Publisher homepage: www.universepg.com, ISSN: 2663-6913 (Online) & 2663-6905 (Print)

https://doi.org/10.34104/ajpab.022.01040115

American Journal of Pure and Applied Biosciences

Journal homepage: www.universepg.com/journal/ajpab

Application of Mahogany Leaves and Sawdust Biochar for Amendment of Saline Soil

Md Aktarul Islam[1], Raman Kumar Biswas[2]*, Shubho Ghosh[3], and Gita Mistry[4]

[1]Dept. of Agriculture Chemistry, Patuakhali Science and Technology University, Dumki-8602, Patuakhali, Bangladesh; [2]Dept. of Disaster Resilience and Engineering Patuakhali Science and Technology University, Dumki-8602, Patuakhali, Bangladesh; [3]Dept. of Environment and Energy Engineering, Chonnam National University, South Korea; [4]Dept. of Environmental Science, Patuakhali Science and Technology University, Dumki-8602, Patuakhali, Bangladesh.

*Correspondence: ramanbiswas@pstu.ac.bd (Dr. Raman Kumar Biswas, Professor, Department of Disaster Resilience and Engineering Patuakhali Science and Technology University, Dumki-8602, Patuakhali, Bangladesh).

ABSTRACT

This research was conducted for the observation of the status of soil fertility and salinity using the biochar produced from the Mehagony leaves and Sawdust. Biochar has been produced by the pyrolysis method. Different feeds produce biochar ranging from 37% to 39% in initial dry weight. Each biochar was distinguished in the study by the percent of organic Carbon, moisture content, total Nitrogen, and cations of Ca++, Na+, K+, Mg++ Pand S. All of the biochar produced from different feedstock contain high amounts of organic Carbon of 69% to76.11%. The pH, EC, and other nutrient contents were determined from the treated soil before and after the treatment of biochar and found higher value pH values and reduction of EC value due to the application of biochar. The EC values were decreased in biochar-treated saline soil than in untreated soil. The maximum decrease of EC was noticed from 13 to 10.5 ds/m in Mahogany leaf biochar-treated soil. The performance of the biochar of Mahogany leaves is higher than the Sawdust biochar for the reduction of salinity and increased other nutrients such as Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P), and Sulfur (S). The overall concentration of P, K, Ca, Mg, and S was increased in all biochar-treated saline soil compared to untreated soil. The findings of the study indicated that the Mahogany leaf biochar and Sawdust biochar have a high potential for desalination of saline soil and buildup of available nutrients in saline soil.

Keywords: Biochar, Mahogany leaf, Sawdust, Saline soil, Electrical conductivity, Amendment, and pH.

INTRODUCTION:

The world population is increasing every day and it will attain 9.6 by 2050 (FAO, 2009). The over-population gradually reduces natural resources and is alarming for the next generation to use. Extra food is necessary to feed the population. Present agriculture productions are under threat due to salinity, drought, and heavy metal problem (Osakabe *et al.,* 2014). In regards to abiotic stresses, soil salinity is the most essential danger to agricultural manufacturing. Salinity is the primary abiotic stress that influences the crop production at some point in the arena. Land degradation-induced salinity is causing an annual financial loss of USD 27.2 billion equivalents to crop loss in irrigated agriculture (Qadir *et al.,* 2014). The higher emission of carbon (C) inputs causes soil degradation in the long run (Wang *et al.,* 2009). Saline soil adversely impacts plant life, which includes the reduction of leaf water contents, nutrient uptake, photosynthesis, and yield of flora (Gupta *et al.,* 2014). Dealing with the salinity

problem in the agricultural section is still challenging regarding safety internationally.

Biochar is a carbon-wealthy excellent anti-decomposability of substance. The common method for the Biochar production is the pyrolysis (thermal degradation) of biomass, especially agricultural waste, in a closed furnace and a complete absence of oxygen (Lehmann *et al.,* 2009). In recent years, biochar is used as a soil supplement, which has drawn people's attention. Applications of biochar are vast. Biochar can increase soil fertility, carbon fixation, bio-strength production, and immobilization of organic including inorganic pollutants (Fiaz *et al.,* 2014). The great attention on biochar application is increasing plant health and nutrient intake in saline circumstances (Akhtar *et al.,* 2014). On the contrary, biochar application could decrease the Sodium ion (Na+) uptake and improve Potassium (K+) uptake below salt pressure (Usman *et al.,* 2016). This study will look at using Mahogany leaves and Sawdust as feed stocks, with mineral & organic aqueous nutrients to determine the effects of Mahogany leaves and Sawdust on soil salinity and build up other mineral nutrients in treated soil. By focusing on the southern part of Bangladesh, a region where little biochar research has been done, this research is important to help farmers and the agricultural community of the country. Expanding what is known about how biochar works in this region can assist local farmers when deciding on soil amendments and other treatments (Yousif and Mohamed, 2022).

The objective of the study is to compare the effects of several types of biochar created from individual feed stocks on soil salinity. The study aims to characterize different biochar prepared from Mahogany leaves and Saw dust feedstock, to identify the ability of Mahogany leaves and Sawdust biochar in reducing soil salinity, and to assess the effectiveness of different biochar for increasing the fertility of saline soil.

MATERIALS AND METHODS:

Raw Materials

Mahogany leaves and Saw dust were collected as raw materials to the produce biochar and applied in the experiment.

Biochar Preparation

The raw materials for biochar preparation were made from Mahogany leaves (*Swietenia macrophylla)* and Sawdust (*Samanea saman* L.). The 5 kg of each raw bio-material were air dried in the open air for 1 week and placed in a biochar oven (local name; *Chulli*) with a cover lid before carbonization at the Department of Agricultural Chemistry, Patuakhali Science and Technology University, Dumki, Patuakhali, Bangladesh. We pyrolyzed the biomass samples by a slow heating condition and gradually increased them to 350-400 ^{0}C for four hours according to the methods of the Worldwide Biochar Initiative (IBI, 2016). After carbonization, the biochar samples were kept in the furnace until room temperature and stored in a desiccator before laboratory use.

Characterization of Biochar

All of the biochar was characterized by present organic Carbon, Sodium, Potassium, Calcium, Magnesium, Phosphorus, and Sulphur using standard methods.

Sample collection

In 2018, we collected the biomass samples from the Agronomy field, PSTU, breakdown the chunks, and cleaned the debris and unwanted waste by sieving and meshing at the net house. Approximately Nine (9) Kg of soil was prepared and moved into different pots and named the label.

Treatment of Samples

Approximately 50 g of soil was kept in a polythene bag for the identification of EC and soil pH for the chemical analysis.

