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EFFECT OF SOME FACTORS ON PHOSPHOROUS CONTENT AND UPTAKE OF WHEAT STRAW GROWN ON A CALCAREOUS SOIL

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ABSTRACT

The current work was carried out to study the effect of irrigation water salinity, farmyard manure levels and moisture content on phosphorous content and uptake of wheat plants grown on a calcareous soil**.** A pot experiment was carried out in the green house of Soils and Water Department, Faculty of Agriculture, Al-Azhar University (Nasr city, Cairo, Egypt), during the winter season of 2009.Wheat plants (*Triticum aestivum*, L.) Sakha 93variety, were used as an indicator plant to experiment treatments.Twenty grains were sown in each pot and the treatments were three replicates including control. After 15 days, the pots were thinned to 10 seed lings. Completely randomized block design was used.

Four salinity levels of irrigation water were prepared (control, 0.44, 1.56, 3.12 and 6.25 dSm^{-1}) under different moisture contents (100%, 75% and 60%) of field capacity determined by weight and four organic matter levels (0%, 1%, 2% and 4%) farmyard manure (FYM). Results showed that phosphorus content and uptake in straw significantly decreased with increasing salinity levels while it was increased with increasing moisture levels .Also, application of farmyard manure at rates up to 2% induced significantly increases in phosphorus content and uptake in wheat straw.

Keywords: Wheat straw- phosphorous content and uptake-irrigation water salinity-soil moisture-farmyard manure- wheat- calcareous soil.

INTRODUCTION

Calcareous soils cover more 30% of the earth's surface and their $CaCO_3$ content varies from a few percent to 95% (Marschnen, 1995). Calcareous soils occur naturally in arid and semi-arid zones as well as humid and semi-humid zones particularly where their parent material is rich in $CaCO_3$ (Brady and Weil, 1999). In Egypt the newly reclaimed soils at Nubaria and Borg El-Arab regions cover more than 900.000 fed. of which 290.000 fed. are calcareous soils (Moursy, 2002). Also, these soils are mainly characterized by slightly alkaline reaction, poor fertility, low organic matter content and poor physical properties. Phosphorus (P) is an essential macronutrient, being required by plants in relatively large quantities (~0.2 to 0.8%) (Mengel and Kirkby, 1987; Mills and Jones, 1996). Potassium and nitrogen are the only mineral nutrients required in larger quantities than P. Providing adequate P to plants can be difficult, especially in alkaline and calcareous soil. Also, Phosphorus is very important element to plant and plays a role in metabolic process such as the conversion of sugar into starch and cellulose. As a result, phosphorus deficiency causes stunting delayed maturity and shriveled seed (Basak, 2006). Hence, some workers have been able to investigate the relation between phosphorous

content and uptake with soil salinity, farmyard manure application and soil moisture content; Singh *et al.* (1992) found that the uptake of phosphorus in wheat plants significantly decreased with increasing salinity levels of irrigation water from 0 to 20 dSm^{-1}. Dahdoh *et al.* (1993) found that the values of contents were obtained when barley plants irrigated with 25% soil moisture depletion compared to 50% soil moisture depletion. Dahdoh *et al.* (1994) found that increasing soil moisture depletion increased P content by barley shoots. The highest values were associated with 25% soil moisture depletion compared to 50 and 75%.

