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Effect of Poultry Manure on Soil Phosphorus Availability and Vegetative Growth of Maize Plant

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Abstract: *A field experiment was conducted at experimental farm of Horticulture department, Faculty of Agriculture of Omar El-Mukhtar University in El-Baida- Libya to investigated influence of different levels of organic fertilizer as "Poultry Manure" on soil phosphorus availability and corn plant growth under calcareous soil condition. Results which obtained indicated that, Soil bulk density and soil pH decreased with increasing levels of poultry manure application whereas, soil porosity, soil organic matter content, plant high, shoot fresh, dry weight and N, P, K and micronutrients uptake of maize were increased compared with the control treatment. The present study indicates that application of higher rate of poultry manure improved soil properties. Furthermore, the application of poultry manure in general significantly increase the soil phosphorus availability and nutrient uptake of maize plant due to improved physical and chemical soil properties.*
Keywords: *Maize, Zea mays, Poultry manure, Soil quality, Soil phosphorus.*

I. Introduction

Phosphorus is an essential nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reaction in plants. The total phosphorus content of most surface soils is low, average only "0.6 %" P. Soil phosphorus classified in tow broad groups, organic and inorganic. Organic-P is found in plant residues, manures and microbial tissues. Soil low in organic matter may contain "3 %" of their total-P in the organic form, but high organic matter soils may contain "50 % " or more of their total-P content in the organic form (Griffith, 2011). Inorganic form of soil-P consist of apatite (the original source of all phosphorus), complex of iron and aluminum phosphate and phosphorus absorbed on clay properties. In soils, with high p-fixing, organic compounds released during decomposition processes may increase p availability by coating p adsorption site or via anion exchange (Cavigell and Thien, 2004). Organic fertilizers contain nutrient that can be released slowly and utilized by the present and following crops. They are now farmed because they are provide balanced nutrients to the plant and therefore, prevent the harmful effect resulting from the excess of particular nutrients (Cook, 1982; Entry *et al*., 1997). Organic manure may content relatively unavailable native and residual p to chemical forms which are more available after decomposition.

Maize plant is an important cereal crop that provides stable food to large number of human population in world. In developing countries maize is a major source of income to many farmers (Tagne *et al*., 2008). It is a monoaceous plants belong to the family commonly cultivated in tropical areas and grown as summer crop in temperate regions (Skerman and Riveros, 1989). The maize plant can be used as green forage or in the form of silage made from the whole plant. Also, the dried leaves and stalks after harvested can be used for feeding animals. The time required to obtain green forage is less than that for grain production (Mohamed, 2010).

Poultry manure is available fertilizer and can sever as suitable alternate to chemical fertilizer. It is application registed over "53 %" increase of N level in the soil from "0.09 to 0.14" % and exchangeable cations increase with manure application (Boateng *et al*., 2006). In agriculture the main reason for applying poultry manure include the organic amendment of the soil and the provision of nutrients to crops (Warnen *et al*., 2006). Poultry manure is an excellent organic fertilizer as it contains high N, P, K and other essential nutrients (Farhad *et al*., 2009). It has been reported to supply P ready to plant than other organic sources (Garg and Bahla., 2008) and (Uwah *et al*., 2012). Therefore the objective of this study was to determine the effect of different rates of poultry manure application on soil phosphorus availability and maize growth plant.

II. Material and Methods

The experiment was carried out at the experimental farm of Agriculture Faculty of Omer EL-Mukhtar University in El-Baida Libya during the summer season of 2014, after deep ploughing field was cultivated. Experimental treatments comprised of four poultry manure (PM) levels were (0, 5, 10, 15) ton/ ha. Experiment was laid out in randomize complete block design (RCBD) with three replication. Net plot size was "4 x 1 " m^2.

Dried poultry manure was applied to the respective plots and incorporated into the soil before sowing. Chemical analysis of poultry manure was conducted before its application as showed in table (3).

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

Properties	Value	unit
Physical		
Hydrometer analysis		
silt	43.0	%
sand	19.0	%
clay	38	%
Bulk Density	1.35	$g.cm^3$
Porosity	49.24	%
Chemical		
pH	8.20	/
Ec	0.50	dS/m
Soluble ions		
Ca	1.9	meq/L
Mg	1.2	meq/L
Na	1.3	meq/L
k	0.4	meq/L
Cl	1.6	meq/L
HCO_3	6.0	meq/L
SO_4	2.3	meq/L
O.M	1.97	%
$CaCO_3$	19.0	%
CEC	15.45	Cmol/kg

Table (2): soil content of macro and micronutrients in mg / kg.

