

The metabolomic fingerprinting and microbiological quality of winter wheat (*Triticum aestivum* L.) in different organic growing systems

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Materials and methods

5-years crop rotation (winter wheat, pea, potato, barley us. red clover, red clover) experiment in 3 cropping systems (started in 2008, modified in 2011). Block scheme.

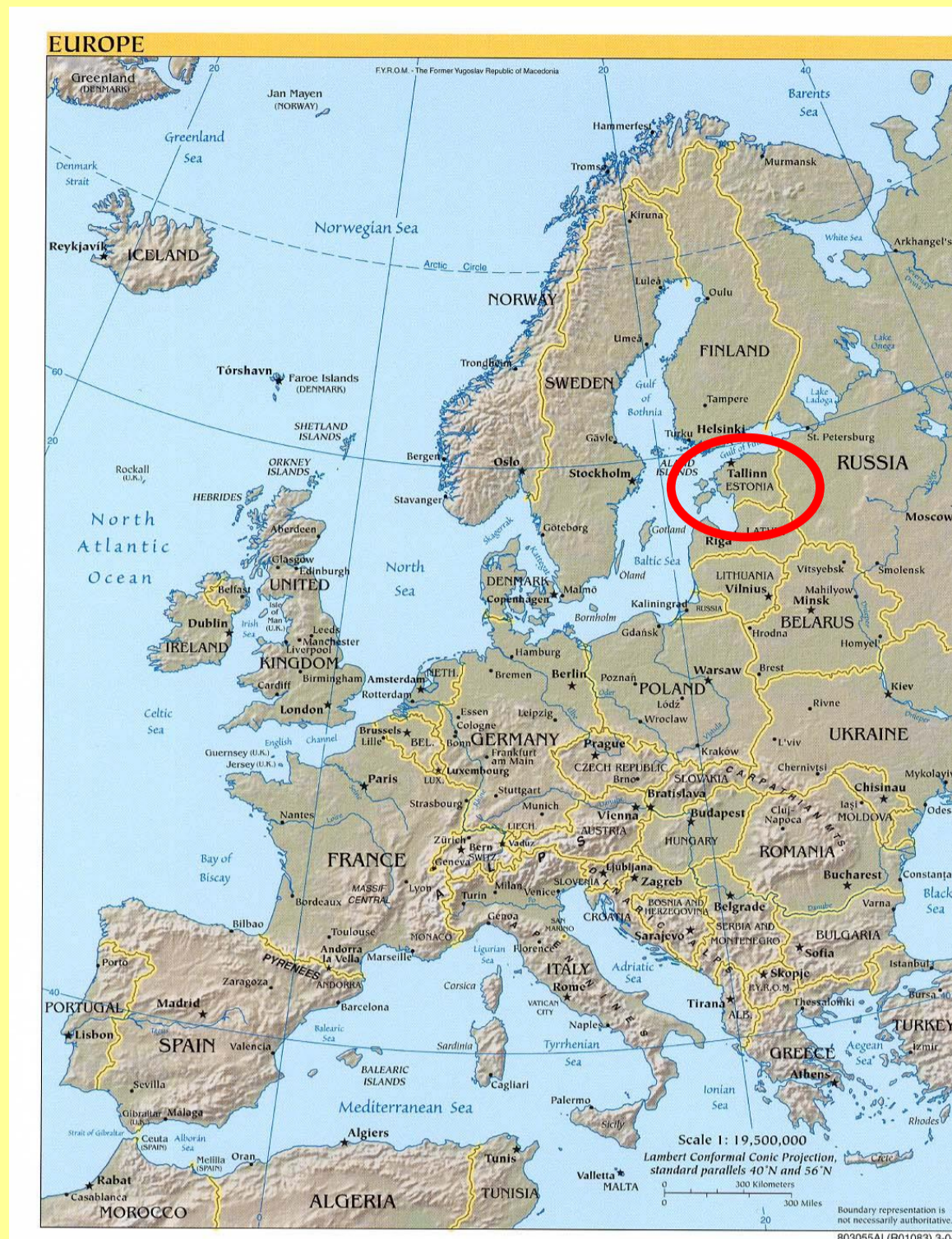
- * **ORG 0** → follows crop rotation (CR)
- * **ORG 1** → CR + green manure (GM) winter cover crops
- * **ORG 2** → CR + GM + composted cattle manure – winter wheat 10 t ha⁻¹, potato 20 t ha⁻¹, barley 10 t ha⁻¹ (in spring)
- * Green manures as winter cover crops: ryegrass after winter wheat, winter oilseed rape after pea, winter rye after potato
- * Each system in 4 replications = 60 plots. Each plot = 60 m²
- * Site: Eerika experimental field (58°22'N, 26°40'E) near to Tartu, Estonia
- * Climate: Precipitation 591 mm y⁻¹, mean annual temperature 4.4 (+30...-30) °C
- * Soil: sandy loam *Albic Stagnic Luvisol*

From different systems grains of winter wheat variety: 'Olivin' were analysed

Metabolomic fingerprinting: Analyses were done using Ultrahigh Liquid Chromatography – q-ToF Mass Spectrometry (LC-MS).

