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MITIGATION OF SALINITY STRESS IN SOYBEAN USING ORGANIC AMENDMENTS

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Abstract

A pot experiment was carried out in semi-controlled condition at the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur from November 2015 to March 2016 to assess the effect of organic amendments to mitigate salinity stress in Soybean var. BARI soybean 5. Two types of organic amendments i) water hyacinth compost and ii) rice husk biochar were mixed in soil @ 5 and 10 t ha^{-1} of both. Saline solution was prepared by adding tap water in seawater to make 5 and 10 dS m^{-1} salinity respectively. Plants were irrigated with the salt solution from 14th day after sowing (DAS) to maturity and the control plants were irrigated with tap water. Data on different parameters like plant height, leaf, stem, root dry matter and yield contributing parameters were recorded at harvest. Experimental results revealed that salinity decreased plant height, dry weight of leaf, stem and root as well as yield of soybean plant^{-1}. Application of water hyacinth compost and rice husk biochar had positive effects on mitigating the negative effects of salinity stress on all those parameters studied. However, rice husk biochar at the rate of 5 t ha^{-1} showed best result to mitigate salinity stress at low salinity (5 dSmdS m^{-1} condition.

Introduction

Soybean (*Glycine max.* L) is one of the most important oilseeds crop of the world due to its high food value. It contains about 36-40% protein, 18-20% oil, 30% carbohydrate, 7.3% sugar and 9.3% dietary fiber and also unsaturated fatty acids, minerals like Ca and P including vitamin A, B, C and vitamin D. In Bangladesh, the total cultivated area under soybean cultivation is 41440 hectares which produces 65883 tons of oil per year (FAO, 2013).The cultivation of soybean is increasing in Bangladesh mostly due to its increasing demand in the poultry sector. Agricultural productivity is severely affected by soil salinity and the damaging effect of salt accumulation in agricultural soils has become an important environmental concern all over the world. Accumulation of excess Na and Cl in plant body causes ionic imbalances that may impair the selectivity of root membranes and induce potassium deficiency (Gadallah, 1999). The deficiency of K initially leads to chlorosis and then causes necrosis (Gopal and Dube, 2003).Excess soluble salts reduce yields by impairing germination, or creating osmotic gradients which interfere with the uptake of essential nutrients by plants (Bernstein, 1975; Stamatiadis *et al.,* 1999; Tanji, 1990).

Out of 2.86 million hectares of coastal and offshore lands, about 1.056 million hectares are affected by varying degrees of salinity (SRDI, 2010). Reclamation of saline soil is difficult.

Therefore, alternative ways may be adopted like mitigation of salinity using different organic amendments. There are evidences that soil amendments with various organic substances such as farmyard manure, poultry manure and mulch can be used for the reduction of toxic effects of salinity in various plant species (Idrees *et al.*, 2004; Abou El-Magd *et al.,* 2008; Leithy *et al.,* 2010; Raafat and Thawrat, 2011). Water hyacinth-compost is a dark, crumbly, earthy-smelling mixture that consists mostly of decayed organic matter. Composts are widely used as sources of nutrients and organic matter. The beneficial influence of compost on soil physical and chemical properties has been well documented (Debosz *et al.,* 2002; Lynch *et al.*, 2005; Tejada *et al.*, 2006; Wanas and Omran, 2006). Biochar is pyrolysed organic material intended for use as a soil amendment to sustainably sequester C and concurrently improve soil function, while avoiding any adverse effects, on both the short and long terms (Verheijen *et al.*, 2009). Biochar enhanced soil water-holding capacity (Asai *et al*., 2009; Laird *et al*., 2010); improved soil water permeability (Asai *et al*., 2009); improved saturated hydraulic conductivity (SHC) (Asai *et al*., 2009); reduced soil strength (Chan *et al*., 2007, 2008) and modification in soil bulk density (ρb) (Laird *et al*., 2010). Therefore, both water hyacinth-compost and biochar may reduce the harmful effect of salinity on crop productivity. However, scarce information is available on the effect of the organic amendments on mitigation of salinity on soybean. Therefore, this experiment was carried out to analyze the effect of water hyacinth-compost and biochar on growth performance of soybean under saline conditions.