The organic matter applications improve soil properties and consequently the plant growth. Farmyard manure is the form of organic matter that has the most economical ways to increase organic matter content in soils. Nowadays many investigators tried to utilize the FYM to fertilize sugar beet to release the cost and minimize the pollution of fertilizers for plants and drainage water. Investigators indicated that the application of FYM increased plant growth and the dry matter production (EL-Shouny, *et al*. 2008, EL- Agodi, *et al.* 2011 and Abou EL-Magd, *et al*.2012).Also, Dormaar *et al.* (1988) reported that manures application increased the organic matter and available P content of the soils considerably. Most of the added P from manure remained in the surface soils (0 - 30cm). EL-Desoky and Ragheb (1993) noticed that sodium bicarbonate extractable P increased with increasing rates of the organic materials. El-Ghozoil (1994) explained that the soil content of available phosphorus increased progressively as the C/ N ratio of the added residues became closer and thus the C/N ratio of 10:1 yield the highest inducing effect on soil content of available phosphorus. Mahmoud (1994) reported that organic acids resulting from the metabolic phosphate. This formed phosphorus was more readily available to higher plants. Mohammed *et al.* (1996) found that the addition of organic materials resulted in improving the status of all the extractable nutrients. With passage of time, there was an increase in the availability of phosphorus; hence the highest value was recorded on the 45 the day at 60 or 90% of water holding capacity. The present study was carried out to investigate the effect of irrigation water salinity, farmyard manure levels and moisture content on phosphorous content and uptake of wheat plants grown on a calcareous soil under the greenhouse conditions.

MATERIALS AND METHODS

A pot experiment was carried out in the green house of Soils and Water Department, Faculty of Agriculture, Al-Azhar University (Nasr city, Cairo, Egypt), during the winter season of 2009. Wheat plants (*Triticum aestivum*, L.) Sakha 93 variety, were used as an indicator plants. Plastic pots of 25 cm in side diameter and 30cm depth, were filled with 5.0 kg of calcareous soil samples which collected from EL-Nobaria region ($CaCO_3$ 30%) Cairo Alexandria, Desert Road. Soil samples were air dried and analyzed to estimated some physical and chemical characteristics; Table 1.

Table 1: Some physical and chemical characteristics of soil sample.

Physical properties									
Particle size distribution (%)				Texture Class	O.M %	$CaCO_3$ %	Moisture content %		
Coarse Sand	Fine Sand	Silt	Clay	Sandy Loam	1.43	30	F.C	W.P	A.W
9.56	57.96	24.98	7.5				23.21	9.27	13.94

Chemical properties									
pH (1:2.5)	EC dSm^{-1}	Soluble cations meq l^{-1}				Soluble anions meq l^{-1}			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.11	2.61	15.21	3.76	6.92	1.23	0.00	1.83	2.50	22.79

The cultivated plants were fertilized according to the general recommendations of Ministry of Agriculture. Twenty grains were sown in each pot and the treatments were three replicates including control. After 15 days, the pots were thinned to 10 seed lings. Completely randomized block design was used. Four salinity levels of irrigation water were prepared (control 0.44, 1.56, 3.12 and 6.25 dSm^{-1}) under different moisture contents in a green house. Irrigation was practical to maturity when the soil water depletion reached (100%, 75% and 60%) of field capacity determined by weight and four organic matter levels (0%, 1%, 2% and 4%) farmyard manure(FYM). The farmyard manure was taken from station of Animal production, Faculty of Agriculture, Al-Azhar University. Some chemical characteristics of organic manure; Table **2**. The plant samples were collected from each treatment after harvesting then dried in an oven at 70° C for 48 hour, ground in stainless steel mill and stored in polyethylene bags for analysis.

Table 2: Some chemical properties of farmyard manure used:

pH (1:10)	EC dSm^{-1} (1:10)	O.M. (%)	O.C. (%)	C/N ratio	Total macronutrient (%)		
					N	P	K
7.62	6.89	42	24.4	17.06	1.43	0.78	1.99

RESULTS AND DISCSSION

Data presented in Tables 3 and 4. Show that, increasing salinity levels significantly decreased phosphorus content and uptake of straw. This was true at all rates of water salinity, where phosphorus content in straw reached 0.25, 0.23, 0.19 and 0.15 % at salinity levels (control,1.56, 3.12 and 6.25 dSm^{-1}), respectively. The corresponding values for phosphorus uptake by straw were 25.98, 21.86, 16.74 and 12.35 mg pot^{-1} at the same levels of salinity.

