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PATTERN OF ORGANIC RESIDUE DECOMPOSITION IN SALINE SOILS

M.E. Hauqe[1*], S. Ahmed[2], L. Heng[3] and R. V. Rallos[4]

Abstract

A pot experiment was conducted to investigate the decomposition of incorporated organic residues in saline soil at the Laboratory of Soil Science Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh. The experiment was arranged in completely randomized design (CRD) with three replications involving four levels of salinity , S_0 = non saline water (0.7 dS m^{-1}), S_1 = 5 dS m^{-1} saline water, S_2 =10 dS m^{-1} saline water and S_3 = 20 dS m^{-1} saline water and three treatments of organic crop residues (C_0 = no incorporation of crop residue, C_1 = incorporation of rice residue @ 10 t ha^{-1} and C_2 = incorporation of groundnut residue @ 10 t ha^{-1}). Decomposition rate of organic crop residues were decreased with the increase of salinity level irrespective of crop residues. The decomposition rate of crop residues varied between 0.63 and 0.71 % per day. The highest decomposition rate (0.71% per day) was observed in non-saline soil (0.7 dS m^{-1} salinity level) and the lowest decomposition rate (0.63% per day) was observed at 20 dS m^{-1} salinity level. The decomposition rate of groundnut residue (0.72% per day) was higher compared to rice residue (0.64% per day). Approximately, 58% rice and 64% groundnut residues were decomposed within 90 days of incubation. The overall results suggest that organic residue decomposition was inversely correlated to the extent of soil salinity.

Key words: Soil salinity, Crop residue decomposition, Soil pH and EC

Introduction

Bangladesh is a deltaic country with total area of 147,570 km^2. The major part (80%) of the country consists of alluvial sediments deposited by the rivers Ganges, Brahmaputra, Tista, Jamuna, Meghna and their tributaries. Terraces with an altitude of 20-30 m cover about 8% of the country, while hilly areas with an altitude of 10-1000 m occur in the southeastern and northeastern part. The coastal region covers almost 29,000 km^2 or about 20% of the country and about 53% of the coastal areas are affected by salinity (Haque, 2006).

Agriculture is the most important sector of Bangladesh's economy. More than 30% of the cultivable land in Bangladesh is in the coastal area. Out of 2.86 million hectares of coastal and off-shore lands about 1.056 million ha of arable lands are affected by varying degrees of salinity, resulting in very poor land utilization (SRDI, 2010). These coastal saline soils are distributed unevenly in 64 upazilas of 13 coastal districts covering portions of 8 agro-ecological zones of the country. It is mentioned that coastal regions of Bangladesh are quite lower in soil fertility (Haque, 2006). Salinity largely reduces the yield of crop in the

[1]Soil Science Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202, Bangladesh; [2]MS Student, Department of Soil Science, BAU, Mymensingh (present address: Agricultural Extension Officer, DAE, Mymensingh); [3]SWMCN Section, IAEA, Vienna, Austria; [4]Phillipine Nuclear Research Institute (PNRI), Manila, The Philippine; *Corresponding author: ekrambina@gmail.com

coastal areas of the country mainly in Khulna, Jessore, Bagerhat, Borguna, Patuakhali, Noakhali and Chittagong districts and in the islands of Bay of Bengal like Bhola, Hatiya and Sandip. Usually 30-50% yield losses occur depending on the level of soil salinity. According to the intergovernmental panel on climate change (IPCC), crop production may fall by 10-30% by 2050 in Bangladesh due to climate change (IPCC, 2007). The severity of salinity problem in Bangladesh increases with the desiccation of the soil. It affects crops depending on degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. Soil reaction values (pH) in coastal regions range from 6.0-8.4. The organic matter content of the soils is also low (1.0-1.5%). Nutrient deficiencies of N and P are quite dominant in saline soils. Deficiencies of micronutrients such as Cu and Zn are also widespread in saline soils (Haque, 2006). Application of crop residues will supply the nutrients in addition to improving physical, chemical and biological properties of soil towards improving and conserving the soil fertility.

The management of crop residues has become an important aspect of sustaining long-term fertility in cropping systems. Crop residue decomposition is a complex process strongly affected by environmental factors, crop residue composition and soil native organisms (FAO, 2003). Several mechanisms are well understood while others such as the effect of frequent crop residue addition, mixing of residues of different quality, spatial interactions between crop residues and saline soil are poorly understood although crop residues can be added to the soil continuously, often in mixtures of residues from different crop species in the presenceof growing plants.These knowledge gaps were addressed in the present study.

