LINKING SOIL PHYSICAL PROPERTIES TO THE TEA BAG INDEX FOR DIFFERENT LAND USES

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INTRODUCTION

- Organic matter (OM) decomposition is an important process in global carbon cycling and its rate is altered by various factors. Changes in land use can have a significant effect on decomposition rates, with consequences on CO_2 emissions.

- The tea bag index (TBI) method is recognized as a simple approach to investigate OM decomposition. Despite the fact that TBI has been globally applied, most research mainly focuses on soil microbiological aspects; its relations to soil physical properties have earned less attention.

- Linking TBI to the soil physical properties in different land uses can reveal how soil microhabitat affects OM decomposition.

FIELD SITES

In this transect tea bag study, we selected 22 sites from the east to west coast in central Denmark covering 4 land uses: forest, heath, grass and cropland. The 4 land uses were grouped into natural and agricultural systems.

The study was conducted from the end of March to the beginning of July, 2017.

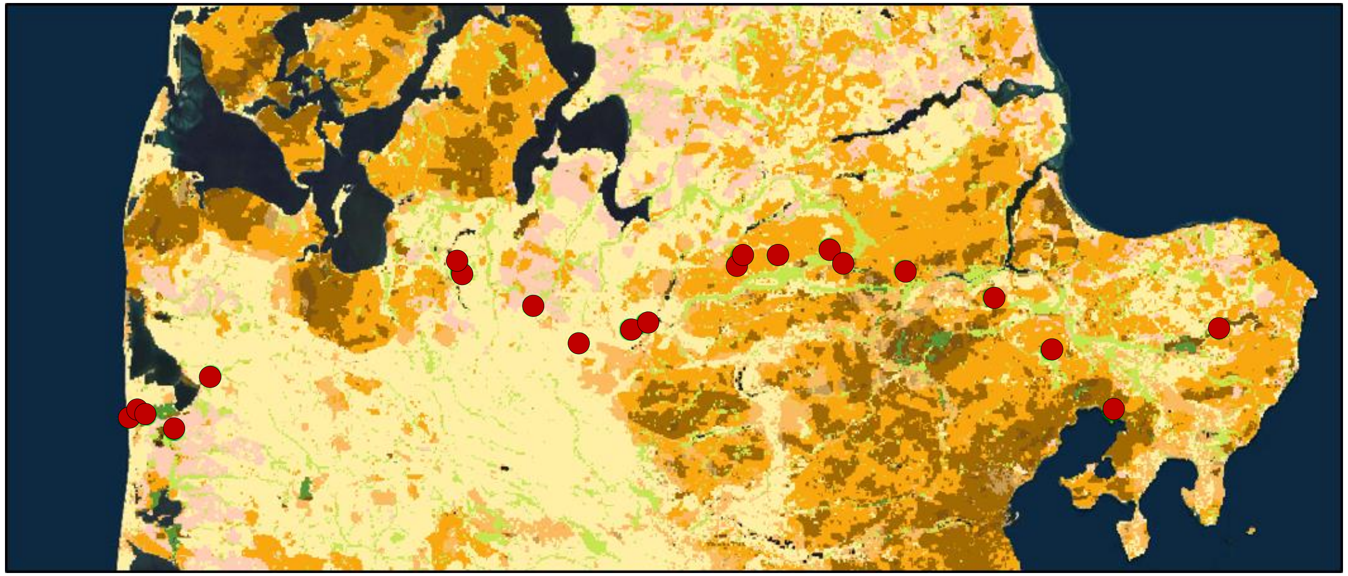

Figure 1. The location of tea bag burial sites. The background is the soil texture map of Denmark

Table 1. Vegetation information of the sites

Group	Land use	Dominant Vegetation	Group	Land use	Vegetation
Natural	Forest	English oak (*Quercus robur*); Scots pine (*Pinus sylvestris*); European beech (*Fagus sylvatica*)	Agricultural	Grass (Grazing)	Perennial grass
	Heath	Heather (*Calluna Vulgaris*)		Cereal	Winter wheat (*Triticum aestivum*)

