect of chemical fertilization on soil salinity.

Application of manure significantly increased soil salinity at seedling stage, while it significantly decreased soil salinity at harvest stage (tables 4 & 7). The increase at the seedling stage was consistent with the results of Ouda & Mahadeen (2008), which justified that to the organic fertilizers containing high soluble salts, HCO_3^- and organic carbonates. The decrease at harvest stage may be due to the increase in the decomposition of organic waste over time increases soil porosity and develops good soil structure, then improves salts and

sodium leaching conditions, including NaCl, exchangeable sodium percentage (ESP) and salinity (Lakhdar *et al.*, 2010).

Using of *A. niger* did not show significant effect on soil salinity at the seedling stage and end of the growing season (Table 4). At seedling stage, the highest values of salinity were associated with the high rate of chemical fertilization ($120 \text{ kg P. ha}^{-1}$) when interacted with the rate of 30 Mg. ha^{-1} of manure, while opposite finding was obtained at harvest stage which the highest values of salinity, were associated with low rates of chemical fertilizer and manure. Data in fig. (2) revealed a significant increase in soil salinity from 7.33 to 18.53 dS. m^{-1} as the growth season of the sunflower progresses from seedling stage to harvest stage. This increase may be due to high temperature at the end of the season (June) resulting in appreciable evaporation processes from soil surface and consequently increase soil salinity.

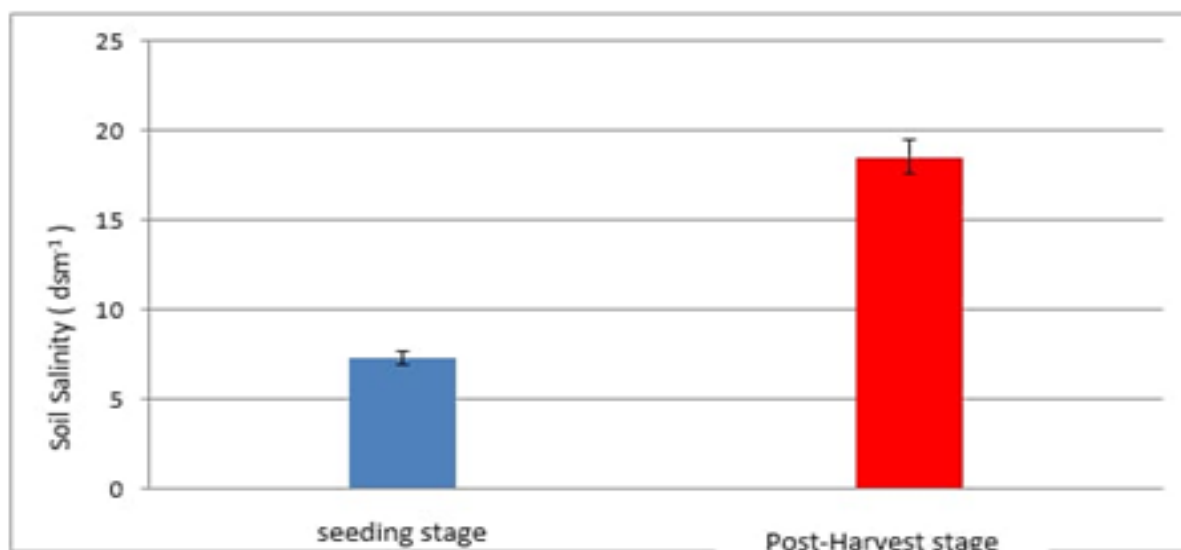


Fig. (2): Soil salinity values (EC) during the sunflower growing season.

