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Potential Risk Of Organic Manures Application On Soil Salinization

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Abstract
Application of organic manures as fertilizer is essential in supporting plant with nutrients and soil improvement. Field and laboratory experiments were carried out to assess the effect of three organic manures on soil salinity. Field experiment was arranged in randomized split plot, the main plots were two levels of soil salinity at average of 2.9 and 8.7 mS/cm, the sub plots were alfalfa green manure, chicken manure and cow manure at rate of 20 t/ha added one month before sowing of maize crop. The results showed that; soil salinity was raised up to 5.5, 5.1 and 5.8 mS/cm in low saline soil in the first season for alfalfa, cow and chicken manure respectively, whereas in the second season the salinity was increased in respective up to 7.3, 5.3 and 6.4 mS/cm. The high saline soil salinity was increased from 8.7 mS/cm to 10.9, 12.4 and 13.1 mS/cm in the first season, and 12.6, 13.6 and 14.4 mS/cm in the second season for alfalfa, cow and chicken manure respectively. The results of the laboratory experiment showed that salinity level increased linearly with increasing rate of organic manure for all organic materials investigated in this study.
Keywords: organic manures, soil salinity, sustainable agriculture

Introduction

Application of organic materialssuch as green manure, chicken and cow manures and other animal wastes are known as beneficial for soil properties improvement and crop production.several research have shown that application of organic manures has many advantages for physical, chemical and biological soil properties and crop performance, such as increasing level of organic matter, soil aggregation, balanced nutrients supply , growth control, better resistance to some disease and insect attacks, microorganisms activities and many others (Nuria, 2012; Bailey 2003). The effect of organic manures application depends on many factors including soil properties, manure characteristics, irrigation water quality, cultivated crop and its life duration and climate condition.

Nowadays, there is an increasing interest in replacing synthetic fertilizer with organic amendments as sustainable alternatives and environmentally friendly (Lazarovits, 2001). This interest towards organic products is supported by consumers in developed countries who are comparatively more aware about the risk caused by non-organic agricultural products. Conversely, organic amendments application have many drawbacks on agricultural sustainability, among which; high salt content that could be released into soil and therefore, formation of secondary soil salinization and hindering agricultural production. The present study was carried out mainly to evaluate the risk of salinity that can be produced by applying organic manures.

Materials and methods

Field experiment was conducted at the Agricultural Research Station of King Abdulaziz University, west of Saudi Arabia. The soil texture was classified as loamy sand. Experimental plots were established under drip irrigation system. The experiment was carried out for two seasons 2012/2013 and 2013/2014. Split plot was arranged in randomized complete block design to determine the effect of alfalfa green manure, cow manure and chicken manure on two saline soils with average salinity of 2.9mS/cm and 8.7 mS/cm.

Manures were incorporated in the soil one month before planting of maize crop at rate of 20 ta/ha. NPK fertilizer (20:20:20) was applied at rate of 100 Kg/ha to support the cultivated crop. Soil samples were obtained at harvesting time for each season. All samples were air dried ground to pass through stainless steel (2mm). Electrical conductivity of saturated soil paste extracts was determined by E.C meter. Na, Ca and Mg were detected from the extracts by *inductively coupled plasma* mass spectrometry (*ICP*-MS). Sodium adsorption ratio (SAR) was calculated according to the following equation:

$$SAR = \frac{Na}{\frac{\sqrt{Ca + Mg}}{2}}$$

In laboratory scale, different rates of organic manures (0, 5, 10, 15%) were incubated for one month, to confirm the potential risk of salinity induced by organic manures application on soil. The results of field and laboratory experiments were subjected to analysis of variance and means separated using LSD test at P = 0.05 according to

(El-Nakhlawy. 2010).