TEMPERATURE AND RAINFALL DATA

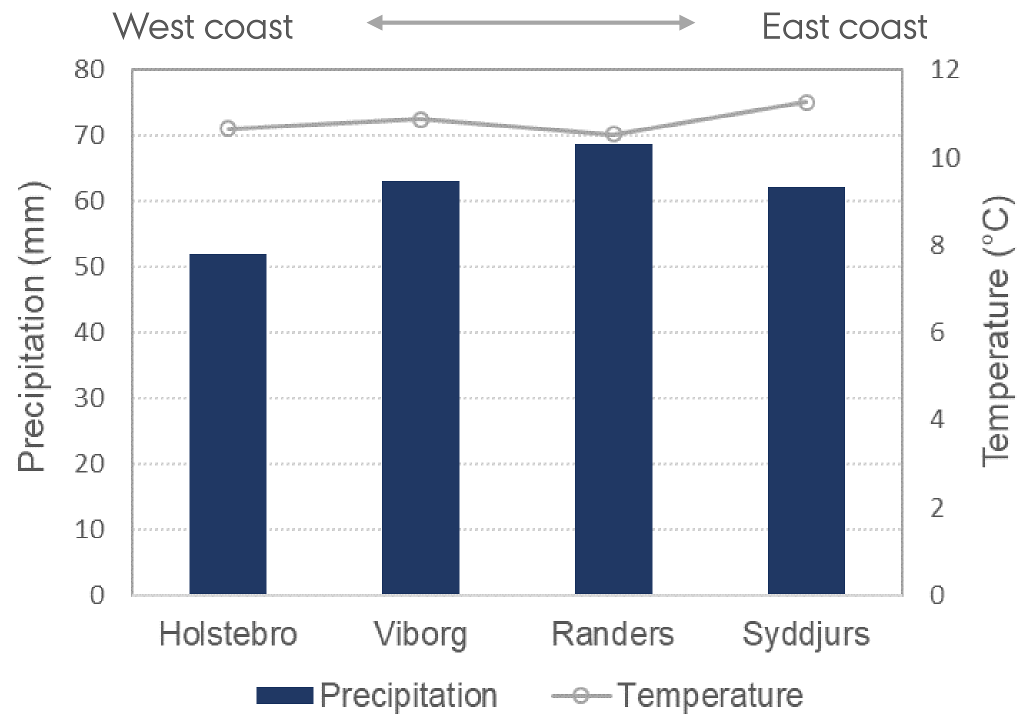

Figure 2. Mean temperature and mean precipitation from April to June, 2017 in the tea bag incubation area.

Table 2. The temperature and precipitation data during the tea bag incubation period

Mean temperature (°C)				
Location / Month	Holstebro (West coast)	Viborg (Central)	Randers (Mid-east)	Syddjurs (East coast)
April	6.1	6.1	5.9	6.6
May	11.7	12	11.6	12.2
June	14.2	14.5	14.1	15
Mean rainfall (mm)				
Location / Month	Holstebro (West coast)	Viborg (Central)	Randers (Mid-east)	Syddjurs (East coast)
April	50.2	61.2	57.1	56.6
May	32.2	24.4	27.3	30.8
June	73.5	103.5	121.5	99.5

Data from Danish Meteorological Institute

METHODS

Tea bag index

The study followed the Tea Bag Index protocol (Keuskamp *et al*. 2013). Briefly, three pairs of tea bags (Lipton green tea and rooibos tea) were buried in each site and retrieved after three months. Three undisturbed soil cores (100 cm^3) and bulk soil per site were collected at the same time as tea bag burial time. Tea bag index - decomposition rate (k) and stabilization factor (S) were calculated by equations given in Keuskamp *et al*. (2013).

Soil characteristics and physical properties

Soil texture, organic carbon content, bulk density (BD) and pH were measured.

Soil volumetric water content, air permeability (K_a) and gas diffusivity (D_p/D_0) were measured at matric potential of –10 and –100 kPa.

