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Biochar manages salt-degraded land and conserves water: Effects and mechanism

Xinqing Lee[1], Yimin Huang[1,2], Fang Yang[1,2], Ying Xing[1,2], Liang Xu[3], Zhongtang Liu[4], Rongmei Wang[3], Ran Holtzman[5], Iddo Kan[6], Yunlong Li[1,2], Like Zhang[1,2], Wei Wu[1,2], Yuena Ma[1,2], and Hui Zhou[1]

[1]Institute of Geochemistry, CAS, State Key Lab. Environ. Geochem., Guiyang, China (lee@mail.gyig.ac.cn)

[2]University of Chinese Academy of Sciences. 19(A) Yuquan Road, Shijingshan District, Beijing 100049, China

[3]The Kashgar Prefecture Meteorological Bureau. 5 Dazhong Road, Kashgar 844000, Xinjiang Autonomous Region, China

[4]The Kashgar Prefecture Agricultural Technology Extension Center. 245 Keziduowei Road, Kashgar 844000, Xinjiang Autonomous Region, China(Liuzhongtang@163.com)

[5]Fluid and Complex Systems Research Centre, Coventry University, United Kingdom(ran.holtzman@coventry.ac.uk)

[6]The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot 76100, Israel(iddo.kan@mail.huji.ac.il)

Soil salinization represents a wide-spread land degradation in the world, especially in arid regions. Current management involves excessive water consumption. As a pyrolyzed residue of biomass waste, biochar has the potential to combat salinization at limited water supply, the effect and mechanism, however, remain to be clarified. We monitored the movement of salts and water in the profile of irrigation-silt soil during watering and evaporation in both laboratory and the field in Kashgar oasis in Xinjiang, China, and found that biochar exacerbates salinization within a short period of time after its application due to its high content of salts, nevertheless, it strengthens salt leaching in irrigation while intensifies salt accumulation in the top soil at the expense below during evaporation, all as results of invigorated movement of salts. Removing the top 2 cm before sowing, therefore, rejuvenates the soil well. Adsorption of biochar retards migration of salts in cation forms, but the effect is trivial. Due to increase to soil water content, biochar promotes evaporation before soil cracking. This is reversed, however, once the cracking occurs, which is inevitable in irrigated farmland and increases evaporation by 77%. Biochar counteracts soil cracking by alleviating soil compaction, lowering water evaporation by 43% at 10% of biochar application rate. Our results indicated that agriculture application of biochar creates salt distribution conducive to desalting in a mechanical way. In conjunction with the effect of anti-fracturing and enhanced salt leaching, it lowers water demand substantially, providing a new solution to the agricultural sustainability at reduced water supply.