Materials and Methods

The pot experiment was carried out in the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur from November 2015 to March 2016 to investigate the effect of organic amendments to mitigate negative effects of salinity stress on different parameters of soybean var. BARI soybean 5. The soil was a sandy loam with pH 6.93, total N =0.07%, available P= 0.08 mg 100 g^{-1} dry soil, exchangeable K = 0.79 $cmol_c$ kg^{-1} dry soil, available S = 10 ppm, organic carbon = 0.61%, CEC = 13.05 $cmol_c$ kg^{-1} dry soil and EC = 0.4 dS m^{-1}. The experiment was consisted of 15 treatments as: T_0=Control (without organic amendments and seawater),), T_1=5 dSm^{-1}seawater, T_2=10 dS m^{-1} seawater, T3 = Compost @ 5 t ha^{-1},T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 5 dSm^{-1}sea water, dS m^{-1} seawater, T_6= Compost @ 10 t ha^{-1} with 5 dS m^{-1} seawater, T_7= Compost @ 5 t ha^{-1} with10 dSm^{-1} sea water with 10 dS m^{-1} seawater,T_8= Compost @ 10 t ha^{-1} with10 dSm^{-1} sea- water, with 10 dS m^{-1} seawater, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1},T_{11}= Biochar @ 5 t ha^{-1} with 5 dSm^{-1}seawater,dS m^{-1} seawater, T_{12}= Biochar @10 t ha^{-1} with 5 dSm^{-1}seawater,dS m^{-1} seawater, T_{13}= Biochar @ 5 t ha^{-1} with10 dSm^{-1}seawater,with 10 dS m^{-1} seawater, T_{14}= Biochar @ 10 t ha^{-1} with10 dSm^{-1}seawater.with 10 dS m^{-1} seawater. Saline solution was prepared by adding tap water in sea- water to make 5 and 100 mM salinity, respectively. Plants were irrigated with 5 dSm^{-1}dS $m^{-1}$and 10 dSm^{-1}dS m^{-1}salt solution from 14 days after sowing (DAS) to maturity and control plants were irrigated with tap water. The organic amendments were mixed with pot soil. The experiment was laid out in a completely randomized design (CRD) with three replications. Data on different parameters like plant height, dry matter production in different plant parts, yield and yield contributing charecteristieswere recorded at harvest. The recorded data were statistically analyzed by “CROPSTAT 7.2” software to examine the significant variations in the results due to different treatments. The treatment means were compared by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Soil salinity caused a significant effect in plant height of soybean. At control, plant height was found 17.3 cm but it was 17.7 cm and 15.0 cm under 5and 10 dSm^{-1} salinity levels, respectively

(Fig. 1). It was observed that plant height increased at 5 dSm^{-1} than control, because lower level of salinity might have acted as nutrient of plant growth. At 10 dSm^{-1} seawater treatment caused a drastic decreased in plant height and it indicates that high level of salinity was harmful for plant height. Organic amendments significantly increased the plant height of soybean under both control and salt stress conditions. At control condition, highest plant height (23.0 cm) was found when soil was treated with biochar @10 t ha^{-1} and the lowest height (19.3 cm) with water hyacinth compost was added in the soil @10 t ha^{-1}. At 5 dSm^{-1} salinity stress highest plant height (22.0 cm) was recorded when soil was treated with water hyacinth compost @ 10 t ha^{-1} and the lowest height (19.7 cm) when soil was treated with compost @ 5 t ha^{-1} but similar plant height also recorded from biochar amendment @ 10 t ha^{-1}. On the other hand, under 10 dSm^{-1} salinity stress the tallest plant (20 cm) was found when soil was treated with biochar @ 10 t ha^{-1} and the shortest plant (16.7 cm) from compost amendment @ 5 t ha^{-1}. Results indicated that plant height decreased with increasing salinity level and varied with different organic amendments.

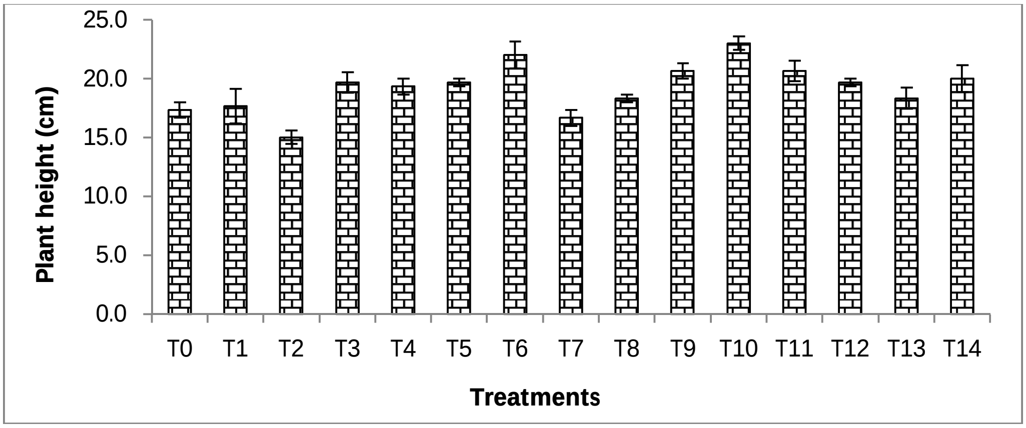

Fig. 1. Effect of organic amendments on plant height of soybean under saline conditions. Bars indicate SE (±)