Soil moisture content

Soil moisture content was not affected by application of chemical fertilizer at the two stages of growth (table 5). The increase in organic fertilizer resulted in an increase moisture content in the soil at the two stages. The increase percent were 7 and 17% at seedling stage and 12 and 22% at harvest stage for rates of 15 and 30 Mg.ha⁻¹, respectively, compared to control treatment . These results were similar to this presented by Al-Maliky (2010). Prasad & Power (1997) stated that the organic matter has the ability to grasp an amount of water equivalent to 20 times of its weight because of that the interaction of organic

matter with clay make it water insoluble, so retains high amount of water.

Interaction effect of manure at rate of 30 Mg. ha⁻¹ with either chemical fertilizer or biofertilizer on moisture content was found significant (table 5) and gave higher values of soil moisture with significant superior over other combinations. It might attributed to the continuous decomposition of manure and production of humic acid which increases soil holding of water. Stevenson (1982) pointed out that humus is most effective on physical and chemical soil properties as compared to other parts of organic matter.

Table (5): Effect of integrated nutrient management of phosphorus on soil moisture content (% ± SD). at various growing stages of sunflower.

chemical Fertilizer rate (Kg p ha ⁻¹)	Manu re rate Mg ha ⁻¹	Seeding stage			Post-Harvest stage		
		inoculation	non inoculation	Mean	Inoculation	non in0culation	mean
0	0	25.71±2.06	24.69 ± 1.02	25.20±1.56	23.92±0.11	24.62 ± 0.29	24.24±0.43
	15	29.63±0.70	25.47 ± 1.49	27.55±2.50	26.41±2.45	25.93 ± 2.36	26.17±2.17
	30	32.42±1.00	28.03 ± 3.83	30.43±3.32	33.31±0.31	30.75 ± 3.44	32.03±2.60
40	0	21.66±0.40	25.30 ± 2.89	23.48±2.71	24.54±3.99	26.98 ± 4.19	25.76±3.89
	15	22.83±4.67	24.51 ± 2.03	23.67±3.35	25.72±2.59	32.81 ± 0.55	29.27±4.22
	30	24.92±1.12	27.95 ± 0.38	26.44±1.81	25.96±1.00	34.28 ± 1.29	30.12±4.67
80	0	18.11±0.70	24.74 ± 2.37	21.43±3.95	25.28±2.18	23.91 ± 0.60	24.59±1.62
	15	24.24±3.50	25.44 ± 2.31	24.84±2.73	27.62±4.88	23.50±2.73	25.56±4.20
	30	26.83±2.02	26.73 ± 3.05	26.78±2.32	32.55±1.41	28.34 ± 0.52	30.44±2.49
120	0	22.62±1.62	27.97 ± 2.85	25.30±3.68	23.69±0.61	26.95 ± 4.31	25.32±3.28
	15	23.31±2.90	28.99 ± 1.60	26.15±3.75	28.65±2.46	33.63 ± 1.46	31.14±3.27
	30	26.96±1.26	29.04 ± 1.24	28.00±1.60	29.39±1.38	28.72 ± 1.61	29.05±1.39
Mean		24.94±2.01	26.61±2.56		27.25±3.66	28.37±4.15	

Data in fig. (3) showed the effect of growth period of sunflower on soil moisture content. A significant increase from 25.77 to 27.81% was observed at growth progress from seedling stage to harvest stage. The increase in the total root volume of the plant at the end of the season compared to the seedling period, as well as the

low water evaporation from the soil surface by increasing plant canopy helps to maintain a larger amount of water in soil. Similar results were reported by Hassan (2018) who obtained an increase in soil moisture at the growth of sunflower progresses.