N %	P	K	Fe	Zn	Mn	Cu
0.13	4.47	315	2.81	1.52	2.30	0.23

Table (3): physical and chemical properties of poultry manure used.

pH	Ec	N	P	K	Ca	O.C	O.M	C : N	P_2O_5	K_2O
1:1	dS/m	%	mg/kg	mg/kg	mg/kg	%	%	/	%	%
6.85	10.26	9.155	1.87	1.710	0.973	2.854	4.782	0.311	8.569	4.119

The data on initial physical, chemical and fertility properties of soil at the site of experiment are presented in tables (1, 2). Randomize soil samples were collected at the depth (0-25 cm) before actual experiment, air dried and passed through “2 mm " stainless steel sieve and stored . The prepared soil samples were analyzed for various physical and chemical properties. Soil paste was prepared and saturation extract was obtained. Then the soil pH was determined with a pH meter and Electrical conductivity was measured by using electrical conductivity meter. Soil organic matter content was determined by using Walky and Black method (Page *et al*., 1982). Available p was determined by spectrophotometer (Olsen.,1954), extractable potassium was determined by using flame photometer, Total N was determined by kjeldahl method, For micronutrients (Fe, Zn, Mn and Cu) were extracted with DTPA extraction method (Lindsay and Nervall ., 1978) and read on AAS, and Particle Size Analysis was done by Bouyoucus Hydrometer Technique (Bouyoucus, 1962). Soil bulk density (Db) was determined from oven dried undistributed core samples collected to the depth of azreo by core method (Stoltle *et al*., 1992). Total porosity (*Ps* 0 was calculated from bulk density (Db), as assuming a particle density (Dp) of 2.65 g/cm^3 using the relationship between particle density (Db) and bulk density (Db) i.e *Ps* = (1 - Db / Dp *)* x 100.

For plant analysis, after three months of planting, maize plant per plot was cultivated up soil surface. The shoot of each sampled plant was washed with clean water, and measured the plant high and fresh weight, then bagged in brown envelope and labeled accordingly for mineral content. The samples were dried in the oven at “°70 ” until constant weight was recorded. The dried plant samples were grounded with a willey mill to pass through ″0.5 mm" sieve. The ground samples were digested with (1: 2) H_2SO_4: H_2O2 according to (Lowther, 1980). Total N was determined by kjeldahl method, phosphorus was determined calorimetrically by vanado-molybdate method. Potassium was determined on flame photometer. For micronutrients (Fe, Zn, Mn and Cu) were read on AAS. The chemical composition of the poultry manure used in this study is presented in table (3) it was generally relatively high in major nutrients. The electrical conductivity, N content and organic matter level were high. Statistical analysis, Data was subjected to analysis of variance (ANOVA) according to the method described by Steel *et al.,* (1996) and means between treatments were compared by least significant difference (LSD) at ($\geq$ 0.05).

III. Result and Discussion

Effect of poultry manure on vegetative growth parameters:-

Data presented in table (4) revealed that treatments of poultry manure had a significant effect on the plant growth parameters which included plant high, fresh, dry weigh and P uptake by maize plant. The shoot fresh and dry weight and plant high were significantly increased by all treatments in compared to the control, which is mean increased in plant growth parameters significantly at (≥ 0.05). Plots amended with poultry manure application had higher increased in plant high, fresh and dry weight in compared to control plot (without poultry manure application). Poultry application increased plant high, fresh and dry weight by (13.87, 19.81, 24.71) % (54.85, 72.78, 84.15) %, (49.58, 76.10, 11.90) for plant high, fresh and dry weight respectively at rates application of (5, 10, 15) t / ha respectively over plot without poultry manure application. Data in table (5) showed that poultry manure application increased leaves in table (5), N, P, K, concentration by (27.74, 40.77, 63.77) %, (10.21, 12.65, 19.95) %, (3.91, 7.51, 13.61) % weight at rates of application (5, 10, 15) t / ha respectively over plot without poultry manure application. Fig (1) showed effect of poultry manure addition on phosphorus plant uptake and fig (2) showed correlation coefficient between PM addition and P p concentration in plant was high where (r = 0.95) this mean strong relation (passive relation). Also, in the table (5) increased in micronutrients (Fe, Zn, Mn, Cu) concentration by (1.02, 9.23, 15.22) % , (5.36, 13.05, 37.50) %, (0.46, 2.52, 18.80) %, (13.35, 28.0, 53.35) % for Fe, Zn, Mn, Cu at rates of application (5, 10, 15) t / ha respectively over plot without poultry manure application, this finding agreement with Elamin and Elagib (2001) whose indicated that poultry manure increased the fresh and dry weight of maize (*Zea mays* L.). Poultry manure contain high amount of N, Since nitrogen enhanced plant growth in general this increase in plant high, fresh and dry weight due to nitrogen was expected, and also could be attributed to large quantity of available p and k of manure, this results was supported by Mohamed (2010). Similar results were reported by Agbed *et al*., (2008), the plant high, fresh and dry weight, and weight of roots, shoot and grain were significantly increased due to poultry manure application rate increased. Addition of nitrogen from poultry manure increased the plant high because nitrogen found to increase number of nodes as well as internodes length and consequently plant high.