T_0=Control (without organic amendments and sea water), T_1= 5 dSm^{-1} mM seawater, T_2= 10 dSm^{-1} sea-water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 5 dSm^{-1} sea-water, T_6= Compost @ 10 t ha^{-1} with 5 dSm^{-1} sea- water, T_7= Compost @ 5 t ha^{-1} with 10 dSm^{-1}sea- water, T_8= Compost @ 10 t ha^{-1} with 10 dSm^{-1} sea- water, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 5 dSm^{-1} sea water, T_{12}= Biochar @10 t ha^{-1} with 5 dSm^{-1} sea- water, T_{13}= Biochar @ 5 t ha^{-1} with 10 dSm^{-1} sea- water, T_{14} = Biochar @ 10 t ha^{-1} with 10 dSm^{-1} sea-water

Dry matter production in different plant parts

Leaf dry matter

Leaf dry matter weight $plant^{-1}$ was reduced due to salinity (Fig. 2). The lowest leaf dry mass (1.97 g $plant^{-1}$) was recorded at 10 dSm^{-1}salt condition. Organic amendment significantly increased leaf dry matter of soybean under control and saline conditions. Highest leaf dry matter (7.11 g $plant^{-1}$) was observed when biochar was added @ 5 t ha^{-1} and it was 6.32g $plant^{-1}$ when compost was added @ 10 t ha^{-1} under control condition. At 5 dSm^{-1} salinity condition, highest leaf dry matter (4.57 g $plant^{-1}$) was obtained from compost @ 5 t ha^{-1} and lowest (3.9 g $plant^{-1}$) at compost @ 10 t ha^{-1}. At 10 dSm^{-1}saline condition, highest leaf dry matter (2.69 g $plant^{-1}$) was obtained when soil was treated with biochar @ 10 t ha^{-1} and it was lowest (2.43 g $plant^{-1}$) when compost added @ 10 t ha^{-1}. Dry weight of stem, leaves and whole plant showed approximately decrease with salinity observed by Hussein *et al.* (2007).

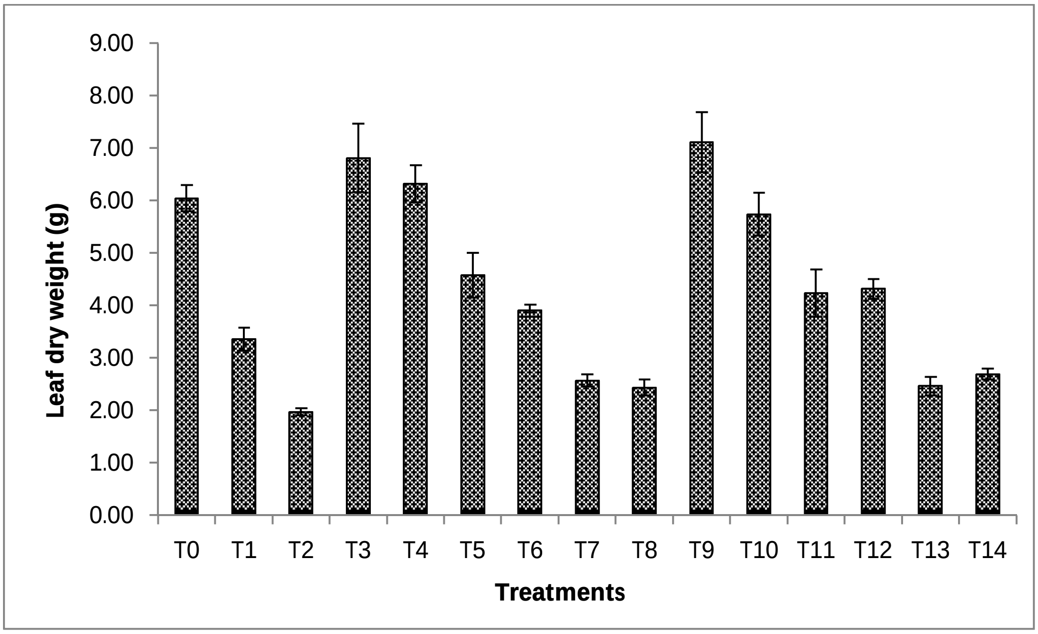

Fig. 2. Effect of organic amendments on leaf dry weight of soybean under saline conditions. Bars indicate SE (±).

