Crop diversification to reduce wind erosion hazard in a semiarid blown-sand area of Hungary

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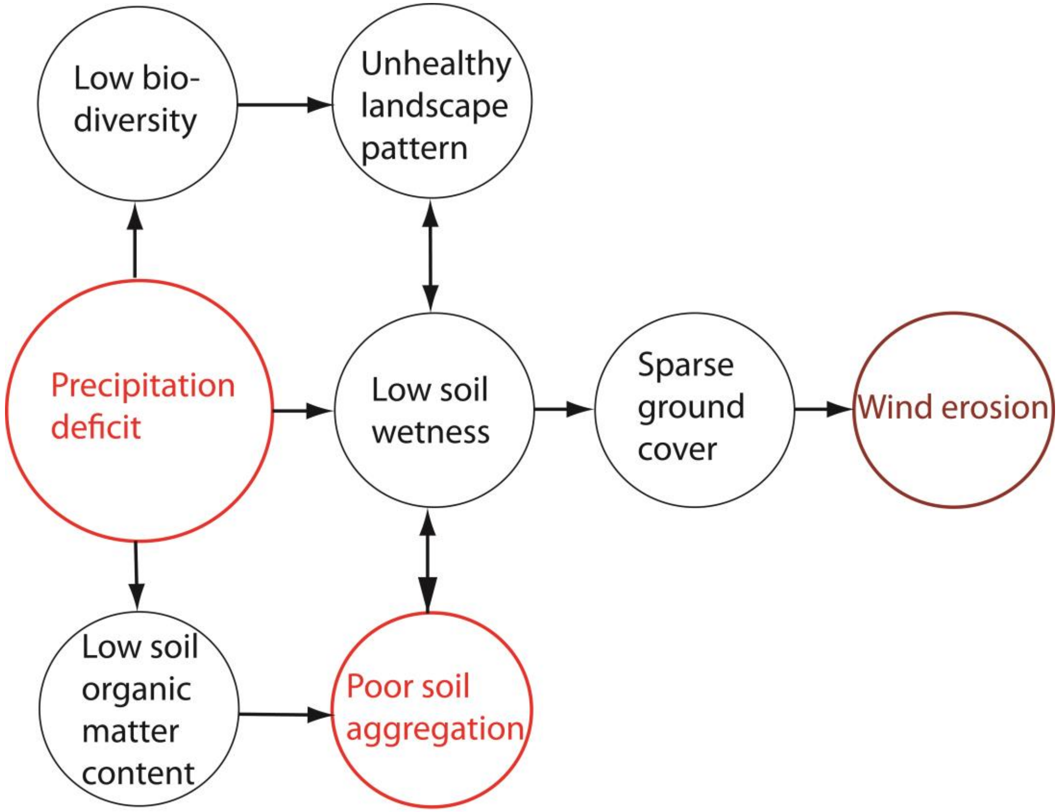
Crop cultivation under intensifying drought