Treatment for Mahogany Leaves and Sawdust Biochar

The pot distribution is done based on the arrangement below: Mahogany Leaves Biochar.

Pot no.	R1	Pot no.	R2	Pot no.	R3
1	M_0S_0	13	M_0S_0	25	M_0S_0
2	M_0S_4	14	M_0S_4	26	M_0S_4
3	M_0S_8	15	M_0S_8	27	M_0S_8
4	M_0S_{12}	16	M_0S_{12}	28	M_0S_{12}

5	$M_{25}S_0$	17	$M_{25}S_0$	29	$M_{25}S_0$
6	$M_{25}S_4$	18	$M_{25}S_4$	30	$M_{25}S_4$
7	$M_{25}S_8$	19	$M_{25}S_8$	31	$M_{25}S_8$
8	$M_{25}S_{12}$	20	$M_{25}S_{12}$	32	$M_{25}S_{12}$
9	$M_{50}S_0$	21	$M_{50}S_0$	33	$M_{50}S_0$
10	$M_{50}S_4$	22	$M_{50}S_4$	34	$M_{50}S_4$
11	$M_{50}S_8$	23	$M_{50}S_8$	35	$M_{50}S_8$
12	$M_{50}S_{12}$	24	$M_{50}S_{12}$	36	$M_{50}S_{12}$
The pot distribution is done based on the arrangement below: Sawdust Biochar					
Pot no.	**R1**	**Pot no.**	**R2**	**Pot no.**	**R3**
37	Sd_0S_0	49	Sd_0S_0	61	Sd_0S_0
38	Sd_0S_4	50	Sd_0S_4	62	Sd_0S_4
39	Sd_0S_8	51	Sd_0S_8	63	Sd_0S_8
40	Sd_0S_{12}	52	Sd_0S_{12}	64	Sd_0S_{12}
41	$Sd_{25}S_0$	53	$Sd_{25}S_0$	65	$Sd_{25}S_0$
42	$Sd_{25}S_4$	54	$Sd_{25}S_4$	66	$Sd_{25}S_4$
43	$Sd_{25}S_8$	55	$Sd_{25}S_8$	67	$Sd_{25}S_8$
44	$Sd_{25}S_{12}$	56	$Sd_{25}S_{12}$	68	$Sd_{25}S_{12}$
45	$Sd_{50}S_0$	57	$Sd_{50}S_0$	69	$Sd_{50}S_0$
46	$Sd_{50}S_4$	58	$Sd_{50}S_4$	70	$Sd_{50}S_4$
47	$Sd_{50}S_8$	59	$Sd_{50}S_8$	71	$Sd_{50}S_8$
48	$Sd_{50}S_{12}$	60	$Sd_{50}S_{12}$	72	$Sd_{50}S_{12}$

Application of NaCl to Build up Salinity

For preparing the saline soil of 4, 8, and 12 dS/m, we added 23.87g, 47.74g, and 71.62 g of NaCl to the soil kept in different pots. Firstly, the calculated amount of NaCl was dissolved in distilled water, then the whole salt solution was sprayed on the soil to build up the expected salinity soil. After successful spraying of salt solution, 111.6g, and 223.21g biochar were added respectively and perfectly mixed with soil and potted and then stored in a room. The pH and EC of the soil samples (the primary sample) were determined by pH meter and EC meter, and data were collected in a research notebook. At the 1st step/initial value, 10g of soil was taken from each biochar-treated soil from the pot, and EC including soil pH was measured. In the 2nd step, 10g of soil was taken from each biochar-treated soil, similarly, EC and soil pH was measured. In the same way, the EC and soil pH were measured from the biochar-treated soil in the 3rd and 4th steps.

Determination of Nutrients

The biochar-mixed soil sample has been collected from the pots and different soil nutrients were determined and data recorded.

Identification of EC and Soil pH

For the identification of EC & soil pH, 10 g of soil was used adding 25 ml of ultrapure water and mixing it well keeping it for 15-20 minutes and the reading was taken for the pH measurement using the gas electrode pH meter (Hanna Instruments, USA). Then additional 25 ml of ultra-pure water was mixed into the sample containing a conical flask and ringed well. After 20-25 minutes, the EC was measured by the EC meter (dS/m).

Processing of Samples

We collected the soil biochar samples from biochar-treated pots. Then the collected soil samples were ground and sieved carefully. After that, we keep the soil samples for further chemical analysis.

Extraction procedure from samples

Extraction of Na, K, Ca, and Mg from samples

Ammonium acetate (1N) was added for the extraction of Na, K, Ca, and Mg from samples in the methods described by Jackson, (1973). 5 g of soil sample was taken in a 250 ml size conical flask and 25 ml of the ammonium acetate was added into the flask. The conical flask was shaken with an electrical shaker for 30 minutes. Then it was filtered through Whatman No.

42 filter paper. The volume was made to 50 ml and shaken thoroughly. The soil extract was then transferred to a labeled plastic bottle for the identification of available Sodium (Na), Potassium (K), Calcium (Ca), and Magnesium (Mg).

Extraction of Phosphorus (P) from samples

For the extraction of Phosphorus (P) from samples the techniques by Oleson *et al.* (1954) were used. The 2.5 g sample was taken in a 250 ml conical flask and 0.20 g of phosphorus-free charcoal was also added to the flask. Then, 50 ml of 0.5 M NaOH was added to a conical flask and it was immediately shaken with a reciprocating shaker for 30 minutes. After shaking it was filtered through Whatman No. 42 filter paper. The soil extract was then moved to a well-labeled plastic bottle for the determination of available phosphorus from the soil samples.

Extraction of Sulphur (S) from samples

To determine of available Sulphur 0.10 g of air-dried soil sample was taken into a 250 ml conical beaker. Also, 50 ml of lodging result (0.15 $CaCl_2$,) was added to the conical beaker. It was shaken on an orbital shaker for 30 beats. After shaking, it was filtered through Whatman no. 42 sludge paper. The soil extract was also transferred to a well-labeled plastic bottle for the determination of available Sulphur.

Extraction of Sodium (Na) and Potassium (K)

Extraction of Sodium (Na) and Potassium (K) were determined separately with the help of a flame emission spectrophotometer (Spectrolab, UK) using appropriate filters and standard series of Na and K solutions. The flame emission spectrophotometer reading was taken from the direct solution.

