EFFECT OF DIFFERENT SALINITY LEVELS OF A SOIL ON NUTRIENT AVAILABILITY OF MANURE AMENDED SOIL

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ABSTRACT Sri Lanka has been identified as one of the tropical country where scattered dry zone is now under Agricultural benefits. In order to that, salinization is recognized as the major factor contributes in land degradation, which ultimately influence on crop yield.Saline soil which is characterized with salt comprises the high concentration of soluble salts and very low amount of organic matter as well as nitrogen content.Release of inorganic forms of nutrients in soil is functionally associated with carbon mineralization hence, is affected by the salinity stress that inhibits the mineralization of organic materials in soil. For that, present study was designed to assess the plant nutrient availability of manure treated soil at different soil salinity levels. A laboratory study was conducted to evaluate the effect of different soil salinitylevels on nutrient availability. Cow dung and paddy straw were chosen as organic amendments and applied at the rate of 10 tons/ ha. Manure decomposition and nutrient availability studied at three salinity levels namely 1500 ppm, 2000 ppm and 2500 ppm. The study was arranged in a completely randomized design (CRD) using 7 treatments and replicated three times .Treatments were incubated at 25^{o}C for 42 days.With increasing salt concentration nutrient availability was significantly decreased in manure amended soil. Application of cow dung to soil had shown highest available N (0.223%) and P content (110.14ppm) at 1500ppm salt concentration. Highest available K content (158.33ppm) was observed from paddy straw treated soil at 1500ppm salt concentration.

Key words: Cow dung, mineralization, organic matter, paddy straw, salinity

1. INTRODUCTION

Organic matter plays an important role in maintaining structural stability in most agricultural soils (Le Guillou*et al*., 2011). Adding organic matter improves aggregate stability and soil porosity which in turn promotes water infiltration, enhances salt leaching, decreases the exchangeable sodium percentage and electrical conductivity and increases the soil microbiological activities (Tejada*et al*., 2006). And also organic matter decreases bulk density, increases moisture holding capacity, makes tillage easier, forms water-stable aggregates and contributes to soil Cation Exchange Capacity.

Decomposition of organic matter in soil is the most important prerequisite to make these nutrients available, often through microbial biomass which is part of organic matter produced by soil microorganism (Jedidi*et al*. 2004). Release of inorganic forms of Nitrogen (N), Phosphorous (P) and other organically-bound nutrients in soil is functionally associated with carbon mineralization (Mafongoya*et al.,* 2000), hence, is affected by the salinity stress that inhibits the mineralization of organic materials in soil.

Salinity affects soil microbial communities, can cause severe changes in the process of organic matter turnover (Wichern*et al.,* 2006) and thus reduce the released of plant nutrients. The effects of salinity on soil microbial communities and organic matter turnover have been the subject of many recent studies (Setia*et al.,* 2010;

Chowdhury*et al*., 2011) and they agree on the negative effects of salinity on the activity of microbial comminutes and thus organic matter decomposition. It was observed that high salinity decreased CO_2 production and soil microbial biomass

As it is believed that soil salinity can alter the organic manure decomposition and nutrient availability, the present study was designed to assess the nutrient availability of manure treated soil at different soil salinity levels.

2. METHODOLOGY

2.1 Experimental Procedure

The soil used in the present study was collected from an agricultural field. The soil used to this study belongs to the Sandy regosols. Cow dung and paddy straw were chosen as organic amendments for this experiment. 100g of sieved (2mm sieve) air dried sandy regosol soil samples were thoroughly mixed with 473mg (at the rate of 10 tons/ ha) of organic manure and placed in the gas-tight glass bottles. Thirty five ml of 1500ppm, 2000ppm and 2500ppm concentrations salt solution were applied to the manure amended soil at 30% water-filled pore space (WFPS). The treated soil samples along with the control were incubated in the dark room at 25±1^{o}C temperature for 42 days. Constant moisture content of the soil was maintained throughout the incubation period.

Figure 2.1 Incubation of treatments

2.2 Treatments

The study was arranged in a completely randomized design (CRD) using 7 treatments and replicated three times. The treatments were; T1- Control (no organic matter and salt), T2-1500ppm salt solution+ cow dung, T3-2000ppm salt solution + cow dung, T4-2500ppm salt solution+ cow dung, T5-1500ppm salt solution+ paddy straw, T6-2000ppm salt solution+ paddy straw, T7-2500ppm salt solution+ paddy straw.