Poultry manure influenced maize growth parameters significantly and this could be attributed to the ability of poultry manure in supplying nutrients and organic matter to the soil and improving the soil physical and chemical properties and nutrient status. This result agreement with Adeleye *et al.,* (2010); Colaccicco (1982). Also, A study were conducted by Ayeni (2008); Ayeni *et al*., (2008). Their results showed that ,poultry manure application increased uptake of N, P, K, Ca, Mg, Zn, Fe, and Cu by maize grown on an alfisol in south west of Nigeria. Ewulo *et al*., (2008). Found that, the poultry manure improved soil nutrient contents led to increased uptake of nutrients by tomato plant. In other study done by Akanni and Ojeniyi (2007) observed that poultry increased uptake of N, P, K, Ca and Mg by tomato plant. The increased availability of micronutrients "Fe, Zn, Mn and Cu" attributable to reduced soil pH.

Table (4): Effect of different levels of poultry manure on plant growth parameters

PM ton / ha	High of plant cm	Fresh weight gm	Dry weight gm	P uptake mg/kg
0.0	198.858	623.33	190.125	78.14
5.0	226.458	965.275	284.838	128.82
10.0	238.280	1077.008	337.808	155.01
15.0	248.0	1147.866	402.883	198.62
	***	***	***	
LSD at 0.05	**2.287**	**29.066**	**17.997**	

Table (5): Effect of different levels of poultry manure on plant nutrients contents

PM ton / ha	Macronutrients %			Micronutrients mg /kg			
conc↓	N	P	K	Fe	Zn	Mn	Cu
0.0	2.433	0.411	1.278	14.758	9.843	7.775	0.600
5.0	3.108	0.453	1.328	14.910	10.371	7.811	0.680
10.0	3.425	0.463	1.374	16.121	11.128	7.971	0.768
15.0	3.985	0.493	1.452	18.481	13.537	9.237	0.956
	***	***	***	***	***	***	***
LSD at 0.05	**0.117**	**0.012**	**0.033**	**0.486**	**0.531**	**0.271**	**0.028**

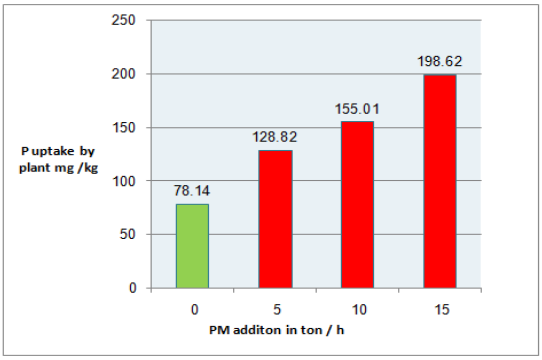

Fig (1): Effect of poultry manure addition on P plant uptake.

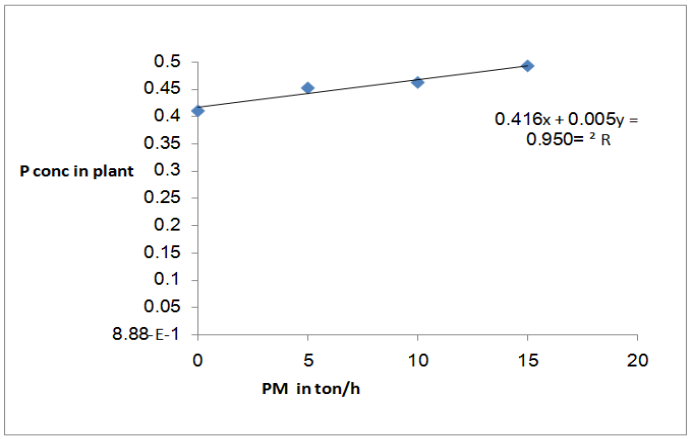

Fig (2): Correlation coefficient between poultry manure addition and P concentration in plant