Extraction of Calcium (Ca)

Using the complex metric method of titration with Na_2 EDTA as a complexing agent, Calcium was measured (Page *et al.,* 1982). In the titration process, 2 ml of extract solution was taken into a 100 ml of the conical flask and added 20 ml distilled water, and 2 ml 10% NaOH solution. Then it was shaken. After that, each of the 10 drops of Triethanol Amine (TEA), hydroxylamine hydrochloride ($NH_2OH.HCl$), and Potassium ferrocyanide $K_4Fe(CN)_6$ solutions were added to eliminate the interferences of various ions. Finally, 5-6 drops of Calgon ($(NaPO_3)_6$) indicator were added until the aliquot color changed to pink. The solution was titrated against 0.02 M Na_2_EDTA until changed the color of solution from pink to pure blue colors.

Extraction of Magnesium (Mg)

The estimation of magnesium was done following a complex metric method of titration. Na_2EDTA is a complex agent used in this method. This analytical method was practiced for eliminating possible interference of non-target ions in the presence of Eriochrome Black–T indicator (EBT). To determine Mg, 5 ml of the extracts were taken into a 100 ml conical flask, and added 20 ml distilled water, and 2 ml 10% NaOH. Then it was shaken. After that, each of 10 drops of the Tritanol Amine (TEA), hydroxylamine hydrochloride ($NH_2OH.HCl$), Potassium ferrocyanide ($K_4Fe(CN)_6$), and Sodium tungstate (Na_2WO_4) were also added to eliminate the competition of various ions (Fe, Cu, Zn, Mn and phosphate). Finally, we added 1-2 drops of EBT were added until the aliquot color changed up to pink. The solution was titrated against 0.02M Na_2_EDTA until the solution`s color changed from pink to pure blue color.

Extraction of Phosphorus (P)

Phosphorus (P) was determined using ascorbic acid as a reductant for color development and reading was recorded by the spectrophotometer (T6OUV). For the preparation of 50 ppm primary standard phosphorus solution, exactly 0.2195 g KH_2PO_4 (AR grade) was taken in a 1000 mL volumetric flask and filled up to the marking line with pure water. Then 4 mL of 50 ppm solution was taken in a 100 volumetric flask and made up to the marks with pure water. This solution contained a 2 ppm P solution and was used as a working standard stock solution. 35 mL of concentrated Sulphuric acid (H_2SO_4) was diluted to 250 mL solution with distilled water for the preparing 5 N Sulphuric acids. A 4% ammonium molybdate solution was prepared by dissolving 20 g of ammonium molybdate tetrahydrate ($NH_4.Mo_7O_{24}.4H_2O$) into a 500 mL size volumetric flask and made up to the marks with distilled water. 1.76 g of ascorbic acid was dissolved into a 100 mL flask and volume up to the mark with distilled water. We prepare the Antimony tartrate solution by dissolving 0.27 g of antimony tartrate in 100 mL of distilled water. Finally, for the

preparation of the mixed reagent, 50 mL of 5 N H_2SO_4, 15 mL of 4% ammonium molybdate solution, 5 mL of antimony solution, and 30 mL of ascorbic acid solution were mixed after the addition of each reagent. This mixed reagent cannot be preserved for a longer time. 01.0.2, 0.3, 0.4, and 0.5 ppm standard P working solutions were prepared using pipets of 5, 10, 15, 20, and 25 mL of 2 ppm standard P stock solution into 100 mL volumetric flasks as well as 8 mL mixed reagent solution was added and then made volume up to the volumetric flasks with distilled water. In the same way, color was developed by taking a 10 mL sample solution into a 50 mL volumetric flask with the addition of 4 mL mixed reagent, and making up to 50 mL instead of the secondary standard solution. In the case of a very concentrated sample, it was required to dilute several times.

The absorbance was read after 15 minutes in a spectrophotometer (T60 UV). Finally, a standard curve was prepared by plotting the absorbance of light from the spectrophotometer against the P concentrations and the amount of the P calculated from the soil sample by using this standard curve.

Extraction of Sulphur (S)

Sulphur (S) was measured by the turbidimetric system using a spectrophotometer (T60UV) (Tandon, 1995a). 100 ppm of Sulphur standard result was prepared by dissolving exactly 0.385 g of Epsom swab in a 500 mL volumetric beaker containing about 200- 300 mL distilled water. It was shaken completely. Distilled water was used to make up the difference in volume. This result contained 100 ppm S. Also, a series of Sulphur standard results containing 5, 10, 15, 20, 25, and 30 ppm S was set up in the seven test tubes by pipetting 0, 2.5, 5, 7.5, 10, 12.5, and 15 mL of the 100 ppm S result, and adding 50, 47.5, 45, 42.5, 40, 37.5 and 35 mL of distilled water from a burette independently. The acid seed result was prepared by pouring about 50 mL H_2O into a 100 mL volumetric beaker, adding 6.5 mL of concentrated HNO_3, 25 mL of acetic acid, and 20 mL of 100 ppm S stock result, and making the volume up to the mark with distilled water. After reagent medication, 5 mL of each soil excerpt sample was taken in a 25 mL the volumetric beaker. Also, 1 mL of acid seed result and 0.20 g barium chloride were added to each standard series and made volume 25 with distilled water. After mixing, when the barium chloride dissolved fully, the absorbance reading was taken at a 425 nm wavelength with the spectrophotometer.

RESULTS AND DISCUSSION:

Production rate of biochar

Production rates (dry mass basis) of biochar from different feed stocks ranged from 37 to 39% of initial dry weight (**Fig. 1**). The higher biochar production rate was found in Sawdust (39%) whereas it was lower in Mahogany leaves (37%). This might be due to bulky and compact materials like Mahogany leaves and Sawdust, respectively. Hickory wood, bagasse, and bamboo feed stocks were also used to produce 22 to 47% biochar at varied temperatures of 300 C to 450 C.

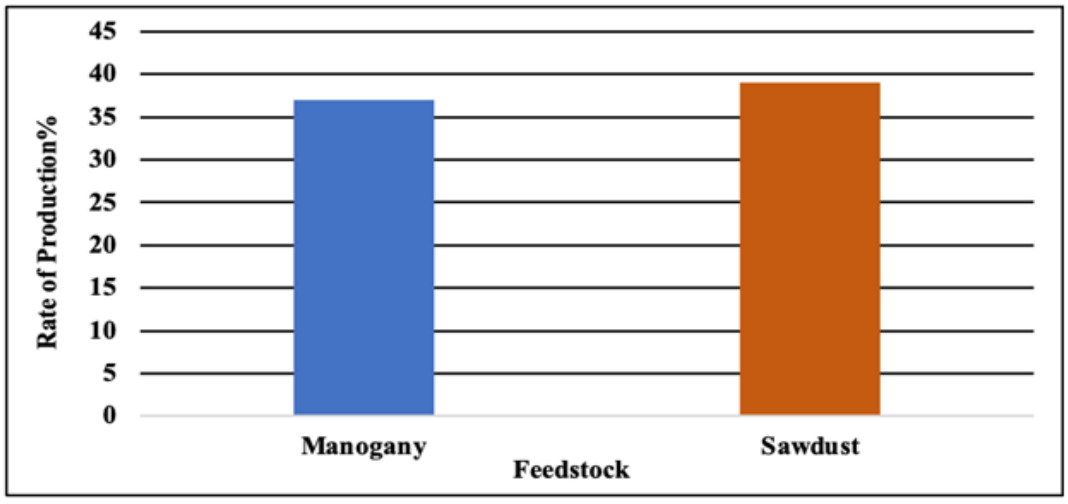

Fig. 1: Production rate of biochar from different feedstock.

