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Using Animal Manure for Improving Soil Chemical Properties under Different Leaching Conditions

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Abstract: Lack of adequate Organic Matter (OM) in the agricultural soils of Iran is responsible for the poor physic-chemical condition of these soils. Thus, increasing soil OM via. Manure application has an important function in improving the soil fertility. To enhance animal productivity and maximize economic returns, mineral salts are routinely added to animal feed worldwide. Salinity induced by manure application and chemical composition of soil and plant after its usage was investigated. The main purpose of this greenhouse study was to evaluate the impact of sheep manure and leaching of manure on growth, nutrient concentration and some chemical properties of soil. Leaching of some manure with 1:10 manure-water ratio was done because reducing of its salinity. Treatments consisted of four levels of sheep manure (0, 1, 2 and 4% based on dry weight) and two levels of manure leaching (with and without leaching). The results have shown that the application of sheep manure significantly increased N, Fe, Cu, Zn and Mn concentrations of soybean roots. Also, manure leaching reduced the negative effects of salinity-induced in 2% treatments. The effect of leaching on the root nutrients concentration was not consistent. Due to the lack of information on the effect of leaching on the growth of soybean it is recommended to study the effect of different levels of organic wastes leaching on more varieties of soybean in different soils.

Key words: Soybean root, sheep manure, leaching, salinity effects reduction, concentration, organic waste

INTRODUCTION

In general, absorb nutrients via their roots, therefore, fertilizers applied into the soil (Mengel, 2002). Although, inorganic fertilizers have strong ability to improve crop growth and yield, however, their contamination is higher than organic ones. Thus, it is better to use organic manure only or accomplished with lower rates of inorganic fertilizers to reduce ground water contamination. Since most animal manures are land-applied for their nutrient value (Garbarino *et al*., 2003; Jackson and Bertsch, 2001), their impact on the environment has become an issue of concern. To enhance the feed flavors and maintain cation-anion balance in the diet (Dong *et al*., 2001; Goff, 2006), salts are commonly added to animal feed. Nevertheless, salinity of animal manure and secondary soil salinization induced by its application has been of much less concern. In fact, salinity is defined as a kind of nonpoint pollutions like nutrient pollution by N and P, sediment, pesticides and pathogens (Shortle *et al*., 2001). In arid and semi-arid regions of Iran, the distinct feature of most cultivated soils is relatively low organic matter content. Consequently, soil application of organic wastes to supply at least a part of the plant nutrient requirement of soil is highly important. Abdel-Ghaffar (1982) believes that in arid and semi-arid regions of the world, the two most important factors limiting crop production are water and OM. There were many reports about organic manures application to improve vegetative and reproductive growth and development (Suthar, 2009; Azam Shah *et al*., 2009; Maftoun and Moshiri, 2008; Sawyer *et al*., 2006). Sawyer *et al.* (2006) reported that it is better to provide approximately 50% of soybean plants needs to total nitrogen via manuring nitrogen and consequently this plant will receive remaining rates through fixation. However, it wasn't shown that if the organic manure leached in soybean cultivation or how much it removes from root growth areas. Although research with organic manure as a fertilizer has demonstrated different effects on crop production, the major drawbacks encountered with long term use of organic manures are the pollution of ground and surface waters due to the leaching and runoff of nutrients, accumulation of excessive soluble salts and the build up of certain trace elements. Li-Xian *et al.* (2007) showed that potential risk of secondary soil salinization exists with successive application of animal

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manure even in the humid region. The main aim of this study was to investigate manure effects on dry weight and chemical composition of soybean root and also leaching and non-leaching effects of manure on soybean root characteristics.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse of soil science department, Shiraz University from April to July, 2006 using surface layer (0-30 cm) of local soil called Ramjerdi. The classification of this soil was done regarding to method of Soil Survey Staff (2006) (Fine, mixed, mesic, Fluventic Haploxerepts). The mentioned soil and some rates of sheep manure were dried, passed via 2 mm sieve and used to determine physic-chemical characteristics (Table 1) (Sparks, 1996). Soil texture and organic matter were assessed by hydrometer and Walkley-Black methods, respectively.

