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PHOSPHORUS STATUS IN SOME SOILS OF DAMIETTA GOVERNORATE

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ABSTRACT

Phosphorus (P) is an essential plant nutrient, and its deficiency in soils severely restricts crop yields. In order to evaluate the phosphorus status in some soils of Damietta Governorate soils, chosen nineteen soil profiles were done at selected nineteen site to represent the soil of Damietta Governorate from north to south were studied . Soil samples were taken from each profile at three depths, (0-30, 30-60, and 60-90 cm). The obtained results could be summarized in:

Total phosphorus content in profiles 6-19 which were clay and clay loam in texture was ranged from 585.5 to 3760.3 mg/kg soil which was found in layer C of the profile No.14 and 15, respectively. Total phosphorus significantly increased with increasing the distance from the sea. Total phosphorus in layer A and C was increased with the distance and the correlations were r= 0.69 and 0.3, respectively

Total phosphorus was significantly correlated with clay and organic matter content. A negative significantly correlation was found between available phosphorus and the distance from the sea (r=-0.4), where it decreased with increasing the distance from the sea.

- A non significant correlation was found between available phosphorus content and soil depth where available phosphorus had no constant trend with soil depth.
- The available phosphorus contents (mg/kg soil) of Damietta governorate soils in the first five profiles, where the soil was sandy and sandy loam in texture were moderate in each layer, except the surface layer of profile 4. While available phosphorus content (mg/kg soil) of Damietta governorate soils in profiles from 6-19, where the soil was clay and clay loam in texture was low in A and B layers except the surface layer of profiles 8, 12, and 18 which were moderate.
- A negative significant correlation was found between soil organic matter and available phosphorus content (r=-0.37), where available phosphorus content decreased with increasing soil organic matter and the distances from the sea. A negative significant correlation was found between available phosphorus content and soil pH (r=-0.34) where available phosphorus content decreased with increasing soil pH and the distance from the sea.

Keywords: phosphorus, organic matter, pH, distance from the sea

INTRODUCTION

Phosphorus (P) is an essential plant nutrient, and its deficiency in soils severely restricts crop yields. phosphorus deficiency often appeared in alkaline and acidic soils. Moreover, most of these soils possess a high phosphate sorption capacity. Strongly sorbed or fixed phosphate is unavailable for plant uptake. There are many factors affecting total and available phosphorus such as soil mineral type**,** amount of clay, soil pH, temperature and soil organic matter. Therefore, substantial P inputs are required to improve soil P status which give optimum plant growth with adequate food and fiber production.

Manure application has been reported to increase soil concentrations of both total and soluble P, as well as concentrations of specific P forms, including stable organic P moieties (Erich *et al*., 2002).

Soil pH is an important factor to control P speciation, as well as precipitation–dissolution and adsorption–desorption reactions, and thus P solubility and availability to plants (Hinsinger, 2001). Iron- and Al-oxides, which sorb P which can partially be solubilized by NaOH, exhibit highest P sorption potential at *around pH 5.0, with very low sorption occurring above pH 7.0 (Gahoonia et* al. 1992 and Stevenson and Cole 1999). In addition, Ca-phosphates have decreasing solubility with increasing pH (up to pH 8.0) (Hinsinger, 2001).Gahoonia *et al*., (1992) found positive correlations between soil pH and all inorganic P fractions at .Among the soil properties, soil pH, exchangeable Ca, P-sorption capacity and organic matter are reported to be the main factors affecting the agronomic potential of PRs (phosphorus rocks) (Khasawneh and Doll 1978).

In this study the phosphorus status in some Damietta soils was determined to assess the phosphorus status. Phosphorus distribution with soil depth was investigated. The relations between total, available phosphorus , soil organic matter and soil reaction are studied. In order to know phosphorus status and soil requirement of manufactured water-soluble P fertilizers such as super phosphates and to correct P deficiency this study was set up .

MATERIAL AND METHODS

In order to evaluate the phosphorus status in some Damietta Governorate soils, nineteen soil profiles were done in selected nineteen site of Damietta Governorate (Fig. 1). Phosphorus distribution with soil depth was investigated. The relations between total, available phosphorus and soil organic matter as well as soil reaction were studied. The studied area exists in between latitude 30° ; 32 N and 31°; 15 N and between longitude 31°;45 E and 31° ; 30 E.