T_0=Control(without organic amendments and sea water), T_1= 50 mM sea water T_2= 100 mM sea water, T_3 = Compost @ 5 t/ha, T_4= Compost @ 10 t/ha, T_5= Compost @ 5 t/ha with 50mM sea water, T_6= Compost @ 10 t/ha with 50mM sea water, T_7= Compost @ 5 t/ha with 100mM sea water, T_8= Compost @ 10 t/ha with 100mM sea water, T_9= Biochar @ 5 t/ha, T_{10}= Biochar @ 10 t/ha, T_{11}= Biochar @ 5 t/ha with 50mM sea water, T_{12}= Biochar @10 t/ha with 50mM sea water, T_{13}= Biochar @ 5 t/ha with 100mM sea water, T_{14}= Biochar @ 10 t/ha with 100mM sea water

Stem dry matter

Stem dry matter plant^{-1} of soybean was reduced due to salinity and reduction was higher with increasing salinity levels (Fig. 3). The lowest stem dry mass (2.02 g plant^{-1}) was recorded at 100 mM salt condition. At every case of compost and biochar treatment the stem dry mass was increasing compared to normal condition. Highest stem dry matter (6.18 g plant^{-1}) was observed when biochar was added @ 5 t ha^{-1} and the lowest value (5.40 g plant^{-1}) when compost was added 5 t ha^{-1} under control condition. At 5 dSm^{-1}salinity condition, highest stem dry matter (4.70 g plant^{-1}) was obtained from biochar @ 5 t ha^{-1} and the lowest stem dry matter (4.21 g plant^{-1}) at 5 t ha^{-1}. Under 10 dSm^{-1} saline condition highest stem dry matter (2.69 g plant^{-1}) was obtained when soil was treated with compost @ 5 t ha^{-1} and lowest (2.28 g plant^{-1}) when biochar was added 10 t ha^{-1}. Reduction in stem dry matter due to salinity as compared to control was reported earlier by Karim *et al.* (1992) in triticale.

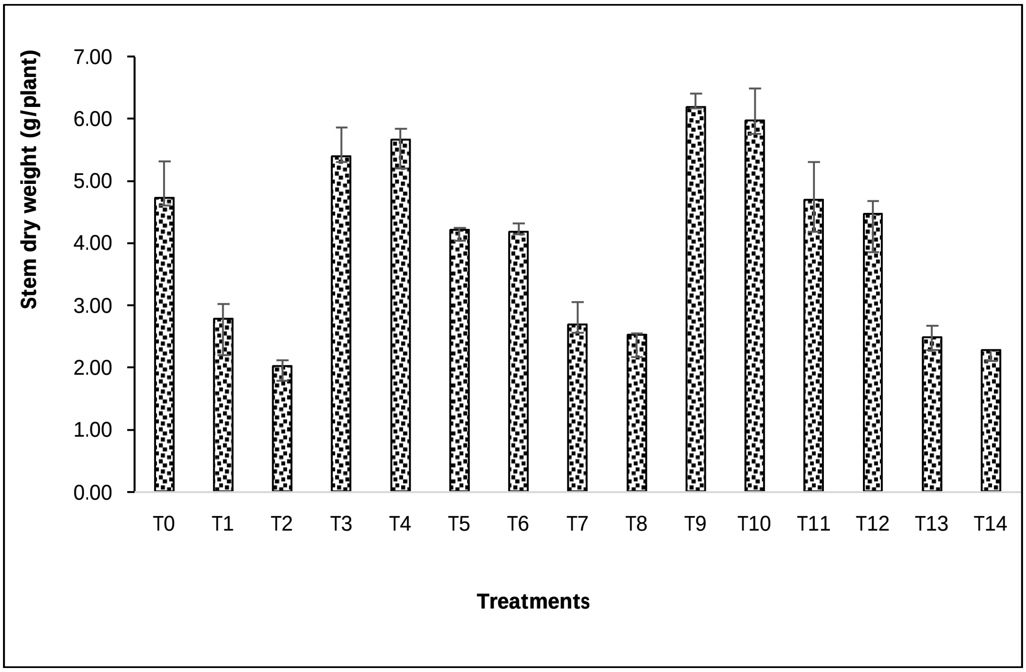

Fig. 3. Effect of organic amendments on stem dry weight of soybean under saline conditions. Bars indicate SE (±).

T_0=Control (without organic amendments and sea water), T_1= 50 mM sea water T_2= 100 mM sea water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 50mM sea water, T_6= Compost @ 10 t ha^{-1} with 50mM sea water, T_7= Compost @ 5 t ha^{-1} with 100mM sea water, T_8= Compost @ 10 t ha^{-1} with 100mM sea water, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 50mM sea water, T_{12}= Biochar @10 t ha^{-1} with 50mM sea water, T_{13}= Biochar @ 5 t ha^{-1} with 100mM sea water, T_{14} = Biochar @ 10 t ha^{-1} with 100mM sea water

Root dry matter

Experimental results revealed that root dry matter was significantly affected by salinity (Fig. 4). The lowest root dry mass (0.50 g plant^{-1}) was recorded at 10 dSm^{-1} salt condition. Under control condition, highest root dry matter (2.53 g plant^{-1}) was recorded with adding biochar @ 5 t ha^{-1} and the lowest (2.17 g plant^{-1}) with @ 10 t ha^{-1}. At 5 dSm^{-1} salinity condition, highest root dry matter (1.70 g plant^{-1}) was obtained with biochar @ 5 t ha^{-1} and lowest (1.37 g plant^{-1}) with compost @ 5 t ha^{-1}. At 10 dSm^{-1} saline condition, highest root dry matter (0.90 g plant^{-1}) was obtained when soil was treated with compost @ 5 t ha^{-1} and lowest (0.77 g plant^{-1}) with biochar as well as compost both @ 10 t ha^{-1}. Salinity induced root mass reduction was reported earlier by Raptan *et al.* (2001) and Sultana *et al.* (2007) in mungbean.

