

Winter cover crops improve soil properties in organic cropping systems

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Implications

An introduction of winter cover crops (wcc) into the crop rotation had a positive impact on soil quality in organic cropping systems. Wcc alone and in combination with composted manure enriched soil with organic matter, activated soil life (increased number of earthworms and soil microbial activity), increased soil pH value, and supported nutrient cycling and soil formation.

Background and objectives

To achieve a more sustainable production it is important to establish growing systems with appropriate crop rotations to ensure fertile and biologically active soils that are providing good crop yields in the long-run. One way to improve soil is to grow winter cover crops as green manure in crop rotations.

The aim of the present research was to investigate the impact of winter cover crops on different soil properties in organic cropping systems in comparison with supply of mineral fertilizers in a conventional system.

Description

Site: Eerika experimental field (58°22'N, 26°40'E) near to Tartu, Estonia

Soil: sandy loam *Albic Stagnic Luvisol*, humus layer 27-29cm. (C_{org} 1.1–1.2%, N_{tot} 0.10–0.12%, P 107–120 mg kg⁻¹, K 114–118 mg kg⁻¹, pH_{KCl} 5.9). Soil bulk density 1.45–1.50 g cm⁻³.

5-years crop rotation (**winter wheat, pea, potato, barley us. red clover, red clover**) experiment in 5 cropping systems (started in 2008, modified in 2011).

Org. 0 → follows crop rotation (CR);

Org. I → CR+ winter cover crops (WCC) ;

Org. II → CR+WCC+composted cattle manure – winter wheat 10 t ha⁻¹, potato 20 t ha⁻¹, barley 10 t ha⁻¹ (in spring);

Conv I → follows crop rotation, as control (no fertilizer use), with pesticides;

Conv II → follows crop rotation + winter wheat and potato 150 kg ha⁻¹ N, barley us. red clover 120 kg ha⁻¹ N and pea 20 kg ha⁻¹ N, with pesticides.

Winter cover crops: winter turnip rape+winter rye, winter turnip rape, winter rye



Results

Soil organic carbon (C_{org}) content increased due to use of cover crops and composted manure

