Journal of Environmental Studies [JES] 2010. 4:9-13
Article

Influence of Consumed Tea Residues and Phosphorus Fertilizer on Phosphorus Availability and Growth of Chickpea (*Cicer arietinum* L)

Dilshad, A. D. [1*] and Kocher, R. M.[2]
Biology Dept., Education College Scientific Dept., University of Salahaddin – Erbil, Iraq

Rec. 15 May, Accept. 15 June 2010

Abstract

A pot experiment was conducted in the green house of College of Education/ Scientific Departments , University of Salahaddin/Erbil, to study the effect of five levels of tea residues (0.0, 0.5, 1, 1.5, 2 ton donum^{-1}), four levels (0.0, 50, 100 and 150 Kg donum^{-1} of P_2O_5) of phosphorus fertilizer and their combination on phosphorus availability and Chickpea growth. The experiment was a factorial on the basis of completely randomized design with three replications. The results were indicated that the application of tea residues in different levels had a significant effect at ($p \leq 0.01$) and ($p \leq 0.05$) on available phosphorus in soil, plant phosphorus concentration, total dry matter and relative growth rate, where the highest values (9.83 mg kg^{-1}, 4.57mg g^{-1}, 4.34 gm pot^{-1} and 0.074 g g^{-1} plant^{-1} day^{-1}, respectively) were produced by this treatment (T_1). Also, tea residues and phosphorus fertilizer combination, affected significantly ($p \leq 0.01$ and $p \leq 0.05$) on available phosphorus, plant phosphorus concentration, total dry matter and relative growth rate of chickpea, where the highest values (17.41mg kg^{-1}, 6.57 mg g^{-1}, 8.67 g pot^{-1} and 0.138 g g^{-1} plant day^{-1}) were produced from the combination treatment (T_1P_1) compared to control.

Key Words: Tea Residues, Availability and Phosphorus.

Introduction

Chickpea (*Cicer arietinum* L.) is belongs to genus *Cicer*, family Fabaceae. Chickpea is the third important food legume of the world and it is an important field crop of Iraq, being cultivated either in irrigated fields or in fields without irrigation. Almost all the produce (88%) was obtained from the northern region of Iraq where climatic conditions are more congenial to its production than in other parts of the country (Chakravarty 1976). Tea is a popular beverage in most countries and its consumption is increasing, also it is the part of human life and a cheap drink, therefore tea is the most preferred drink after water and has been increased all over the world (Adiloğlu and Adiloğlu 2006). Phosphorus (P) is an essential plant nutrient that may limit plant growth and agricultural productivity if not available for plant uptake in sufficient quantities at the time required. Phosphorus availability affected by many factors such as amount of clay, type of clay, time of application, aeration, compaction, moisture, phosphate status of soil, temperature, other nutrients, crop and soil pH were summarized by Gupta (2004). In alkaline soils, availability of phosphorus is determined largely by the solubility of the calcium compounds in which the phosphate is found. At pH more than 7.0 phosphate ions quickly reacts to form less soluble compounds like tri-calcium phosphate. Although this compound is quite insoluble, it may be converted further in the soil to even more insoluble compounds like hydroxy apatite, chloro- apatite and fluorapatite.
This problem is more serious in soils where excess $CaCO_3$ is present (Gupta 2004).

Many Kurdistan soils are calcareous soils, thus they are deficient in available P, despite a long history of P fertilizer application, and this is due to the fertilizer P is rapidly becoming unavailable largely through biochemical fixation. The resulting low P fertilizer efficiency and coupled with rapidly rising cost of fertilizers, has increased interest in biological cycling of P from other sources such as crop residues.