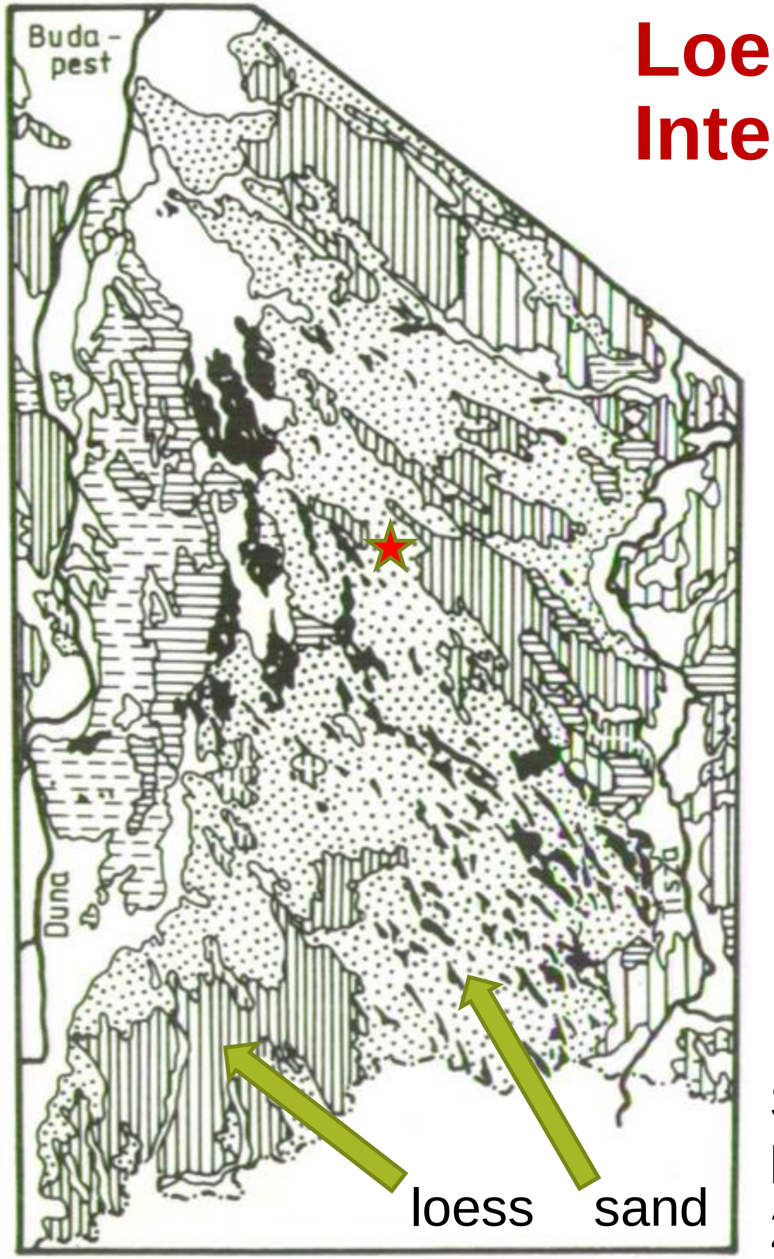
Pleistocene alluvial fan of the Danube in central Hungary: loess ridges: relatively fertile soils: intensive cultivation

blown sand-mantled surfaces: least favourable conditions for agriculture – high deflation hazard



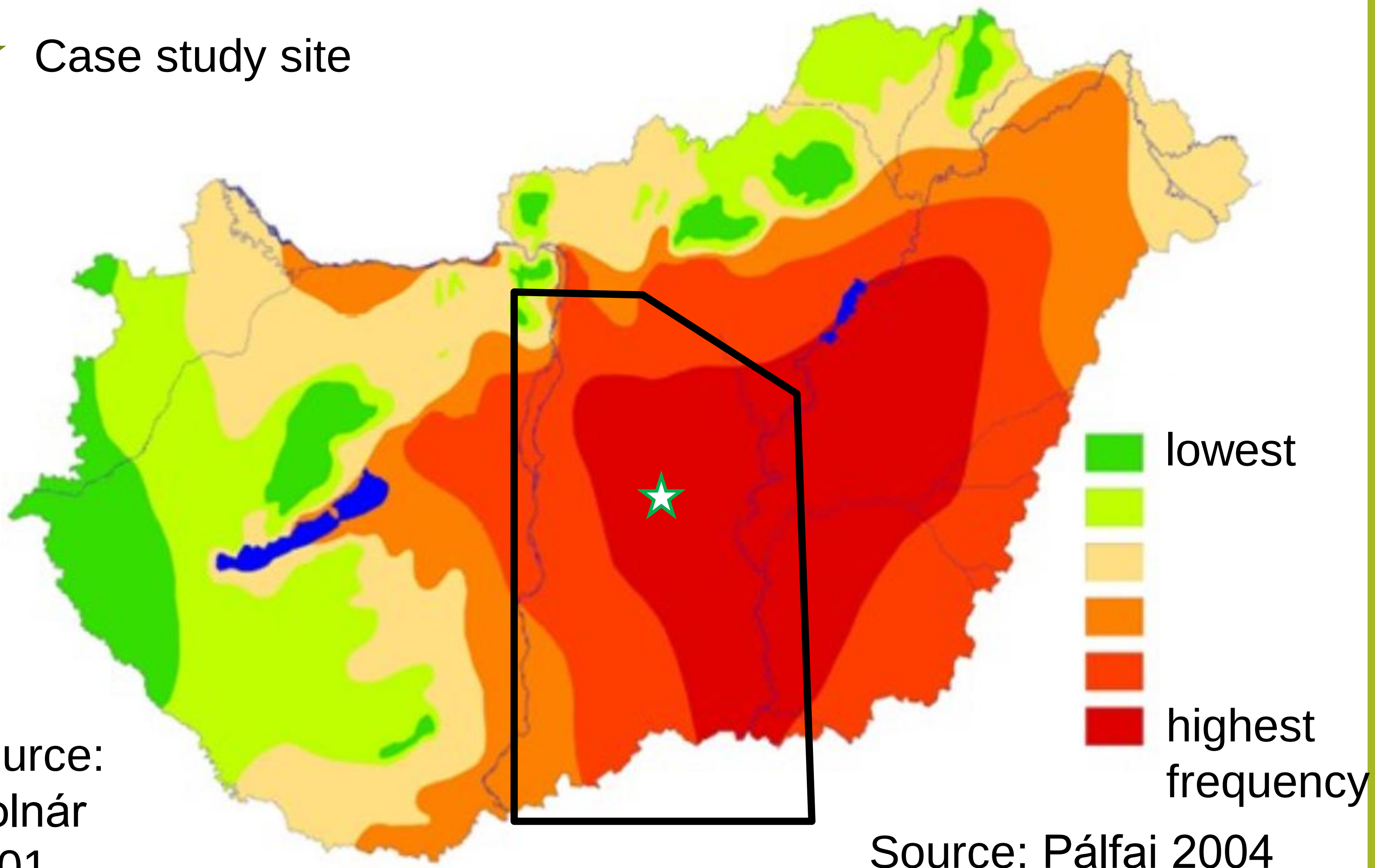
Sand ripples formed after the sand storm of 28.02.2019