Keuskamp, J. A., Dingemans, B. J. J., Lehtinen, T., Sarneel, J. M., & Hefting, M. M. (2013). Tea Bag Index: A novel approach to collect uniform decomposition data across ecosystems. *Methods in Ecology and Evolution*, 4(11), 1070–1075

RESULTS

- Soil samples from cropland, grassland and heath had similar BD, while forest soil samples had low BD and one forest sample had very low BD caused by its 58.5% OM.
- The majority of soil samples had clay content below 10%.
- Soil samples in this study had similar amount of OM, except 2 outliers.
- Agricultural soils had higher pH values.

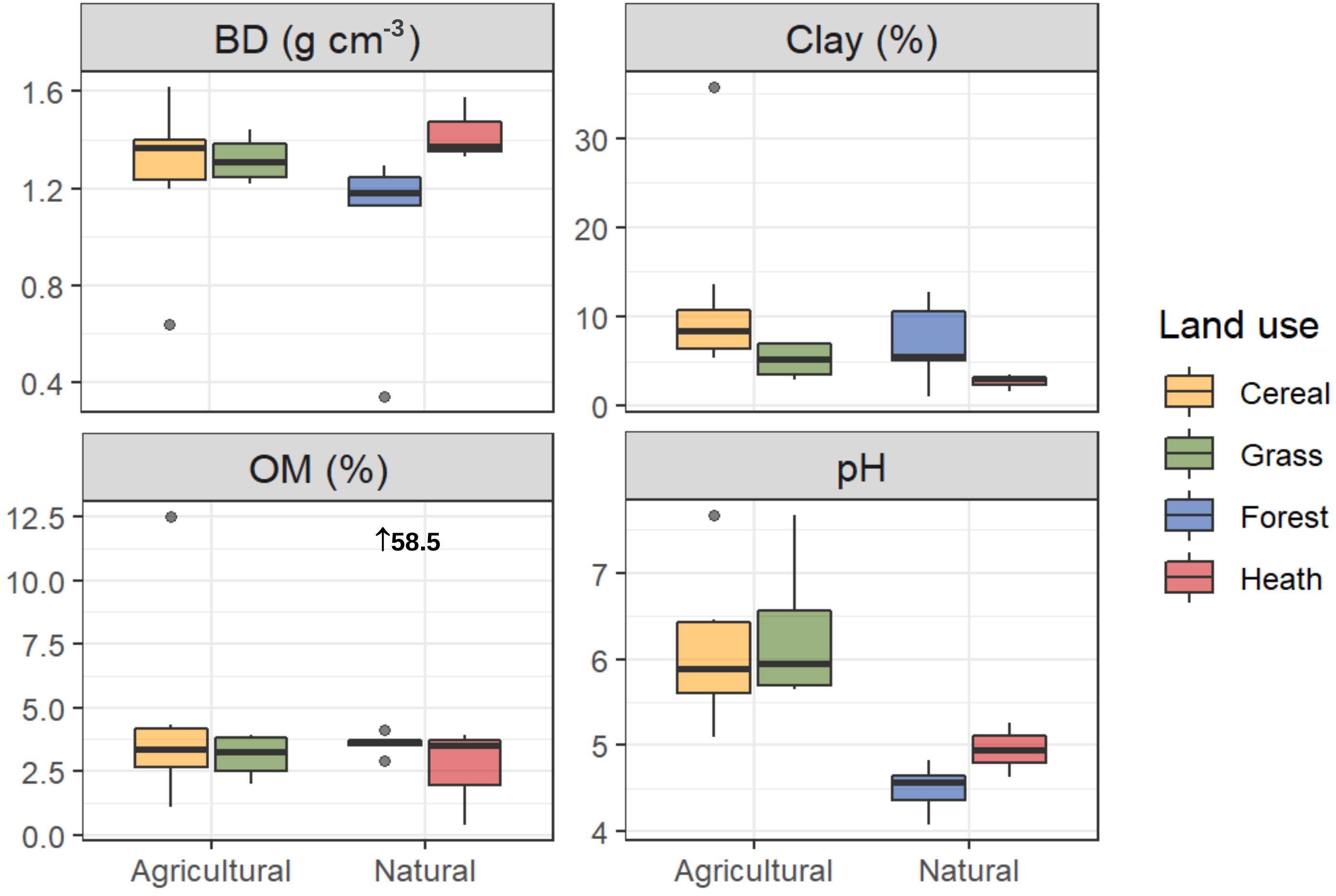

Figure 3. Boxplots of bulk density (BD), clay content, organic matter (OM) content and pH of soils of 4 land uses in 2 groups.