The reduction of P content under high salinity levels could be explained on the fact that, the presence of Na salts raised the pH of the soil, which in turn reduced the availability of phosphorus to plant. Also the presence of calcium as dominant ion in soil under investigation $CaCO_3$ 30%

precipitated phosphorus ion to insoluble tri calcium phosphate, consequently the availability of phosphorus to plant was decreased. Results could be enhanced with those obtained by many author such as Navarro *et al.* (2001) who stated that phosphate availability is reduced in saline soil not only due to ionic strength effect that reduced the activity of phosphate but also because phosphate concentrations in soil solution are tightly controlled by Ca - P interaction.

With regard to the effect of farmyard manure rates on P content and uptake of wheat straw under different levels of water salinity and moisture %, the results in Tables 3 and 4 showed that, increasing farmyard manure levels up to 2% in straw significantly increased phosphorus content and uptake of wheat plant, where phosphorus content in straw reached 0.17, 0.22, 0.24 and 0.20 % at application farmyard manure (0, 1%, 2% and 4%), respectively. The corresponding values for phosphorus uptake by straw were 14.12, 19.84, 24.37 and 18.61 mg pot^{-1} at the same levels of farmyard manure.

Table3: Phosphorus content (%) in straw of wheat plants as affected by the interaction among salinity levels, farmyard manure and moisture percentages.

Salinity (S) dSm^{-1}	Moisture (M) %	P content (%) Farmyard manure (FYM) %				
		0	1	2	4	Mean
	100	0.22	0.27	0.30	0.26	0.26
	75	0.21	0.26	0.29	0.25	0.25
Control	60	0.20	0.25	0.28	0.24	0.24
Mean		**0.21**	**0.26**	**0.29**	**0.25**	**0.25**
	100	0.20	0.25	0.28	0.23	0.24
	75	0.19	0.24	0.27	0.22	0.23
1.56	60	0.18	0.30	0.25	0.20	0.23
Mean		**0.19**	**0.26**	**0.27**	**0.22**	**0.23**
	100	0.17	0.20	0.24	0.19	0.20
	75	0.16	0.19	0.21	0.18	0.19
3.12	60	0.15	0.18	0.20	0.17	0.18
Mean		**0.16**	**0.19**	**0.22**	**0.18**	**0.19**
	100	0.14	0.18	0.19	0.15	0.17
	75	0.13	0.16	0.17	0.14	0.15
6.25	60	0.11	0.15	0.16	0.12	0.14
Mean		**0.13**	**0.16**	**0.17**	**0.14**	**0.15**
	100	0.18	0.23	0.25	0.21	0.22
	75	0.17	0.21	0.24	0.20	0.20
Mean	60	0.16	0.22	0.22	0.18	0.20
Mean		**0.17**	**0.22**	**0.24**	**0.20**	**0.21**
LSD at 5% level						
Salinity (S)		0.003				
Moisture (M)		0.002				
Farmyard manure (FYM)		0.003				
S × M		0.004				
S × FYM		0.005				
M × FYM		0.004				
S × M × FYM		0.009				

Phosphorus content and uptake of the wheat straw was increased by increasing the rate of farmyard manure up to rate of 2%. Further increase up to 4% caused a marked decrease in P content and uptake. This was true under all rates of water salinity and moisture content. The increase of P content and uptake caused by the presence of farmyard manure could be interpreted on the base of one or more of the following reasons: 1: during the decomposition of farmyard manure, 2: through some organic and inorganic acid released which decrease pH value in the Rhizospher, consequently the availability of P to the ability of to plant increased, 3: organic acids chelate Ca^{2+} ion which precipitate P ion.

Table4: Phosphorus uptake (mg pot^{-1}) by straw of wheat plants as affected by the interaction among salinity levels, farmyard manure and moisture percentages.