Due to the lower temperature involved, the thermal carbonization often had a better production rate than the conventional slow pyrolysis method (Libra *et al.,* 2011). Under 250 ℃, samples lost weight substantially due to the loss of humidity and hydration water whilst above the 250℃, feedstock launches to putrefy and trans-figure into a complex organic matter mixed with feasts including water vapor, CO_2, CO, H_2, CH_4, and heavier hydrocarbons (Antal *et al.,* 2013). Therefore, the lower biochar production rate at a relatively higher temperature was probably because of more organic matter in the samples.

Characterization of Biochar

Elemental analysis of different biochar shows (**Table 1**) that all biochar from different feedstock contains higher amounts of the Carbon of 69 to 76.11% with Nitrogen and other elements. A high amount of the organic Carbon was found in Sawdust biochar at 76.11% and the lowest amount was found in Rice husk biochar at 69% (**Table 1**). The Coconut coir biochar contains the percent of organic Carbon, Total Nitrogen, moisture, Sodium (Na), Potassium (K), Calcium (Ca), magnesium (Mg), Phosphorus (P), and Sulfur (S) was 69.5%, 1.3%, 3.9%, 0.04%, 0.77%, 0.32%, 0.06%, 0.25%, & 2.1% respectively. The highest P was found in biochar from Rice straw followed by Mahogany leaf, Sawdust, and Coconut coir biochar. The total Nitrogen was higher in Sawdust biochar and lowest in biochar from Rice straw (**Table 1**). It also found carbon contents increased from 53% to 83% with increasing temperatures from 200 to 600℃ for bagasse, hickory wood, and bamboo biochar (Sun *et al.,* 2014).

We found that the results from Jindo *et al.* (2014) and the current study result aligned with the physical and chemical characterization of the biochar derived from different agricultural residues. Acacia wood, coconut coir, & rice husk biochar were used at multiple temperature ranges and were found to have high carbon and low nitrogen contents (Pituy *et al.,* 2016).

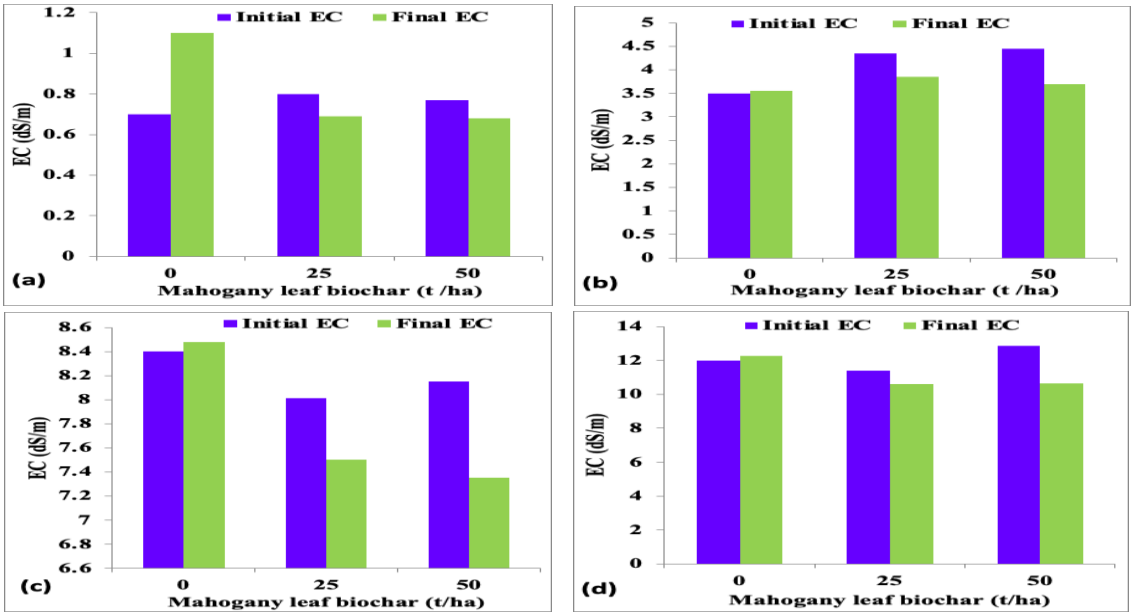

Fig. 2: Electrical conductivity (dS/m) of saline soil before (initial) and after (final) treatment with Mahogany leaf biochar at (a) 0, (b) 4, (c) 8 and (d)12 ds/m salinity level.

Table 1: Elemental Composition of Different Biochar.

Parameters	**Mahogany Leaf Biochar** (Percentage)	**Sawdust Biochar** (Percentage)
Organic carbon	68.5	76.11
Total nitrogen	1.36	1.77
Moisture	3.8	2.6
Na	0.01	0.01
K	0.5	0.5

Ca	0.29	0.3
Mg	0.05	0.06
P	1.71	0.56
S	2.01	1.9

Table 2: The pH of salinity-treated soil before and after treatment of different biochar.

