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-Short Communication

EFFECTS OF SOIL AND WATER SALINITY ON pH, EC AND THE SELECTED ION CONTENTS IN DIFFERENT CROPS GROWN IN NON-SALINE AND SALINITY AFFECTED AREAS OF BANGLADESH

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Salinity intrusion is a growing problem in the coastal areas around the globe. Climate change associated hazards like sea level rise, cyclone and storm surge have been contributing to this problem. Currently, cyclones accompanied by storm surge and increased salinity intrusion into fresh water and soils are the most catastrophic phenomena for coastal communities of Bangladesh, especially in Satkhira, a vulnerable coastal district. In last decade, number of cyclonic events from Bay of Bengal increased. Cyclone Sidr in 2007, cyclones Nargis and Reshmi in 2008 and cyclone Aila in 2009 caused huge damage. The government of People's Republic of Bangladesh estimated that it directly affected about five million families and crops of about 0.7 million hectares (DMB 2010). According to Bangladesh Bureau of Statistics, Sidr caused damage to more than 0.1 million tons of rice crop in Khulna (BBS 2010). Cyclone and storm surges force saline water into agricultural lands along coast, which damages crops in year of cyclone hits and for several years afterwards. This happened in area Shyamnagar *Upazila* under Satkhira district, studied in this present research. Saline water intrusion caused by cyclone Aila in 2009 led to loss and damage to rice crops in this area. Some recent studies indicated that salinity intrusion in both soil and water might increase further because of escalating intensity of cyclone and storm surge (SRDI 2010 and Rabbani *et al.* 2010). Coastal rice crops in Asia, for instance, are frequently affected by exposure to sea water brought in by cyclones around the Indian Ocean (Sultana *et al.* 2001). Salinity in Bangladesh river networks is reasonably well understood, with empirical and physically based study. Sea-level rise is likely to play a significant role in increasing salinity in natural drinking water sources in the future (Aerts *et al*. 2000 and Khan *et al*. 2011). The present study was undertaken to calculate soil, water, crops and salinity balances for different regions of Bangladesh that differ widely in water availability and the salt contents of the irrigation water. The prime aim was to study the impact of salinity on some selected ion contents such as Na, K, Ca, Mg, and Cu present in soil, water and crop samples.

Selection of the sampling area and sample collection: The study was conducted in four villages under Unions at Shyamnagar, Tala and chitalmari *Upazila* in Satkhira and Bagerhat District (salinity affected); Tongbari under Munshiganj District (non-saline).

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Satkhira and Tala are exposed coastal area in South West region under Khulna division of Bangladesh. Samples were collected from the field and were carried to laboratory in plastic bag. In laboratory, they were washed with deionized water to remove dirt. Separated parts were dried in air and at lower oven drying temperature 80˚C (Jarrett 1983) for few hours until constant weight was attained. After cooling samples were grinded and sieved. They were then preserved for analyses in air tight plastic bag.

Sample preparation for laboratory analysis: Reagent grade $HClO_4$ and HNO_3 were procured from E. Merck, Germany. Certified standard stock solutions of nutrients were obtained from Varian, Australia for calibration purpose. All working solutions were also prepared in distilled water. Prior to analysis samples were digested with conc. HNO_3 and $HClO_4$ (2:1) mixture in acid digestion bomb (Model 4749A). Na and K were analyzed by flame photometer and other inorganic nutrients were measured by AAS. Salinity, pH and conductivity were measured by HACH Sension 156 portable multi meter.

The chemical parameters like pH, Electrical conductivity and salinity of water and soil samples are presented in Table 1. Concentrations of Na, K, Ca, Mg, Cu and Zn in different samples collected from various salinity and non-saline areas are presented in Tables 2–3. Concentrations in 12 crop samples varied within the range of Na (1796 - 8362 mg/kg), K (9710 - 48921 mg/kg), Mg (433 - 4660 mg/kg), Ca (415 - 7477 mg/kg), Cu (16 - 46 mg/kg) and Zn (5 - 11 mg/kg).

The pH of the collected water samples ranged from 6.75 to 7.35 with an average value of 7.05. The highest and the lowest pH values were detected respectively at Tala area (pH = 7.35) and Shymnagar (pH = 6.75). The pH values of the soil samples ranged from 6.50 to 7.50 with an average value of 7. The highest pH value was recorded at Tala (pH = 7.50) and the lowest pH value was found at Tangbari (pH = 6.50). According to the standard value set by the Guide to the Environmental Conservation Act 1995 and Rules 1997, for irrigation and drinking water purposes the value of pH is 6.5 - 8.4. At the studied area, pH values of water and soil samples were found within the permissible limit. The EC values of the collected water samples ranged from 965 to 4570 µS/cm with an average value of 2527 µS/cm. The highest and lowest EC values of water samples were recorded at Shymnagar and Tala, respectively. The EC value of the collected soil samples ranged from 150 to 3590 µS/cm with an average value of 1870 µS/cm. The highest EC value was found at Shymnagar (EC = 3590 µS/cm) and the lowest value was recorded at Tala *Upzila* (EC = 150 µS/cm). The highest EC value of the region indicated that the area is salinity affected. So there can be harmful effect by salt concentration or salinity hazard in respect to EC. The salinity of the water and soil samples ranged from 0.2 ppt to 20 ppt and from 0.2 ppt to 0.6 ppt, respectively. The highest salinity value was found at Shyamnagar in both water and soil samples. Result clearly showed Shyamnagar as more salinity affected area. The lowest values were found at Munshiganj (0.2) and Tala (0.4 ppt) for water and soil samples respectively evinced that soil contained less amount of salt than that of water sample.