However, few research works have been conducted in Bangladesh regarding the available nutrient release pattern and their effects on saline soil. With such information in views, the present study was undertaken to analyze the decomposition rate of rice and groundnut residues in saline soils and to see the changes in pH and EC values in organic residue amended saline soil.

Materialsand Methods

A pot experiment was laid out in a completely randomized design (CRD) with three replications at the Laboratory of Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The treatment consists of two factors, such as – i) Four levels of saline water and ii) Three types of crop residue,which were analyzed under different incubation periods (seven harvest date) following destructive method. Hence, totally 252 (two hundred fifty two) pots were required (4 levels of salinity × 3 types of crop residue × 7 harvest time × 3 replication = 252) for the implementation of the study as follows:

Factor-1 (Saline water): S_0 = Normal water (0.7 dS m^{-1}); S_1 = Saline water with 5 dS m^{-1}; S_2 = Saline water with 10 dS m^{-1} and S_3 = Saline water with 20 dS m^{-1}

Factor-2 (Crop residue): C_0 = No incorporation of crop residue; C_1 = Incorporation of rice residue @ 10 tha^{-1} and C_2 = Incorporation of groundnut residue @ 10 t ha^{-1}

Time of the soil harvest: H_0 = 0 days after incubation = 0 DAI; H_1 = 15 days after incubation = 15 DAI; H_2 = 30days after incubation = 30 DAI; H_3 = 45 days after incubation = 45 DAI; H_4 = 60 days after incubation = 60 DAI; H_5 = 75 days after incubation = 75 DAI and H_6 = 90 days after incubation = 90 DAI

Eight grams (8g) of crop residue (from each rice and groundnut) were taken in a nylon mesh bag and kept in the soil of each pot for incubation. The experiment was designed to observe the decomposition pattern of tested crop residue and also monitor the changing pattern of soil pH and EC value of incubated soil.

Soil pH was determined by glass electrode pH meter as described by Ghosh *et al.* (1983). Fifteen gram of incubated soil was taken in a plastic container and 50 ml of distilled water was added to it. The suspension was shaken for half an hour and allowed to stand for about an hour and pH value was measured. To measure electrical conductivity, 10 mL of extracted sample was taken in a beaker and EC of the samples was measured with the help of EC meter (Model- D.6072 Dreieich, West Germany) following the method as outlined by Ghosh *et al.* (1983) and Singh and Parwana (1999).

Results and Discussion

From the study, it was observed that the decomposition rates of crop residues were decreased with the increase of salinity level irrespective of crop residues. Within the 90 days incubation period, crop residues were decomposed as 64, 63, 60 and 56% in 0.7, 5, 10 and 20 dS m^{-1} salinity level, respectively (Fig. 1). The decomposition rate of rice and groundnut residues are depicted in Fig.2. The decomposition rate of crop residues seems quite faster. Hot and humid climate of Bangladesh and incubation environment (waterlogged situation) help this rapid decomposition. The congenial environmental conditions associated with the leaching losses of readily digestible water soluble compounds from the crop residues might have triggered the activity of soil fauna and soil microbes, which are responsible for this decomposition.

Saline soils are characterized by high concentrations of soluble salts and low organic matter and nitrogen content (Asmalodhi*et al*., 2009). The decrease of decomposition with the increase of salinity level might be the depressing of microbial activity at high salinity level (Anjum*et al*., 2005). Changes in soil pH during decomposition of rice and groundnut residues under different level of soil salinity were presented in Fig 3 to Fig 6. In case of 0.7 dS m^{-1} salinity level (non saline), pH value increased initially and maximum pH value was found 5 for control, 5.2 for rice and 5.45 for groundnut at 90, 90 and 60 DAI, respectively. The pH value increased up to 15 days, then decreased up to 60 DAI and then increased up to 90 DAI in control soil. However, in groundnut residue treated soil, pH value increased up to 60 DAI and then decreased up to 75 days. In rice residue treated soil, pH value remain unchanged up to 30 days and then increased up to 60 days, then it decreased up to 75 days.