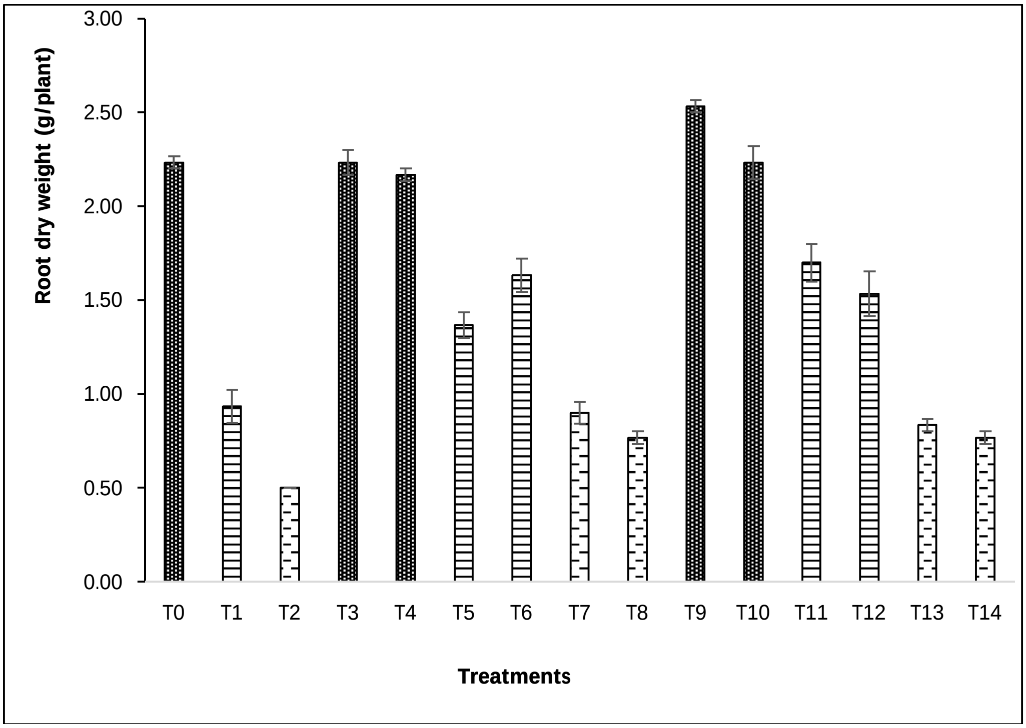

Fig. 4. Effect of organic amendments on root dry weight of soybean under saline conditions. Bars indicate SE (±).

T_0=Control (without organic amendments and sea water), T_1= 50 mM sea water T_2= 100 mM sea water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 50mM sea water, T_6= Compost @ 10 t ha^{-1} with 50mM sea water, T_7= Compost @ 5 t ha^{-1} with 100mM sea water, T_8= Compost @ 10 t ha^{-1} with 100mM sea water, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 50mM sea water, T_{12}= Biochar @10 t ha^{-1} with 50mM sea water, T_{13}= Biochar @ 5 t ha^{-1} with 100mM sea water, T_{14} = Biochar @ 10 t ha^{-1} with 100mM sea water

Shoot dry matter

The shoot dry weight is defined as the sum total of leaf, stem, and petiole dry weight. Shoot dry matter was negatively affected by increasing salinity level (Fig. 5). The lowest shoot dry mass (3.99 g $plant^{-1}$) was recorded at 10 dSm^{-1} salt condition. Organic amendment significantly increased shoot dry matter of soybean under control and saline conditions. Highest shoot dry matter (13.30 g $plant^{-1}$) was recorded when biochar was added @ 5 /ha^{-1} and it was 11.71 g $plant^{-1}$ when biochar was added @ 10 t ha^{-1} under control condition. At 5 dSm^{-1}salinity condition highest shoot dry matter (8.93 g $plant^{-1}$) was obtained adding biochar @ 5 t ha^{-1} and lowest (8.08 g $plant^{-1}$) adding compost @ 10 t ha^{-1}. Under 10 dSm^{-1} saline condition, highest shoot dry matter (5.26 g $plant^{-1}$) was recorded with compost @ 5 t ha^{-1} and the lowest (4.97 g $plant^{-1}$) with biochar as well as compost both @ 10 t ha^{-1}.Reduction in shoot dry weight due to salinity as compared to control was reported by Sultana *et al.* (2007) in six mungbean varieties. Increasing salinity level resulted in significant reductions of shoot biomass, root length and volume. At each salinity level, incorporation of biochar increased shoot biomass, root length and volume observed by Akhtar *et al.* (2015).

