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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

INTRODUCTION

In general, absorb nutrients *via* their roots, therefore, fertilizers applied into the soil [1]. 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 [2,3] their impact on the environment has become an issue of concern. To enhance the feed flavors and maintain cation-anion balance in the diet [4,5], 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 [6].

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 [7] indicated 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 [8-10]. Sawyer *et al.* [10] reported that it is better to provide approximately 50 percent 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

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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.* [11] showed that potential risk of secondary soil salinization exists with successive application of animal 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 [12] (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) [13]. Soil texture and organic matter were assessed by hydrometer and Walkley-Black methods, respectively. The Electrical Conductivity (EC) 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 kjeldhal, yellow ammonium-molybdate method [14] 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) [15] (Table 1 and 2). Chlorine (Cl) was determined by titration method [15].

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 soil as $CO(NH_2)_2$ (1/2 before planting and 1/2 one month after planting), 25 mg Phosphorus/Kg soil as KH_2PO_4, 5 mg Iron kg/soil as Fe EDDHA, 5 mg Zinc/kg soil as $ZnSO_4.2H_2O$, 5 mg manganese/kg soil as $MnSO_4$ and 2.5 mg copper/Kg soil as $CuSO_4$ were added up to the mentioned soil to provide pot mixture. Treatment included:

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

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, six seeds of soybean *var.* Williams were sown in 1.5-2 cm depth in each pot and thinned to three per pot ten 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 >800μmol $m^{-2}.s^{-1}$, respectively. Both root and shoot parts of plants were harvested separately after sixteen 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-Kjeldhal method. For analysis of iron, manganese, zinc and copper shoot part were ground and dry-ashed at 550°C (24h) and used by atomic absorption spectrophotometer (Shimadzo AA-670; Shimadzu Corporation, Japan) [15]. 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) 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 of sheep manure was relatively high (11.2 dS/m) and after leaching was decreased to 4.9 dS/m. Soybean is moderately tolerant to salt stress (salinity threshold of soybean=5.0 dS/m [16], application of 4% sheep manure significantly decreased

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

Soil characteristics	Clay %	Silt %	OM %	Moisture (FC) %	pH %	EC dS/m	CEC Cmolc/kg
Value	48	23	0.23	20	7.5	0.27	11

Table 2: Analytical characteristics of sheep manure

	Quantity	
Characteristic	Without leaching	With leaching
pH (1:5 sheep manure: water)	7.8	7.9
Total N (%)	2.81	2.63
Total P (mg/kg)	7100	6550
Total Fe (mg/kg)	654	532
Total Mn (mg/kg)	488	430
Total Zn (mg/kg)	347	319
Total Cu (mg/kg)	41	36
EC (dS/m) (1:5 sheep manure: water)	11.2	4.9

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

	root dry weight		Fe	Zn	Cu	Mn	Nodule dry weight	Nodule	Nitrogen fixation
Treatment	(g pot^{-1})	N (%)	mg/kg				mg/Pot	number	mg/kg soil
A	0.66b	1.16b	183.04b	104.88b	160.70c	101.14b	35.25b	16.67bc	0.54b
b	0.81b	1.54b	1821.73ab	121.04b	427.90	159.58b	60.71a	20.67abc	1.81a
c	0.42c	1.63b	1890.44ab	109.36b	340.05bc	127.24b	57.98a	22ab	0.56b
d	1.50a	1.54b	776.9b	115.20b	313bc	173.06b	48.04ab	19abc	0.46b
e	0.54b	1.64b	498.9b	148.72ab	145.25c	180.72b	60.72a	24a	0.84b
f	0.57b	2.35a	4250.08a	182a	735.5a	674.8a	38.15b	15.67c	0.85b
g	1.32a	1.56b	2373.16ab	110.88b	652ab	295.8b	50.17ab	19abc	0.24b

root dry weight from 1.50 g (in 2% treatments) to 0.57 g pot^{-1}. Leaching of manure in 4% treatments lead to the highest root dry weight.

N concentration, also was 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 [17] 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 (in 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 by Cabral *et al.* [9] on wheat. Maftoun and Moshiri [18], 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. Similar results were reported by Lawson *et al.* [19].

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 [20] also reported that the increment of nitrogen fixation by application of different manures.

CONCLUSION

Our 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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