Soil profiles were taken one km intervals and the first profile was 1 km from the Mediterranean Sea. Soil samples were taken from each profile at three depths, (A:0-30, B: 30-60 and C: 60-90 cm). Soil samples were taken at November 2012 then prepared (air dried, ground, and sieved). Soil organic matter, soil reaction, total and available phosphorus were determined in soil samples.

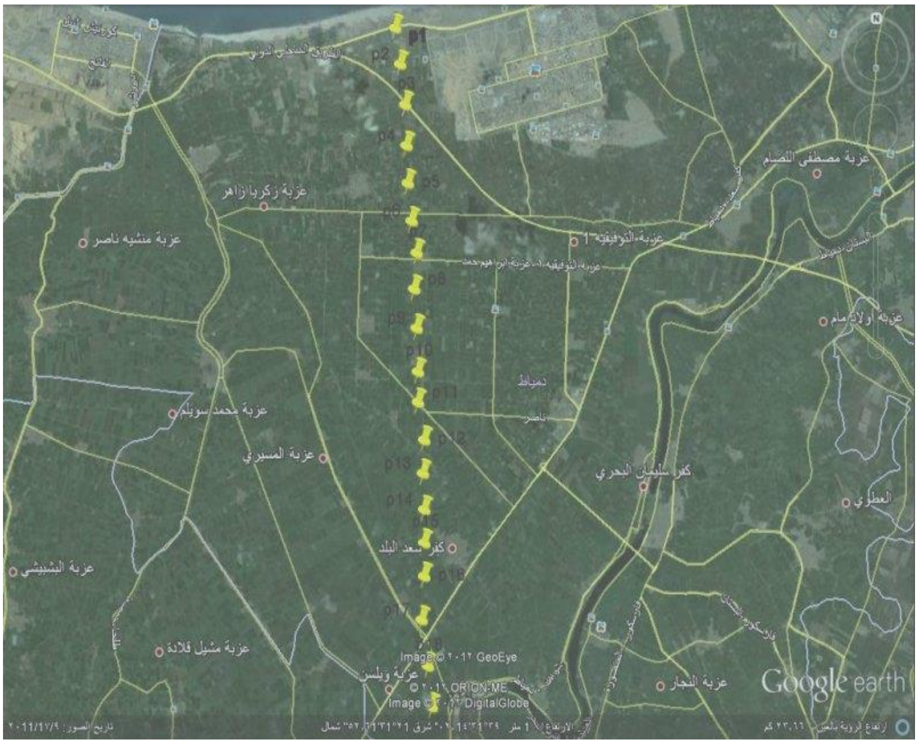

Fig. (1): Studied area map of Domietta Governorate.

- Particle size distribution was determined using the international pipette method as described by Black (1965).
- pH value of soil was determined in soil paste using Beckman pH meter (Jakson, 1967)
- EC for soil paste extract was determined using an electrical conductivity meter as described by Jakson (1967).
- Organic matter content was determined by walkly black rapid titration method as described by Dewis and Freitas (1970).
- total phosphorus was determined according to Hesse (1971) soil samples were digested using mixture of HF, $HClO_4$ and H_2SO_4 . Then phosphorus was determined using Jenway 6530 spectrophotometer at 660 nm.
- Available phosphorus was determined as described by Olsen et al., (1954) where 5 g of soil are suspended in 100 ml of sodium bicarbonate 0.5M $NaHCO_3$, pH = 8.5 and the suspension was shaken for 30 minutes. The P content in the filtrate is analyzed calorimetrically using Jenway 6530 spectrophotometer at 660 nm

Statistical analysis

Correlations coefficients between parameters were estimated by Costat Program (Version 6.303, CoHort, USA, 1998-2004).

