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Research Paper

Long term effect of crop residue and tillage on carbon sequestration, soil aggregation and crop productivity in rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system under partially reclaimed sodic soils

RANBIR SINGH[1], ARVIND KUMAR RAI[2], RENU KUMARI[3], DINESH KUMAR SHARMA[4], SATYENDRA KUMAR[5], P.K. JOSHI[6], S.K.CHAUDHARI[7], P.C. SHARMA[8], AJAY SINGH[9] AND BABLI[10]

ICAR-Central Soil Salinity Research Institute, Karnal, Haryana 132 001

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ABSTRACT

A long-term field experiment (2006–2016) was laid out at Karnal, Haryana, to evaluate long-term effect of crop residue and tillage management on carbon sequestration potential, soil aggregates and wheat (*Triticum aestivum* L.) productivity under rice (*Oryza sativa* L.)–wheat cropping sequence on partially reclaimed sodic soil. Residue incorporation in conventional (CV + R) and reduced tillage (RT + R) resulted in significantly higher system productivity (13.01 t/ha and 12.48 t/ha respectively) than other treatments used in present study. Soil properties also improved with zero tillage and residue incorporation. The soil organic carbon (SOC) under tillage with residue treatments (CV+R, RT+R and ZT+R) increased from 14.81 to 39.47% at 0–15 cm soil depth over the control. The highest carbon sequestration potential (0.67 t/ha/year) was obtained in zero tillage + residue (ZT+R) treatment at 0–15 cm soil depth. Crop residue in zero tillage favoured a higher amount of carbon to be preferentially stabilized in fine and coarse aggregates. Crop residue either incorporated in conventional and reduced tillage or anchors in zero tillage proved a useful indicator for assessing soil carbon and sustaining crop productivity in the partially reclaimed sodic soil.

Key words: Reduced tillage, Residue incorporation, Rice residue, Soil organic carbon, Soil organic carbon, System productivity, Tillage, Wheat-equivalent yield, Zero tillage

Present-day intensive agriculture faces many challenges to sustain the requirement of food production for burgeoning population with limited chances of horizontal expansion on cultivable area (Stevenson *et al*., 2013). Rice–wheat cropping system, which covers 13.5 million ha area, representing prime agricultural regions of India, Pakistan, Bangladesh and Nepal, is vital for food security, rural development and natural resource conservation (Gupta *et al*., 2003). Conventional rice–wheat cropping system is quite exhaustive in nature, requiring huge volume of water and nutrients, more labour and energy intensive. Tillage and crop establishment accounts for nearly 25 to 30% of the total production cost of rice–wheat cropping system (Gathala *et al*., 2011). Farmers prefer multiple tillage operations (harrowing, cultivation) to prepare fine seed-beds. These results in higher energy consumption, increasing costs of production, destroy the soil structure and lower the benefit: cost ratio.

Numerous strategies have indicated the usefulness of resource-conservation technologies (reduced, zero tillage and crop-residue incorporation) towards sustaining agricultural productivity under intensive cropping system (Malik *et al.,* 2005). In India, about 6.74 million ha of land is salt-affected, out of which 56% area is sodicity affected. Sodicity affects plant growth and development directly by causing osmotic stress and ion toxicity and indirectly through increased soil dispersion and decreased infiltration rate (Wakeel, 2013).

Crop-residue incorporation develops continuous organic mass, energy flow and improves infiltration rate of sodic soil through the release of organic compounds and enhances the activity and biomass of soil microorganisms and enhances the aggregation of soil particles (Song *et al.,* 2016). Integration of crop residue incorporation with mini-

[1]**Corresponding author's Email:** ranbirsingh59@rediffmail.com; ranbir.singh@icar.gov.in

[1,2]Principal Scientist, [3,9,10] Senior Research Fellow, Soil and Crop Management Division. [4]Emeritus Scientist, CSSRI-Lucknow, Uttar Pradesh, [5]Principal Scientist, Irrigation and Drainage Engineering Division, [6]Retired Principal Scientist, [8]Director, ICAR-Central Soil Salinity Research Institute, Karnal, Haryana 132 001, [7]Assistant Director General (ADG), ICAR, New Delhi 110 012