EFFECT OF SOIL SLAKING AND DRYING ON DESALINIZATION FROM SALINE SOIL

塩類土壌の除塩に及ぼすスレーキングと乾燥の効果

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Introduction

Increasing salinity is a major abiotic stress affecting approximately 7 % of the world's total land area resulting in billion dollar losses in crop production around the globe. Improper land use and unscientific irrigation practices leads to degradation of salinized soils which are important issues regarding to plant growth and water quality. At the same time soil degradation caused by salinization and sodification is of great concern in the modern world because it reduces potential agricultural lands (Tanji 1990; Maas and Grattan 1999; Sadiq et al., 2007). In improving those saline soils to find out the effective (an efficient and low cost method) is required. Soil slaking has long been studied from the stand point of stability of aggregates. However, it has not been studied from that of salt removal. Accordingly, the objective of the present study is designated to evaluate the effects of slaking and drying on salt removal of salinized soil. We focus at soil dryness or soil moisture content at which slaking initiates and mostly enhanced. The specific objectives of this study is (1) to identify optimum soil moisture content for slaking, (2) to evaluate salt released accompanied by slaking and (3) to discuss the effect and mechanism of drying on slaking, which deserve attention due to increasing global water shortage and awareness of the environmental impacts associated with irrigation.

Methods and materials

A slaking test was carried out during August-September, 2008 for evaluating the effect on slaking and their impacts on salt removal of salinized soil under various water contents (60, 50, 40, 30, 20 and 10 % by weight). We collected a bulk amount of natural/virgin soil from 50-70 cm depth of Kojima Bay Polder, Okayama. Soil was mixed thoroughly and prepared at the different intensities of experienced drying; natural, air-dry and oven-dry soils. Then the soil sample was packed into the samplers (2.5 cm height and 5 cm diameter) by pushing it into these soils. In case of air-dry and oven-dry soils, we first saturate the soils up to 80 %. The samplers were kept into the incubators at 30°C for drying treatment to attain different soil moisture stages from natural water content to 10%. The weights of each sampler were monitored carefully until the desired moisture contents. There were 54 (18 of each) soil samples for 6 moisture conditions i.e., each moisture levels were replicated thrice. After completing each moisture adjustment it was kept into the refrigerator. Finally, the each adjusted soil sample was immersed into water (tap water; EC: 0.112 mS/cm, volume: 9080 cm^3) on the 4.75 mm sieve for slaking test. After twenty four hours later the slaked and unslaked soils were collected and weighted separately. The EC of equilibrated water and $EC_{1:5}$ of slaked and unslaked soils were measured. Slaking properties were calculated by the following equations:

Slaking rate (%) = Weight of slaked soil/weight of soils (slaked + unslaked) X 100…… (1)

Salt in the slaked soil = $EC_{1:5}$ X weight of slaked soil X 5…….... (2)

Salt in the unslaked soil = $EC_{1:5}$ X weight of unslaked soil X 5…….... (3)

Salt in equilibrium water = EC X volume of equilibrium water…… (4)

Results and discussion

Some selected fundamental properties of studied soils are given in Table 1. Figure 1 shows dependence of slaking rate and EC in equilibrated water after 24 hours slaking on the initial water content. The EC is a measure of salt released from the soil block. The result indicates that soil slaking is remarkably affected by the initial water content and experienced intensity of drying.

Table 1: Some selected fundamental properties of studied soil.