Microbiological quality: Analyses of wheat grains were done in post harvest (autumn 2012) and in the end of storage time (spring 2013). For the enumeration of total microorganisms (aerobic mesophilic bacteria) on winter wheat Colony-count technique at 30 °C (EVS-EN ISO 4833:2006)¹ and for enumeration of total yeasts and moulds Horizontal method at 25 °C (ISO 21527-1:2008)² was used.

Experimental place and design



Study aim:

The aim of present study was to find out the influence of green manures as winter cover crops and their combination with composted cattle manure on metabolomic fingerprinting and microbiological quality of winter wheat in a crop rotation experiment in three organic systems (ORG 0, ORG 1, ORG 2) at the Estonian University of Life Sciences in 2012.

Results

Metabolomic fingerprinting

Data analysis with approximately 3500 detected compounds shows that 120 compounds were differentially expressed between the ORG 0, ORG 1 and ORG 2 ($p < 0.05$). Under influence of only green manures (ORG 1) more compounds were expressed than in system without green manures (ORG 0). The highest number of expressed compounds was in ORG 2 system ($p < 0.05$) where green manures were combined with cattle manure. PLS-DA (partial least square-discriminant analyses) of expressed compounds shows that ORG 2 system (green+cattle manure) differentiates from other systems (ORG 0 and ORG 1) (Figure 1). The study showed that green manures in combination with cattle manure had different impact on metabolomics than other systems.

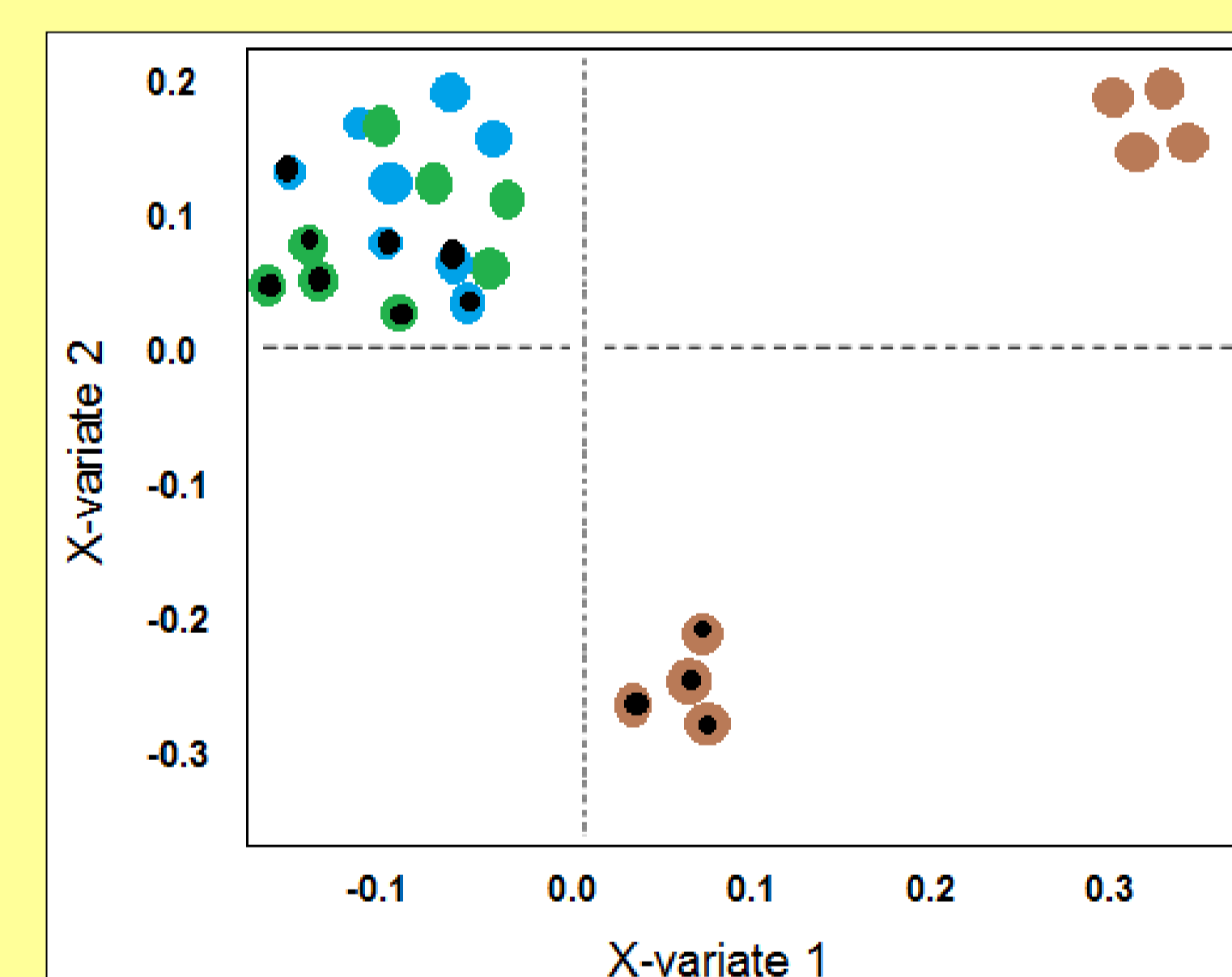


Figure 1. PLS-DA of expressed compounds for the effect of farming systems (blue – ORG 0 - control, green – ORG 1 – green manure, brown – ORG 2 – green+cattle manure). Figure shows both – positive and negative (with black dots) ions.