RESULTS AND DISCUSSION

Data in Table (1) show total phosphorus content (mg/kg soil) of the 19 studied profile. Total phosphorus content in the first five profiles, where the texture was sandy and sandy loam (EL-Agrodi *et al.,* 2012), ranged between 502.3 and 1807.8 mg/kg soil which was found in C layer of profile 2 and 3, respectively. Total phosphorus content in profiles 6-19 having the texture of clay and clay loam was between 582.5 and 3760.3 mg/kg soil in layer C of the profile 14 and 15; respectively. Total phosphorus significantly increased with increasing the distance from the sea where in layer A and C it increased with the distance and the correlations were r= 0.69 and 0.3 respectively. On the other hand, in layer B total phosphorus content was increased and the increase was insignificant.

On the other hand, there is no clear trend was found between total phosphorus content and soil depth, where total phosphorus in profiles 1-5 was higher in the surface layer than B and C layers except in profiles 1and 3. Total phosphorus content in profiles of 7, 8, 9, 10, 11, 15 and 16 tended to increase up to C layer with increasing soil depth in contrast with the content of profiles 6, 12, and 14 which tended to decrease with increasing soil depth. These results may be accused to the agricultural practices such as adding phosphate fertilizers, organic fertilizers and irrigation methods.

Table (1): Total phosphorus and available phosphorus (mg/kg soil) in studied soil layers.

	Total phosphorus (mg/kg soil)				Available phosphorus (mg/kg soil)			
Soil layers / Soil pro.No.	A (0-30cm)	B(30-60cm)	C(60-90cm)	MEAN	A (0-30cm)	B(30-60cm)	C(60-90cm)	MEAN
P1	760.5	1256.9	1361.1	1126.2	9.02	10.09	11.37	10.16
P2	1281.7	1060.8	502.3	948.3	12.09	9.02	7.92	9.68
P3	552.0	1147.6	1807.8	1169.1	9.87	10.47	11.64	10.66
P4	1256.9	1140.2	1080.6	1159.2	17.50	10.64	10.56	12.90
P5	1676.3	1594.4	1529.9	1600.2	8.23	6.92	5.04	6.73
P6	1811.2	1270.8	1026.4	1369.5	7.61	9.95	8.23	8.60
P7	1305.6	1562.9	1575.7	1481.4	6.47	7.68	10.68	8.28
P8	1400.8	2185.6	2741.3	2109.2	9.78	6.11	6.82	7.57
P9	1264.4	1327.4	1418.8	1336.9	6.30	6.66	7.44	6.80
P10	1184.6	1588.6	2141.8	1638.3	6.20	9.44	10.30	8.65
P11	1377.6	1467.7	1725.0	1523.4	4.80	8.13	11.57	8.17
P12	726.6	626.3	585.1	646.0	13.02	7.32	6.47	8.94
P13	1763.6	1542.3	1727.6	1677.8	8.83	7.25	7.16	7.75
P14	860.4	757.5	582.5	733.5	8.25	7.97	7.90	8.04
P15	2327.1	2538.1	3760.3	2875.2	2.18	6.94	7.25	5.46
P16	1727.6	2149.5	3101.6	2326.2	4.39	6.87	9.80	7.02
P17	2906.0	1902.5	2538.1	2448.9	6.40	3.30	4.58	4.76
P18	2834.0	726.6	1511.4	1690.7	10.33	7.97	7.97	8.76
P19	2707.9	700.9	886.2	1431.7	8.30	8.49	9.49	8.76
MEAN	1564.5	1397.2	1663.3	1541.7	8.40	8.00	8.50	8.30

The relation between total phosphorus content and sand, silt, clay percentage and soil organic matter content (%).

Data presented in Table (2) show the percentage (%) of sand, silt and clay in studied soil layers. Total phosphorus significant and negatively correlated with the percentage of sand which the correlation between total phosphorus and sand percentage was (= -0.324). Total phosphorus decreased with increasing the sand percentage . On the other hand , a non significant correlation between total phosphorus and the silt percentage (%). A highly correlation (r =0.38) between the clay percentage and total phosphorus (mg/kg) where, total phosphorus was increased with increasing the clay percentage.

Table (2): The percentage (%) of sand, silt and clay in studied soil layers.