Loess and sand areas on the Danube-Tisza Interfluve and drought zoning of Hungary



Source: Molnár 2001

★ Case study site



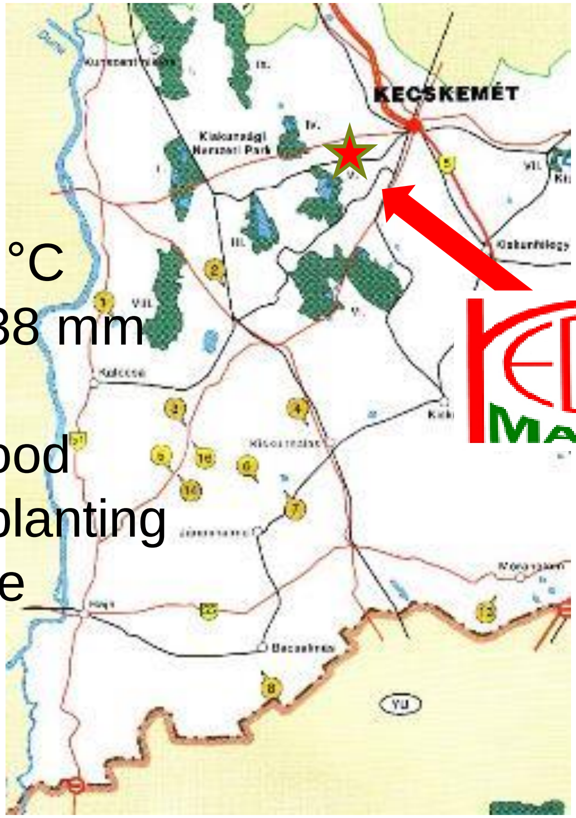
Source: Pálfai 2004

DIVERFARMING

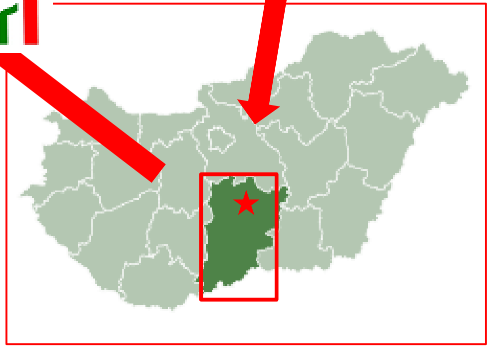
Crop diversification and low-input farming across Europe: from practitioners’ engagement and ecosystems services to increased revenues and value chain organisation (Horizont 2020 project)

Case study no 10: Horticulture in the Pannonian pedoclimatic region

Site: JAKABSZÁLLÁS (Kiskunság sand region), experimental plot: 1.3 ha
Geographical coordinates: 46°44’52.6”N 19°34’25.7”E
Mean annual temperature (1971-2000): 10.8 °C
Average annual precipitation (1971-2000): 538 mm
Annual potential evapotranspiration: 848 mm
Crop: asparagus (Asparagus officinalis) for food
Cropping system: 7-10-year monocropping, planting on ridges, soil cover by plastic foil, large-scale pesticide and fertilizer application
Harvest in April-May, manually