After 75 days it was increased up to 90 DAI. Between the residues, maximum pH value was found for groundnut residues. Changes in electrical conductivity during decomposition of rice and groundnut residues under different level of soil salinity were presented in Fig 7 to Fig 10. In case of 0.7 dS m^{-1} salinity level (non saline), EC increased up to 45 DAI for all the treatments and then changed irregularly. However, the increase of EC was much higher in residue-treated soil compared to control. Initially EC value increased in groundnut residue-treated soil. It increased up to 75 DAI in groundnut residue and reached to maximum EC point (6.97 dS m^{-1}). After 75 days it declined. In case of rice residue, the EC value increased initially. After 15 days it decreased up to 30 days and then increased again. After 60 days it was increased again. The maximum EC value was recorded at 90 DAI (6.89 dS m^{-1}) and the minimum was at 0 DAI (6.64 dS m^{-1}). Between the residues, maximum EC value was found for groundnut residue-treated soil (Fig 7).

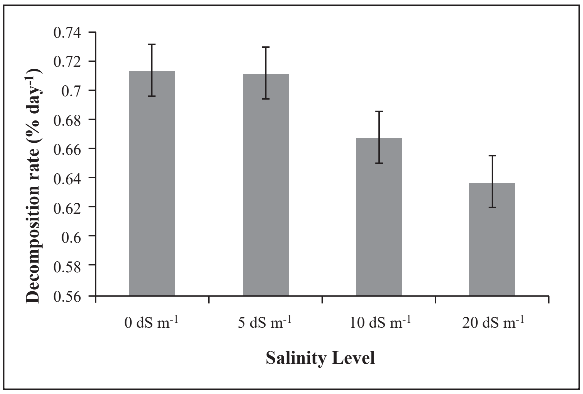

Fig. 1. Crop residue decomposition rate at different salinity levels

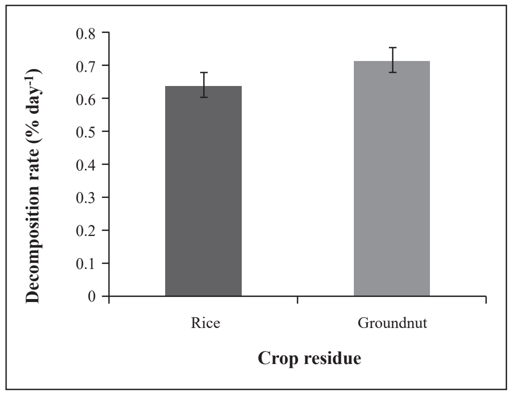

Fig. 2. Decomposition rate of different crop residues

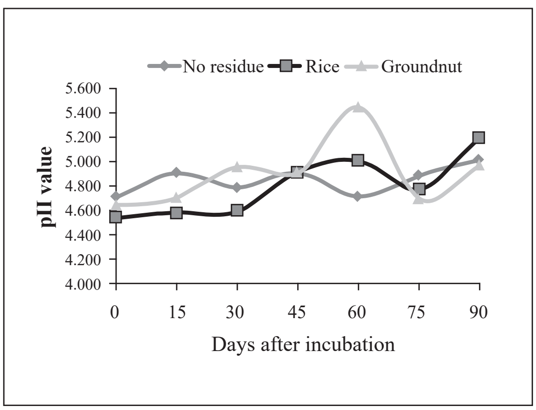

Fig. 3: Changes in pH value of different crop residue treated soils at normal water (0.7 dS m^{-1})

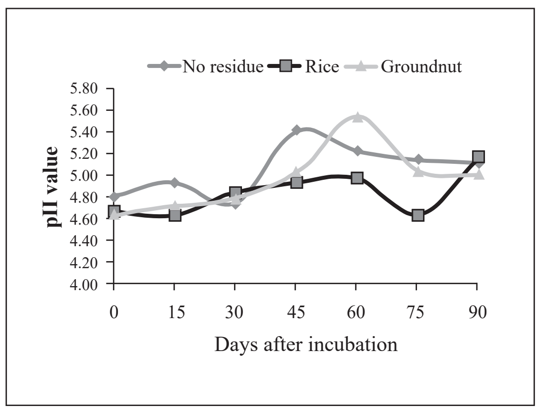

Fig. 4: Changes in pH value of different crop residue treated soils at 5 dS m^{-1} salinity level

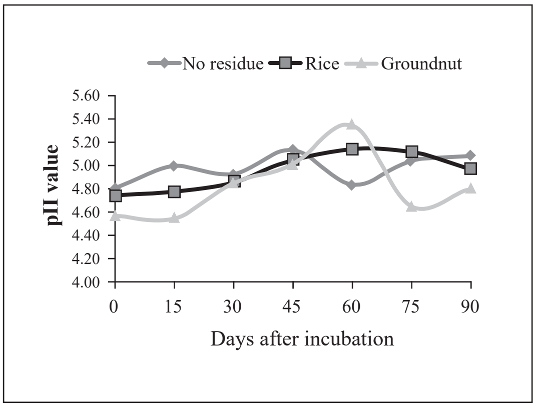

Fig. 5: Changes in pH value of different crop residue treated soils at 10 dS m^{-1} salinity level