RESULTS

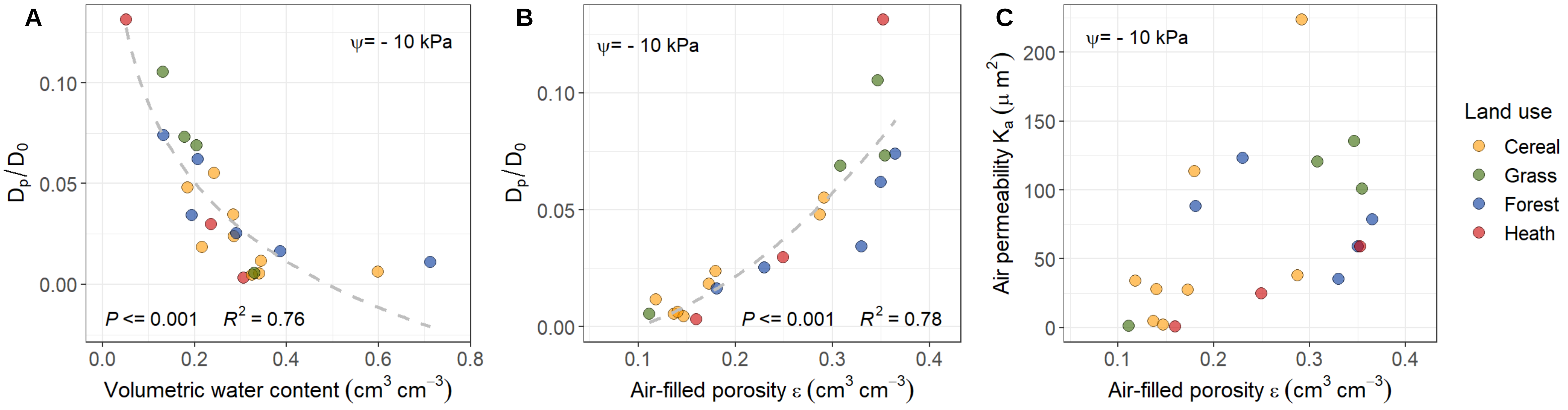

Figure 4. Gas diffusivity (D_p/D_0) versus volumetric water content. The dashed line is the logarithmic fitting line (A); gas diffusivity (B) and air permeability K_a (C) versus air-filled porosity ε. The dashed line in (B) is the polynomial fitting line. Data were obtained at matric potential -10 kPa.

No effect of land use on relations between gas diffusivity, air permeability and fluid content is found.