Results and discussion

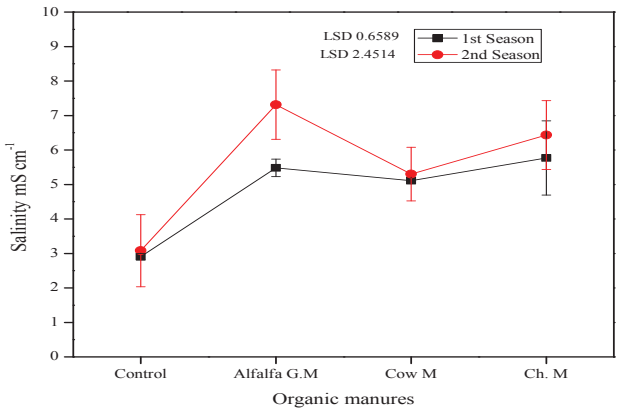

Fig.(1): Effect of organic manures on soil salinity for two seasons in low saline soil

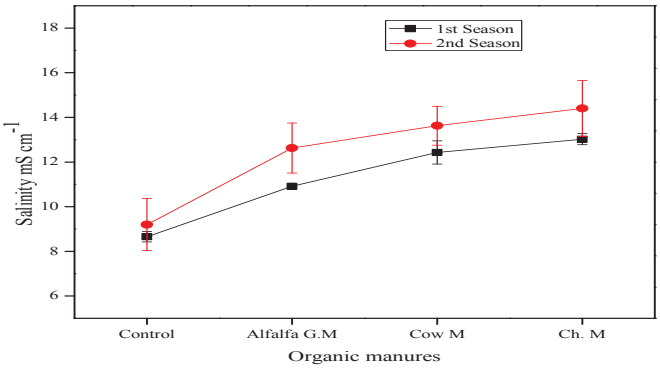

Fig.(2): Effect of organic manures on soil salinity for two seasons in high saline soil

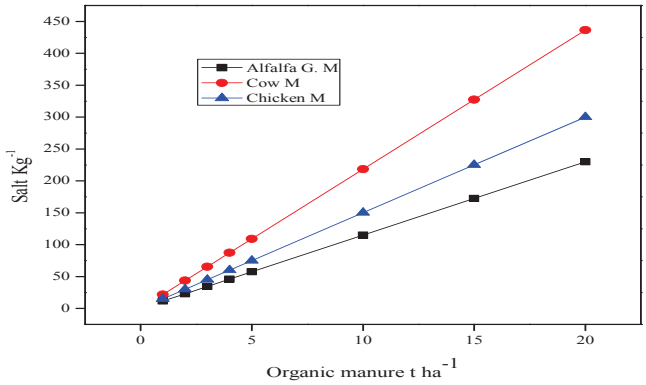

Fig.(3): Quantity of soluble salts that can be released in soil according manure type and application rate