The Electrical Conductivity (ECe) and pH in saturated paste were evaluated by EC-meter (Lovibond, con200) and pH-meter (Ecoscan), respectively. Cation Exchange Capacity (CEC) and equal calcium carbonate were determined using sodium acetate and neutralizing with HCl methods, respectively. Total nitrogen, available phosphorus and extractable potassium were assessed using kjeldal, yellow Ammonium-Molybdate method (Murphy and Riley, 1962) and flame photometer (Corning 405), respectively. Micronutrients were extracted using DTPA (Diethylen Triamene Penta Acetate) and their concentration were determined with atomic absorption spectrophotometer (Shimadzo AA-670; Shimadzu Corporation, Japan) (Chapman and Pratt, 1982) (Table 1 and 2). Chlorine (Cl) was determined by titration method (Chapman and Pratt, 1982).

Regarding to high salinity level of sheep manure, the leaching was done with 1:10 ratio of manure: distilled water. Based on soil analysis, 50 mg N Kg^{-1} soil as $CO(NH_2)_2$ (1/2 before planting and 1/2 one month after planting), 25 mg Phosphorus Kg^{-1} soil as KH_2PO_4, 5 mg Iron Kg $soil^{-1}$ as Fe EDDHA, 5 mg Zinc Kg^{-1} soil as $ZnSO_4.2H_2O$, 5 mg Manganese Kg^{-1} soil as $MnSO_4$ and 2.5 mg Copper Kg^{-1} soil as $CuSO_4$ were added up to the mentioned soil to provide pot mixture. Treatment included:

- Pot mixture+0% of sheep manure (control pots)
- Pot mixture+1% of sheep manure without leaching
- Pot mixture+1% of sheep manure with leaching
- Pot mixture+2% of sheep manure without leaching
- Pot mixture+2% of sheep manure with leaching
- Pot mixture+4% of sheep manure without leaching
- Pot mixture+4% of sheep manure with leaching

Table 1: Some physic-chemical characteristics of soil prior to use in the experiment

Soil characteristics	Values
Clay (%)	48.00
Slit (%)	23.00
OM (%)	0.23
Moisture (FC %)	20.00
pH	7.50
EC (dS m^{-1})	0.27
CEC (Cmolc kg^{-1})	11.00

Table 2: Analytical characteristics of sheep manure

	Quantity	
Characteristics	Without leaching	With leaching
pH (1:5 sheep manure: water)	7.80	7.90
Total N (%)	2.81	2.63
Total P (mg kg^{-1})	7100.00	6550.00
Total Fe (mg kg^{-1})	654.00	532.00
Total Mn (mg kg^{-1})	488.00	430.00
Total Zn (mg kg^{-1})	347.00	319.00
Total Cu (mg kg^{-1})	41.00	36.00
EC_e (dS m^{-1}) (1:5 sheep manure: water)	11.20	4.90

Sheep manure was used based on dry weight in leached and non-leached status. After preparation of required treatments and filling the 3 Kg pots, 6 seeds of soybean var. Williams were sown in 1.5-2 cm depth in each pot and thinned to three per pot 10 days after. Under greenhouse condition, aid temperature ranged between 13±2°C (night) and 20±2°C (day). Plants were irrigated with distilled water to keep soil moisture near the Field Capacity (FC). RH and light intensity were maintained in 55±5% and >800 μmol $m^{-2,-1}$, respectively. Both root and shoot parts of plants were harvested separately after 16 weeks of emergence. Then, the plant parts rinsed with distilled water to remove soil fractions of parts and consequently dried at 65°C and weighted. Total nitrogen of both shoot and root was determined using Micro-Kjeldal method. For analysis of iron, manganese, zinc and copper shoot part were ground and dry-ashed at 550°C (24 h) and used by atomic absorption spectrophotometer (Shimadzo AA-670; Shimadzu Corporation, Japan) (Chapman and Pratt, 1982). Soil samples of each treatment were used to study the modification of chemical characteristics after experiment. Total nitrogen, $NaHCO_3$-extractable phosphorus (Olsen method), DTPA-extractable iron, manganese and copper also analyzed. Electrical conductivity (EC_e) and potassium was determined in saturated paste. The experiment was arranged in Completely Randomized Design (CRD) with 7 treatments and three replications in each that each replicate consisted of 3 pots. Mean were compared using Least Significant Difference (LSD) at 5% level.

