Elution patterns and distribution of salts from multi-layer reclaimed soils with subsurface layer of porous granules in the newly reclaimed Saemangeum tidal area

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Abstract
This study was carried out to identify the elution patterns and distribution of salts from multi-layer reclaimed soils with a subsurface layer of porous granule in the newly reclaimed Saemangeum tidal area. To do this, paddy and upland plots were established with a layer of porous granule below the surface layer of the indigenous reclaimed soils at a depth of 30~60 cm. Soil samples were taken from the surface and subsurface (porous granule applied) layers at each plot to measure changes of EC of each soil layer at intervals of 1 month during the experiment. The results of EC measurements showed that in the paddy plot with porous granules EC of the top soil (0~30 cm) after 5 months rice cultivation was drastically decreased from 10.54 dS/m to 0.81dS/m while EC decreased from 5.74 dS/m to 0.82 dS/m in the control plot. In the upland plot, EC of top soil decreased from 18.08dS/m to 12.25 dS/m, while in the control upland plot EC value increased from 14.01dS/m to 28.41dS/m. From these results we could assume that the porous granule layer placed at 30~60cm enhanced leaching of salts from the surface layer and cut off capillary rise of salts from the subsurface soil, resulting in lowering the level of salinity to values that would not affect any plant growth.

Key Words
Reclaimed land, desalinization, EC, salinity

Introduction
On the western coast of Korea, tidal flats are extensive with wide distances between the high and low tide levels. These areas are suitable for tideland reclamation and the comprehensive tidal land reclamation projects have been implemented for satisfying the demand of land and water resources increased since the beginning of 1970s(Son *et al.* 2000). However, changes of tides and land use caused by practising tideland reclamation may influence the environment in the area. The majority of reclaimed land in Korea was made through dike construction and had very high salt concentrations in early periods, so to cultivate crops in newly reclaimed lands, soils must be desalinized. Soil salinity plays a very important role in determining plant productivity (Yang *et al.* 2008; Maas *et al.* 1984; Lee *et al.* 2003; U.S. Salinity Laboratory Staff1954). A quantitative and systematic investigation on the characteristics of soil salinity and its distribution in the newly reclaimed soil is not only important to the understanding of tidal soil systems to determine the utilization of the reclaimed land but also for potential development of reclamation methods for the newly established tidal soils in Korea(Jung *et al.* 2003). For salt-affected soil with relatively good permeability, desalinization through vertical drainage can be effective for rapid and desirable desalinization. In this research, we investigated elution patterns and distribution of salts from multi-layer reclaimed soils with subsurface layer of porous granule (coal bottom ash) which could be applied as modification of water flow in newly reclaimed saline soil.

Materials and methods
Study area
Saemangeum was an estuarine tidal flat on the coast of the West Sea in Korea. It was dammed by the government of South Korea in April 2006 and is scheduled to be converted into either agricultural or industrial land. Saemangeum is at the mouths of the Dongjin and Mangyeong Rivers, on the coast of Jeollabuk-do. It is just south of the estuary of the Geum River. Neighboring districts include Gunsan City, Buan County, and Gimje City. After the estuary has been completely filled, an area of about 400 km² (roughly two-thirds the size of Seoul) will have been added to the Korean peninsula, making it one of the biggest landfills in history.

Figure 1. Pictures of Saemangeum rclaimed tidal land area located on the mid-western coast in Korea.

An experimental field was located on Saemangeum reclaimed land, Korea. The soil series was Munpo and soil texture was sandy loam. Experimental paddy and upland plots were made. These plots were established with layer of the porous granule below the surface layer of the indigenous reclaimed soils at depth of 30~60cm. For paddy plots, irrigation water was applied and maintained 10cm above the surface soil during the experimental period, while in the upland plots rainfall was the water sources throughout the experiment. Soil samples were taken from the layers of surface and subsurface (porous granule applied) at each plot to measure changes of EC of each soil layer at intervals of 1 month during the experiment. The chemical properties of the tidal soils obtained from the Saemangeum area are shown in Table 1.

Table 1. Chemical properties of the tidal soils obtained from Saemangeum area.