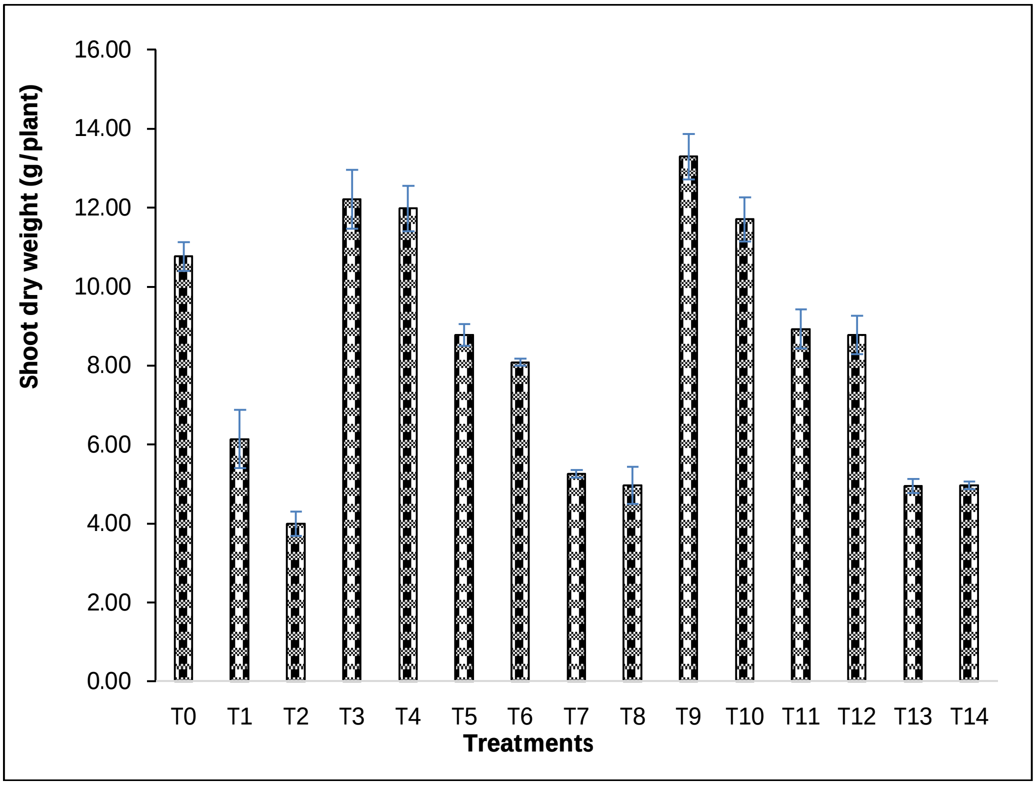

Fig. 5. Effect of organic amendments on shoot dry weight of soybean under saline conditions. Bars indicate SE (±).

T_0=Control (without organic amendments and sea water), T_1= 50 mM sea water T_2= 100 mM sea water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 50mM sea water, T_6= Compost @ 10 t ha^{-1} with 50mM sea water, T_7= Compost @ 5 t ha^{-1} with 100mM sea water, T_8= Compost @ 10 t ha^{-1} with 100mM sea water, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 50mM sea water, T_{12}= Biochar @10 t ha^{-1} with 50mM sea water, T_{13}= Biochar @ 5 t ha^{-1} with 100mM sea water, T_{14} = Biochar @ 10 t ha^{-1} with 100mM sea water

Total dry matter

Reduction in total dry matter production under saline condition and the positive effect of organic amendment on total dry matter production are presented in Fig. 6. Both 5 dSm^{-1}and 10 dSm^{-1} salinity affect significantly on the total dry matter production in soybean plant. Total dry matter of plant was decreased with the increase of soil salinity and the highest (4.36 g plant^{-1}) reduction occurred at 10 dSm^{-1} salinity level. Organic amendment significantly increased total dry matter of soybean under control and saline conditions. Highest total dry matter (15.66 g plant^{-1}) was recorded with adding biochar @5 t ha^{-1} and the lowest (13.94 g plant^{-1}) with biochar @10 t ha^{-1} under control condition. At 5 dS m^{-1} mM salinity condition, highest total dry matter (10.53 g plant^{-1}) was obtained from biochar @ 5 t ha^{-1} and the lowest (9.72 g plant^{-1}) from compost @ 10 t ha^{-1}. Under 10 dSm^{-1} saline condition, highest total dry matter (6.16 g plant^{-1}) was obtained when soil was treated with compost @ 5 t ha^{-1} and lowest (5.46 g plant^{-1}) when biochar was added in the soil @ 5 t ha^{-1}. Reduction in total dry matter production under salinity was also reported Raptan *et al.* (2001) in mungbean.