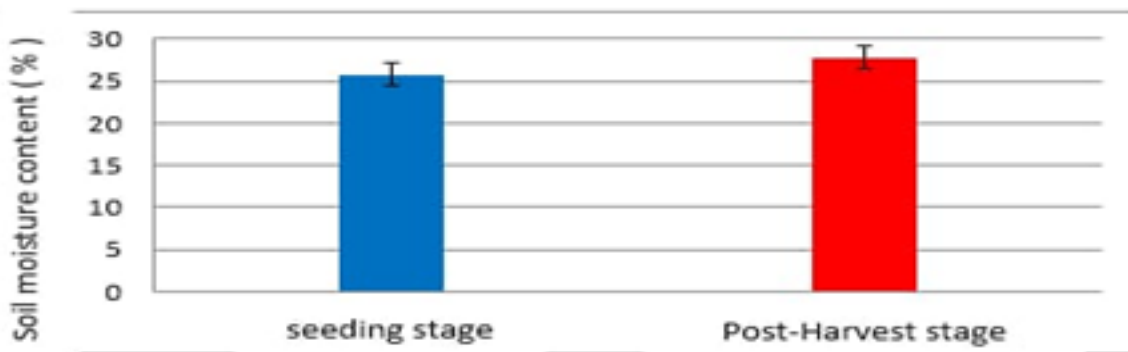


Fig. (3): Soil moistures values (%) during the sunflower growing season.

Available Phosphorus:

Increasing phosphorus rates significantly increase available P throughout growing season (table 7) with highest value at rate of 120 kg P ha⁻¹ (table 6). These findings are in agreement with Al-Tamimi *et al.* (2009), Mansoor (2014) and Amruth *et al.* (2017). Application of manure significantly increased the available phosphorus at all growth stages (table 6). Incorporation of manure in soil increased the availability of phosphorus due to reduction in fixation of soluble P, increased mineralization of organic P by microbial action, then enhanced availability of phosphorus. Rosen & Eliason (2002) explained that one tonne of fresh animal residue could add 2 pounds of P₂O₅. acre⁻¹. Reducing soil pH (table 3) and increasing soil moisture (table 5) can justify the increase of

phosphorus availability after adding of manure . These findings are consistent with Alam *et al.* (2002). The results in table (7) displayed a significant effect of biofertilization on available phosphorus at the vegetative and flowering stages. The phosphorus was increased by 9% and 14% for the vegetative and flowering stages, respectively as a result of inoculation with *A. niger* compared with non-inoculation. This is due to the secretion of benefit metabolites in root zone improve availability of phosphorus as associated with fungus (Ann, 2010). Furthermore, hydroxyl-containing acids produced by phosphate solubilized organisms can be bond with Ca⁺⁺ leading phosphorus in free form, as well as the role of phosphatases enzymes in solubilizing phosphorus compounds (Foerster, 1984; Kundu *et al.*, 2009).

Table (6): Effect of integrated nutrient management of phosphorus on soil available P (mg kg⁻¹ soil ± SD) at various growing stages of sunflower.