Profile no.	Sand%			Silt%			Clay%		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
1	94.1	83.16	83.21	2.36	3.37	8.40	3.54	13.47	8.40
2	71.37	81.9	70.62	17.18	6.568	20.57	11.45	11.51	8.81
3	65.96	83.34	68.88	21.25	3.33	29.78	12.79	13.33	11.34
4	64.29	68.82	67.14	27.46	19.84	16.43	8.28	11.34	16.43
5	67.91	66.19	67.03	20.93	23.00	21.98	11.16	10.82	10.99
6	11.27	7.48	1.97	44.34	46.98	45.24	44.36	45.55	53.04
7	12.32	10.5	6.45	44.54	9.18	6.68	43.15	80.32	86.86
8	33.17	19.69	10.75	15.27	23.51	22.31	51.55	56.81	66.94
9	15.92	13.61	6.89	22.02	24.11	23.77	62.06	62.28	69.34
10	9.7	11.79	6.17	41.81	37.32	23.54	48.49	50.89	70.62
11	10.8	7.75	7.59	33.90	27.90	26.40	55.31	55.8	66.01
12	15.88	13.38	24	20.60	22.08	20.39	63.52	64.54	55.61
13	23.36	22.01	20.69	24.30	31.57	8.13	52.34	46.43	71.17
14	19.48	16.63	28.6	18.12	24.09	46.97	62.41	59.29	24.42
15	13.04	12.71	6.51	28.36	23.28	21.88	58.60	64.02	71.61
16	18.17	20.99	16.82	32.35	29.40	18.90	49.48	49.61	64.27
17	17.77	18.15	15.83	27.41	32.03	28.69	54.82	49.82	55.48
18	19.89	20.48	24.05	29.81	33.29	37.97	50.30	46.23	37.97
19	21.35	23.71	22.83	28.09	34.68	33.07	50.56	41.61	44.10
Means	**31.88**	**31.70**	**29.26**	**26.32**	**23.98**	**24.27**	**41.80**	**43.88**	**47.02**

Data presented in Table (3) show the organic matter content in the different layers of the 19 selected profiles. Correlation between organic matter content and total phosphorus content were done and it was found that a significant correlation (0.49) was revealed between total phosphorus content and soil organic matter where, it was increased with increasing organic matter.

So , as mentioned before the total phosphorus content in soils depends largely on the soil content of clay and organic matter. The total phosphorus contains inorganic and organic forms so, clay fraction is responsible for inorganic P content and organic matter is attributed to organic P content.

Table (3): Soil organic matter percentage(%)and soil reaction (pH) values in the studied soil layers.

Soil organic matter content (%)					Soil reaction values (pH)			
Soil layers / Soil pro.No.	A (0-30cm)	B(30-60cm)	C(60-90cm)	MEAN	A (0-30cm)	B(30-60cm)	C(60-90cm)	MEAN
P1	0.10	0.08	0.10	0.09	7.92	8.05	8.03	8.00
P2	0.15	0.08	0.06	0.10	7.45	7.98	7.98	7.80
P3	0.19	0.10	0.06	0.12	8.04	8.07	7.40	7.84
P4	0.17	0.19	0.17	0.18	7.86	7.70	7.41	7.66
P5	0.19	0.19	0.19	0.19	7.89	7.77	7.82	7.83
P6	0.74	0.51	0.34	0.53	8.01	8.03	7.97	8.00
P7	0.80	0.40	0.46	0.55	7.91	8.03	8.02	7.99
P8	0.46	0.34	0.46	0.42	8.03	8.13	8.17	8.11
P9	0.69	0.57	0.29	0.52	7.87	8.12	8.35	8.11
P10	0.86	0.57	0.40	0.61	7.98	7.60	7.62	7.73
P11	0.57	0.57	0.29	0.48	7.88	7.52	8.18	7.86
P12	0.57	0.45	0.30	0.44	8.12	8.33	8.43	8.29
P13	0.52	0.45	0.37	0.45	8.38	8.28	8.35	8.34
P14	0.52	0.60	0.22	0.45	7.88	7.99	8.05	7.97
P15	0.74	0.45	0.37	0.52	8.29	8.31	8.33	8.31
P16	0.52	0.42	0.30	0.41	8.40	8.85	8.65	8.63
P17	0.74	0.45	0.22	0.47	8.15	8.42	8.40	8.32
P18	0.45	0.45	0.37	0.42	8.15	8.11	8.12	8.13
P19	0.67	0.45	0.15	0.42	8.05	8.05	8.12	8.07
MEAN	0.51	0.39	0.27	0.39	8.01	8.07	8.07	8.05

Table (4): Electrical conductivity (EC dSm^{-1}) values in the studied soil layers.