2.3 Soil analysis

Soil analysis was carried out at the end of the experiment for the parameters of total nitrogen, available phosphorous and exchangeable potassium.Soil available phosphorous was extracted by Borax solution (pH 1.5) and phosphorus was determined by vanadomolybdate blue method (Beater, 1949). Total Nitrogen in soil was determined by Kjeldahl method, Bremner (1965) and exchangeable Potassium was determined by Flame photometry (**Toth and Prince, 1949).**

2.4 Data analysis

The data generated were subjected to analysis of variance (ANOVA) using the SAS software (SAS Institute, 1988). The mean separation was performed using the least significant difference (LSD) at $P<0.05$.

3. RESULTS AND DISCUSSION

The variation in total nitrogen, available phosphorus and exchangeable potassium content after 42 days of incubation period with respect to different organic amendments and different salt concentration presented in the table 01.

Table:01 Nutrient content of content of soil after the incubation period

Treatment	N %	P (ppm)	K (ppm)
T1- Control (no organic matter and salt)	0.128 ^{d}	73.9 ^{e}	91.67 ^{d}
T2- 1500ppm salt solution + cow dung	0.223 ^{a}	110.14 ^{a}	141.67 ^{b}
T3- 2000ppm salt solution + cow dung	0.209 ^{ab}	99.17 ^{b}	141.67 ^{b}
T4- 2500ppm salt solution + cow dung	0.186 ^{bc}	97.77 ^{b}	108.33 ^{c}
T5- 1500ppm salt solution+ paddy straw	0.186 ^{bc}	81.014 ^{c}	158.33 ^{a}
T6- 2000ppm salt solution+ paddy straw	0.156 ^{cd}	79.611 ^{cd}	149.89 ^{ab}
T7- 2500ppm salt solution+ paddy straw	0.141 ^{d}	77.597 ^{d}	137.50 ^{b}

Mean followed by the same letters are not significantly different according to the Duncan Multiple Range test at 5% level.

3.1 Total Nitrogen

Nitrogen (N) in the soil is the most important element for plant growth. Nitrogen mineralization is the process of converting organic forms of nitrogen to the inorganic forms, $NH_4^+$and NO_3^-(Wang *et al*., 2006). The total nitrogen content was found to 0.18% of initial soil which increased with addition of organic manure to a level of 0.223% .As shown in Table significant ($P < 0.05$) differences were found among two different organic manures.

Compare to organic manure amended salt treated soil, control had lowest nitrogen value at the end of the incubation (Table 4.4), which has no organic amendment and no salt. In control soil N value was 0.18% which decreased to 0.128% after 42 days of incubation period. And also the great difference in N value was observed between the control (0.128%) and cow dung amended 1500ppm salt solution treated soil (0.223%).

Among the organic manure amended soil, cow dung amended salt treated soil had higher nitrogen value (0.223%) than paddy straw amended soil at the end of the incubation (Table 1). This may due to immobilization of inorganic N in paddy straw due to its high C: N ratio and its slow degradation due to the presence of lignin bound cellulose (Mandal, K.G *et al*., 2004). Nitrogen value in cow dung amended soil was increased after 42days of incubation period beyond the initial value.

However, the application of cow dung and paddy straw resulted in significant decrease in available N value at different concentration of salinity. Among the cow dung amended soil, 2500ppm salt concentration recorded lowest value of N (0.186%) and 1500ppm salt concentration recorded highest value of N (0.223%). Similar trend in N changes was observed in paddy straw treated soil. The results indicates with increasing salt concentration N mineralization decreases due to this higher salt concentration shows lower N in soil.Pathak and Rao (1998)demonstrated that N mineralization was stimulatedat low salinity and had a decreasing trend withincreasing salinity. Salinity induced biological stress to microbial assemblages resulted in smaller and less efficient microbial communities (Jackson and Vallaire, 2009). Salinity is well known to depress soil microbial activity (Polonenko*et al*., 1981) and to inhibit nitrification (McCormick and Wolf, 1980). Many interacting factors governing N mineralization such as salt type, soil microbes and their reaction to salinity and soil type (Wichern*et al*., 2006).