Table 1. Chemical parameters of soil and water samples collected from sampling areas.

Sampling Locations	Sample types	pH	Conductivity(µS/cm)	Salinity(ppt)
Tala	Water	7.35	646	0.3
Shyamnagar		6.75	4575	20.0
Chitalmari		7.15	1250	0.6
Tangibari		7.04	484	0.2
Tala	Soil	7.50	150	0.2
Shyamnagar		6.90	3590	0.6
Chitalmari		7.12	318	0.3
Tangibari		6.50	780	0.4

Sodium concentration of the collected water and soil samples ranged from 2 to 480 mg/kg and 1389 to 11160 mg/kg respectively. The highest value of Na in water sample was found in Shyamnagar and the lowest value was found in Tangibari. The highest value of Na in soil was recorded at Shymnagar and the lowest value was recorded at Tala. Potassium and magnesium contents were highest (9438 and 13821 mg/kg) in Chitalmari soil samples and the lowest values were recorded (0.19 and 0.65 mg/kg) in Tala water samples. Calcium content was found highest (12578 mg/kg) in Tala soil samples and the lowest (1.25 mg/kg) in Tala water samples. Cu and Zn content (48 and 88 mg/kg) were highest in Chitalmari soil and the least (0.003 & 0.0013 mg/kg) in Shymnagar and Tala water samples respectively (Table 2).

Table 2. Concentrations of selected ion contents of soil and water samples collected from sampling areas.

Location	Sample Type	Concentration of ion contents(mg/kg)					
		Na	K	Mg	Ca	Cu	Zn
Tala	Soil (S-1)	1389	6932	9822	12578	26	66
	Water (W-1)	8	0.2	0.7	1	0.003	0.001
Shyamnagar	Soil(S-2)	11160	6776	10270	5578	12	72
	Water(W-2)	480	14	50	17	BQL	0.002
Chitalmari	Soil(S-3)	2352	9438	13821	11844	48	88
	Water(W-3)	10	0.8	0.9	4	BQL	0.004
Tangibari	Soil(S-4)	1873	6856	12159	7364	44	14
	Water(W-4)	2	1.5	0.7	2	BQL	0.04

BQL= below quantification limit

Among twelve different crop samples, bitter lemon of Tala (8363 mg/kg) followed by cucumber of Shyamnagar (8335 mg/kg) recorded for the maximum Na content and Tangibari potatoes were recorded for the minimum Na concentration (1796 mg/kg). Bitter lemon (Shymnagar) and cucumber (Tangibari) were found to contain the highest and least amounts (48921 and 9711 mg/kg) of K content (Table 3). Both the Mg and Ca

contents were recorded to be highest in cucumber of Shymnagar area (4660 and 7478 mg/kg). In Cucumber and Potato of Tala area minimum concentrations (434 and 416 mg/kg) of Mg and Ca respectively. On the other hand in Bitter lemon of Tala area maximum Zn and Cu contents (46.95 and 11.27 mg/kg) were recorded. Potatoes contained minimum concentrations of Zn and Cu (16.74 and 5.54 mg/kg). Sampling locations with the higher electrical conductivity leads to high salinity. Shyamnagar was found to be most salinity affected area. Studied ion concentrations were found higher in soil than those of water samples and the higher concentrations were recorded in salinity affected areas than those of non-salinity affected areas. When the salt concentration is higher in the soil, water moves from plant into soil. When salts accumulate in soils, problems arise for two main reasons: the soil becomes less permeable and salt damages. Especially high Na concentration affects soil and can lead to sodic soil condition. High Ca, Mg and Zn contents were recorded in samples. If Ca and Mg present in large quantities encounter the effect of Na and help to maintain good soil properties.

Table 3. Concentrations of ions in crop samples collected from sampling areas.

Samples	Concentration of ionic contents (mg/kg)					
	Na	K	Mg	Ca	Zn	Cu
S-1: Potato(Tala)	2925	14535	960	416	19.86	5.64
S-2: Potato(Shyamnagar)	3774	23799	1401	721	25.15	7.47
S-3: Potato(Chitalmari)	3549	25822	1460	425	16.02	5.54
S-4: Potato(Tangibari)	1796	11159	1095	463	16.74	5.73
S-5: Cucumber(Tala)	6026	38605	434	684	45.39	7.66
S-6: Cucumber(Shyamnagar)	8335	40693	4660	7478	43.68	8.01
S-7: Cucumber(Chitalmari)	8065	29385	3200	6055	37.23	6.79
S-8: Cucumber(Tangibari)	3512	9711	759	1186	22.59	6.32
S-9: Bitter Lemon (Tala)	8363	43434	3115	1840	46.95	11.27
S-10: Bitter Lemon (Shyamnagar)	4847	48921	2921	2838	34.76	7.67
S-11: Bitter Lemon (Chitalmari)	7347	34841	2283	1704	29.79	6.99
S-12: Bitter Lemon (Tangibari)	8024	34047	2644	3104	31.26	7.78

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