Salinity (S) dSm^{-1}	Moisture (M) %	P uptake (mg pot^{-1})				
		Farmyard manure (FYM) %				
		0	1	2	4	Mean
	100	20.70	29.16	38.16	28.83	29.21
	75	19.50	25.94	32.56	25.65	25.91
Control	60	16.34	22.52	30.32	22.12	22.83
Mean		**18.85**	**25.87**	**33.68**	**25.53**	**25.98**
	100	17.82	25.52	33.12	25.78	25.56
	75	15.86	23.08	27.62	19.71	21.57
1.56	60	13.46	19.55	22.95	17.88	18.46
Mean		**15.71**	**22.72**	**27.90**	**21.12**	**21.86**
	100	14.36	19.76	26.23	18.75	19.78
	75	12.00	16.34	19.08	16.29	15.93
3.12	60	10.99	15.03	17.28	14.80	14.53
Mean		**12.45**	**17.04**	**20.86**	**16.61**	**16.74**
	100	11.46	16.39	18.10	13.17	14.78
	75	9.49	13.36	15.13	11.18	12.29
6.25	60	7.51	11.41	11.88	9.13	9.98
Mean		**9.49**	**13.72**	**15.04**	**11.16**	**12.35**
	100	16.09	22.71	28.90	21.63	22.33
	75	14.21	19.68	23.60	18.21	18.92
Mean	60	12.08	17.13	20.61	15.98	16.45
Mean		**14.12**	**19.84**	**24.37**	**18.61**	**19.23**
LSD at 5% level						
Salinity (S)		0.060				
Moisture (M)		0.052				
Farmyard manure (FYM)		0.060				
S × M		0.105				
S × FYM		0.121				
M × FYM		0.105				
S × M × FYM		0.209				

These results are in harmony with those obtained by many authors such Rodd *et al.* (2002) and Koreish *et al.* (2004) who postulated that application of nitrogen fertilizer increased concentration of phosphorus in wheat and barley plants. Moreover, Uyanoz *et al.* (2006) observed that the application of organic materials increased uptake and accumulation of phosphorus.

Data tabulated in Tables 3 and 4 show clearly that, increasing moisture levels significantly increased phosphorus content and uptake of straw wheat plant, where phosphorus content in straw reached 0.22, 0.20 and 0.20 % at moisture levels (100, 75, 60 % of field capacity), respectively. The corresponding values for phosphorus uptake by straw were 22.33, 18.92 and 16.45 mg pot^{-1} at the same levels of moisture. Represent the P content and uptake of wheat plant straw subjected to increase soil moisture up to 100% of field capacity led to increase of P content and uptake of wheat straw. This finding indicates the importance of water use in distribution and movement of P in calcareous soil especially in the root rhizosphere which directly or indirectly affected the absorption of phosphorus by the growing plants.

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تاثير بعض العوامل على محتوى وامتصاص الفوسفور لقش القمح النامى فى الارض الجيرية

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يهدف هذا البحث دراسة تاثيرمستويات ملوحة مياة الرى و التسميد العضوى و الرطوبة الارضية على محتوى وامتصاص الفوسفور لقش نباتات القمح (سخا 93)النامى فى الارض الجيرية.اجريت الدراسة فى صوبة كلية الزراعة جامعة الازهرالقاهرة حلال موسم شتاء 2009 عشرون حبة من نبات القمح وضعت فى كل اصيص وكررت المعاملات ثلاث مرات من ضمنها الكنترول وخففت النباتات الى عشرة نباتات فى الاصيص بعد خمسة عشر يوما من (6,25 - 3,12-1,56-كنترول(الزراعة .وقد تم استخدام مياة الرى بتركيزات مختلفة من الملوحة ديسيمينز/ م وكانت المستويات المستخدمة من الرطوبة(100- 75-60٪)من السعة الحقلية. وكذلك كانت االاضافات من لسماد البلدى (0-1-2-4٪) .وقد اظهرت النتائج ان محتوى وامتصاص الفوسفور فى قش القمح قل معنويا بزيادة مستويات الملوحة بينما زاد بزيادة مستوى الرطوبة. وايضا ادى اضافة السماد البلدى الى زيادة معنوية فى محتوى وامتصاص الفسفور عند مستوى اعلى من 2٪

قام بتحكيم البحث

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