chemical Fertilizer rate (Kg p ha ⁻¹)	Manure rate Mg ha ⁻¹	Seeding stage			Vegetative growth stage			Flowering stage			Post-Harvest stage		
		Inoculation	non inoculation	Mean	inoculation	non inoculation	Mean	Inoculation	non inoculation	mean	Inoculation	non inoculation	mean
0	0	14.60±1.27	13.80±1.81	14.20±1.46	19.22±1.50	18.00±2.59	18.61±2.01	20.40±1.26	17.14 ±1.89	18.77±2.29	2.31 ±0.52	2.46 ± 0.47	2.38±0.45
	15	12.98±1.12	13.13±1.56	13.05±1.22	29.32±1.46	28.08±8.09	28.70±5.24	27.43±2.39	20.31 ±1.26	23.87±5.29	2.29 ±0.07	2.65 ± 0.00	2.47±0.20
	30	11.17±0.00	10.96±1.09	11.07±0.69	37.55±3.27	42.05±3.54	39.80±3.92	27.95±3.09	22.71 ±1.53	25.33±3.60	2.57 ±0.48	2.69 ± 0.42	2.63±0.41
40	0	12.71±1.39	11.51±0.49	12.11±1.14	34.10±3.01	29.80±0.97	31.95±3.09	31.05±6.60	23.14 ±1.90	27.09±6.14	2.53 ±0.10	2.14 ± 0.27	2.34±0.28
	15	13.07±1.12	13.56±1.03	13.31±1.00	36.42±0.00	33.02±3.25	34.72±2.77	35.30±3.06	31.01 ±5.78	33.15±4.76	2.54 ±0.42	2.82 ± 0.17	2.68±0.32
	30	13.22±1.00	15.67±1.38	14.45±1.72	48.40±6.20	45.04±8.14	46.72±6.73	42.56±2.58	36.20±1.71	39.38±3.99	2.74 ± 0.36	3.9 ± 0.33	3.34±0.72
80	0	12.06±0.96	12.71±0.00	12.38±0.72	36.08±5.33	35.44±4.22	35.76±4.31	35.11±0.00	30.82±2.80	32.96±2.94	3.08 ±0.66	3.42 ± 0.39	3.25±0.52
	15	11.53±0.82	12.40±1.24	11.96±1.05	45.43±11.3	34.76±3.67	40.09±9.68	42.17±1.66	40.20±3.26	41.18±2.55	3.78 ±0.53	3.58 ± 0.13	3.68±0.36
	30	14.99±0.60	16.79±1.00	15.89±1.23	46.64±6.00	46.27±0.00	46.45±3.80	43.24±3.21	40.21±5.80	41.72±4.51	4.53 ±0.20	3.81 ± 0.67	4.17±0.59
120	0	14.03±0.25	12.87±1.71	13.45±1.26	44.03±4.99	36.08±0.96	40.06±5.41	37.42±6.45	36.97±3.44	37.19±4.63	3.25 ±0.50	2.53 ± 0.85	2.89±0.74
	15	14.52±1.44	17.89±2.48	16.20±2.59	45.19±3.92	37.47±2.64	41.32±5.17	48.13±4.39	44.13±0.37	46.13±3.54	4.31 ±0.48	3.94 ± 0.06	4.13±0.37
	30	19.24±0.90	19.34±1.51	19.29±1.11	52.09±1.95	48.62±1.82	50.36±2.54	50.79±2.26	50.07±2.48	50.43±2.06	4.39 ±0.21	4.00 ± 0.39	4.19±0.29
Mean		13.68±2.22	14.22±2.80		39.54±9.93	36.22±9.05		36.80±9.28	32.24±10.1		3.17 ±0.84	3.17±0.74	

Table (7): Analysis of variance (RLSD at probability level of 5%) for soil characteristics under INM system of sunflower.

S.O.V.	Df	pH		Salinity		Moisture		Available P			
		S	H	S	H	S	H	S	V	F	H
P	3	0.05	Ns	0.49	1.55	Ns	Ns	0.83	3.09	2.35	0.28
O	2	0.04	0.07	0.43	1.35	1.30	1.38	0.71	2.68	2.03	0.24
B	1	Ns	Ns	Ns	Ns	*	Ns	Ns	*	*	Ns
P×O	6	Ns	Ns	0.86	Ns	Ns	2.77	1.42	3.90	3.00	0.49
P×B	3	Ns	Ns	0.70	2.20	Ns	Ns	Ns	Ns	Ns	Ns
O×B	2	Ns	Ns	Ns	Ns	1.85	Ns	1.00	Ns	Ns	Ns
p×0×B	6	Ns	Ns	1.21	Ns	Ns	Ns	Ns	4.42	4.13	0.69

P: Chemical fertilizer rate; O: manure rate; B: biofertilizer treatments; S: seeding stage; H: post-harvest stage; v: vegetative growth stage; F: flowering stage; ns: non-significant; *:significant.

In general, combined application of 120 kg P ha⁻¹ + 30 Mg ha⁻¹ of manure + inoculation of *A. niger* gave higher available phosphorus, and was found significantly superior over most of other combinations (table 6). However, this treatment had no significant differences with combination of 120 kg P ha⁻¹ + 15 Mg ha⁻¹ manure + inoculation and with combination of

120 kg P ha⁻¹ + 30 Mg ha⁻¹ manure + non inoculation. The above results clearly indicated that application of manure or biofertilizer along with chemical fertilizer improves soil fertilizer status than sole use of chemical fertilizer. The results are in line with findings of Mansoor (2014).

