

In crop rotation green manures as winter cover crops enhance ecosystem services of farming

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Experiment description

5-years crop rotation (**winter wheat, pea, potato, barley us. red clover, red clover**) experiment in 3 organic cropping systems:

- **Org. 0** → follows crop rotation (**CR**);
- **Org. I** → CR+ green manure catch crops as winter cover (**GM**);
- **Org. II** → CR+GM+composted cattle manure – winter wheat 10 t/ha, potato 20 t/ha, barley 10 t/ha (in spring).

Green manures: ryegrass after winter wheat, winter oilseed rape after pea, winter rye after potato, red clover

Block scheme. Each system in 4 replications = 60 plots

Each plot = 60 m²

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

Climate: Precipitation 591 mm/y

Mean annual temperature 4.4 (+30...-30) °C

Soil: sandy loam *Albic Stagnic Luvisol*

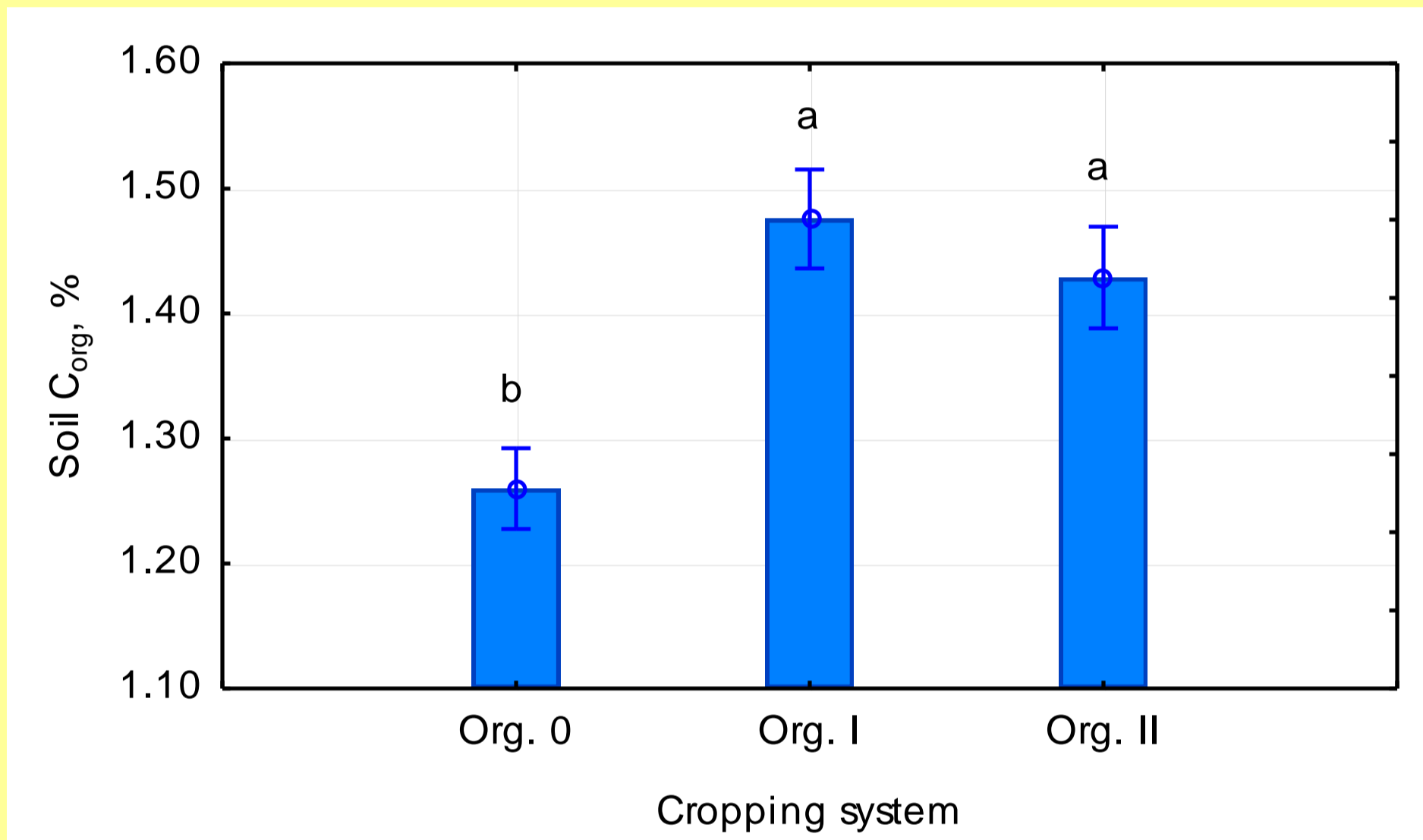
Experimental place



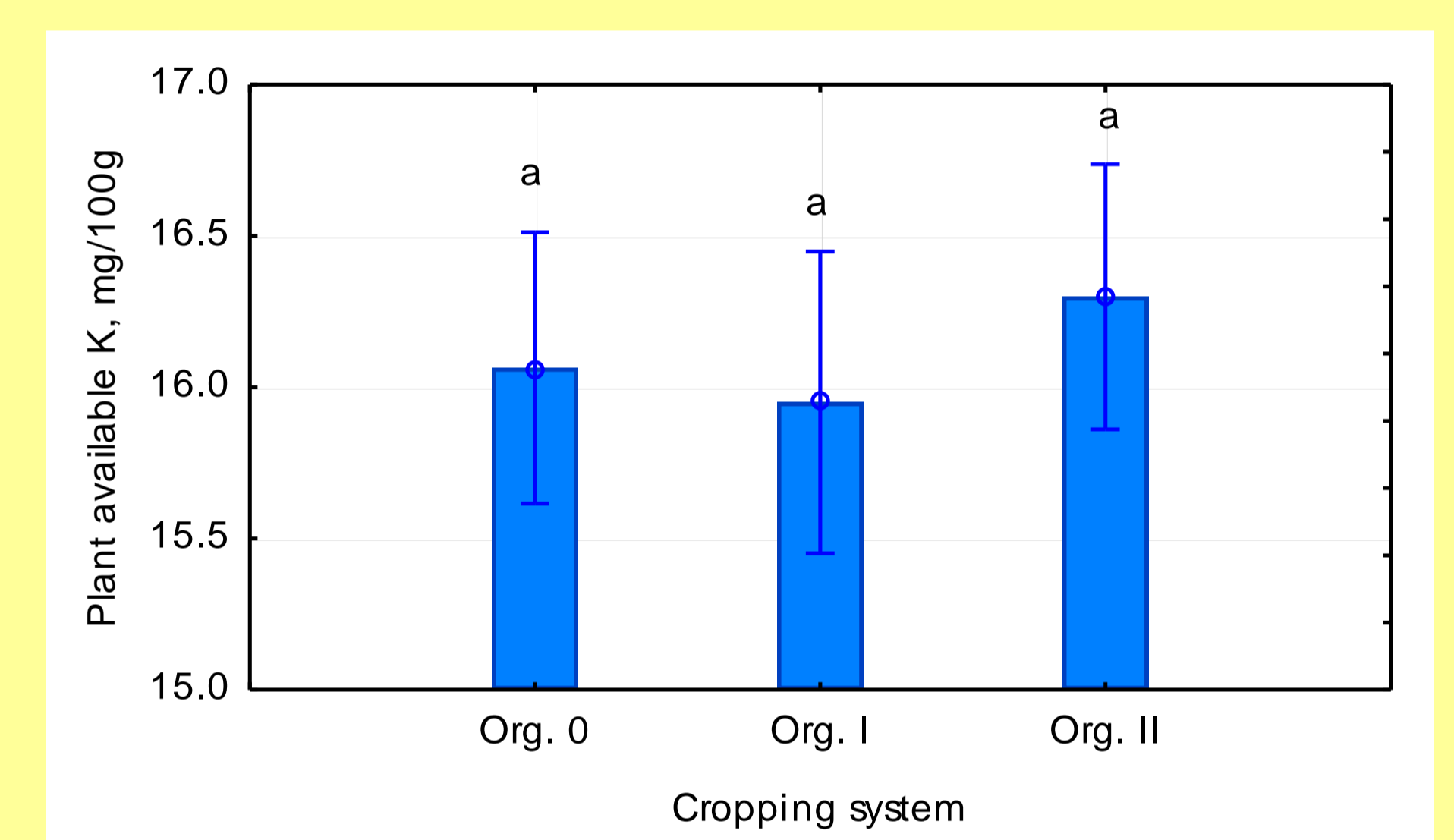
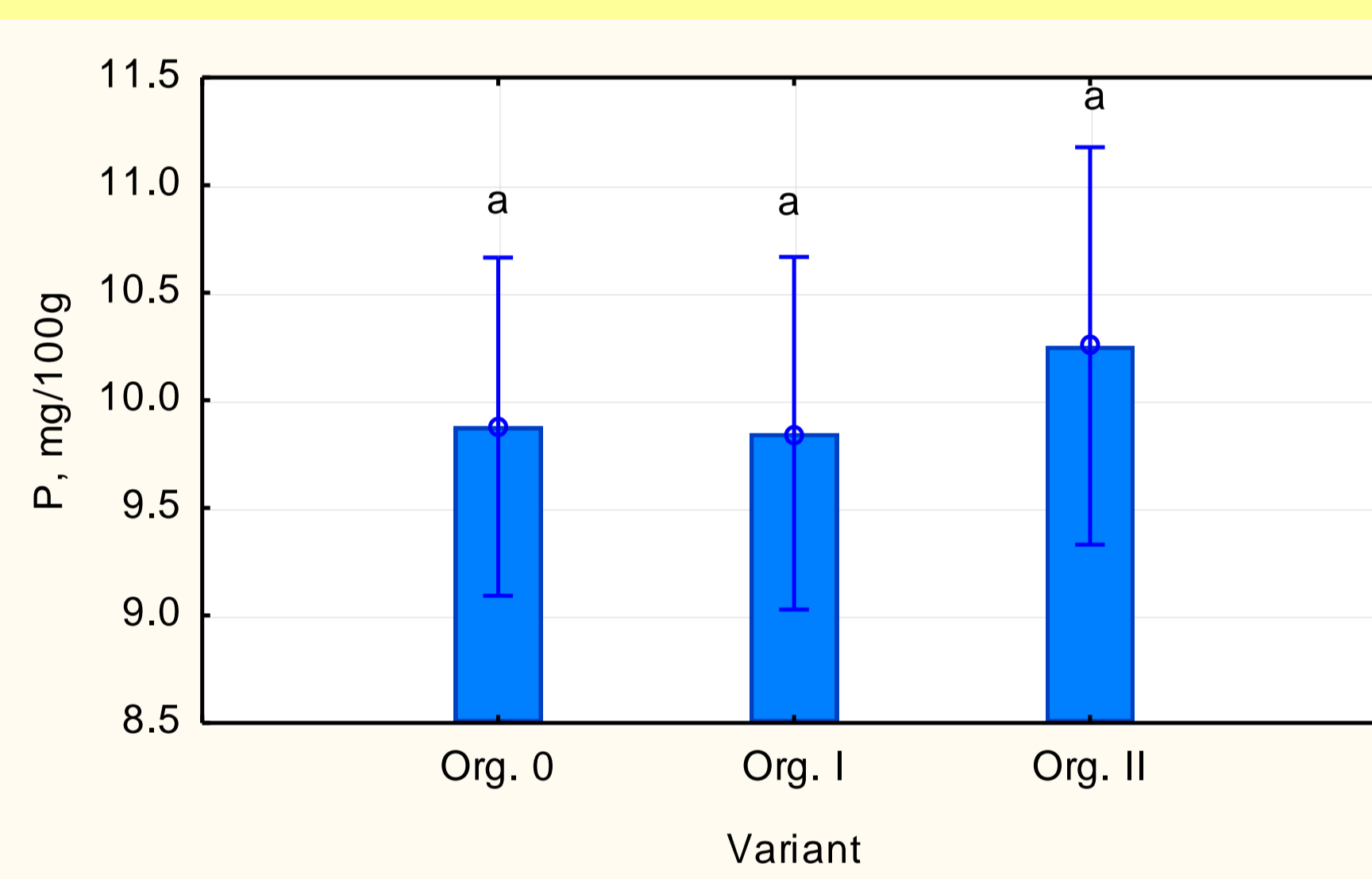
The aim of this research is to investigate the effect of different green manures and their combination with cattle manure on ecosystem services - soil properties, biodiversity indicators - weeds, carabids and crop yields in five-field crop rotation experiment of three different organic cropping systems.