Biochar name	Treatment (t/ha)	0 (dS/m)		4 (dS/m)		8 (dS/m)		12 (dS/m)	
		Initial pH	Final pH	Initial Ph	Final pH	Initial pH	Final pH	Initial pH	Final pH
Mahogany leaf biochar	0	6.8	7.16	6.88	7.25	6.83	7.38	6.86	7.49
	25	6.79	7.47	6.83	7.33	6.67	7.19	6.77	7.13
	50	6.82	7.47	6.97	7.31	6.72	7.37	6.8	7.37
Sawdust biochar	0	6.8	7.16	6.88	7.25	6.83	7.38	6.86	7.49
	25	6.87	7.22	6.84	7.2	6.81	7.17	6.72	7.23
	50	6.99	7.4	6.85	7.14	6.89	7.16	7.02	7.58

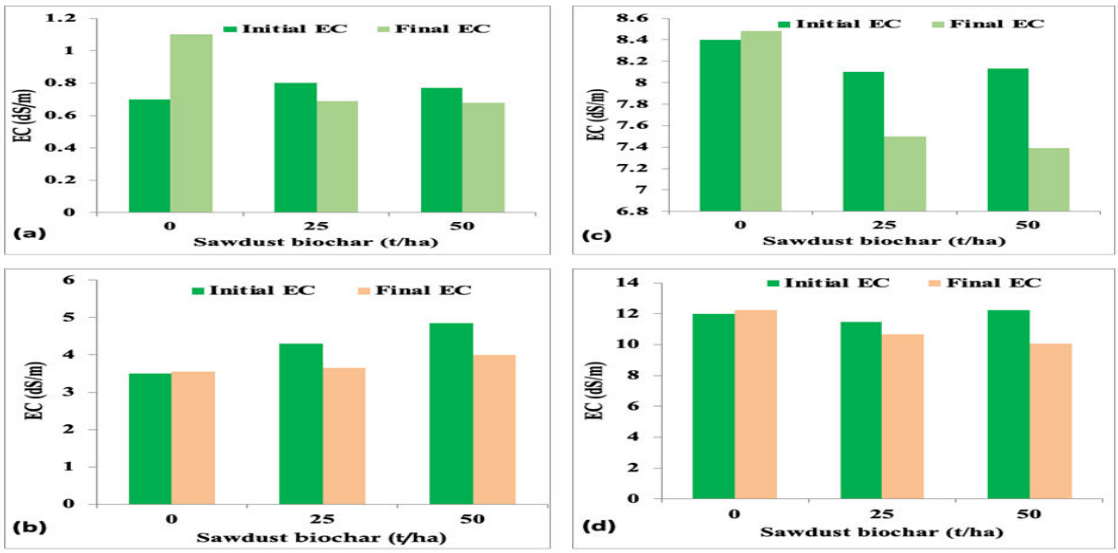

Fig. 3: Electrical conductivity, EC (dS/m) of saline soil before (initial) and after (final) treatment with Sawdust biochar at (a) 0, (b) 4, (c) 8 and (d)12 ds/m salinity level.

Exchangeable Na Content

Na content of the soil increases with NaCl to increase soil salinity from 4 to 12 dS/m. In all salinity levels of soil (4 to 12 dS/m) the application of Mahogany leaves biochar reduced the Na contents of soils. Application of Mahogany leaves biochar at 25 t/ha soil having a salinity level 4 dS/m reduced soil Na contents from 557.881-537.049 mg/kg. This soil was incubated with Mahogany leaf biochar for 8 months. Exchangeable Na content was highest when the soil was treated with 12 dS/m salinity but the Na content is not proportionately rise due to the application of Mahogany leaves biochar at 50 t/ha. Sawdust biochar also reduced the salinity level of soil, but it was slower than the Mahogany leaves biochar (**Fig. 4**).

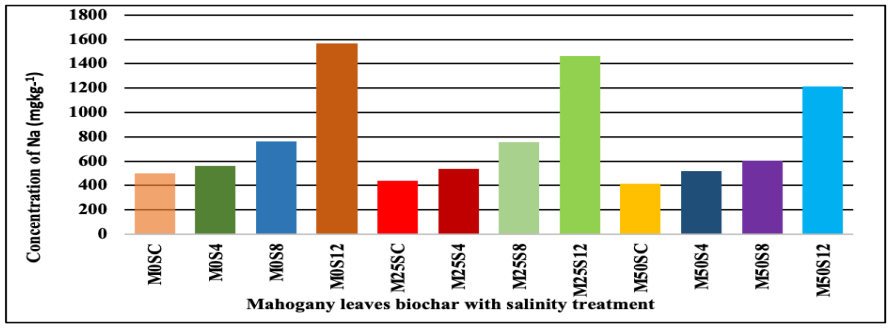

Fig. 4: Na content (mg/kg) in Mahogany leaves biochar and salinity treated soil after eight months.

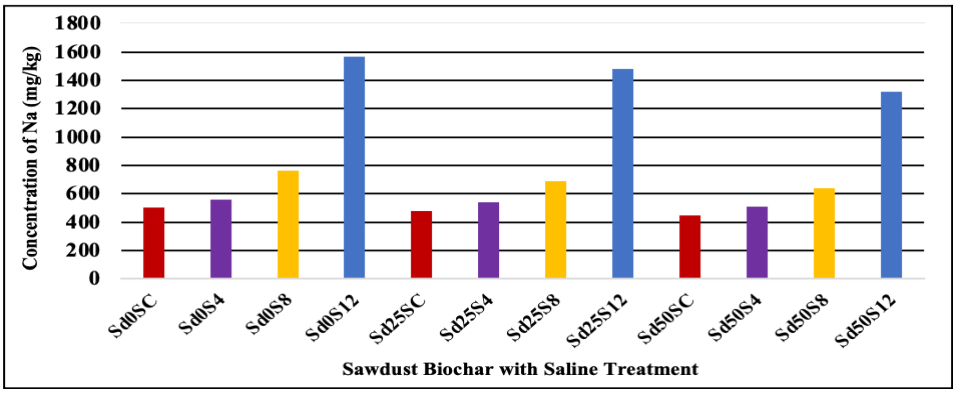

Fig. 5: Na content (mg/kg) in Sawdust biochar and salinity-treated soil after eight months.

Exchangeable K Content

In different degrees of soil salinity, the application of Mahogany leaves biochar did not influence the amount of K in the soil remarkably. In biochar-untreated soil, the increasing level of salinity increases the level of K in the soil. On the contrary, in Mahogany leaves biochar-treated soil, we found that K level was not increasing consequently similar to the results in the case of Sawdust biochar-treated soil. The increasing trends of K were insignificant (**Fig. 6, 7**).