* Corresponding author:
Dr. Dilshad Aziz Darwesh
🖂 dadaziz06@yahoo.co.uk

A different investigations were carried out to study the effect of organic matter of plant residues particularly on availability of phosphorus and crop yield such as Abdullah *et al*.,(2000), Nziguheba *et al*.,(2000), Edmeades (2003), El-Dewiny *et al.,*(2006), Zeidan (2007), Awodun (2007a) and Awodun (2007b). Both the need of nutrients to support a maximum plant growth and environmental conditions needed may vary from crop to another. Because of the large amount of tea consumption and making a large amount of tea residues, It is convenient to use these tea residues in agriculture management, since investigation to study the effect of tea residues on availability of nutrients particularly on phosphorus are rare. Thus, the objectives of this study are: to determine the effect of tea residues on phosphorus availability and to increase the efficiency of P use when tea residues are applied to crops, and to determine the effect of tea residues on growth, yield and P content of chickpea.

Materials and Methods

This research was conducted in the green house of College of Education/ Scientific Departments, University of Salahaddin–Erbil to study the effect of consumed tea residues and phosphorus fertilizer on phosphorus availability and chickpea growth. The experiment was a factorial on the basis of completely randomized design including two factors and three replications, the first factor involved tea residues using five levels (0.0, 0.5, 1, 1.5, 2 ton donum^{-1}), the second factor was phosphorus fertilizer including four levels (0.0, 50, 100 and 150 Kg P_2O_5 donum^{-1}) and their combination with available phosphorus, plant phosphorus concentration, plant height, total dry matter and RGR of chickpea. Hence 20 experimental treatments were tested, in each replicate making the total of 60 pots. Each pot packed with 7 kg of air-dried soils after sieve it through 4 mm sieves, and 5 seeds of chickpea were planted in each pot (Table 1). Plants were irrigated with tap water to maintain soil moisture near field capacity and weeding done was needed. The soil was collected from Askikalak region. The chemical and physical characteristics of the studied soil that are present in the table (1) were determined according to methods described by Richards (1954); Black (1965) and Allen (1974).

Plant sampling: Plant samples were dried at 65C° for at least 48 hours .After weighting and grinding with stainless steel mill the samples were stored for chemical analysis.

Plant analysis: Plant samples were digested according to Allen (1974) by using H_2O_2 and H_2SO_4 (1:1 v/v) . The phosphorus content was determined by using ammonium molybdate $SnCl_2$ method as described by Allen (1974).

Statistical analysis: The collected data was statistically analyzed by the computer using SPSS programme. The pair comparisons were performed by Tukey's MSD procedure at 5% and 1% level of probability (Steele and Torrie 1969).

Physical properties		
Particle Size Distribution g (Kg^{-1})	Sand	690.80
	Silt	257.10
	Clay	52.10
Textural name	Sandy loam	
Saturation (%)	29.50	
Field capacity (%)	14.58	
Chemical properties		
pH	7.79	
ECe dS (m^{-1})	0.61	
Organic matter (g Kg^{-1})	8.20	
Total $CaCO_3$ (g Kg^{-1})	270	
Active $CaCO_3$ (g Kg^{-1})	38.00	
Total Nitrogen (g Kg^{-1})	0.336	
Total Phosphorus (g Kg^{-1})	0.112	
Available Phosphorus (mg Kg^{-1})	2.73	
CEC Cmolc (Kg^{-1})	19.68	
Cation (mm L^{-1})		
Calcium	2.00	
Magnesium	0.75	
Potassium	0.62	
Sodium	0.86	
Iron	0.0096	
Anion (mm L^{-1})		
Chloride	1.45	
Bicarbonate	1.99	
Carbonate	0.00	

Table 1: Some Physical and Chemical Properties of soil under study.