Results

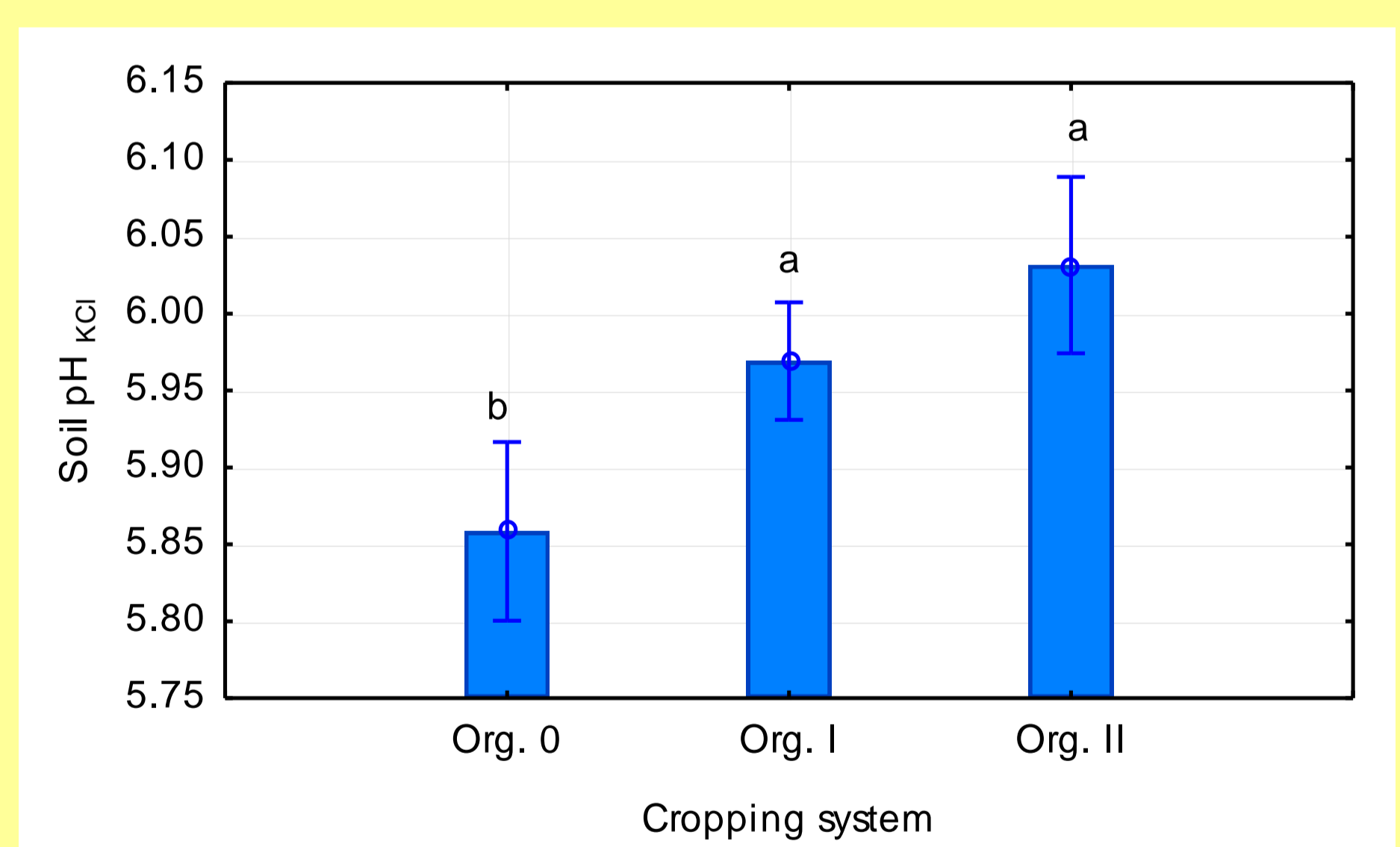
Green manures (GM) increase soil organic carbon.



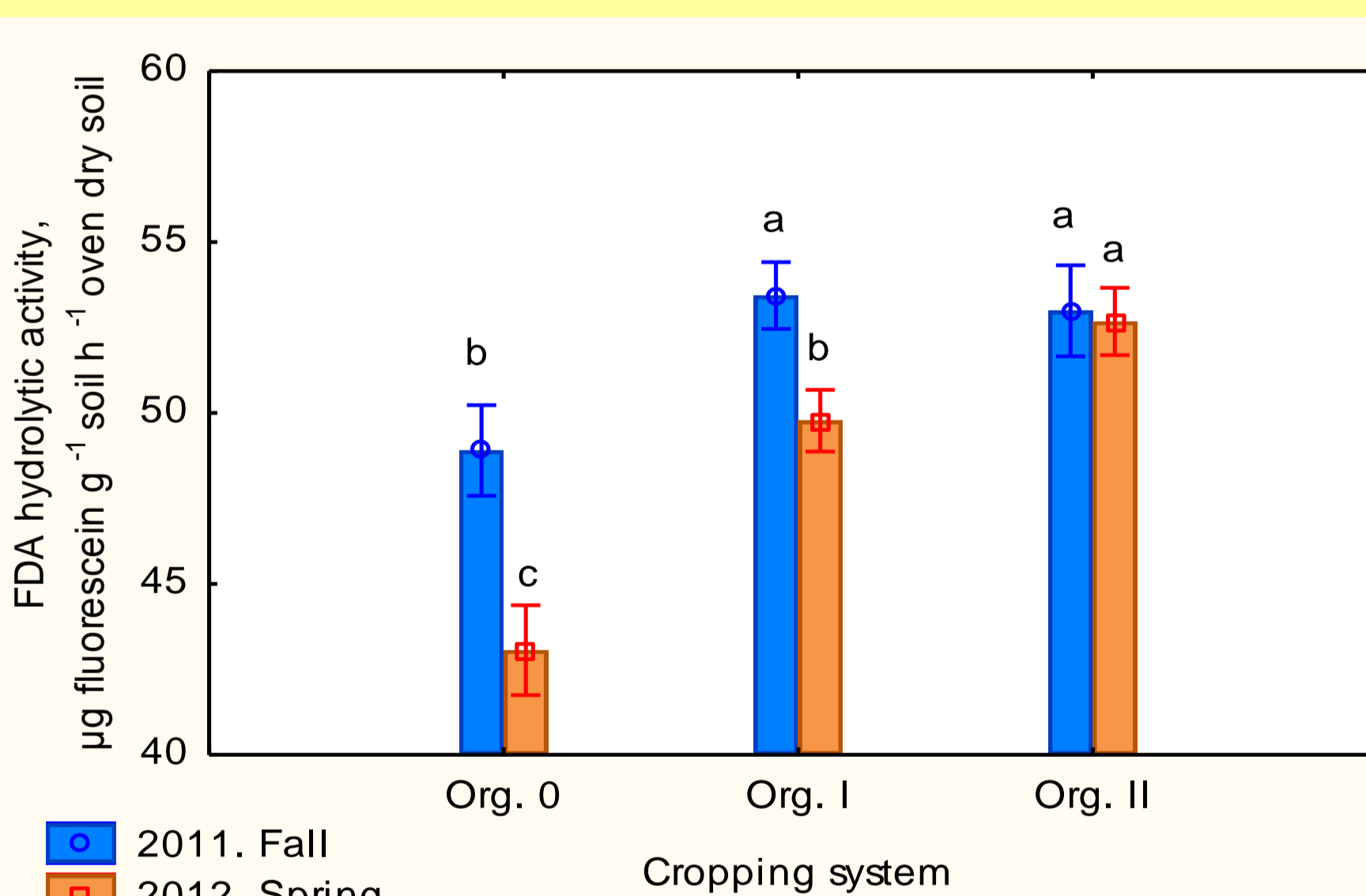
GM in combination with cattle manure had a tendency to increase the plant available P and K in soil.