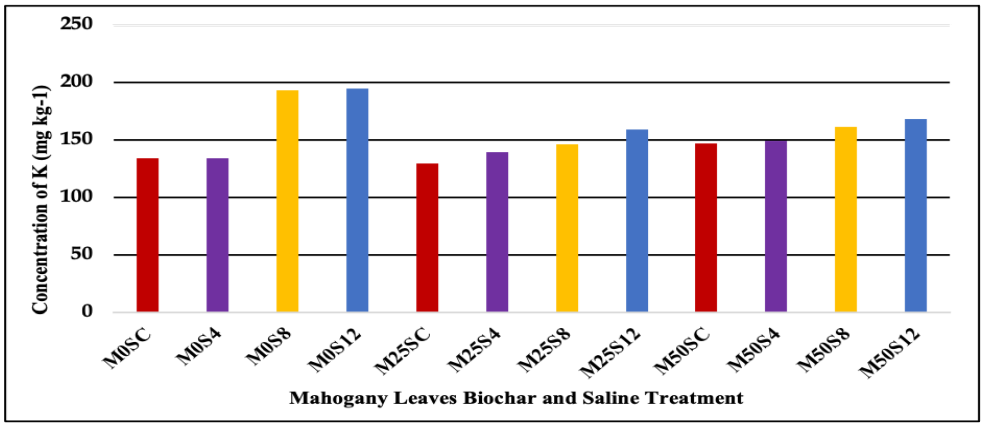

Fig. 6: K content (mg/kg) in Mahogany leaves biochar and salinity-treated soil after eight months.

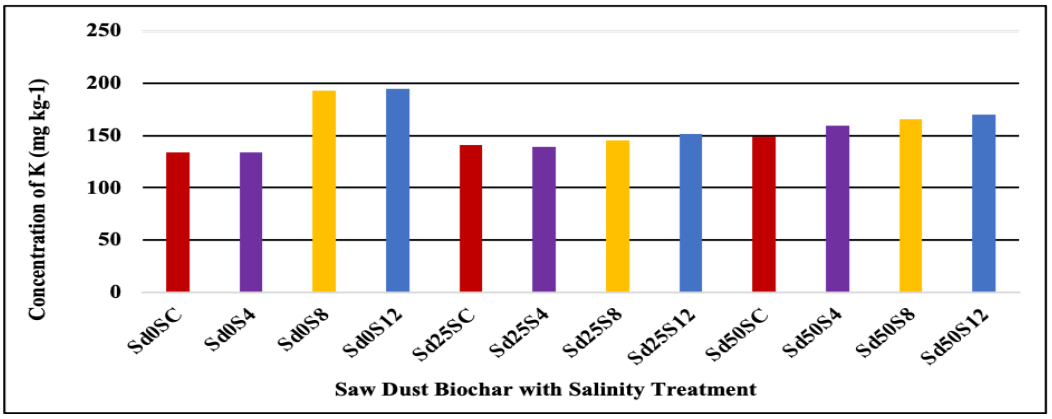

Fig. 7: K content (mg/kg) in Sawdust biochar and salinity-treated soil after eight months.

Exchangeable Mg and Ca Content

The lowest Mg concentration was detected in salinity and biochar-controlled soil and the highest Mg concentration was detected in incubated soil which was treated with 8 dS/m Salinity and 50 t/ha Mahogany leaves biochar. The amount of exchange-able Mg increased when low salinity (4 dS/m) treated soil was incubated with 25 t Mahogany leaf biochar.

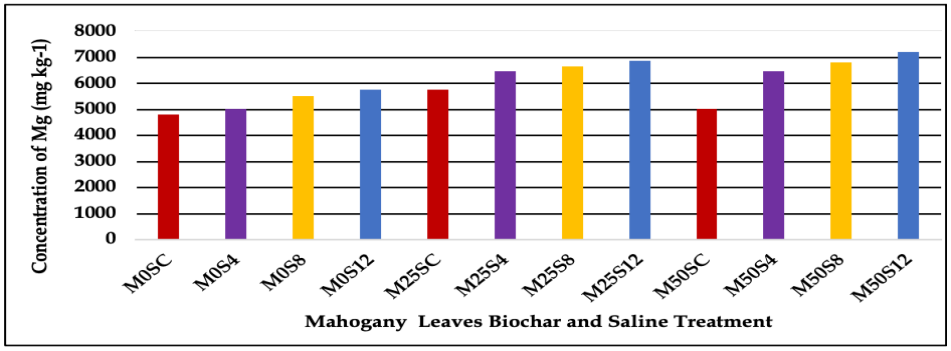

Fig. 8: Mg (mg/kg) content in Mahogany leaves biochar and salinity-treated soil after eight months.

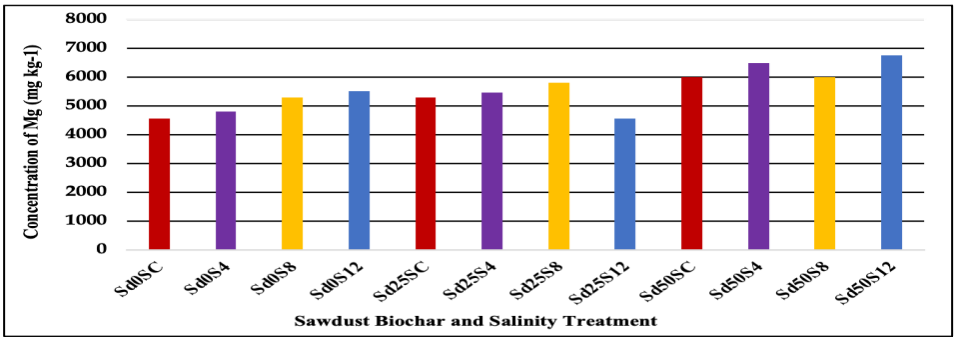

Fig. 9: Mg (mg/kg) content in Sawdust biochar and salinity-treated soil after eight months.

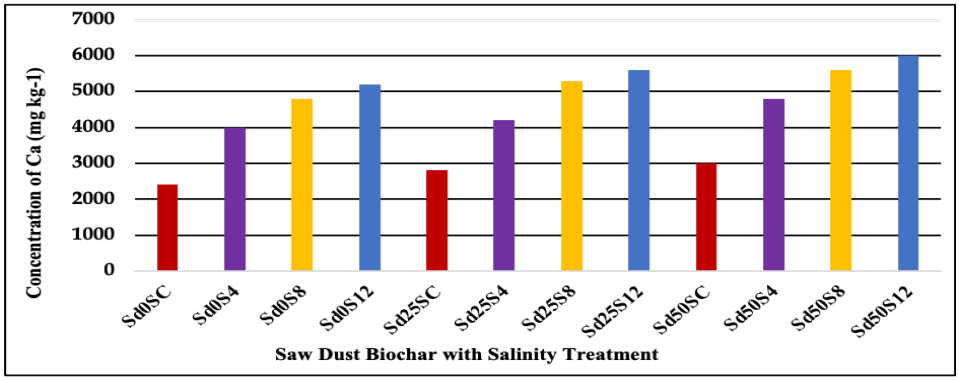

Fig. 10: Ca (mg/kg) the content in Sawdust biochar and salinity-treated soil after eight months.