RESULTS AND DISCUSSION

Results showed that EC_e of sheep manure was relatively high (11.2 dS m^{-1}) and after leaching, decrease

Table 3: Effects of manure application and leaching on the soybean root parameters

Treatments	Root dry weight ($g\ pot^{-1}$)	N (%)	Fe	Zn	Cu	Mn	Nodule dry weight ($mg\ Pot^{-1}$)	Nodule number	Nitrogen fixation ($mg\ kg^{-1}$ soil)
			--------------------------$mg\ kg^{-1}$			-------------------------			
a	0.66^{b}	1.16^{b}	183.04^{b}	104.88^{b}	160.70^{c}	101.14^{b}	35.25^{b}	16.67^{bc}	0.54^{b}
b	0.81^{b}	1.54^{b}	1821.73^{ab}	121.04^{b}	427.90	159.58^{b}	60.71^{b}	20.67^{abc}	1.81^{b}
c	0.42^{c}	1.63^{b}	1890.44^{ab}	109.36^{b}	340.05^{bc}	127.24^{b}	57.98^{b}	22.00^{ab}	0.56^{b}
d	1.50^{b}	1.54^{b}	776.90^{b}	115.20^{b}	313.00^{bc}	173.06^{b}	48.04^{ab}	19.00^{abc}	0.46^{b}
e	0.54^{b}	1.64^{b}	498.90^{b}	148.72^{ab}	145.25^{c}	180.72^{b}	60.72^{b}	24.00^{b}	0.84^{b}
f	0.57^{b}	2.35^{b}	4250.08^{b}	182.00^{b}	735.50^{b}	674.80^{b}	38.15^{b}	15.67^{c}	0.85^{b}
g	1.32^{b}	1.56^{b}	2373.16^{ab}	110.88^{b}	652.00^{ab}	295.80^{b}	50.17^{ab}	19.00^{abc}	0.24^{b}

to 4.9 dS m^{-1}. Soybean is moderately tolerant to salt stress (salinity thres hold of soybean = 5.0 dS m^{-1} (Rhoades *et al.*, 1992), application of 4% sheep manure significantly decreased root dry weight from 1.50 g (2% treatments) to 0.57 g pot^{-1}. Leaching of manure in 4% treatments lead to the highest root dry weight.

N concentration, also, increased due to manure application (Table 3). The highest amounts of N were obtained at 4%. Also, application of sheep manure increased Fe concentration in soybean root. Hegde (1996) also reported a significant increase in Fe availability and this was due to organic matter application. Application of 4% sheep manure significantly increased root Zn concentration from 104.88 mg (control pots) to 182 mg kg^{-1}. Mn and Cu concentrations showed the same trend as Fe and Zn and the highest amounts of these micronutrients were observed at the highest rate of manure application (Table 3). This finding is in agreement with that reported in wheat (Cabral *et al.*, 1998). Maftoun *et al.* (2004) reported that the application of manure brought about a remarkable improvement in the availability of micronutrients cations in spinach and soil. Though, leaching of manure increased the number and dry weight of root nodules but this reduction wasn't statistically significant. the highest number (24) and dry weight (60.72 mg pot^{-1}) of root nodules obtained in 2% treatments. This result is the same with Lawson ***et al.*** (1995) research.

Increasing manure doses increased significantly net nitrogen fixation in root nodules from 0.54 mg in control pot to 1.81 mg kg^{-1} in 1% treatments. Dev and Tilak (1976), also reported that the increment of nitrogen fixation by application of different manures.

CONCLUSION

In this study, the results clearly indicate that use of sheep manure improved the dry weight and chemical composition of soybean root. The major obstacle for long term use of organic manure is its induced salinity in the soil after harvesting the plants. Improper and/or long term, addition of organic manures might lead to the accumulation of soluble salts in the soil and thus, manure leaching is recommended as a way to preventing the accumulation of the excess salts beneath the root zone. Land application of organic manures, however, offers the most practical means for managing the large amounts of these bio solids produced. For this reason, the proper management of organic manures and periodic monitoring of soil fertility and productivity parameters and environment quality are needed to ensure successful, safe and long term use of these materials on agricultural lands.

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