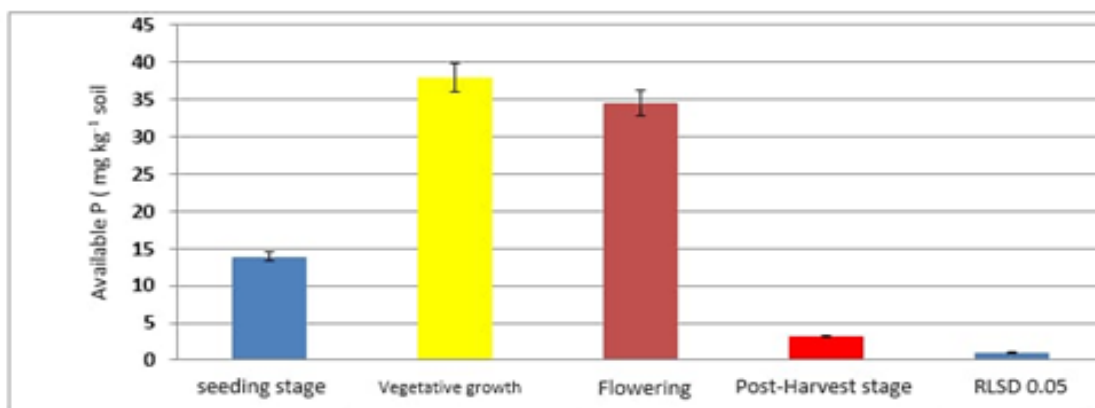


Fig. (4): Phosphorus values during season of sunflower.

Available phosphorus was found to be significantly higher at vegetative growth stage, then significantly decreased at flowering stage and harvest stage (Fig. 4). The values were 13.52, 37.87, 34.76 and 3.15 Mg.kg⁻¹ soil for seedling, vegetative growth, flowering and harvest stages, respectively. Similar results were obtained by Amruth *et al.* (2017) who reported that the variation in available phosphorus during the growing season depends on plant uptake intensity, environments condition and soil type.

Conclusion:

It can be concluded from this study that the effect of cattle manure was more pronounced than triple superphosphate fertilizer and *A. niger* inoculation on soil properties (pH, EC and moisture content), while the effect of the three fertilizers was more closely with respect to available P in soil. Integrated use of 120 kgp.ha⁻¹ of superphosphate, 30 Mg.ha⁻¹ of manure, and inoculation of *A. niger* resulted in an improvement of phosphorus fertility status of soil.

Acknowledgements

The authors thank the staff of the Department of Soil Sciences and water Resources, College of Agriculture, the University of Basrah for the supporting and devices in some parts of the study.