RESULTS

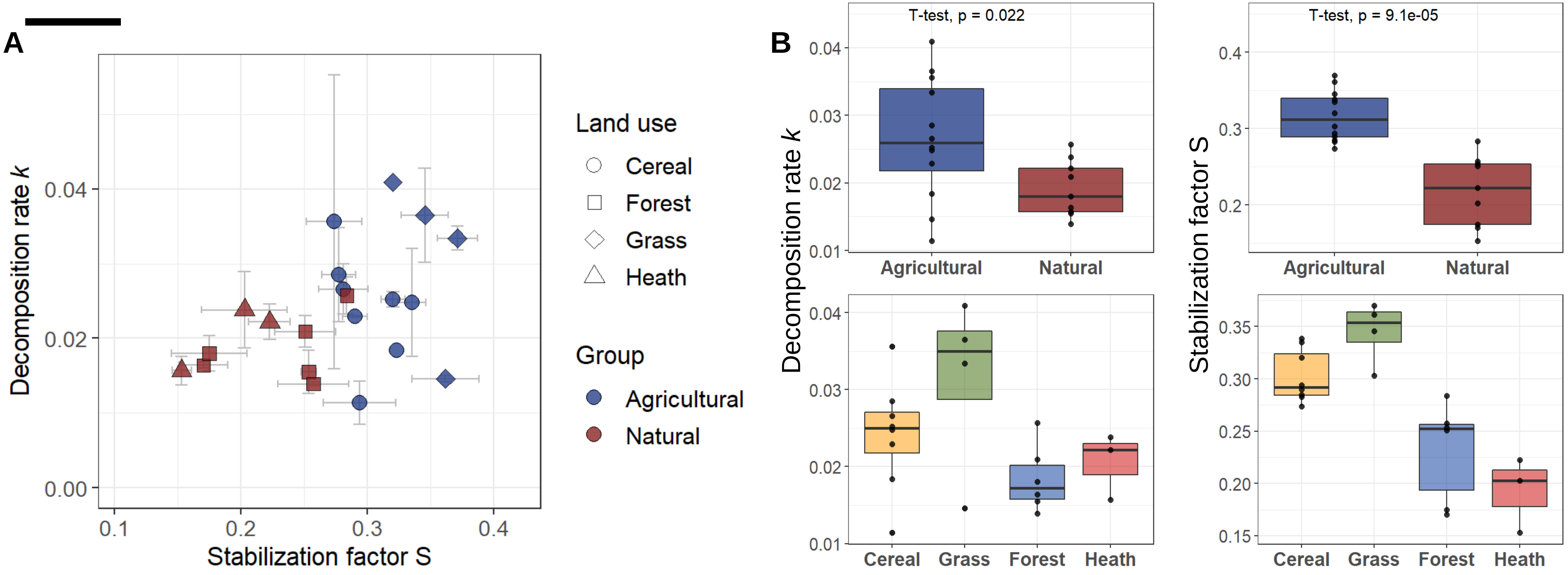

Figure 5. Tea bag index parameters of 4 land uses in 2 groups. Data present mean values ± standard error (A); boxplots of decomposition rate *k* and stabilization S of 2 groups and 4 land uses (B).

- Grass exhibited highest OM decomposition rate and stabilization factor.
- The S in agricultural systems is higher than in natural systems.

