Impact of conservation practices on soil aggregation and the carbon management index after seven years of maize–wheat cropping system in the Indian Himalayas

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\textbf{A R T I C L E  I N F O}

\textbf{Article history:}
Received 17 February 2015
Received in revised form 23 September 2015
Accepted 28 September 2015
Available online 24 October 2015

\textbf{Keywords:}
Runoff and soil loss
Labile C pools
Soil degradation
Maize and wheat productivity

\textbf{A B S T R A C T}

The carbon management index (CMI) and labile organic carbon (LOC) pools are postulated as very sensitive indicators of changes in soil organic carbon (SOC) due to land degradation within a short time in response to management practices. To test this hypothesis, we investigated LOC and CMI under a field experiment (2007–2013) in relation to runoff, soil loss, maize and wheat yields on a 2\% (1.15\%) land slope of the Indian Himalayas. In this study, the impacts of several resource conservation practices, including different combinations of vegetative barriers (VB), minimum tillage (MT), different organic amendments (OA) and weed mulch, were evaluated. Results revealed that the plots under MT+OA with three applications of weed mulch had more SOC, macroaggregate-associated C concentrations and macroaggregates than conventional tillage (CT)+NPK with chemical weed control. Carbon management index varied from 47 to 59 and 42 to 55\% with different conservation practices at depths of 0–5 and 5–15 cm depths, respectively. Incorporation of weed mulch along with application of OM, MT and VB (by \textit{Palmarosa}) under MT improved CMI by 19.7 and 24.2\% compared to CT plots with VB (by \textit{Panicum}) and inorganic NPK at depths of 0–5 and 5–15 cm, respectively. Significant positive correlations were observed between CMI and maize yield ($r = 0.948$; $n = 24$; $P < 0.01$), CMI and wheat yield ($r = 0.872$; $n = 24$; $P < 0.01$) and CMI and wheat equivalent yield ($r = 0.906$; $n = 24$; $P < 0.01$). However, significant negative correlations were obtained for CMI and runoff ($r = 0.701$; $n = 20$; $P < 0.01$) and CMI and soil loss ($r = 0.768$; $n = 20$; $P < 0.01$). Results established that \textit{Palmarosa} as VB along with OA plus weed-mulch under MT was the best management practice for decreasing runoff and soil loss and increasing system productivity on a 2\% slope in the region. The single value CMI was strongly positively correlated with crop productivity and negatively correlated with soil loss. Hence, this single value CMI could potentially be used for assessment of soil degradation elsewhere.