Effect of Biosolid Application on Bioavailability of Potassium in two Different Kinds of Soils Textures and Yield of Corn Plant

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Abstract

One of the most important problems in semiarid and arid regions soil is the organic matter loss. The majority of calcareous soils in arid and some semiarid regions of Iran are low in fertility, organic matter content and productivity. These soils are usually characterized by high pH due to the presence of carbonates and by low contents in organic matter. Interaction between macronutrient and organic matter is considered important on the bioavailability of these elements to plants. Biosolids application on agricultural land as fertilizer is commonly in many countries. Manure is one of the biosolids that rich in macro and micro nutrients. The objective of this study is the evaluation of the effects Macronutrients uptake by corn from biosolid treated soils. This study was carried out in 48 pots in a greenhouse using factorial experiment design as completely randomized and each treatment was replicated three times. Treatments included tree levels for 0 or control, 25, and 50 Mg ha^{-1} Manure and soil including two different calcareous soils. The soil texture were clay loam with 39% clay, 34% silt and 27% sand and sandy loam with 7% clay, 24% silt and 69% sand. Plants were cut for analysis 8 weeks after planting and made ready for chemical analyses. Macronutrient concentrations in shoots, roots of the plants and soils were determined separately. Soil samples were air-dried, sieved (2 mm), and analyzed for pH and electrical conductivity (EC) in soil saturation extracts and organic carbon (C) by standard methods. The results showed that organic matter treatment had positive and significant effect on the shoot dry matter weight and the uptake index of potassium was increased significantly compared to the control. Manure application (50 Mg ha^{-1}) increased potassium transfer-coefficient significantly in sandy loam. Manure application (50 Mg ha^{-1}) increased significantly, concentration of potassium in shoot and root. In general, corn yields increased significantly in the biosolid treatment in clay loam soils. Increasing yield related to nitrogen and phosphorus rates that existing in biosolid. Soil organic matter content has long been suggested as the single most important indicator of soil Productivity. This can result in beneficial effects biosolid on soil fertility and plant nutrition. It seems necessary to provide reasonable levels of organic matter for achieving higher yield and sustainable agriculture one of the strategies is using organic fertilizer among them manure.

Keywords: *Biosolid; Manure; Macronutrient; Potassium; Corn Plant; Calcareous Soils;*

1. INTRODUCTION

Agricultural land use could result in declined soil fertility, especially reduced soil organic carbon and soil N [8]. Land application of biosolids has received increased attention in the last 2 decades [5, 14] and it could help to replenish the reduced soil organic matter, supply nutrients, such as N, P, K, S and essential micronutrients to plants, improve soil texture and water holding capacity, and have beneficial effects on microbial biomass and activity [6,12].

Of all farming practices, rational fertilization is among the most important measures for the sustainable crop production required to meet the food demand of the growing population of the country. There have been concerns that soil degradation threatens the sustainability of cropping systems [4, 16]. Use of manures is generally seen as a key practice for maintaining soil fertility and agricultural sustainability in the wheat–maize rotation and rice-based cropping systems [10, 17, and 18]. These difficult climatic conditions have favored greenhouse production of many kinds of crops (e.g., vegetables, ornamental plants). Our aims were to (i) determine effects of compost application on yield of plant (maize); (ii) to investigate the effects of manure usage on potassium concentration in two soils and plant.

2. MATERIALS AND METHODS

2.1. Greenhouse Study

The experiment was conducted at the Isfahan Azad University Research Station, located approximately 12 km north east of Isfahan city (32 40 N; 51 48 E). A pot experiment was conducted to compare manure that the study was carried out in a greenhouse using a factorial experiment design: biosolid applications such as manure, with levels (25 and 50 Mg ha^{-1}), control and soil (Clay Loam) with three replications. The soil textures were two soils (Clay Loam, Sandy Loam) with three replications. The soil texture were clay loam with 39% clay, 34% silt and 27% sand and sandy loam with 7% clay, 24% silt and 69% sand. Some properties of the soil and manure are shown in (Table 1).

2.2. Sampling and analysis in soil and plant

Soil samples were air-dried, sieved (2 mm), and analyzed for pH and electrical conductivity (EC) in soil saturation extracts and organic carbon (C) by standard methods [2], for CEC using the [15]. Total N (Kjeldahl method), phosphorus (P) (vanado-molybdate spectrophotometer method), and potassium (K) were determined by (flame photometry) [3, 11, 13]. Some properties of the soil and manure are shown in (Table 1).

Zea Maize was selected for this experiment. The plants were grown in a greenhouse for 75 days, and in a day/night temperature regime of 25/18 ºC. The pots were regularly adjusted by weight to 40% of water holding capacity (WHC). Shoots and roots were harvested separately. Roots were washed free of soil with tap water, and then rinsed with double-distilled water. All the plant samples were dried at 65ºC for 48 h, weighed, and then ground with an agate mortar to pass through a 2-mm sieve. Plant dry matter yield was determined 10 weeks after planting. The digestion quality for each plant part was tested using repeated preparation and determination of three replicates. The standard deviation of the results for each plant part was less than 5%. The concentrations of K in shoot and root were determined (dry Ashing) [7]. Finally, concentrations of elements K in soil and plant were determined by flame photometry technique.

2.3. Statistical analysis

All statistical analyses were performed using SAS version 6.10 for personal computers. Means of different treatments (level of sludge application after the last application) were compared using LSD (P B 0.05) test.

3. RESULTS

3.1. Effect of manure on Concentration of K in two soils and plant

Biosolid such as manure addition significantly ($P < 0.01$) increased CEC, %OM, and K concentrations in (Clay loam) soil compared to the control. All the treatments were significantly higher, to two levels of manure additions had with control (figure 1).