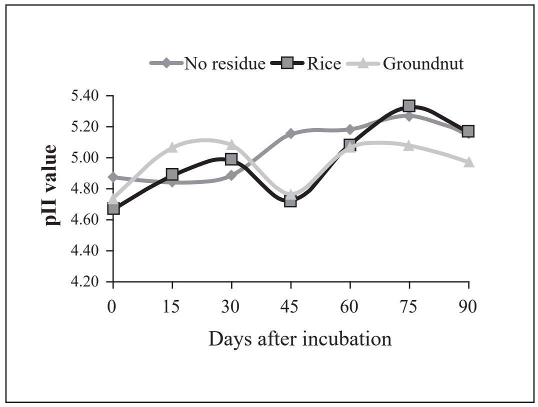

Fig. 6: Changes in pH value of different crop residue treated soils with 20 dS m^{-1} salinity level

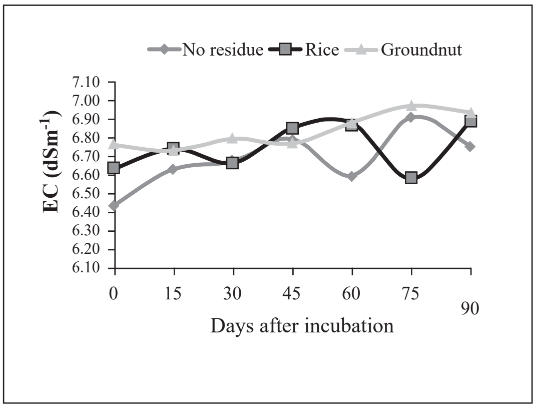

Fig. 7: Changes in EC value of different crop residue treated soils at normal water (0.7 dS m^{-1})

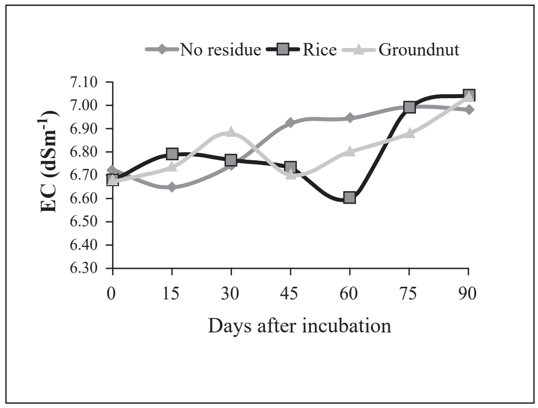

Fig. 8: Changes in EC value of different crop residue treated soils at 5 dS m^{-1} salinity level

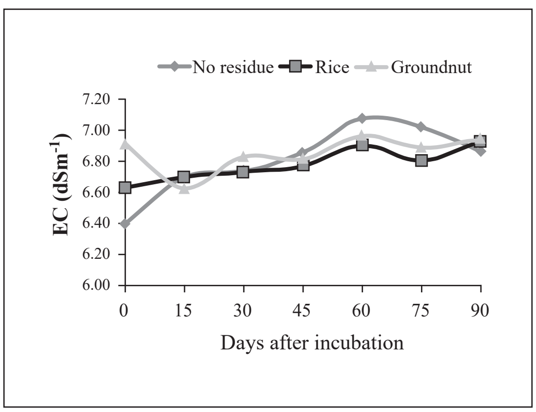

Fig. 9: Changes in EC value of different crop residue treated soils at 10 dS m^{-1} salinity level

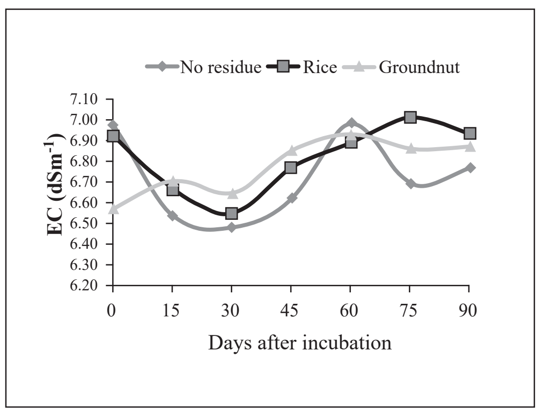

Fig.10: Changes in EC value of different crop residue treated soils at 20 dS m^{-1} salinity level