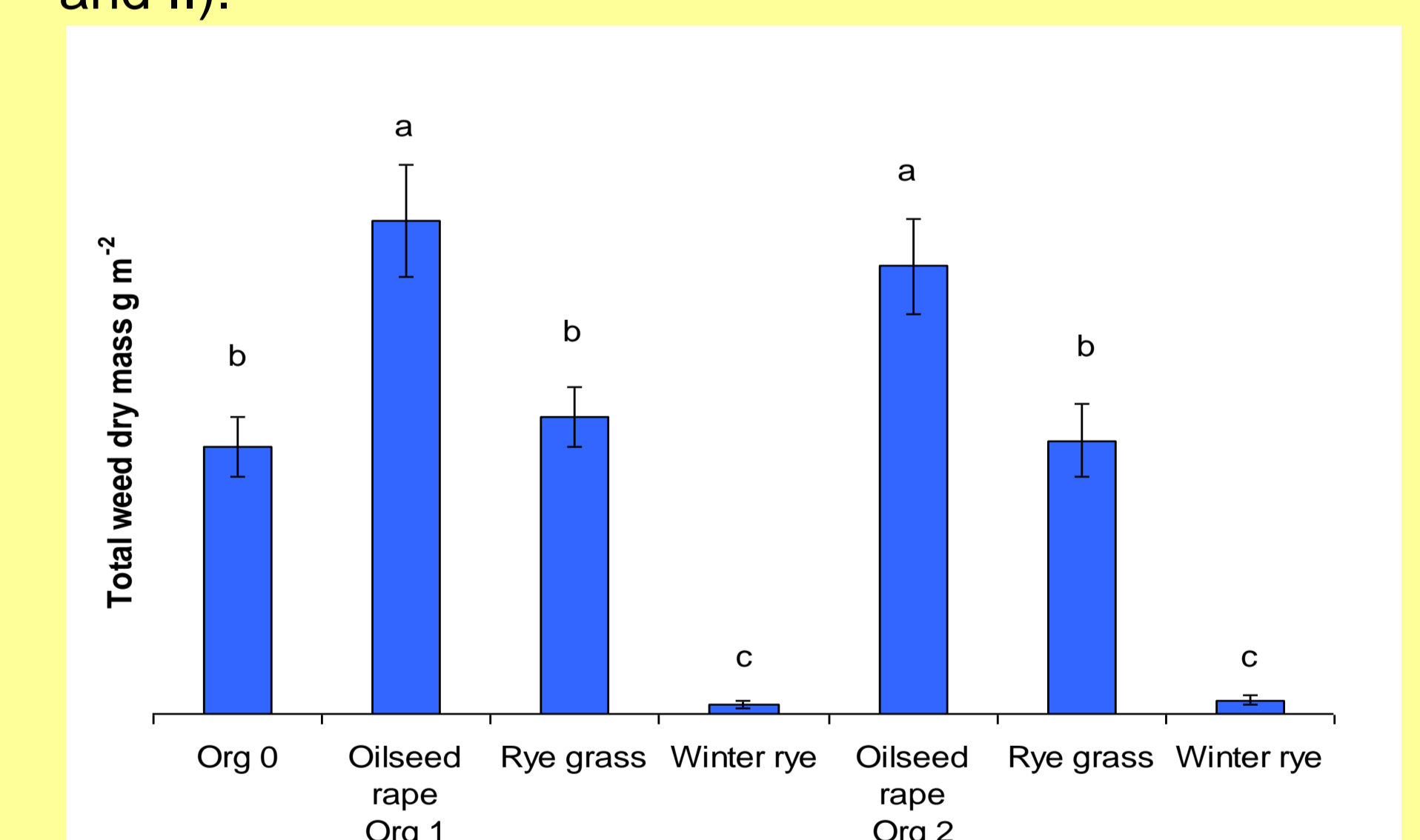
GM and their combination with cattle manure had a tendency to increase soil pH (Org. I, II).