Results and discussion

The data analysis present in table (2) and figure (1) revealed that tea residues significantly ($p \leq 0.05$ and $p \leq 0.01$) affected on available phosphorus in soil, plant phosphorus concentration, total dry matter and relative growth rate. The results showed that the highest values (9.83 mg kg^{-1}, 4.57 mg g^{-1}, 4.34 g pot^{-1} 0.074 g g^{-1} plant day^{-1}) were recorded by the treatment (T_1), while the lowest values (3.38 mg kg^{-1}, 0.85 mg g^{-1}, 1.94 g pot^{-1}0.034 g g^{-1} plant day^{-1}) were recorded by the treatment (T_0). These results could be explained on the ground that the organic matter increases the solubility of phosphate in two mechanisms and may be responsible for that; organic anions compete with phosphate ions for the binding sites on the soil particles, or may be complex organic anions chelate Al^{+3}, Fe^{+3} and Ca^{+2} and thus decrease the phosphate precipitating power of these cations. In addition the organic matter itself contains phosphorus. Also data in the same table revealed that application of high levels of tea residues beyond (0.5 ton $donum^{-1}$) reduce the available phosphorus in soil, plant phosphorus concentration and total dry matter. The reason may be due to that inorganic phosphates may be immobilized by the microorganisms attacking the organic material and fewer phosphates will be available for the plants. Also the other probable reason for decreasing the above mentioned parameters in case of application (T_2, T_3, and T4) treatments may be due to that the application of higher levels of tea residues to soil, and these higher levels may be decomposed or mineralized by microbial activities. This mineralization led to release of some micronutrient such Fe, Mn and Cu, which present originally in tea residues of soil solution. It is well known that these microelements fix phosphorus chemically then finally reduce the available phosphorus and reacted nutrients. A similar result and explanation has been reported by Somani and Kanthaliya (2004) and Adiloğlu and Adiloğlu (2006).

The data in table (3) indicated that combination between tea residues and phosphorus fertilizer affected significantly ($p \leq 0.01$) and ($p \leq 0.05$) on available phosphorus (mg kg^{-1}), plant phosphorus concentration (mg g^{-1}), total dry matter (gm pot^{-1}) and relative growth rate (g g plant day^{-1}) of chickpea. The combination treatment (T_1P_1) produced high values of available phosphorus, plant phosphorus concentration, and total dry matter (17.41 mg kg^{-1}, 6.57 mg g^{-1} ,8.67 gm pot^{-1} and 0.138 g g^{-1} plant day^{-1}, respectively), but the lowest values (2.31 mg kg^{-1}, 0.32 mg g^{-1}, 1.24 gm pot^{-1} and 0.030 g g^{-1} plant day^{-1}, respectively) of the above parameters were obtained from the combination treatment (T_0P_0). This result could be explained that organic matter builds and improves soil structure, thereby improving soil drainage, infiltration of water into the soil, aeration and water-holding capacity, as well as soil organic matter increase the cation exchange capacity of a soil and provides a neutralizing or buffering effect on soil pH (preventing rapid changes in pH). In addition, the incorporation of organic matter reduced the pH of the soil and increased the availability of phosphorus, because organic compounds can protect phosphorus from fixation by masking the fixation sites on the soil colloids, and by forming organic complexes with Ca and other ions, thereby, limiting the reaction of these ions with phosphorus. In addition, the organic matter application can enhance soil aggregation formation and structure stability, resulting in decreased bulk density and increased porosity. The improved soil structure may supply better condition for plant root elongation and respiration by proper aeration in soil and drainage of excess water. These results and interpretations agree with those reported by Somani and Kanthaliya (2004).

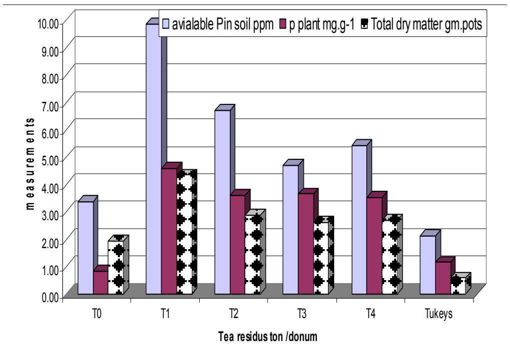

Figure 1: Effect of tea residues on available soil phosphorus, plant phosphorus concentration and total dry matter.