We found that Ca content increased in biochar-treated soil gradually. The Mg and Ca content also increased at a slower rate in Sawdust biochar. In biochar-treated soil, it was increasing gradually at 25 t/ha and 50 t/ha.

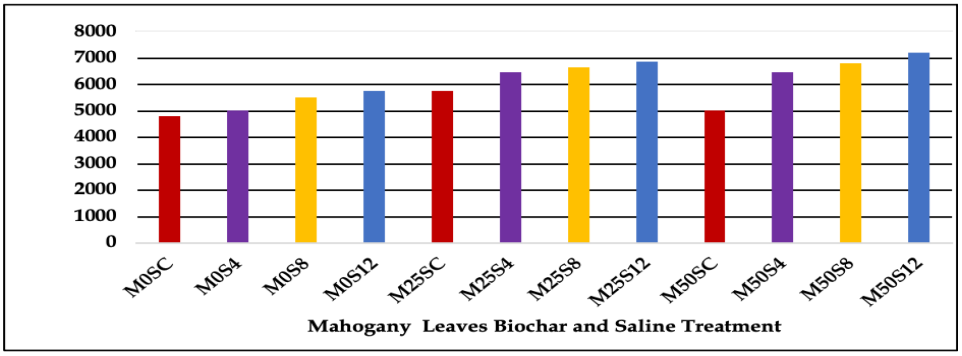

Fig. 11: Ca content (mg/kg) in Mahogany Leaves biochar and salinity-treated soil after eight months.

Exchangeable Phosphorus (P) Content

Due to the application of Mahogany leaves and biochar from 25 –50 tons/ha the concentration of Phosphorus (P) was increased from 13.25% to 14.40%. In Sawdust biochar-treated soil the concentration of Phosphorus (P) was decreased with the increasing doses of biochar.

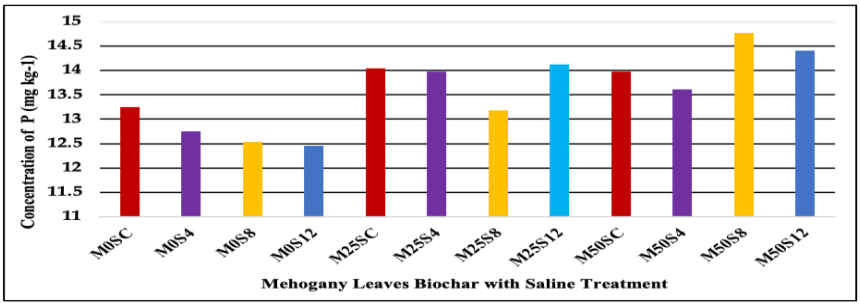

Fig. 12: P content (mg/kg) in Mahogany leaves biochar and salinity-treated soil after eight months.

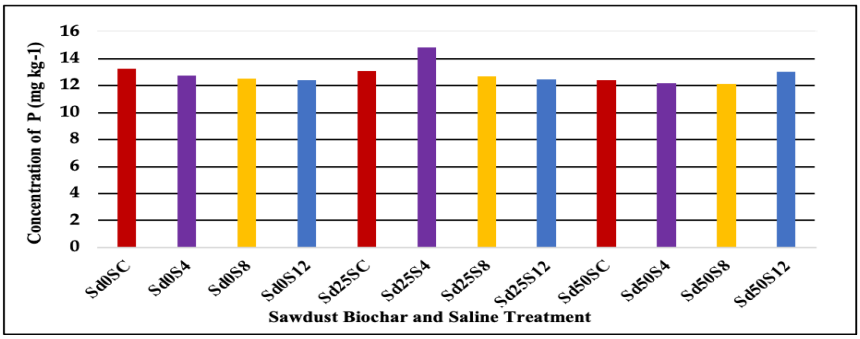

Fig. 13: P content (mg/kg) in Sawdust biochar and salinity-treated soil after eight months.

Exchangeable S Content

The concentration of $CaCl_2.2H_2O$ in extractable S was increased in Mahogany leaves biochar. In the case of Sawdust biochar, the concentration of S increases gradually with the increasing doses of biochar. The highest S content is 198.722 mg/kg) was detected when 12 dS/m salinity level soil was treated with 50 tons/ha mahogany leaves biochar.

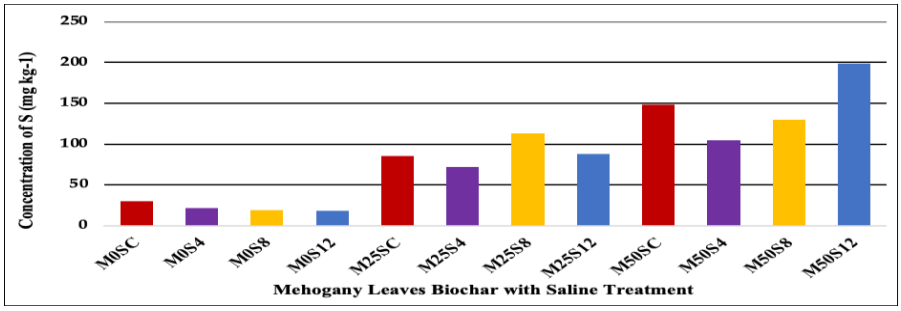

Fig. 14: S (mg/kg) content in Mahogany leaves biochar and salinity-treated soil after eight months.

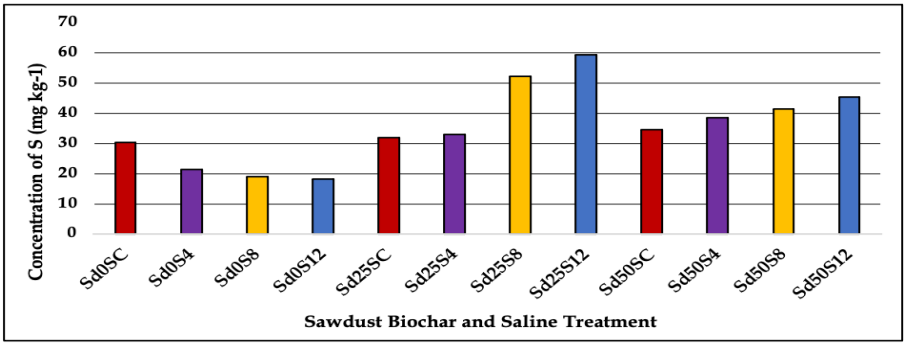

Fig. 15: S content (mg/kg) in Sawdust biochar and salinity-treated soil after eight months.