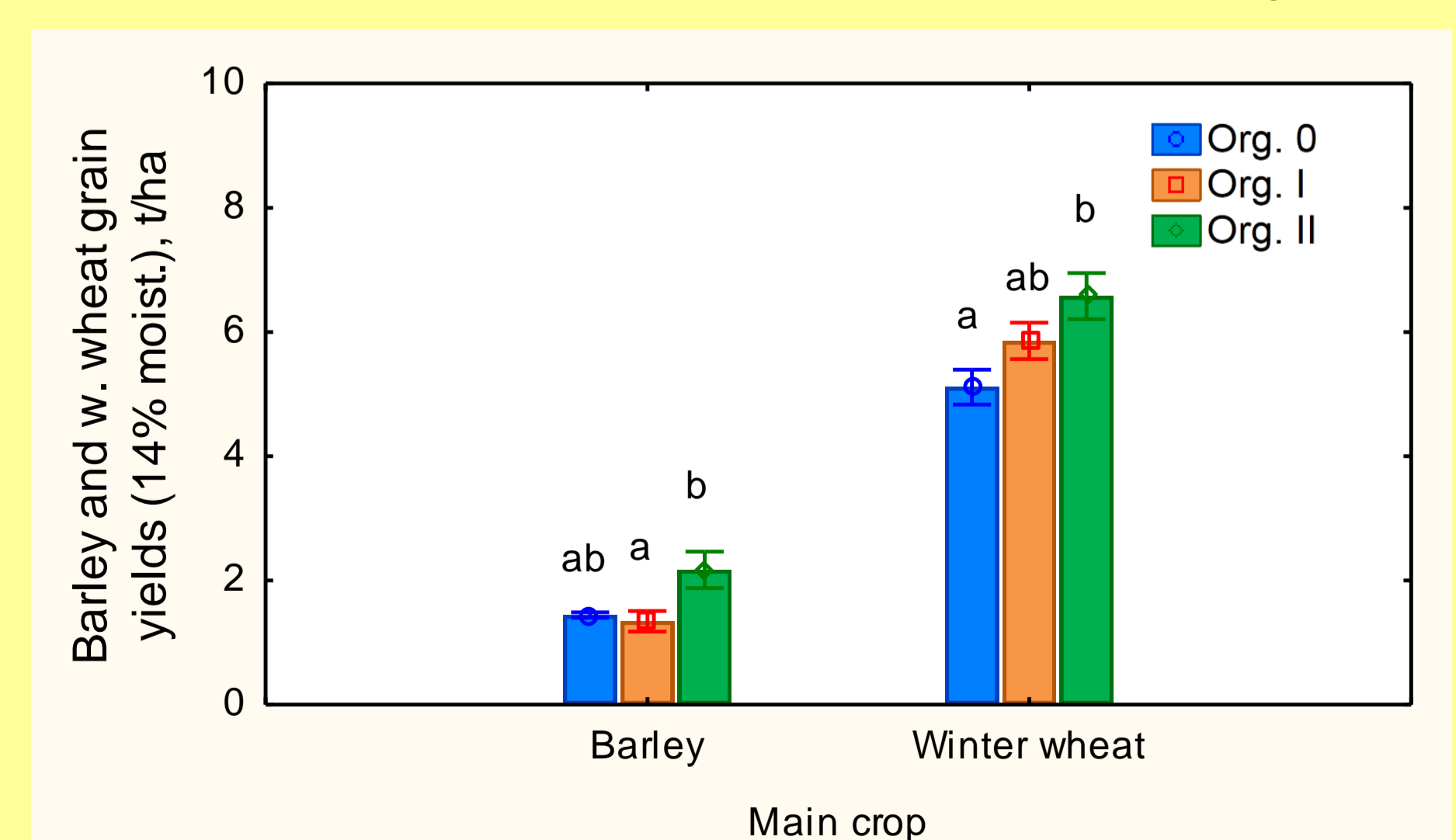
GM and their combination with cattle manure increased the soil microbial activity (Org. I, II).