References

- Ahamad, F.H.; Jber, A.S. & Salman, A.D. (2006). Effect of phosphate fertilizer, soil texture and irrigation water source on some chemical properties of soil. Iraqi J. Agri. Sci., 37(3): 13-20. (In Arabic).
- Alam, S.; Khalil, S.; Ayub, N. & Rashid, M. (2002). *In vitro* solubilization of inorganic phosphate by phosphate solubilizing microorganisms (PSM) from maize rhizosphere. Int. J Agri. Biol., 4(4): 454-458.
- Al-Atab, S.M.S. (2008). Variation of soil properties and classification in some area of Basrah governorate. Ph. D. Thesis. Coll. Agric. Univ. Basrah: 210pp. (In Arabic).
- Al-Delfi, H.F. (2013). Effect of water salinity on soil properties' and growth and yield of corn treated with different types and levels of organic residues. M. Sc. Thesis. Coll. Agric. Univ. Basrah: 214pp. (In Arabic).
- Alkhader, A.M.F. & Abo Rayyan, A.A.M. (2015). The impact of phosphorus fertilizers on nutrients content and uptake in lettuce (*Lactuca sativa* L.) and on selected chemical properties of a calcareous soil. Jordan J. Agri. Sci., 11(4): 1021-1035.
- Al-Maliky, L.A. (2010). Effect of composting manures on some soil properties and physical chemical and yield characteristics of date palm fruits *Phoenix dactylifera* L. C.V. Hillawi. M. Sc. Thesis. Coll. Agric. Univ. Basrah: 163pp. (In Arabic).
- Al-Tamimi, H.; Ashoor, N.I. & Yassen, H.A. (2009). Effect of sodium pyrophosphate on concentrated super phosphate fertilizer reactions in some calcareous soils. Basrah. J. Agric. Sci., 22(1): 41-51.
- Amruth, B.; Thippeshappa, G.N. & Chanda, B.C. (2017). Effect of Phosphorus levels through Integrated Nutrient Management (INM) Packages on different parameters of groundnut crop. Phar. Life Sci., 6(1): 107-112.
- Ann, P.J. (2010). Re-evaluation of the report of the A2 mating type of *Phytophthora infestans* on tomato in Taiwan. Bot. Stud., 51: 203-207.
- Barker, A.V. & Pilbeam, D.J. (2007). Handbook of Plant Nutrition. CRC Press: 773Pp

- Berez, K.; Kismanyoky, T. & Debreczeni, K. (2005). Effect of organic matter recycling in long-term fertilization trials and model pot experiments. *Commun. Soil Sci. Plan*, 36: 191- 202.
- Black, C.A. (1965). *Methods of Soil Analysis. Part 2. Chemical and microbiological properties* Am. Soc. Agron., Inc. Madison Wisconsin: 770pp
- Chaichi, M.R.; Shabani, G. & Noori, F. (2015). Response of berseem clover (*Trifolium alexandrinum* L.) to chemical, biological and integrated use of fertilizers. *Agronomic in Moldova*, 48(1): 67-77.
- Czarnecki, S. & Doring, R.A. (2015). Influence of long-term mineral fertilization on metal contents and properties of soil samples taken from different location in Hesse, Germany. *Soil J.*, 1: 23-33.
- Dambale, A.S.; Ghotmukale, A.K.; Khandekar, S.D.; Suryawanshi, S.B.; Suryarashi, V.P. & Shinde, R.S. (2018). influence of integrated nutrient management on growth, yield, quality and economics of sunflower (*Helianthus annuus* L.). *Int. J. Curr. Micro Appl.*, 6: 1226-1233.
- Fakirah, A.A. & Alshabi, G. (2015). Effect of different levels of Biofertilizer and plant population on the grain yield and yield components of corn (*Zea mays* L.). *Jordan J. Agri. Sci.*, 11(2): 565-581. (In Arabic).
- Fincheira-Robles, P.; Martinez-Slgado, M.M.; Ortega-Blu, R. & Janssens, M. (2016). Compost and humic substance effects on soil parameters of *Vitis vinifera* cv Thompson seedless. *Sci. Agropecuaria*, 7(3): 291-296.
- Foerster, B.H. (1984). Contributions to the mobilization of phosphorus by soil microorganisms 2nd communication influence of thermal sterilizations, microbial colonization, and growth of young wheat plants on phosphorus content of soil and plants. *Zentralbl. Mikrobiol.*, 8: 591-599.
- Hassan, W.B. (2018). Effect of Emulsified oil dripper discharge under different moisture levels in some soil physical properties and growth and yield of sunflower crop (*Helianthus annuus* L.). Ph. D. Thesis. Coll. Agric. Univ. Basrah: 188pp. (In Arabic).
- Kundu, B.S.; Nehra, K.; Yadav, R. & Tomar, M. (2009). Biodiversity of phosphate solubilizing bacteria in Rhizosphere of chickpea mustard and wheat grown in different regions of Haryana. *Indian J. Microbiol.*, 49(2): 120-127.
- Lakhdar, A.; Scelza, R.; Scotti, R.; Rao, M.A.; Jedidi, N.; Gaianfreda, L. & Abdelly, C. (2010). The effect of compost and sewage sludge on soil biologic activities in salt affected soil. *R. C. Suelo Nutr. Veg.*, 10: 40-47.
- Mansoor, M.H. (2014). Effect of phosphate organic and Biofertilization on soil P availability and maize productivity. M. Sc. Thesis Coll. Agri. Univ. Baghdad (In Arabic). 105pp.
- Mengel, K. & Kirkby, E.A. (2001). *Principles of Plant Nutrition*. 5th ed. Int. Potash Inst., Bern: 687pp
- Mohammed, E.J. (2013). Evaluation the effect of organic and mineral fertilizer on some soil property growth and yield of shake cucumber (*Cucumis melo var. flexuosus nauds*). M. Sc. Thesis. Coll. Agri. Univ. Basrah. 173pp. (In Arabic).
- Murphy, T. & Riley, J.R. (1962). A modified single solution method for the determination of phosphate in natural waters. *Anal. Chem. Acta*, 27: 31-36.