RESULTS

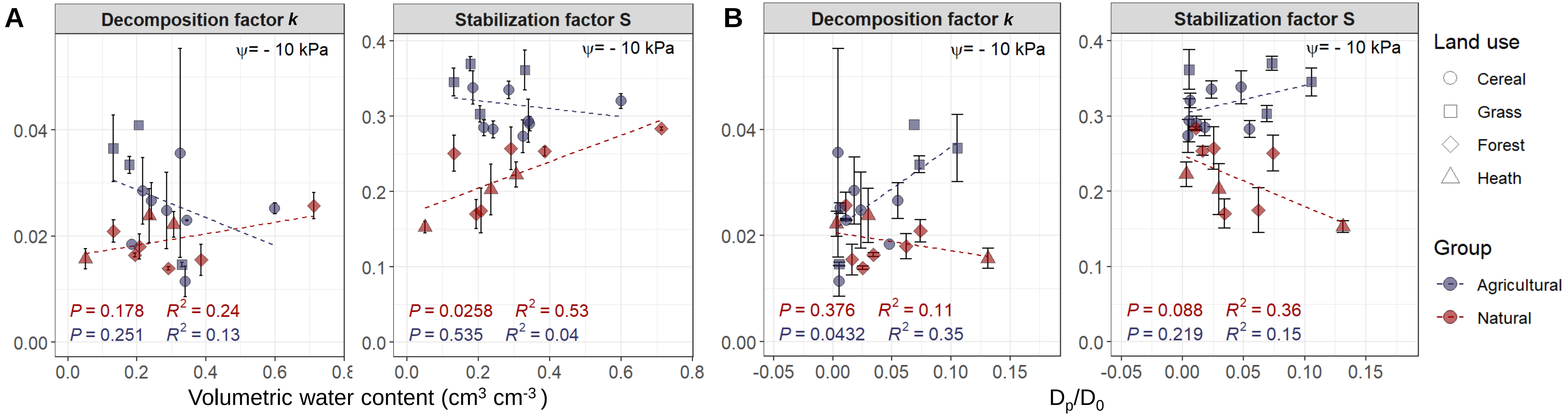

Figure 6. Tea bag index parameters versus volumetric water content (A), and gas diffusivity D_p/D_0 (B) at matric potential -10 kPa. Data present mean values ± standard error. Lines are linear regression of data from 2 groups.

- The S is positively correlated to volumetric water content in natural systems.
- The *k* is positively correlated to gas diffusivity in the agricultural system and S is negatively correlated to gas diffusivity in natural systems.

RESULTS

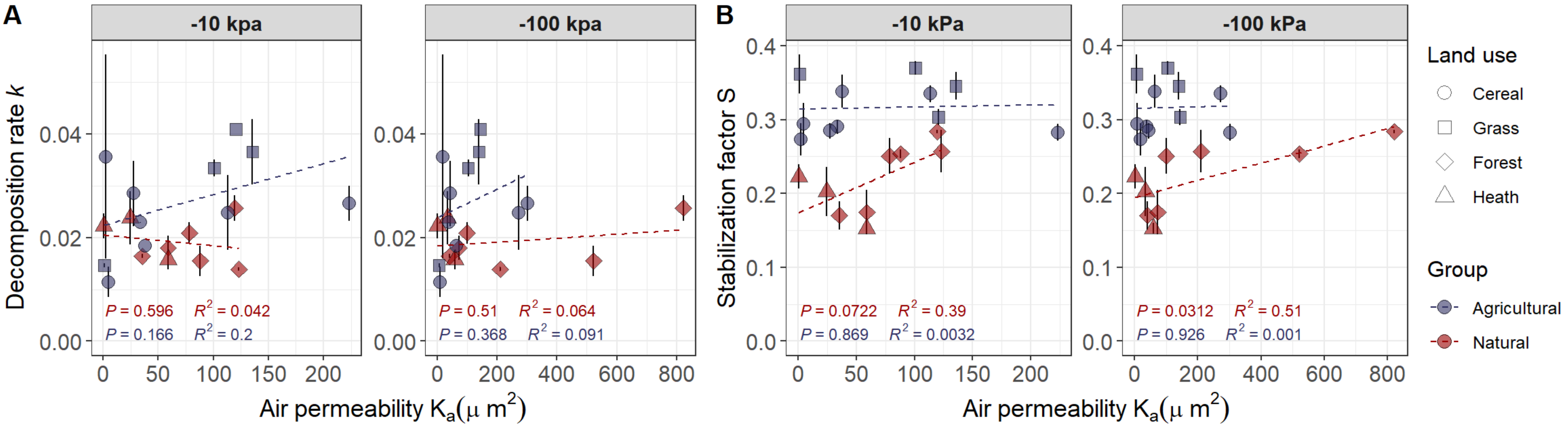

Figure 7. Decomposition rate *k* (A) and stabilization factor S (B) versus air permeability K_a at matric potential -10 kPa and -100 kPa. Data present mean values ± standard error. Lines are linear regression of data from 2 groups.

The S is positively correlated to air permeability in natural systems.

SUMMARY

- The decomposition rate *k* and stabilization factor S are affected by the land use. Values of S and *k* are higher in agricultural systems than in natural systems. Grassland exhibited highest OM decomposition rate and stabilization factor.

- The stabilization factor S is positively correlated to volumetric water content and air permeability and negatively correlated to gas diffusivity in natural systems.

- The decomposition rate *k* is positively correlated to gas diffusivity in agricultural systems. No clear trend or weak opposite trend to natural systems are found in *k* versus volumetric water content and air permeability in agricultural systems.

Thanks for your attention!

Further discussion please contact:
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