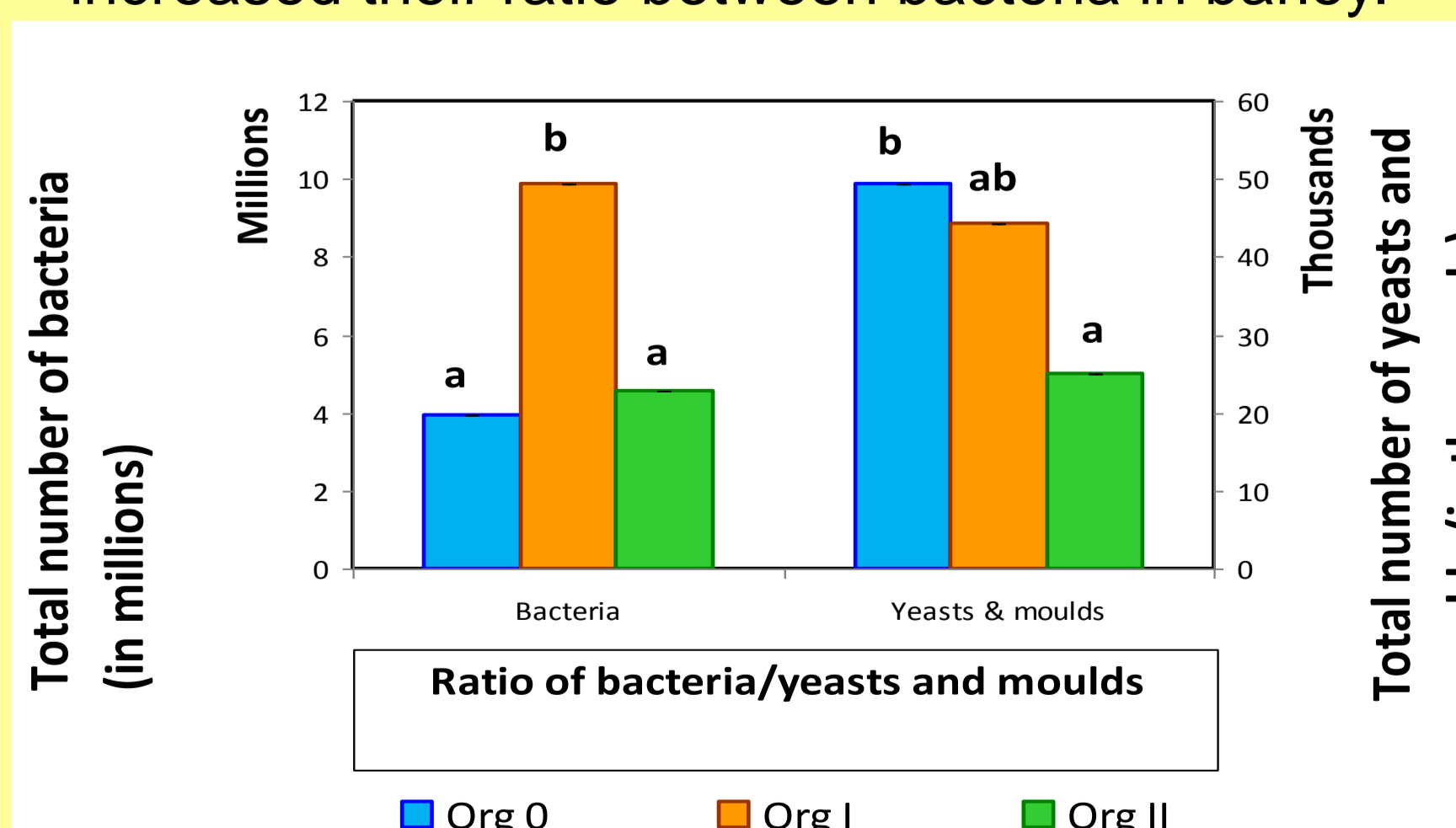
GM influence on weeds - winter rye as a GM winter cover crop was the best weed suppressor (Org I and II).