Profile no.	Layer A (0.30 cm)	Layer B (30 -60 cm)	Layer C (60 -90cm)
1	7.54	7.55	5.48
2	3.42	3.33	3.29
3	3.00	4.70	4.23
4	4.75	3.86	4.50
5	2.80	3.10	2.66
6	4.09	4.95	5.26
7	4.74	4.67	4.82
8	4.60	4.05	4.38
9	5.00	5.00	3.96
10	3.63	4.00	4.20
11	4.01	4.39	4.08
12	5.23	4.38	4.89
13	4.67	4.48	3.97
14	3.61	3.91	4.04
15	4.30	4.13	4.27
16	4.71	4.19	5.00
17	4.03	4.46	4.80
18	3.76	4.18	5.34
19	4.32	5.26	5.06

Data presented in Table (1) and Fig (2) show the available phosphorus content (mg/kg soil) of the studied profiles. In general, a negative significantly correlation was found between available phosphorus and the distance from the sea (r=-0.4) where it decreased with increasing the distance from the sea. Linear correlation equation between available phosphorus content of each layer of profiles and the distance from the sea are :

Y= - 0.2441x+10.838 R= 0.410 for layer A
Y= -0.1604x + 9.464 R= 0.501 for layer B
Y= -0.1356x + 9.9914 R= 0.313 for layer C

Where Y is the available P content and X is the distance from the sea in Km.

The previous equations pointed out that available phosphorus content of each layer was decreased with increasing the distance from the sea. On the other hand, a non significant correlation was found between available phosphorus content and soil depth where available phosphorus had no constant trend with soil depth.

Available phosphorus content in profiles 1, 3, 7, 9, 10, 11, 15, 16 and 19 tended to increase with increasing soil depth up to layer C in contrast to profiles 2, 4, 5, 6, 12, 13, 14 and 18 which were decreased with increasing soil depth. The highest available phosphorus content (17.5 mg/kg soil) was found in profile No.4 at layer A, while the lowest one (3.3 mg/kg soil) was found in profile no. 17 at layer B. The correlation between available phosphorus and total phosphorus was not significant. These results may be regarded to soil chemical properties such as high soil reaction (pH) and it's contents of $CaCO_3$ and organic matter. These results are in agreement with Pandey *et al*.,(2013), where they found that the correlation of the available phosphorus to the organic matter content of the soil decreased in the order of neutral to slightly acidic to strongly acidic to alkaline soils. It is highly significant in neutral soils, while it is significant in slightly and strongly acidic soils. They also found that there is not any significant correlation between soil pH with available phosphorus and available potassium.

The available phosphorus content (mg/kg soil) of the investigated soils in the first five profiles which were sandy and sandy loam in texture was moderate in each layers except the surface layer of profile 4. While available phosphorus content (mg/kg soil) of the studied soils in profiles from 6-19 where the soil was clay and clay loam in texture was low in A and B layers except the surface layer of profiles 8, 12, and 18 was moderate. The critical levels of available phosphorus content in sandy loams soil was arranged in this order; low 0-7 , medium 7-15 and high (higher than 15 ppm) while the critical levels of available phosphorus content in sandy loam soil was recorded as; low 0-9, medium 9-24 and high (higher than 24 ppm) and in clay soil was between low 0-13 , medium 13-30 and high (higher than 30 ppm) (Clements and McGowen, 1994).