Soil organic matter content has long been suggested as the single most important indicator of soil productivity [9]. Potassium is an element with high solubility that can be transmission easily with soluble anions in sandy soils [1].

The organic matter treatment had positive and significant effect on the shoot dry matter weight and the uptake index of potassium was increased significantly in clay loam soil compared to the control. The uptake index at a 50 Mg ha^{-1} manure rate was increased, because this treatment has higher biomass compared to other treatments (figure 2). However, dry yields of maize (75% respectively) increased significantly ($p<0.01$) in the manure (50Mg ha^{-1}) treatment in clay loam soil (figure 2). Manure gave the highest shoot biomass, an intermediate level as follows control. Root biomass levels were much lower than shoot biomass levels. Manure application (50 Mg ha^{-1}) increased potassium translocation factor significantly in sandy loam more than clay loam (figure 2). Manure application (50 Mg ha^{-1}) increased significantly, concentration of potassium in shoot and root.

In all treatments with the manure a significantly higher levels of K were present compared with the levels in the controls. But must be attention to kind of soil texture as index, for biosolid such as manure usage especially in the arid and semi-arid. In calcareous soils with high CaCO3 and pH, the available potassium is low; also application of potassium fertilizers can reduce the available micronutrient. The results showed that the Manure is a suitable fertilizer for providing the macronutrient (N, K, P), of the plants in the soils, especially in calcareous soil of Isfahan's region. Some long-term fertilization experiments show that organic amendments have positive effects on yield trends, i.e. continue to increase yield [17].

4. CONCLUSIONS

This study showed that application of manure not only provides extra organic carbon and major nutrients such as nitrogen (N), phosphorus (P) and potassium (K), but also improves soil physical and chemical properties and consequently traces metal retention or mobility. The increase in organic C and CEC after manure application could be explained by the large amount of organic matter in the manure and the large CEC of the organic matter. It seems necessary to provide reasonable levels of organic matter for achieving higher yield and sustainable agriculture one of the strategies is using organic fertilizer among them manure.

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Table 1- Selected chemical properties of the soils and manure used in the experiment.

Parameter	pH	Ec	CEC	OM	N	P	K
	-	dS/m	$Cmol^+/kg$	%	%		
Clay Loam	7.6	4.4	14.2	2.1	0.08	0.4	1.5
Sandy Loam	7.2	4.2	7.2	0.5	0.07	0.3	1.2
Manure	7.9	15.5	24.4	48	1.7	0.6	3.2

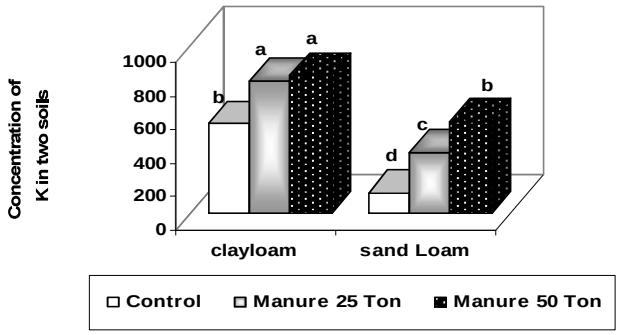

Figure 1. Comparative between two different levels of manure and control in two soils.

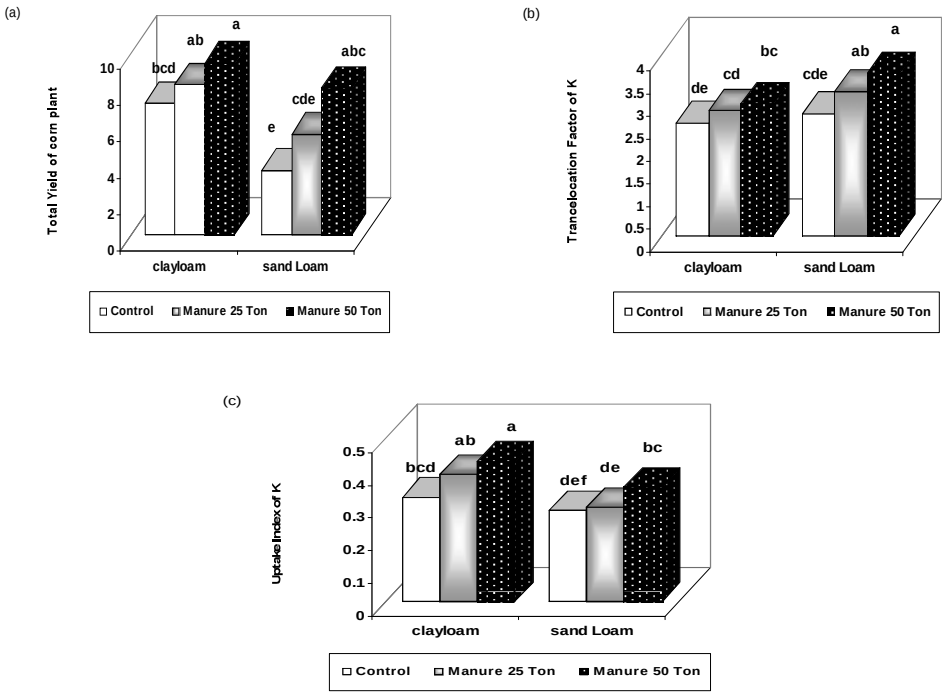

Figure 2- Effect of Manure on dry matter (a), Translocation Factor of K (b), uptake index of K(c), between two different levels of manure and control in two different soils.