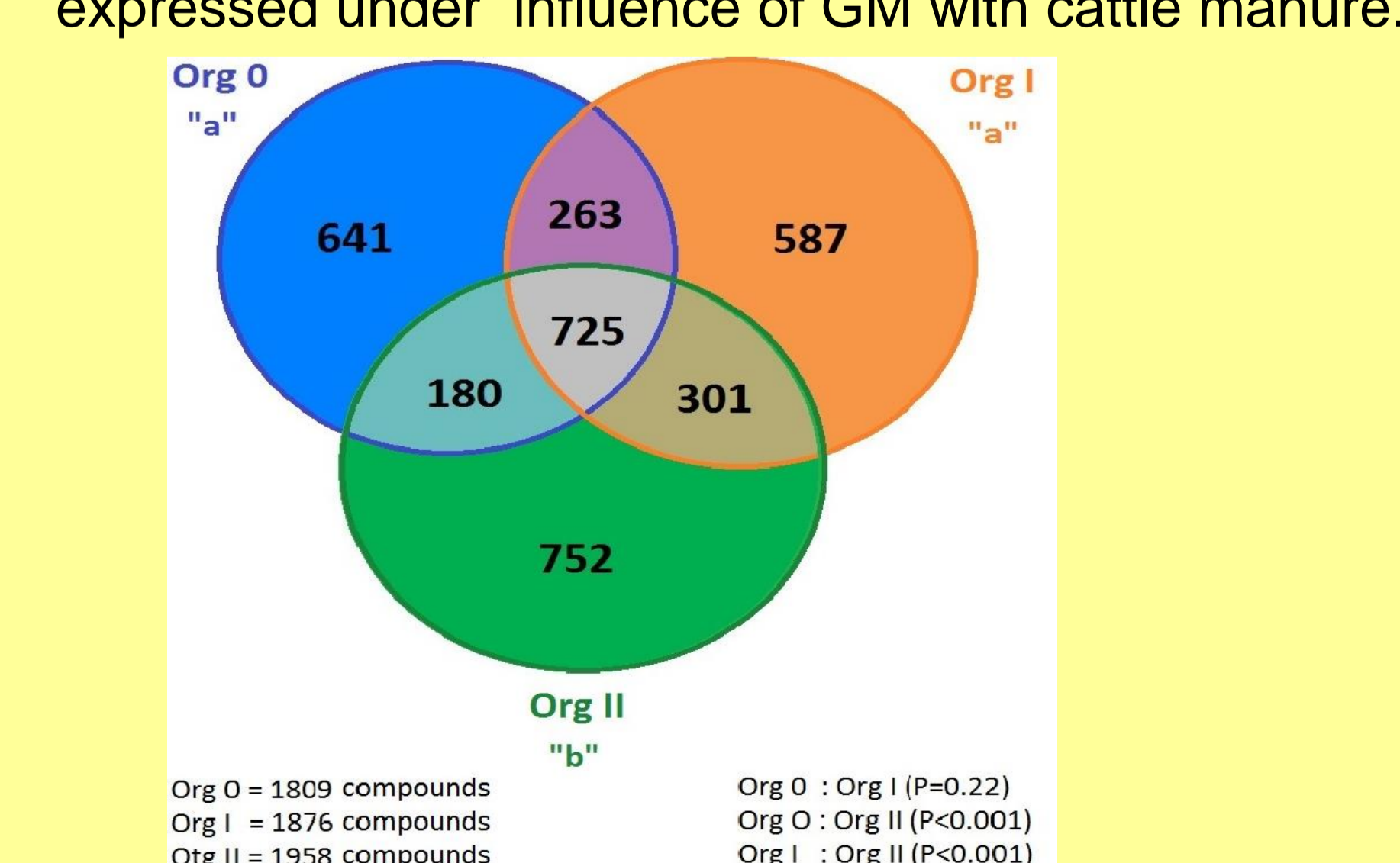
GM in combination with cattle manure significantly increased yields in barley and winter wheat (Org. II).



GM change microbial composition of product - decreased the number of yeasts and moulds and increased their ratio between bacteria in barley.



GM enhance expression of metabolites in product. In winter wheat significantly more metabolites were expressed under influence of GM with cattle manure.



NB! Different letters indicate significant differences (Tukey HSD test ($P < 0.05$)). Vertical bars denote +/- standard errors.

Conclusions

- The first rotation is already showing that the use of green manures as winter cover crops brings multiple benefits for ecosystem services.
- The use of GM tends to improve soil quality: increased organic C and N content, soil microbial activity and pH. Soil P and K contents also increased in conditions of GM combined with cattle manure.

- Winter rye as a GM was the best weed suppressor.
- Ground beetles abundance was significantly higher in systems with green manures, which apparently act as refuges offering them places to hibernate (data not shown).
- Green manures in combination with cattle manure helped to gain significantly higher and better quality yields in winter wheat and barley.