- Ouda, B.A. & Mahadeen, A.Y. (2008). Effect of fertilizers on growth, yield, yield components, quality and certain nutrient contents in broccoli (*Brassica oleracea*). Int. J. Agri. Biol.,10: 627-632.
- Page, A.L.; Miller, R.H. & Kenney, D.R. (1982). Methods of soil analysis. Part 2 chemical and biological properties. Amer. Soc. Agron. Inc. Publisher, Madison. Wisconsin: 1158pp
- Patil, S.L. & Sheelavantar, M.N. (2000). Effect of moisture conservation practices, organic sources and nitrogen levels on yield, water use and root development of rabi sorghum [*Sorghum bicolor* (L.)] in the vertisols of semiarid tropics. Ann. Agric. Res., 21(21): 32-36.
- Prasad, R. & Power, J.F. (1997). Soil Fertility Management for Sub Sustainable Agriculture. Lewis Pub. CRC Press LLC. 243pp.
- Rathore, D.S.; Purohit, H.S.; Yadav, B.L. & Sharma, S.R. (2011). Effect of integrated nutrient management on soil properties and crop yield under black gram-wheat cropping system in a Typic Haplustept. Ann. Arid Zone, 50(1): 21-26.
- Richards, A. (1954). Diagnosis and improvement of saline and alkali soils. Agris. Hand book No. 60. US. Dept. Agric.:154pp
- Rosen, C. J. & Eliason, R. (2002). Nutrient management for commercial fruit and vegetable crops in Minnesota. Univ. Minnesota. Stangev, L.; FIGF, F.; Kurbanov, S.; Mattiv, Y. & Tanif, G. (1990). Agricultural Chemistry. Recently Published Translation by: Nadim, M. I. & Khalil, I.M.A. Fac. Agric., Univ. Baghdad: 40pp. (In Arabic).
- Stangev, L.; Velchev, E.; Gorbanov, S.; Matev, E. & Tanev, Z. (1990). Agroz-chemistry. Zimazadat Pub. Sofya: 496pp. (In Arabic).
- Stevenson, F.J. (1982). Humus Chemistry : Genesis, Composition, Reactions, John Wiley and Sons, New York: 443pp
- Sumalatha, G. & Jebarathnam, T.G. (2018). Integrated nutrient management in sunflower with apiary farming system. J. Adv. Stud. Agric. Biol. Environ. Sci., 5(2): 1-6.
- Tisdale, S.L. & Nelson, W.L. (1975). Soil Fertility and Fertilizers. 3rd. ed. New York, Macmillan Publishing Comp.: 528pp.