Treatments	Available Phosphorus (mg kg^{-1})	Plant Phosphorus (mg g^{-1})	Total Dry Matter (gm pot^{-1})	RGR (g g^{-1} plant day^{-1})
T_0	3.38	0.85	1.94	0.034
T_1	9.83	4.57	4.34	0.074
T_2	6.69	3.59	2.89	0.059
T_3	4.70	3.66	2.63	0.050
T_4	5.40	3.52	2.70	0.048
Tukey's (1% and 5%)	**2.13**	**1.16**	**0.59**	**0.005**

Table 2: Effect of consumed tea residues on available phosphorus in soil, plant phosphorus concentration, total dry matter and relative growth rate.

Consumed tea residues	P Fertilizer	Available Phosphorus (mg kg^{-1})	Plant Phosphorus (mg g^{-1})	Total Dry Matter (gm pot^{-1})	RGR (g g^{-1} plant day^{-1})
T_0	**P_0**	**2.31**	**0.32**	**1.24**	**0.030**
	P_1	**4.79**	**1.23**	**1.87**	**0.039**
	P_2	**3.22**	**0.68**	**2.86**	**0.031**
	P_3	**3.22**	**1.18**	**1.80**	**0.038**
T_1	**P_0**	**3.53**	**3.73**	**3.09**	**0.045**
	P_1	**17.41**	**6.57**	**8.67**	**0.138**
	P_2	**10.33**	**4.20**	**2.99**	**0.060**
	P_3	**8.04**	**3.78**	**2.60**	**0.051**
T_2	**P_0**	**4.86**	**2.50**	**2.93**	**0.036**
	P_1	**9.75**	**5.11**	**3.89**	**0.087**
	P_2	**6.79**	**3.54**	**1.93**	**0.057**
	P_3	**5.37**	**3.21**	**2.80**	**0.054**
T_3	**P_0**	**4.46**	**2.69**	**2.58**	**0.040**
	P_1	**6.95**	**4.14**	**3.57**	**0.071**
	P_2	**4.13**	**3.88**	**2.34**	**0.041**
	P_3	**3.25**	**3.92**	**2.04**	**0.050**
T_4	**P_0**	**4.13**	**3.76**	**2.10**	**0.034**
	P_1	**8.91**	**4.82**	**3.94**	**0.071**
	P_2	**4.41**	**3.03**	**3.02**	**0.038**
	P_3	**4.16**	**2.48**	**1.73**	**0.050**
Tukey's (1%)		**5.34**	**2.90**	**1.53**	**0.014**

Table 3: Combination effect of consumed tea residues and phosphorus fertilizer on available phosphorus in soil, plant phosphorus, concentration and total dry matter.

References

Abdullah L., Kühne R.F. and Vlek P.L.G. 2000. Effect of plant residue quality of secondary forest vegetation on phosphate mineralized cation and immobilization in soil. Retrieved from website (www.ansijournal s.com)

Adiloğlu A. and Adiloğlu S. 2006. An investigation on nutritional status of tea (Camellia sinensis L.) grown in eastern black sea region of Turkey. *Pakistan Journal of Biological Sciences* 9 (3): 365-370

Allen S.E. 1974. Chemical analysis of ecological materials. 1st edition. *Black well Scientific Publications Osney Mead, Oxford*. P: 64-214.

Awodun M.A. 2007a. Effect of Poultry Manure on the Growth, Yield and Nutrient Content of Fluted Pumpkin (Telfaria occidentalis Hook F). *Asian Journal of Agricultural Research* 1 (2): 67-73.

Awodun M.A. 2007b. Effect of Sawdust Ash on Nutrient Status, Growth and Yield of Cowpea (Vigna unguiculata L. Walp). *Asian Journal of Agricultural Research* 1 (2): 92-96.

Black C.A. 1965. Methods of soil analysis. Agr. Mono9 Parts (1&2). *Amer. Soc. Agronomy*. Inc. Pub. Madison. Wisconsin .USA. pp: 1-1575.

Chakravarty H.L. 1976. Plant Wealth of Iraq.Vol. 1, M*inistry of Agriculture & Agvarian Reform, Baghdad*. p:128

Edmeades, D.C. 2003. The long-term effects of manures and fertilizers on soil productivity and quality. *Nutrient Cycling in Agroecosystems* 66: 165–180

El-Dewiny C.Y., Moursy Kh.S. and El-Aila H.I. 2006. effect of organic matter on the release and availability of phosphorus and their effects on spinach and radish plants. *Research Journal of Agriculture and Biological Sciences* 2 (3): 103-108.