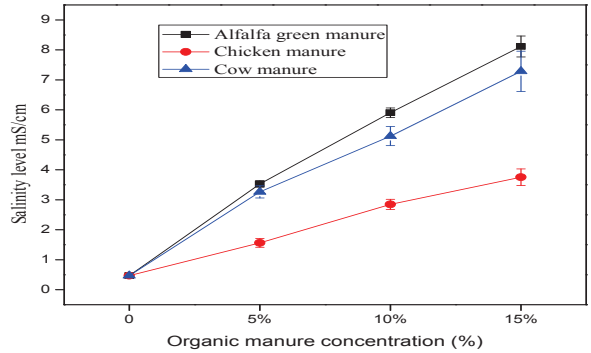

Fig.(4): Effect of organic manures on soil salinity in laboratory experiment

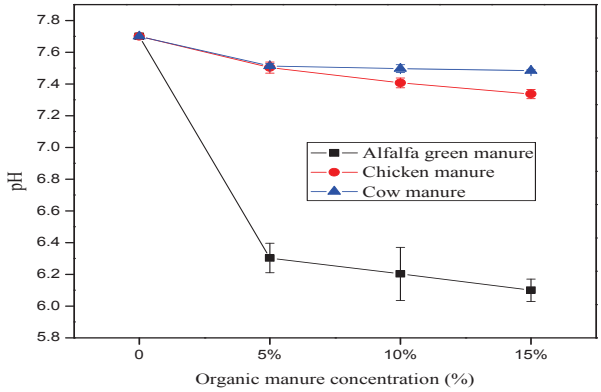

Fig.(5): Effect of organic manures on soil pH in laboratory experiment

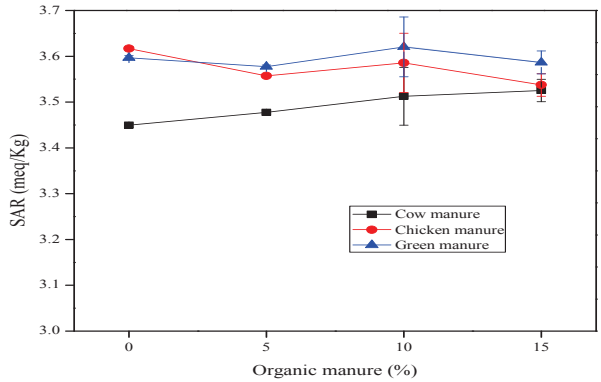

Fig.(6): Effect of organic manures on sodium adsorption ratio of laboratory experiment

Effect on soil salinity

Alfalfa, cow and chicken manures were applied in slight and high saline soils for two agricultural seasons under maize crop, the results showed that application of high salt content organic manures has increased soil salinity significantly over the control at ($P < 0.05$). Soil salinity was raised from 2.9 mS/cm up to 5.5, 5.1 and 5.8 mS/cm in low saline soil in the first season for alfalfa, cow and chicken manure respectively, whereas in the second season, the salinity was increased in respective up to 7.3, 5.3 and 6.4 mS/cm (figure 1). The high saline soil salinity was also increased from 8.7 mS/cm to 10.9, 12.4 and 13.1 mS/cm in the first season and up to 12.6, 13.6 and 14.4 mS/cm in the second season for alfalfa, cow and chicken manure respectively (figure 2). This increase of soil salinity as a result of manure application was attributed to high content of salt which was 1.15%, 2.18% and 1.50% for alfalfa, cow and chicken manures respectively.Slight increase in salinity of the control treatment in the field experiment could be attributed to either salinity of irrigation water or the decomposition of halophytic weeds that grow naturally in the field.

Laboratory experiment showed that; the salinity for all investigated manures was increased linearly with increasing rates of organic manures (figure 4). This result confirmed the negative effect of high salt content of organic materials on soil salinization. The same result was observed by (Chang, 1991), who found that application of animal manures has contributed to increasing soil salinity. Also (Hao, 2003) reported that; application of high rates of salt content manures can result in accumulation of soluble salts in the soil.

Effect on sodium adsorption ratio (SAR)

Soil sodicity was expressed by the sodium adsorption ratio (SAR), which was calculated from the concentration of sodium relative to calcium and magnesium in the soil. The results (figure 6) showed; no significant change in sodium adsorption ratio(SAR) due to organic amendments rates application, this consistency of SAR in the treated soil could be due to short period of incubation. Previous studies conducted by (Zaka, 2003) and (Sarwar, 2008) evidenced that application of organic materials has decreased SAR in the soil, and the reason was the release of organic acids which mobilized the calcium that occurred as calcium carbonate. Changing of soil SAR depends on increase and decrease of divalent (Ca + Mg) and mono-valent (Na) cations.

Effect on soil pH

The pH of the soil in the high rates of organic manures addition was decreased specially the soil amended by alfalfa green manure. This could be attributed to low buffering capacity of loamy sand soil that used in this study coupled with acidification due to nitrification from organic manures. (Figure 5) shows that the pH level of soil depends on the decrease or increase of the application rate. Effect of organic manures on soil pH depends on the its chemical characteristics of the manure, because high content of calcium in the organic material can increase the soil pH, on the other hand lowering of soil pH due to manure application can also be attributed to the production of organic acids during mineralization of organic materials by heterotrophs and autotrophs. Decrease of soil pH due to organic amendments application was reported by many studies (Sarwar, 2008; Pattanayak, 2001).

Conclusion

Annual application and increasing rates of high salt content organic manures has severe effect toward soil Salinization, however increasing rates of organic manures did not affect sodium adsorption ratio in this study. It appears that; the effect of manures on soil salinity and sodicity depends on the soil and manure characteristics. The most effective way to manage soil salinity is through irrigation, however, in case of lack or scarcity of high quality irrigation water, some precautions such as initial assessment of organic manures should be considered.

Acknowledgements

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