Texture	Silty clay
Soil pH (Soil:Water=1: 2.5)	7.5
Hardness (mm)	3.83
Particle density (g/cm^3)	2.51
Plastic limit (%)	39.53
Liquid limit (%)	73
EC (Soil:Water=1: 5; mS/cm)	2.92

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The salt release is closely related to soil slaking and it enhance by this process. After twenty four hours slaking test, the soils were nothing to slake at 60 and 50 % moisture level in natural soil whereas 88-89 % soils were slaked in air-dry soil under the same moisture levels. But the slaking rate was surprisingly high under 30 % moisture condition in natural and 30 and 20 % in air-dry soils in compared to any other conditions, which might be due to initially dry condition i.e., less saturated and contained more entrapped air than previous moisture content (40 to 60 %) resulting the higher force of escaping air pressure, favourable condition for slaking. The EC in the equilibrium water shows the similar dependence as slaking rate on the initial water content (**Fig. 1**). However, in oven-dry soil there was no unslaked soil in different water contents except 40 %.

The proportion of salt released into water after 24 hours slaking test was also striking against slaking rate (**Fig. 2**). The effect was more pronounced in natural/virgin soil than air-dry soil. The results indicate that the virgin soil did not slake until 40 % water content. On the other hand, the 30 and 20 % moisture level which will be effective for the removal of salt from natural soils.

It is noted that the rate of slaking was lowest in both the air-dry and oven-dry soils at 40 % moisture level.

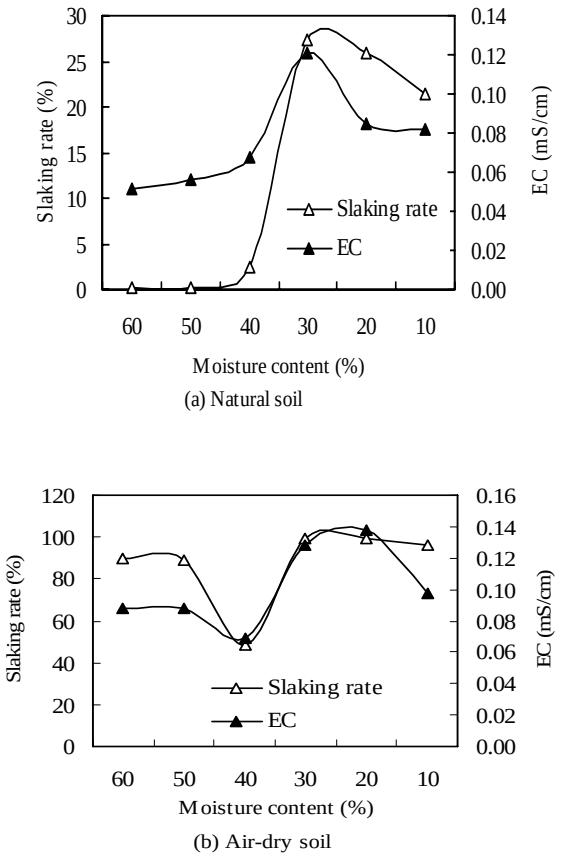

Fig. 1: Dependence of slaking rate and EC in equilibrated water after 24 hours on initial moisture conditions.

Conclusion

The result shows that 24 hours ponded of salinized soil by tap water about 80 % salt will be leached or removed. The results also reveal that the more (about 12 %) salt will be removed by slaking of soil. So, the soil slaking has a good chance to remove the salt under land drying practice. The 30 % moisture level is optimum both in slaking rate and salt released from the saline soils. The continuous research will describe the impacts of slaking and land drying practice on soil properties during desalinization of soil under different moisture conditions.

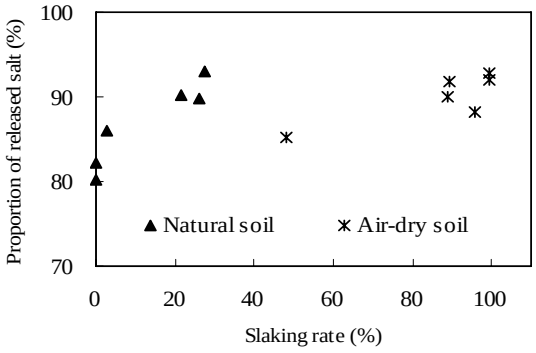

Fig. 2: The proportion of salt released into water after 24 hours against slaking rate in soils.

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