Gupta P.K. 2004. A handbook of Soil, Fertilizer and Manure. 3rd edition. *Agrobios (India)*. pp: 99-312.

Nziguheba G., Merckx R., Palm C.A. and Rao M.R. 2000. Organic residues affect phosphorus availability and maize yields in a Nitisol of western Kenya. *Biolological Fertility Soils* 32: 328–339.

Richards L.A. 1954. Diagnosis and improvement of saline and alkaline soils united states salinity laboratory staff. USDA. *Hand book No*. 60. pp: 1-160.

Somani L.L. and Kanthaliya P.C. 2004. Soils and fertilizers ATA Glance. 1st edition. *Agrotech Publishing Academy.* pp:648-690

Steele R.G and Torrie J.H. 1969. Principle and procedure of statistic. *McGraw Hill Book Co. Inc. New York*. pp: 1-530

Zeidan M.S. 2007. Effect of organic manure and phosphorus fertilizers on growth, yield and quality of lentil plants in sandy soil. *Research Journal of Agriculture and Biological Sciences*, 3 (6): 748-752.

تأثير التداخل لبقايا الشاي المستهلكة والسماد الفوسفاتي على جاهزية الفوسفور و نمو الحمص

دلشاد عزيز درويش و كوَضة رؤستم محمد

قسم علوم الحياة، كلية التربية الاقسام العلمية، جامعة صلاح الدين- أربيل، العراق

الملخص

أجريت هذه الدراسة في البيت الزجاجي التابع لكلية التربية/ الاقسام العلمية، جامعة صلاح الدين - أربيل لدراسة تأثير مستويات مختلفة من بقايا الشاي والسماد الفوسفاتي على جاهزية الفوسفور في التربة ونمو نبات الحمص، وصممت التجربة على أساس القطاعات العشوائية الكاملة العاملية و بثلاث مكررات، اذ شملت التجربة عاملين وهما بقايا الشاي بخمسة مستويات (٠ ، ٠,٥ ، ١، ١,٥، ٢ طن/دونم) والسماد الفوسفاتي بأربعة مستويات (٠ ، ٥٠ ، ١٠٠ ، ١٥٠ كغم P_2O_5/ دونم) والتداخل بينها على جاهزية الفوسفور في التربة، تركيز الفوسفور في النبات و بعض خصائص نمو نبات الحمص، لذا عدد المعاملات العاملية هي ٢٠ معاملة بثلاث مكررات والمجموع ٦٠ سنادين. أظهرت النتائج أن إضافة مستويات مختلفة من بقايا الشاي أثَّر معنويا عند المستوى المعنوي ($p \leq 0.01$) و($p \leq 0.05$) على جاهزية الفوسفور في التربة، تركيز الفوسفور في النبات و الوزن الجاف الكلي ومعدل نسبة النمو. أعلى قيمة للصفات المذكورة (٩,٨٣ ملغم/كغم، ٤,٥٧ ملغم/غم، ٤,٣٤ غم.سندانة$^{-1}$ ، ٠,٠٧٤ غم/غم نبات يوم$^{-1}$) سجلت في المعاملة (T_1). التداخل بين بقايا الشاي و السماد الفوسفوري أثر معنويا عند مستوى ($p \leq 0.01$) و ($p \leq 0.05$) على جاهزية الفوسفور في التربة، تركيز الفوسفور في النبات ومعدل الوزن الجاف الكلي، أعلى قيم (١٧,٤١ ملغم/كغم، ٦,٥٧ ملغم/غم، ٨,٦٧ غم.سندانة$^{-1}$ ٠,١٣٨ غم.غم نبات$^{-1}$. يوم$^{-1}$) سجل في المعاملة العاملية (T_1 P_1) على التوالي.