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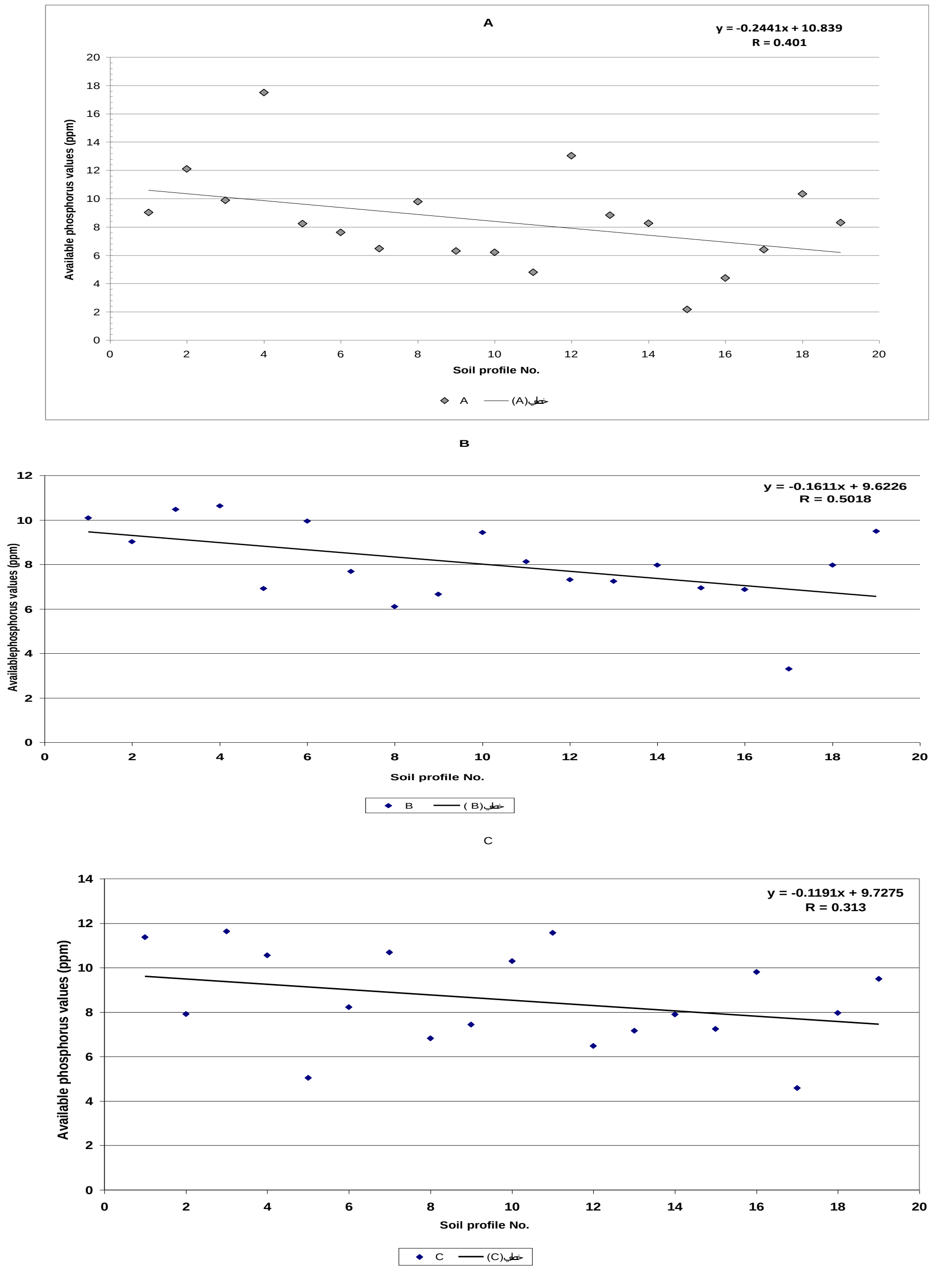

Fig (2): The distribution of available phosphorus (mg/kg soil) in studied soil layer (A, B, C and D) at different profiles.

The relation between available phosphorus content and sand, silt, clay percentage, soil pH, soil organic matter content (%) and EC (dSm^{-1})

Available phosphorus content were significantly correlated with the percentage of sand which the correlation between available phosphorus and sand percentage was (=0.386). Available phosphorus was decreased with decreasing the sand percentage with increasing the distance from the sea . On the other hand , a non significant correlation between available phosphorus and the silt percentage (%). A negative significant correlation (r = -0.33) was found between the clay percentage and available phosphorus (mg/kg) where, available phosphorus was decreased with increasing the clay percentage.