Fertility of Saline Soil after Treated with Biochar

Most of the soils are rich in organic matter and nitrogen content in Bangladesh. From **Table 1**, it is shown that a reasonable amount of organic carbon and nitrogen are added from biochar in saline soil. In addition, we added the Ca, Mg, P, K, and S to the soil from different biochar-prepared feedstocks. So, it increases soil fertility due to the addition of plant macronutrients and organic matter and decreases salinity for future crop production.

CONCLUSION:

To develop an appropriate, eco-friendly, and biochar-based desalination technology on saline soil the experiments were carried out. Production rates of biochar from different feedstock ranged from 37 to 39% of initial weight. The higher biochar production rate was found in Sawdust (39%) whereas lower in Mahogany leaves (37%). Biochar contains a higher amount of organic Carbon with Sodium, Potassium, Calcium, Magnesium, Phosphorus, Sulfur, and other nutrients elements. Biochar application is more effective for the desalination of saline soil than any other way of desalination. The value of pH of the final sample is mostly neutral and the EC value becomes decreased after 8 months of incubation due to Sodium ion adsorbed by biochar. The maximum amount of Na was reduced from the treatment of $M_{50}S_4$. The study showed that the amount of Potassium, Calcium, Magnesium, Phosphorus, and Sulfur was increased in different Mahogany leaves and Sawdust biochar mixed saline-treated soil after eight months of incubation. The study also showed that Mahogany leaves biochar reduced salinity and increased other nutrients such as K, Ca, Mg, P, and S respectively than that of Sawdust biochar.

There will be high scope to work with Mahogany leaves biochar for the desalination of saline soil and increasing the major nutrients in soils in the coastal region of Bangladesh. Due to the availability of Mahogany leaves, the local farmer can be benefited from this biochar and its use in the field. Overall, the experiment finds out that the Mahogany leaves and Sawdust biochar are very effective for salinity amendment at different soil levels.

ACKNOWLEDGEMENT:

The authors of the manuscript are grateful to the Dept. of Agricultural Chemistry, Faculty of Agriculture, Patuakhali Science and Technology University for this research support.

CONFLICTS OF INTEREST:

This is to certify that, this manuscript is original research and there is no conflict of interest of anybody.

REFERENCES:

1) Akhtar SS, Li G, Andersen MN, and Liu F. (2014). Biochar enhances yield and quality SS of tomato under reduced irrigation. *Agri. Water Manage* **138**, 37-44. https://doi.org/10.1016/j.agwat.2014.02.016
2) Antal MJG. (2013). The art, science, and technology of charcoal production, *Ind. Eng. Chem. Res.* 42 1619-1640.
3) Fiaz K, Raza shah MH, and Niaz S. (2014). Drought impact on Pb/Cd toxicity remediated by biochar in Brassica competes. *J. Soil Sci Plant Nutri,* **14**, 845-854.
4) FAO, (2009). How to feed the world in 2050. pp. 1-35.
5) Gupta B, Huang B. (2014). Mechanism of Salinity tolerance in plants; *Physiolog. Biolog. Molec. Characteriz. J Genome*. https://doi.org/101155%20/(2014)/701596
6) International Biochar Initiative, Standardized Product Definition and Product Testing Guidelines for Biochar That Is Used in Soil, *IBI Biochar Standards*, 2016.
7) Jackson, M.L. (1973) Soil Chemical Analysis. *Prentice Hall Pvt. Ltd., New Delhi.*
8) Jindo K, Mizumoto H, and Sonoki T (2014) Physical and chemical characterization of biochars derived from different agricultural residues. *Biogeoscienc.* **11**, 6613-6621. https://doi.org/10.5194/bg-11-6613-2014
9) Libra JA, Ro KS, Kammann C, and Emmerich KH. (2011). Hydrothermal carbonization of biomass residuals: a comparative review of the chemistry, processes, and applications of wet and dry pyrolysis, *Biofuels*, **2**, 89-124.
10) Lehmann, J, Joseph, S. (2009). (Eds), Biochar for environmental management, Science and Technology, *Earthscan,* UK, pp. 1-2.

11) Munns R and Tester M. (2008). Mechanisms of salinity tolerance. *Annual Review of Plant Biology,* **59**, 651-681. https://www.annualreviews.org/doi/full/10.1146/annurev.arplant.59.032607.092911
12) Oleson SR, Watanabe FS and Pean LA., (1954) Estimation of available phosphorous in soils by extraction of sodium bicarbonate, U.S Department of Agriculture Circular, 939.
13) Osakabe Y, Osakabe K, and Tran LP. (2014). Response of plants to water stress, *Forest Plant Sci.* **5**, 1-19.
14) Page AL, Miller RH, Keeney DR. (eds) (1982) Methods of soil analysis. Part 2. Chemical and microbiological properties. *ASA, Inc, SSSA, Inc, Madison*
15) Pituy P, Sriburi T, Wijitkosum S. (2016) Properties of Biochar Prepared from Acacia Wood and Coconut Shell for Soil Amendment. *Engineer. J.*, **21**(3), pp 63-76.
16) Qadir M, Quillerou E, and Nobel AD. (2014). Economics of salt-induced land degradation and restoration, *Nat. Res. Forum,* **38**, 282-295. https://doi.org/10.1111/1477-8947.12054
17) Sun Y, Gao B, Chen H, and Yang L. (2014). Effects of feedstock type, production method, and pyrolysis temperature on biochar and hydrochar properties. *Chemic. Engineer. J.*, **240**, 574-578. https://daneshyari.com/article/preview/147739.pdf
Tandon HLS. (1995a) Sulphur in Indian agriculture: Update 1995. *Sulfur in Agric,* **19**, 3–8. https://link.springer.com/chapter/10.1007/978-94-017-0289-8_19
18) Usman ARA, Al- wabel MI, and Ahmed M (2016). Conocarpus biochar induces changes in soil nutrients availability and tomato growth under saline irrigation, *Pedosphere*, **26**, 27-38.
19) Wang VNL, Dalal RC, and Greene RSB. (2009). Carbon dynamics of sodic and saline soils following gypsum and organic materials addition; A laboratory incubation. *Appl. Soil Ecol,* **41**, 29-40.
20) Yousif AAA., and Mohamed IA. (2022). Prediction of compaction parameters from soil index properties case study: dam complex of upper Atbara project. *Am. J. Pure Appl. Sci.*, **4**(1), 01-09. https://doi.org/10.34104/ajpab.022.01009

Citation: Islam MA, Biswas RK, Ghosh S, and Mistry G. (2023). Application of mahogany leaves and sawdust biochar for amendment of saline soil. *Am. J. Pure Appl. Sci.*, **5**(5), 104-115.
https://doi.org/10.34104/ajpab.023.01040115