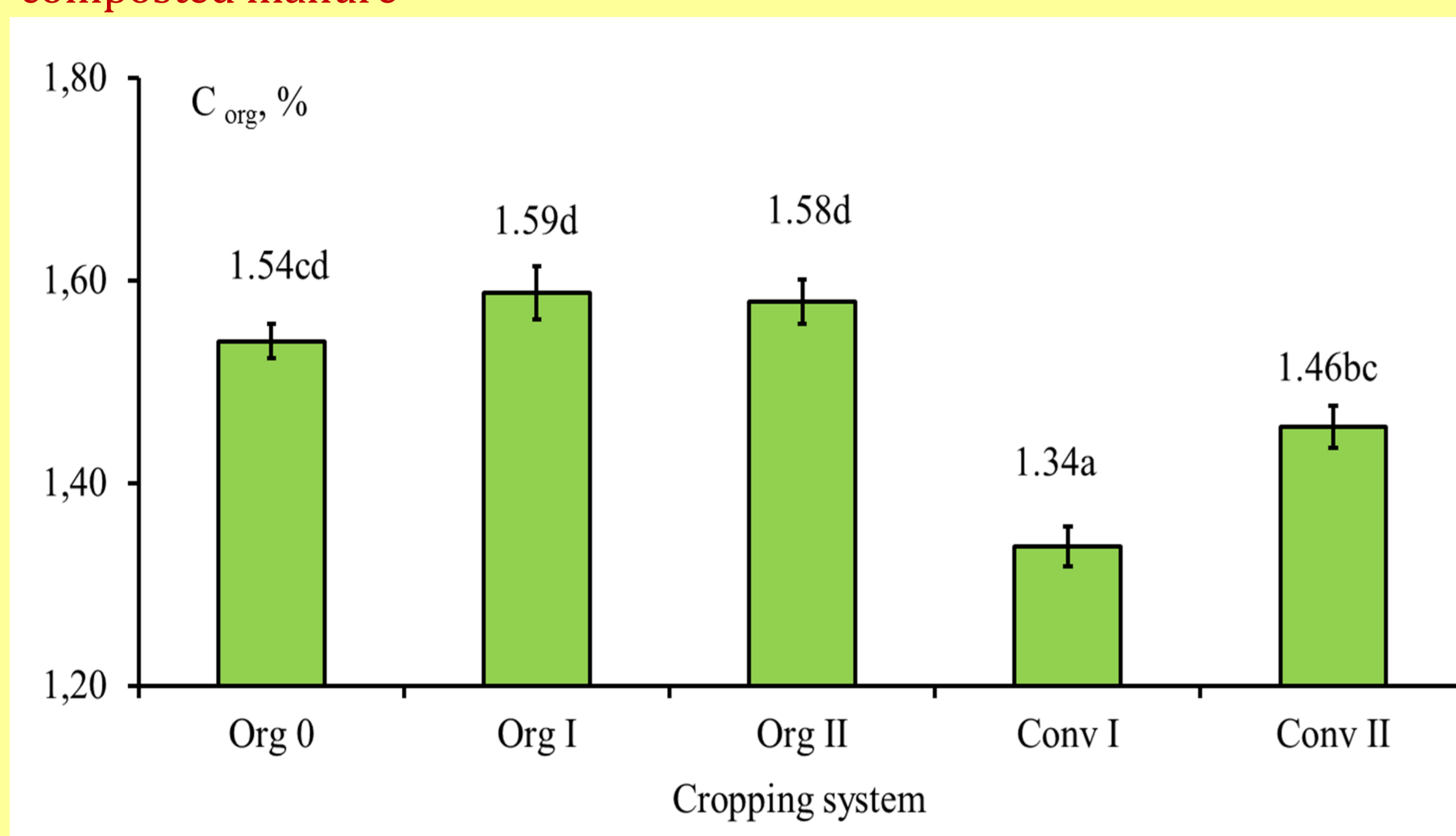


Figure 1. Soil organic carbon content in soil, % (2012-2015 average).