As it's shown in Table (3) soil reaction (pH) significantly increased with increasing the distance from the sea and the linear correlation between soil pH and the distance from the sea was (0.54). A non significant correlation between soil pH and soil depth where soil pH had no constant trend with soil depth .

Data in Fig (3) illustrate that available phosphorus was significantly affected by soil pH and soil organic matter contents. Where ,a negatively significant correlation was found between soil organic matter and available phosphorus content (r=-0.42), where available phosphorus content decreased with increasing soil organic matter and the distances from the sea. These results may be regarded to the low amount of organic matter and raising soil pH. A negatively significant correlation was found between available phosphorus content and soil pH (r=-0.39) where available phosphorus content decreased with increasing soil pH and the distance from the sea.

Data presented in Table (1) and (4) show that a non significant correlation (r= 0.15) was found between available phosphorus (mg/kg soil) and the soil EC (dSm^{-1}).

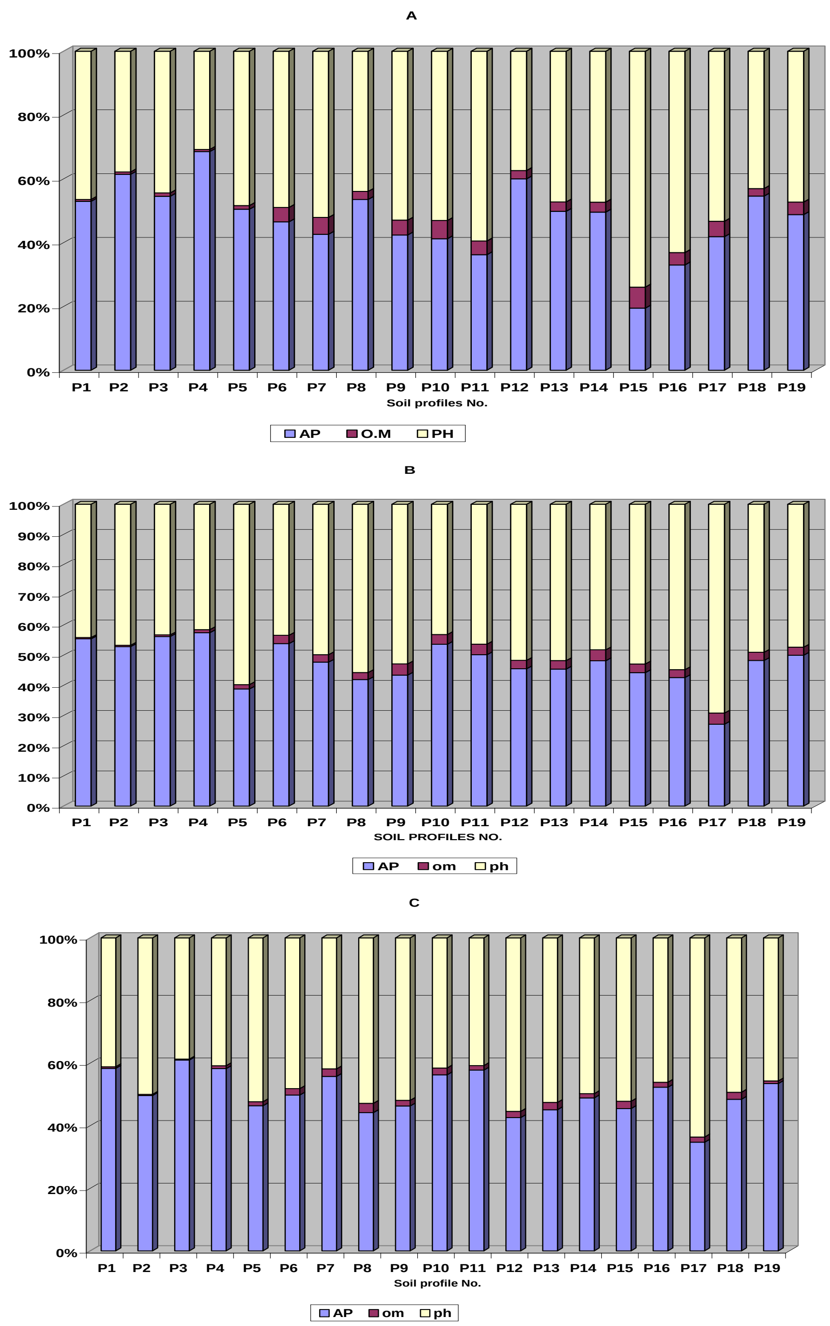

Fig (3): The relation between available phosphorus, organic matter and soil pH in the studied layers (A, B, and C).