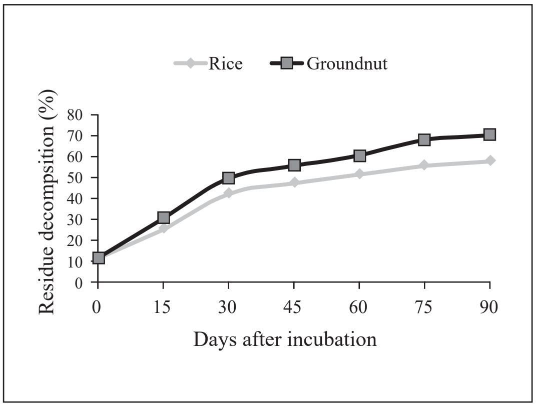

Fig. 11: Decomposition pattern of different crop residues at 0.7 dS m^{-1} salinity level

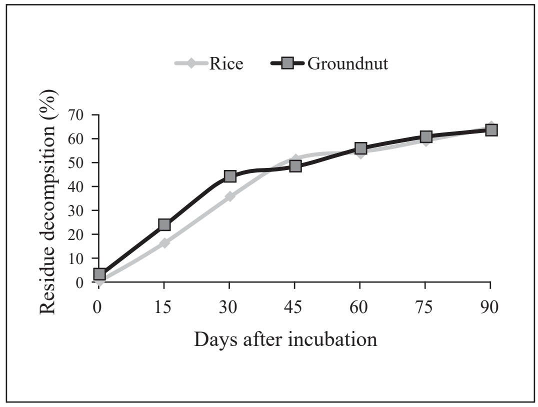

Fig. 12: Decomposition pattern of different crop residues at 5 dS m^{-1} salinity level

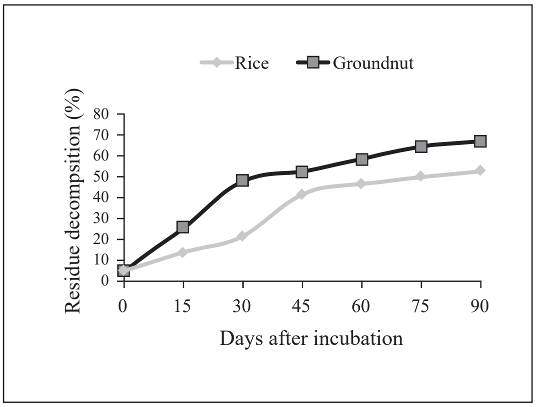

Fig. 13: Decomposition pattern of different crop residues at 10 dS m^{-1} salinity level

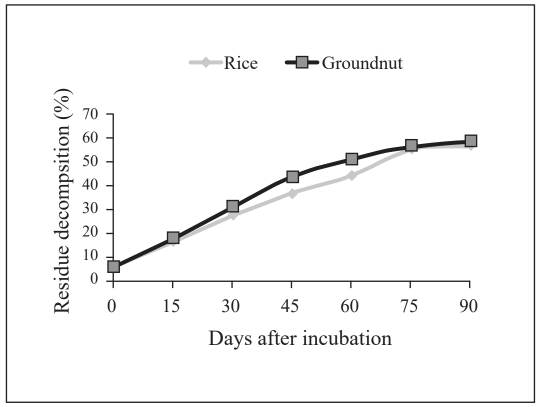

Fig. 14: Decomposition pattern of different crop residues at 20 dS m^{-1} salinity level

Conclusion

Decomposition rate of organic crop residues were decreased with the increase of salinity level and the decomposition rate varied between 0.63 and 0.71 % per day. The decomposition rate of groundnut residue (0.72% per day) was higher compared to rice residue (0.64% per day) and approximately, 58% rice and 64% groundnut residues were decomposed within 90 days of incubation. The overall results suggest that organic residue decomposition was inversely correlated to the extent of soil salinity.

The obtained findings may lead to conclude that decomposition rate of crop residue was decreased with the increasing of soil salinity. Release of N from rice and groundnut residue was relatively same; but higher in groundnut compared to rice residue soil and control soil. Release of N from crop residues depends on the quality of crop residue predominantly the C:N ratio of crop residue. Since the C:N ratio of everything in and on the soil can have a significant effect on crop residue decomposition, particularly residue cover on the soil and crop nutrient cycling predominantly nitrogen. There was a difference in the rate of N mineralization for different residues but the difference was insignificant.

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