Soil microbial activity was higher in organic systems than in conventional ones

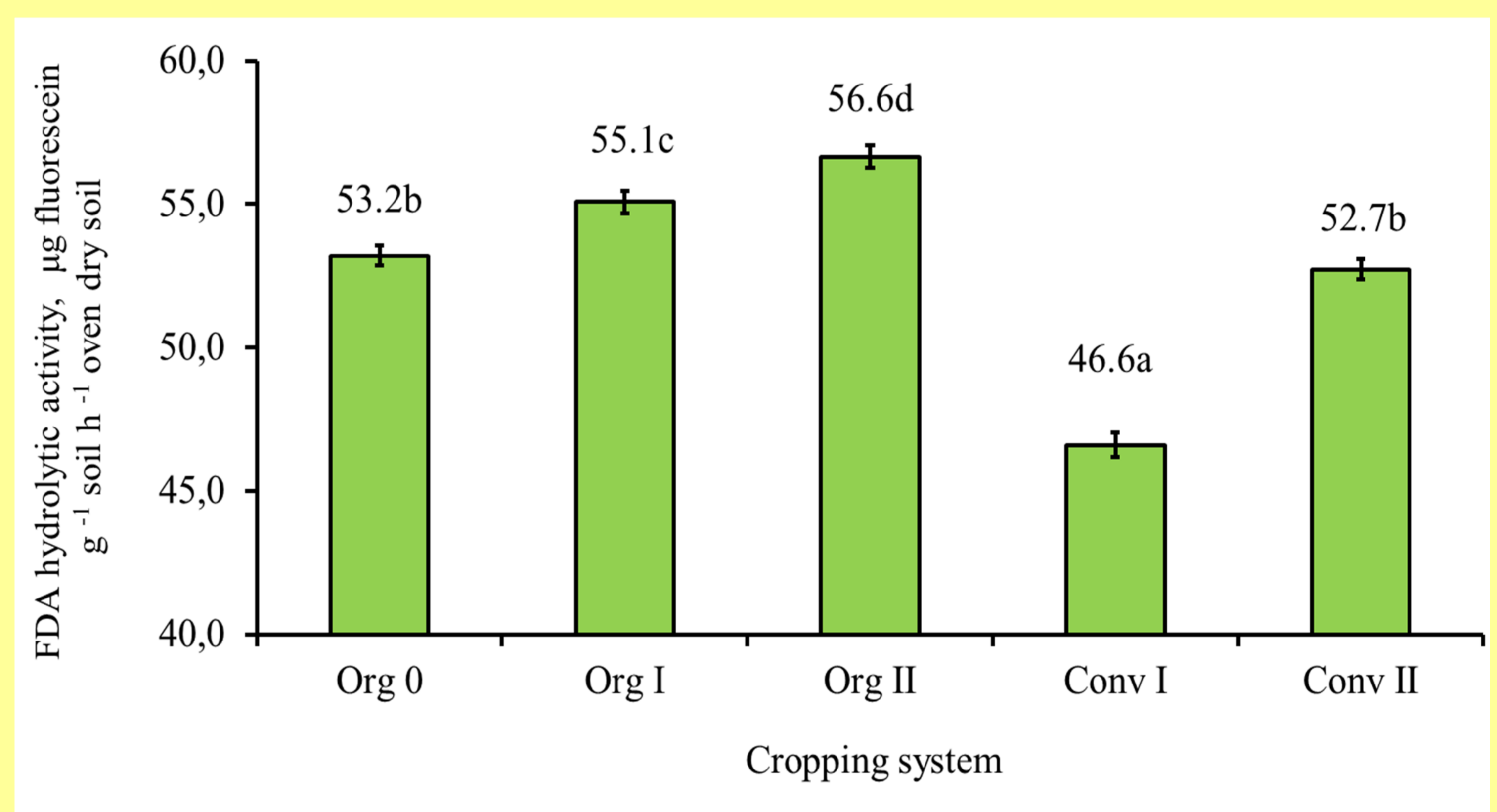


Figure 2. FDA hydrolytic activity (2012–2014 average), µg fluorescein g⁻¹ soil h⁻¹.

In the organic systems soil pH value increased during the experimental period

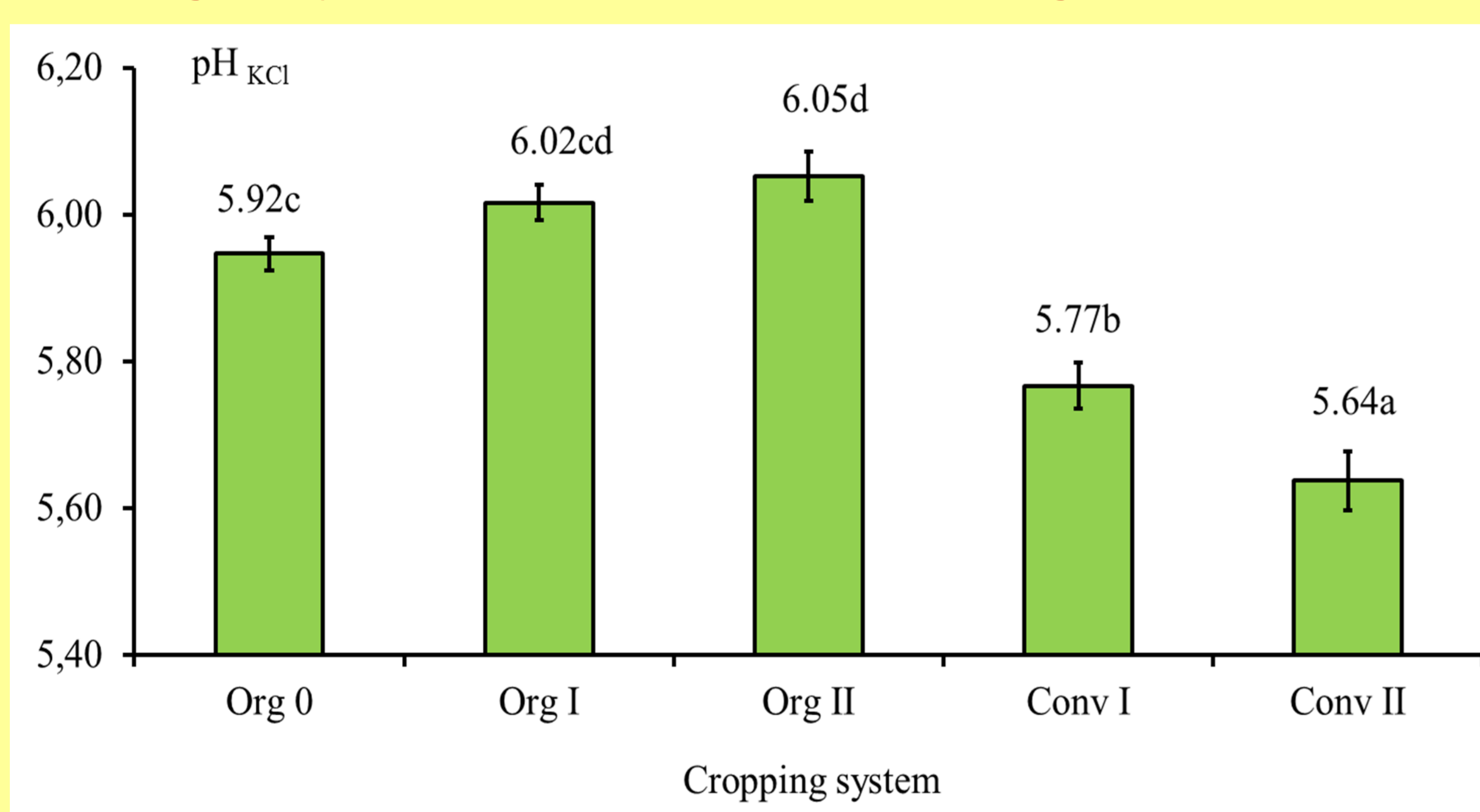


Figure 3. Soil pH_{KCl} (2012-2015 average).