Soil series	pH	EC	T-N	OM	Av. P2O5	Ex. Cations (cmolc/kg)			
	(1:5)	(dSm-1)	(g /kg)	(g /kg)	(mg /kg)	K	Ca	Mg	Na
Moonpo	7.4	22.5	0.6	8.4	75	2.25	3.9	7.2	23.8
Yumpo	6.9	12.3	0.3	3.1	38	1.61	1.4	5.6	13.3
Poseung	8.1	4.1	0.2	1.9	26	0.90	1.1	2.9	15.1

Results and discussion

Figure 2 shows the changes of EC values of top soil in the paddy plot during the experiment. For surface depth of 0~10 cm, EC decreased from 11.36 dS/m to 0.80d S/m (93.0% of salt was lost). Intermediate depth of 10~20 cm, EC value decreased from 10.78 dS/m to 0.64 dS/m (94.1 % of salt was lost). Bottom depth of 20~30 cm, EC value decreased from 9.47 dS/m to 0.99d S/m (89.5% of salt was lost), showing soil was desalinized. Figure 3 shows the changes of EC values in top soil in the upland plot during experiment. EC values decreased or increased according to amounts of rainfall. For surface depth of 0~10 cm, the EC value increased from 17.50 dS/m to 22.07 dS/m (26.1% of salt increased). Intermediate depth of 10~20㎝, the EC value decreased from 19.33d S/m to 10.58 dS/m (45.3% desalinized). Bottom depth of 20~30 cm, EC value decreased from 17.40 dS/m to 4.09 dS/m (76.5% desalinized). On the other hand in the control upland plot, EC values of top soil (0~30 cm) increased from 14.01 dS/m to 28.41 dS/m(102.8% increased).

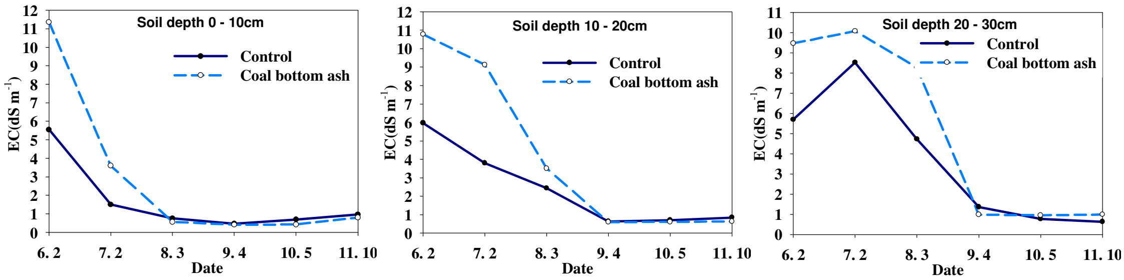

Figure 2. Changes of EC values in multi-layer paddy soil with subsurface layer of porous granules.

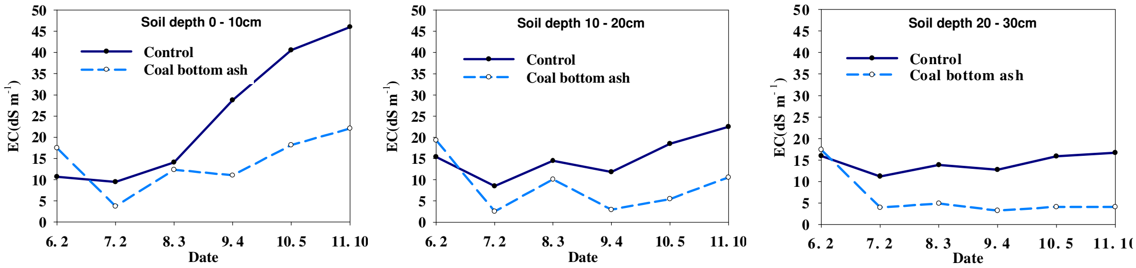

Figure 3. Changes of EC values in multi-layer upland soil with subsurface layer of porous granules.

Conclusion

Multi-layer reclaimed soil with subsurface layer of porous granules (coal bottom ash) show enhanced leaching of salts from the surface soil and diminished capillary rise of salts from the subsurface soil. Therefore, we could conclude that the porous granule layer can be useful as a soil ameliorator for upland cropping in newly reclaimed saline soil.

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