Effect of poultry manure on some soil physical and chemical properties:-

Soil samples were collected from each plot after harvested to measure some soil physical and chemical properties and micro nutrients .Data in tables (6, 7) showed the influence of poultry manure application rate on some soil physical and chemical properties. plots amended with poultry manure had a significantly at (≥ 0.05) lower bulk density than plots without poultry manure application , bulk density was reduced by 20.07 % , this reduction in soil bulk density could make appreciable difference in the root growth and proliferation of maize plant. Poultry manure application increased soil total porosity by 21.10 %. This due to that poultry manure application might be as a result of improved soil particle aggregation brought about by the improved soil organic matter content of the plots amended with manure. This results finding confirmed the earlier reports of Lombin *et al*., (1991); Mbal *et al*., (2004). An addition of poultry manure application improved the soil physical; it reduced the soil bulk density and also increased porosity and water holding capacity of the soils Data showed also influence of poultry manure on soil chemical properties. Application of poultry manure increased, total N, available-P, K and soil micronutrients status. For the Ec, CEC, and O.M were increase significantly with increased rates of poultry manure application by (7.46, 20.12, 39.61) % , (32.84, 54.07, 75.29) % for Ec and CEC at rates of application (5, 10, 15) t / ha respectively over plot without poultry manure application , where as significantly decreased in soil pH by (1.34, 2.19, 4.0) % at rates of application (5, 10, 15) ton / ha respectively over plot without poultry manure application

Effect of poultry manure on soil phosphorus availability:-

Soil available phosphorus increased slightly at higher poultry manure application rate (5, 10, and 15) ton/ha. As showed in fig (3). Soil available phosphorus content was significantly increased with poultry manure rate increased, the increasing percentage were (24.22, 34.34, 61.46) % at rater of poultry manure application (5, 10, 15) ton/ha respectively in compared with control treatment (without addition). Fig (4) showed correlation coefficient between PM addition and soil available phosphorus was high where (r = 0.974) this mean strong relation (passive relation).

The results confirmed by Gupal, 2009, founded that the application of poultry manure may be beneficial to increase availability to meet crop P needs and supported by Jaber *et al*., 2007; Havlin *et al*., 2005; Bahi and Torr (2002); Salako (2008) reported that poultry manure improved surface phosphorus and other major nutrients and yield of maize. The reduction in soil pH in amended plots with poultry manure application

suggested the ability of poultry manure in lowering soil Al and Fe concentration in the soil. Bahi and Torr (2002); Salako (2008) reported that poultry manure improved surface phosphorus and other major nutrients and yield of maize. The reduction in soil pH in amended plots with poultry manure application suggested the ability of poultry manure in lowering soil Al and Fe concentration in the soil. Also they reported that poultry manure improved surface phosphorus and other major nutrients and yield of maize. The reduction in soil pH in amended plots with poultry manure application suggested the ability of poultry manure in lowering soil Al and Fe concentration in the soil. Also table (3) showed the influence of poultry manure application rates on the soil micronutrients content (Fe, Zn, Mn and Cu) were significantly increased by (8.45, 21.11, 37.88) % , (4.79, 16.20, 61.98), (0.72, 3.3, 27.78) , (13.9, 24.14, 39.31) for Fe, Zn, Mn and Cu, at (5, 10, 15) t/ha respectively in compared with control (without addition).

The fertility status of soil is expected to benefit from poultry manure application since the manure is known to improve soil organic matter content and macronutrient status and micronutrient qualities of the soil (Maerere et al ., 2001), (Akande and Adediran, 2004). Increase in available soil nutrient content (phosphorus one of them) adduced to poultry manure are consistent with analysis recorded for manure in the study. In addition, manures supply other nutrients and serve as soil amendments by adding organic matter. Bin (1983) and Ouda and Mabadeen, (2008); Adesodun *et al,*. (2005) had found that application of poultry manure to soil increased soil organic matter, N, P and aggregate stability. The improvement in soil physical properties is attributable to improvement in soil organic matter content. It is ascertained that improved soil nutrient contents caused by poultry manure application addition led to increased uptake of nutrients (macro and micro) by maize plant. Lombin *et al*., (1991). Reported that animal manure improved soil productivity in two ways; through improvement of the physical condition of the soil and through the nutrient it supplies to the soil. In support of these finding, recent studies had shown that poultry manure increased soil organic matter, nitrogen, phosphorus, CEC. Poultry manure application supplies large amount of organic matter which can affect mineral solubility and plant availability. This increase in organic matter also stimulates microorganism activity which can temporarily decrease the availability of some nutrients while enhancing the solubility of others during the breakdown of organic matter in the soil.