Microbiological quality

Microbiological content of grain surface can influence the storage quality. Higher number of yeasts and moulds can lead to spoiling.

* The counts of yeasts and moulds decreased during storage period, their smallest amounts in autumn were on wheat of control system (ORG 0) and in spring of system with green manures in combination with cattle manure (ORG 2) ($p < 0.05$) (Figure 2a).

* The counts of aerobic mesophilic bacteria were bigger in the end of storage than in post-harvesting period. Significantly ($p < 0.05$) the highest amount of bacteria was on wheat of system with green manures in combination with cattle manure (ORG 2) than in other systems in post harvesting period and in spring (Figure 2b).

In spring on wheat grain of ORG 2 system the highest number of bacteria and lowest number of yeasts and moulds could be explained by the ability of bacteria to suppress yeasts and moulds.

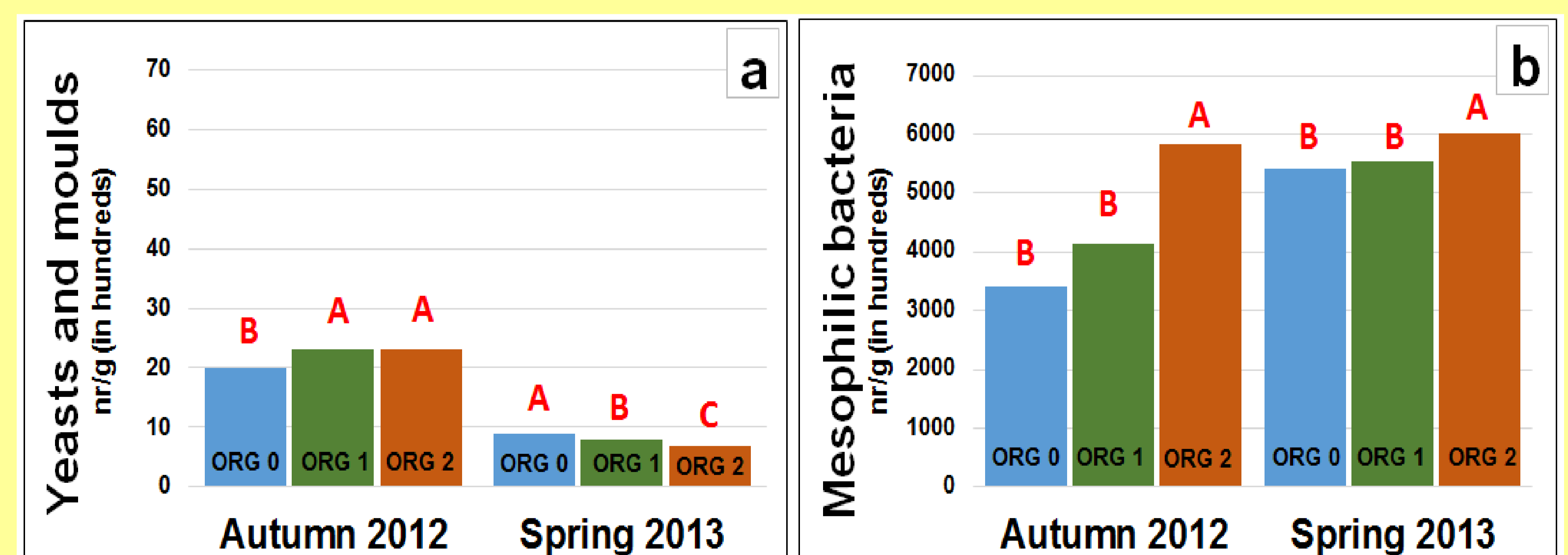


Figure 2ab. Total number of yeasts and moulds (a) and aerobic mesophilic bacteria (b) in post harvesting period and in the end of storage time in different farming systems (ORG 0 - control, ORG 1 – green manure, ORG 2 – green+cattle manure). Red letters (A, B, C) mean significant differences (ANOVA, $p < 0.05$) between farming systems.

CONCLUSIONS

In winter wheat grain green manures increased the number of expressed compounds and the highest number was in ORG 2 system ($p < 0.05$) where green manures were combined with cattle manure. In last case total number of yeasts and moulds decreased and total counts of bacteria increased. Therefore it can be assumed more successful storage for grain of ORG 2 system.

References

- 1 EVS-EN ISO 4833:2006. Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of microorganisms – Colony-count technique at 30 °C.
- 2 EVS-ISO 21527-1:2008. Horizontal method for enumeration of total yeasts and moulds at 25 °C.