3.2 Available Phosphorous

Phosphorus (P) is one of the major nutrients limiting plant growth (Tchienkoua and Zech, 2003) and its deficiency is a major constraint for better crop production in most tropical soils (Tchienkoua and Zech, 2003). Phosphorus is present in the soil in both inorganic and organic compounds. There are several factors that may constrain P availability to plants and these include the medium salinity, and microbes in the medium which makes P immobile (Al-ArbeAttumi, 1997). Initial available phosphorous was found to 74.6ppm of soil which increased with addition of organic manure . There were significant ($P<0.05$) increases in available P under both organic amended soils. Some studies have demonstrated that straw incorporation can increase the availability of soil P and subsequent crop yields (Yadvinder-Singh *et al.,* 2007), through number of mechanisms.

Compare to organic manure salt treated soil, control had lowest value of P at the end of the incubation, which has no organic amendment and no salt treatment. In control soil, P value was 74.6ppm which decreased to 73.9ppmafter 42 days of incubation period.The solubility of phosphates increases, remains unaffected or decreases depending upon the nature and amounts of salts added and presence of lime (Paliwal&Maliwal 1971). Phosphorus equilibrium significantly shifts with the *pH* of soil solution, and in saline soils, the salts which hydrolyse to give a change in pH would show more changes on the solubility and availability of Phosphorous (Black, 1968).

Available phosphorus in soil increased in allthe treatments at the end of the incubation (Table 1), and the increasing trend was more with cow dung amended soil at all salt concentration level than paddy straw treated soil. The availability of inorganic P in animal feces is much higher than that organic P and is comparable to that of water-soluble P (Gracey, 1984). This may be the reason for highest P availability in cow dung amended salt treated soil.

With increasing salt concentration available phosphorus decreased. 1500ppm cow dung amended salt treated soil was recorded higher value of P (110.14ppm) and 2500ppm salt concentration was recorded lower value of P (97.77ppm).A regular decrease in the availability of P in presence of excessive salts appears to be due to reduced activity of phosphate ions in highly saline substrate. Paliwal and Maliwal, (1971) found that slightly higher availability of P in low to moderately saline soils.

Similar trend in P changes was observed in paddy straw treated soil.Some studies have demonstrated that straw incorporation can increase the availability of soil P and subsequent crop yields (Yadvinder-Singh *et al.,* 2007), through number of mechanisms. A slight decrease in available phosphorus was observed with the increase in salt concentration which might be due to fixation of available phosphorus at higher salinities. It was supported by Gupta *et al*., 2001 study.

3.3 Exchangeable Potassium

Potassium (K) is an essential element for the plant growth. Potassium is known for its role in osmo-regulation and stress mitigation, particularly in saline conditions (Cakmak, 2010). The total potassium content was found to 91.7ppm of soil in initial which increased with addition of organic manure to a level of 158.33ppm (Table 1). As shown in Table 1, significant ($P < 0.05$) differences were found among two different organic manures. Compare to organic manure amended salt treated soil; control had lowest potassium value after the 42days of incubation, which has no organic amendment and no salt treatment. And also the biggest difference in K value was observed between the control (91.67ppm) and paddy straw amended soil (158.33ppm) at 1500ppm salt concentration.

Among the organic manure amended soil, paddy straw amended salt soil had higher potassium value (158.33ppm) than cow dung amended soil at the end of the incubation (Table 1).The higher K value might be due to higher *total* K value in the paddy straw than cow dung. However, in both organic amended soils potassium value was increased after the 42 days of incubation beyond the initial value. This indicates that, Potassium (K) plays an important role in mitigating the adverse effects of high salt concentrations in soils (Garg and Gupta, 1998).

However, the application of cow dung and paddy straw resulted in significant decrease in available K value at increasing concentration of salt. Among the paddy straw amended soil, 2500ppm salt concentration recorded lowest value of K (137.5ppm) and 1500ppm salt concentration recorded highest value of K (158.33ppm) at the end of the incubation. Similar trend in K changes was observed in cow dung treated soil. The result indicates with increasing salt concentration decreases K availability due to this at higher salt concentration low K value

recorded in soil.Saqib*et al*., (2000) reported an increased concentration of Na^+ and Cl^-, decreased the concentration K^+.

4. CONCLUSION

With increasing salt concentration nutrient availability was significantly decreased in manure amended soil. Among the treatments control had lowest nitrogen (N), Phosphorus (P) and Potassium (K) content. Highest N and P content was observed for 1500 ppm salt solution treated cowdung amended soil and highest K was observed for1500 ppm salt solution treated paddy straw amended soil. Results could be concluded that the response pattern of decomposition of organic manure incorporated to the soil and nutrient changes depended on salinity stress.

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