Table (6): Effect of different levels of poultry manure on some soil physical and chemical properties

PM ton / ha	Bulk density	porosity	pH	Ec	CEC	O.M
	g / cm^3	%	/	dS / m	Cmol /kg	%
0.0	1.30	51.12	7.864	0.308	17.49	2.25
5.0	1.20	54.69	7.758	0.331	23.24	2.69
10.0	1.14	59.26	7.691	0.370	26.95	3.21
15.0	1.026	61.40	7.549	0.430	30.67	3.93
	***	***	***	***	***	***
LSD at 0.05	**0.013**	**0.017**	**0.031**	**0.011**	**0.0173**	**0.011**

Table (7): Effect of different levels of poultry manure on soil micronutrients contents

PM ton / ha	Micronutrients mg /kg			
Con.↓	Fe	Zn	Mn	Cu
0.0	0.805	1.710	1.389	0.323
5.0	0.873	1.192	1.278	0.368
10.0	0.975	1.987	1.436	0.401
15.0	1.110	2.77	1.775	0.450
	***	***	***	***
LSD at 0.05	**0.029**	**0.096**	**0.048**	**0.016**

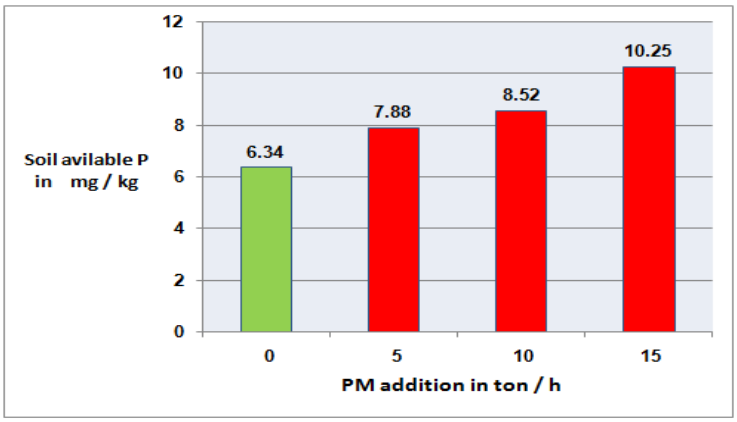

Fig (3): Effect of poultry manure addition on soil phosphorus content.

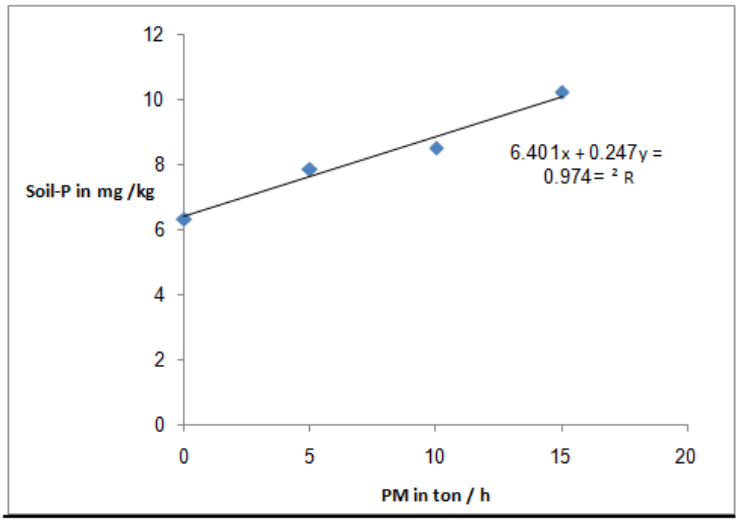

Fig (4): Correlation coefficient between poultry manure addition and P available in soil

IV. Conclusion

The study revealed that application of poultry manure significantly improved soil physical and chemical properties as well as the uptake of macro and micronutrients and increased of soil phosphorus availability as well as other performance parameters of maize plant were found in this study to peak when application rates of poultry manure reached 15 ton/ha. Application of poultry manure in this rate is therefore recommended for maize plant growth as it gave values of performance parameters and nutrients uptake. Poultry manure reduced soil bulk density and enhanced porosity, these improvements led to significant increase in growth parameters of maize.

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