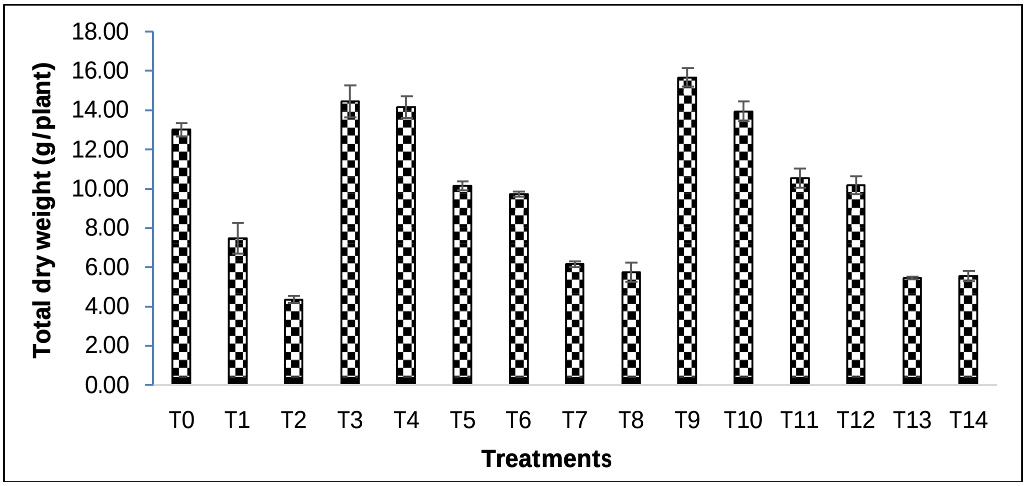

Fig. 6. Effect of organic amendments on total dry matter weight of soybean under saline conditions. Bars indicate SE (±).

T_0=Control (without organic amendments and sea water), T_1= 50 mM sea water T_2= 100 mM sea water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 50mM sea water, T_6= Compost @ 10 t ha^{-1} with 50mM sea water, T_7= Compost @ 5 t ha^{-1} with 100mM sea water, T_8= Compost @ 10 t ha^{-1} with 100mM sea water, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 50mM sea water, T_{12}= Biochar @10 t ha^{-1} with 50mM sea water, T_{13}= Biochar @ 5 t ha^{-1} with 100mM sea water, T_{14} = Biochar @ 10 t ha^{-1} with 100mM sea water

Yield and yield contributing characters

Number of pods plant^{-1}

Soybean plants exposed to salinity caused a significant reduction in number of pod plant^{-1} (Table 1). Organic amendments with water hyacinth compost and rice husk biochar increased pods plant^{-1} at 50 mM and 100 mM salinity stress. The lowest number of pod plant^{-1} was found at 10 dSm^{-1}salinity level (16). But due to organic amendment, the number of pod plant^{-1} was increased as compare to the control. Highest number of pods plant^{-1} (51) was observed when biochar was added @ 5 t ha^{-1} and the lowest (33.67) @ 10 t ha^{-1} under control condition. At 5 dSm^{-1} salinity condition, highest number of pods plant^{-1} (35.33) was obtained from biochar @ 5 t ha^{-1} and lowest (27.67) by applying compost @ 5 t ha^{-1}. Under 10 dSm^{-1}salinity condition, highest number of podplant^{-1} (22.67) was obtained when soil was treated with compost @ 5 t ha^{-1} and the lowest (20.33) was recorded when biochar as well as compost added @ 10 t ha^{-1}. Similar result was found by Leithy *et al.* (2010) on peanut at different levels of salinity.

Number of seed pod^{-1}

The number of seed pod^{-1} also reduced by salinity stress in soybean (Table 1). This reduction rate was increasing with the increasing salinity stress. Application of compost and biochar (5 and 10 t ha^{-1}) significantly increased the number of seeds pod^{-1} in soybean at 0, 5 and 10 dSm^{-1} salinity level. The lowest number of seeds pod^{-1} (0.8) was observed at 10 dSm^{-1} salinity level. But due to addition of organic amendment, the number of seeds pod^{-1} was increased compared to control. The highest number of seeds pod^{-1}(2.17) was observed when biochar was added @5 t ha^{-1} and the lowest (1.84) when compost added @ 10 t ha^{-1}. At 5 dSm^{-1}salinity condition, highest number of seeds pod^{-1}(1.80) was obtained from biochar @5 t ha^{-1} and lowest (1.27) at @ 10 t ha^{-1}. Under 10 dSm^{-1}saline condition, highest number of seed pod^{-1}(1.31) was obtained when soil was treated with biochar @ 5 t ha^{-1} and it was lowest (1.05) when compost was added in the soil @ 10 t ha^{-1}. Similar result was also found by Leithy *et al.* (2010) on peanut at different levels of salinity.