Note – Means followed by different letters within each column indicate significant influence ($P < 0.05$) of farming systems TUKEY HSD

The changes in soil chemical and biological properties were correlated by changes in soil physical parameters. The highest bulk density, lower percentage of water permeability and lower air filled pores fraction was found in Conv I compared with the other systems

Plant available P, K, Mg contents decreased with time in the ploughing layer of the conventional systems

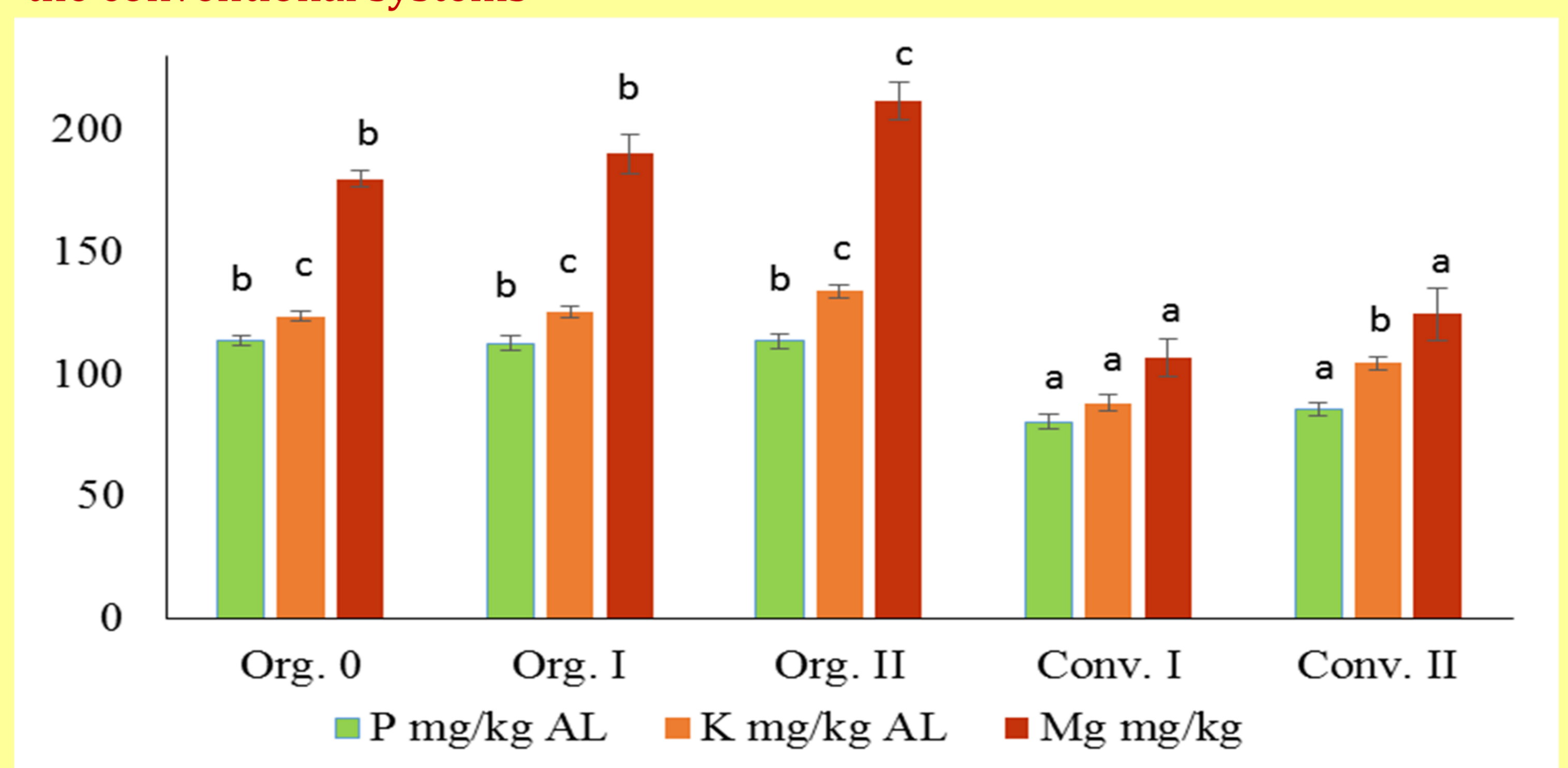


Figure 4. Soil P, K, Mg content (2012-2015 average).

Conclusion

Winter cover crops in crop rotation, especially in combination with manure, have significantly positive impact on soil biological, chemical and physical properties in organic systems in comparison with mineral fertilizing in conventional systems.