CONCLUSION

From the results mentioned previously it can be concluded that; total phosphorus significantly increased with increasing the distance from the sea where in layer A and C it increased with the distance and the correlations were r= 0.69 and 0.3 respectively. A negative significantly correlation was found between available phosphorus and the distance from the sea (r=-0.4) where it decreased with increasing the distance from the sea. The available phosphorus content (mg/kg soil) of these soils in the first five profiles where sandy and sandy loam texture was moderate in each layer except the surface layer of profile 4. While available phosphorus content (mg/kg soil) of Damietta governorate soils in profiles from 6-19 where the soil was clay and clay loam texture was low in A and B layers except the surface layer of profiles 8, 12, and 18 was moderate. Thus, Damietta governorate soils require to add phosphatic fertilizers to improve soil fertility and provide plants demands.

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تقييم حالة الفوسفور في بعض أراضي محافظة دمياط

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يعتبر الفوسفور أحد العناصر الغذائية الاساسية للنبات ولتقييم حالة الفوسفور في بعض أراضي محافظة دمياط تم أخذ تسعة عشر قطاعا أرضيا من تسعة عشرا موقعا من محافظة دمياط ، حيث أخذت عينات التربة علي مسافة 1كم بين القطاع والأخر و أربعة طبقات لكل قطاع (صفر -30 و 30-60 و60-90و 90-120 سم) وملخص النتائج المتحصل عليها كالتالي:

- محتوي الفوسفور الكلي بالمليجرام / كجم في القطاعات 6-19 كان بين 585.5 و 3760.3 مليجرام /كجم وذلك في الطبقة C للقطاعات 14 و15 علي الترتيب .
- ازداد محتوي الفوسفور الكلي بالمليجرام / كجم زيادة معنوية بزيادة البعد عن البحر حيث كان معامل الارتباط بين محتوي الفوسفور الكلي والبعد عن البحر للطبقات Aو C هو 0.69 و 0.3 علي الترتيب
- يرتبط الفوسفور الصالح ارتباطا معنويا سالبا (-0.4) مع البعد عن البحر حيث يقل الفوسفور الصالح بزيادة البعد عن البحر .
- لا يوجد ارتباط معنوي بين الفوسفور الصالح و عمق التربة حيث لا يوجد اتجاه ثابت مع عمق التربة .
- محتوي أراضي محافظة دمياط من الفوسفور الصالح (مليجرام /كجم)في القطاعات الخمسة الأولي حيث القوام الرملي والرملي الطمي كان متوسط بينما في القطاعات من 6-19 حيث القوام الطيني و الطيني الطمي كان محتوي الفوسفور الصالح منخفض في الطبقات A و B ماعدا الطبقة السطحية من القطاعات 8 و12 و18 كان محتواها متوسط .
- وجد أن الفوسفور الصالح يرتبط ارتباطا معنويا سالبا (0.37-) مع محتوي التربة من المادة العضوية حيث يقل الفوسفور الصالح بزيادة المادة العضوية والبعد عن البحر وهذه النتيجة ربما ترجع الي ارتفاع رقم تفاعل التربة وانخفاض محتوي التربة من المادة العضوية.
- يرتبط الفوسفور الصالح ارتباطا معنويا سالبا (0.34) مع تفاعل التربة (pH) حيث يقل الفوسفور الصالح مع زيادة تفاعل التربة والبعد عن البحر.
- أراضي محافظة دمياط تحتاج الي إضافة الأسمدة الفوسفاتية لتحسين خصوبة هذه الأراضي وإمداد النباتات باحتياجاتها من الفوسفور .

قام بتحكيم البحث

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