100-seed weight

Salt stress caused a significant decrease in 100- seed weight of soybean plant (Table1). Organic amendments with both compost and biochar significantly increased the 100-seed weight of soybean at 0, 5 and 10 dSm^{-1} salinity stress conditions. Highest 100-seed weight (14.9 g) was observed when biochar was added @ 5 t ha^{-1} and the lowest 100-seed weight (13.86 g) when compost was added @ 5t ha^{-1}under control condition. At 5 dSm^{-1}0 mM salinity condition, highest 100-seed weight (12.40 g) was obtained from biochar @ 5 t ha^{-1} and lowest 100-seed weight (11.20 g) when compost was applied @ 5t ha^{-1}. Under 10 dSm^{-1} saline condition, highest 100- seed weight (11.2) was obtained when soil was treated with compost @ 5 t $ha^{-1}$and it was lowest (9.67) when biochar was added in the soil @ 5t ha^{-1}.

Seed yield

Salt stress caused a significant decrease in yield of soybean plant (Table1). Organic amendments with both compost and biochar significantly increased the yield of soybean at 0, 50 and 100 mM salinity stress conditions. Under 5 dSm^{-1} salinity stress, both compost and biochar also showed a considerable yield in soybean plant.

Table 1. Effect of organic amendments on yield and yield contributing characters of soybean under saline condition

Treatments	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	100- seed weight (g)	Seed yield (g $plant^{-1}$)
T_0	33.33	1.43	13.10	6.18
T_1	25.00	1.17	10.40	2.94
T_2	16.00	0.80	8.90	1.16
T_3	37.00	1.96	13.90	11.42
T_4	33.67	1.84	14.30	9.41
T_5	27.67	1.40	11.20	4.79
T_6	32.00	1.27	12.20	4.87
T_7	22.67	1.17	11.20	2.95
T_8	20.33	1.05	10.40	2.19
T_9	51.00	2.17	14.90	15.65
T_{10}	46.00	2.02	14.50	13.33
T_{11}	35.33	1.80	12.40	8.63
T_{12}	32.33	1.71	12.10	7.54
T_{13}	21.67	1.31	9.70	2.74
T_{14}	20.33	1.17	10.30	2.61
LSD (0.05)	3.92	0.20	0.68	2.15
CV (%)	7.80	8.20	3.40	20.10

T_0=Control (without organic amendments and sea water), T_1= 5 dSm^{-1} sea- water T_2= 10 dSm^{-1} sea- water, T_3 = Compost @ 5 t ha^{-1}, T_4= Compost @ 10 t ha^{-1}, T_5= Compost @ 5 t ha^{-1} with 5 dSm^{-1}seawater, T_6= Compost @ 10 t ha^{-1} with 5 dSm^{-1}seawater, T_7= Compost @ 5 t ha^{-1} with 10 dSm^{-1} seawater, T_8= Compost @ 10 t ha^{-1} with 10 dSm^{-1}seawater, T_9= Biochar @ 5 t ha^{-1}, T_{10}= Biochar @ 10 t ha^{-1}, T_{11}= Biochar @ 5 t ha^{-1} with 5 dSm^{-1} seawater, T_{12}= Biochar @10 t ha^{-1} with 5 dSm^{-1}sea- water, T_{13}= Biochar @ 5 t ha^{-1} with 10 dSm^{-1}sea- water, T_{14}= Biochar @ 10 t ha^{-1} with 10 dSm^{-1} sea- water

At 5 dSm^{-1} salinity stress yield was higher at 10 t ha^{-1} than 5 t ha^{-1}compost treatments but at 10 dSm^{-1} salt level the increment of yield occurred at 5 t ha^{-1}compost treatment. In case of biochar, at 0, 5 and 10 dSm^{-1} salt condition yield was higher at 5 t ha^{-1} than 10 t ha^{-1}. Highest seed yield (15.65 g $plant^{-1}$) was observed when biochar was added @ 5 t $ha^{-1}$and the lowest (9.41 g $plant^{-1}$) yield when compost was added @ 10 t ha^{-1}under control condition. At 5 dSm^{-1}salinity condition, highest seed yield (8.63 g $plant^{-1}$) was obtained from biochar @ 5 t $ha^{-1}$and the lowest seed yield (4.79 g $plant^{-1}$) when compost was applied @ 5 t ha^{-1}. Under 10 dSm^{-1}saline condition, highest seed yield (2.95 g plant^{-1}) was obtained when soil was treated with compost @ 5 t ha^{-1} and lowest (2.19 g plant^{-1}) when compost added in the soil @ 10 t ha^{-1}.

Conclusion

From the results it may be concluded that salinity decreased plant height, leaf, stem, root dry matter and yield contributing parameters of soybean plant. Application of water hyacinth compost and rice husk biochar had positive effects on mitigation of negative effects of salinity stress on soybean growth and yield. However, rice husk biochar at the rate of 5 t ha^{-1} showed best result to mitigate salinity stress at low salinity (5 dSm^{-1}) condition.

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