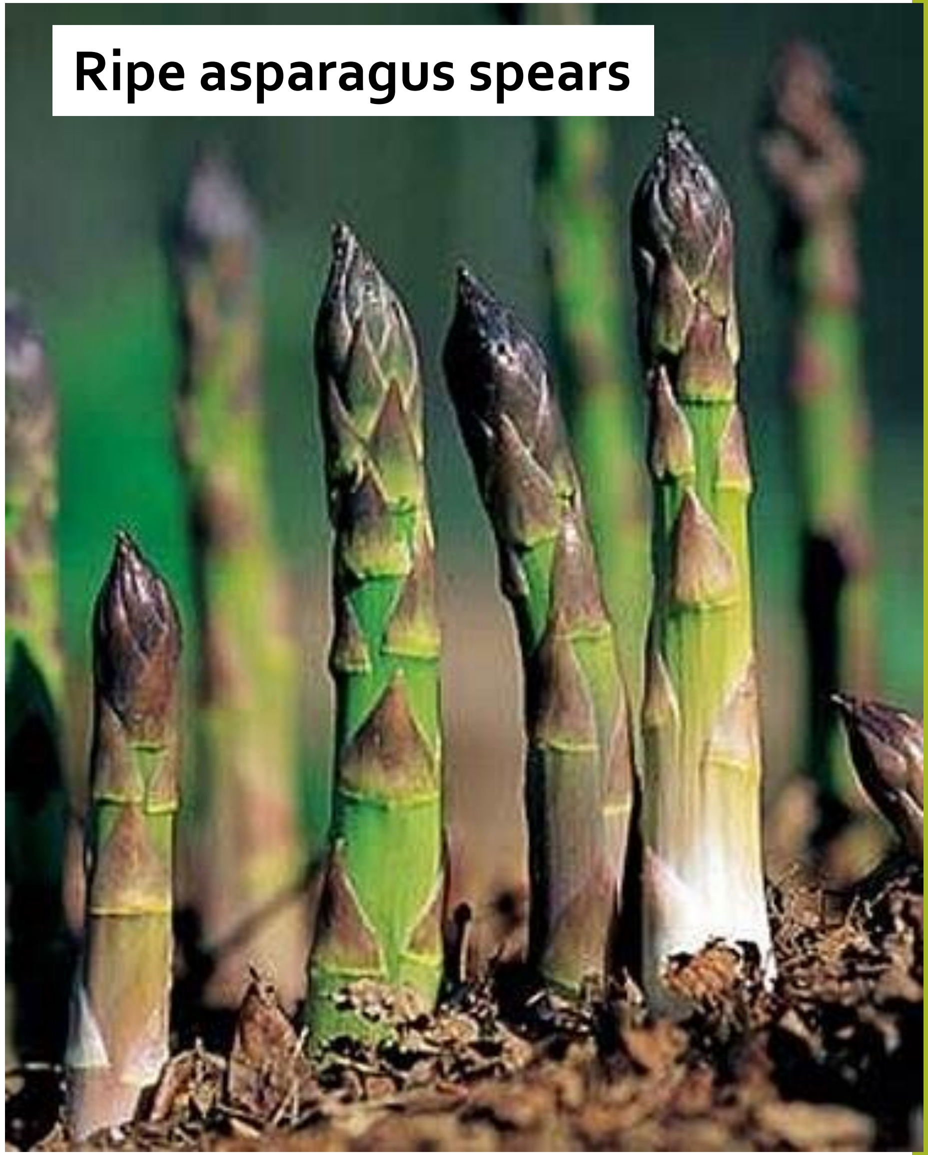


KEDEL MARKET



Humic Arenosol – cultivation only possible due to loam horizons indicative of historical sand movement and soil formation

Ripe asparagus spears



In monocropping alleys between crop rows are exposed to wind erosion. The plastic foil cover of asparagus ridges intensifies wind erosion through a wind channel effect. The alleys are unprotected from wind erosion.

Ridges aligned in downwind direction

interval: 180 cm – suitable for intercropping

Cut green asparagus growth after harvesting

Opportunities to protect the soil surface from deflation (in theory)

1. To prevent or at least slow down ground **desiccation**

    method: irrigation to promote crusting – almost impossible

2. To strengthen protection by increasing **vegetation** cover

    at landscape level: planting shelter belts

    at the level of agricultural fields:

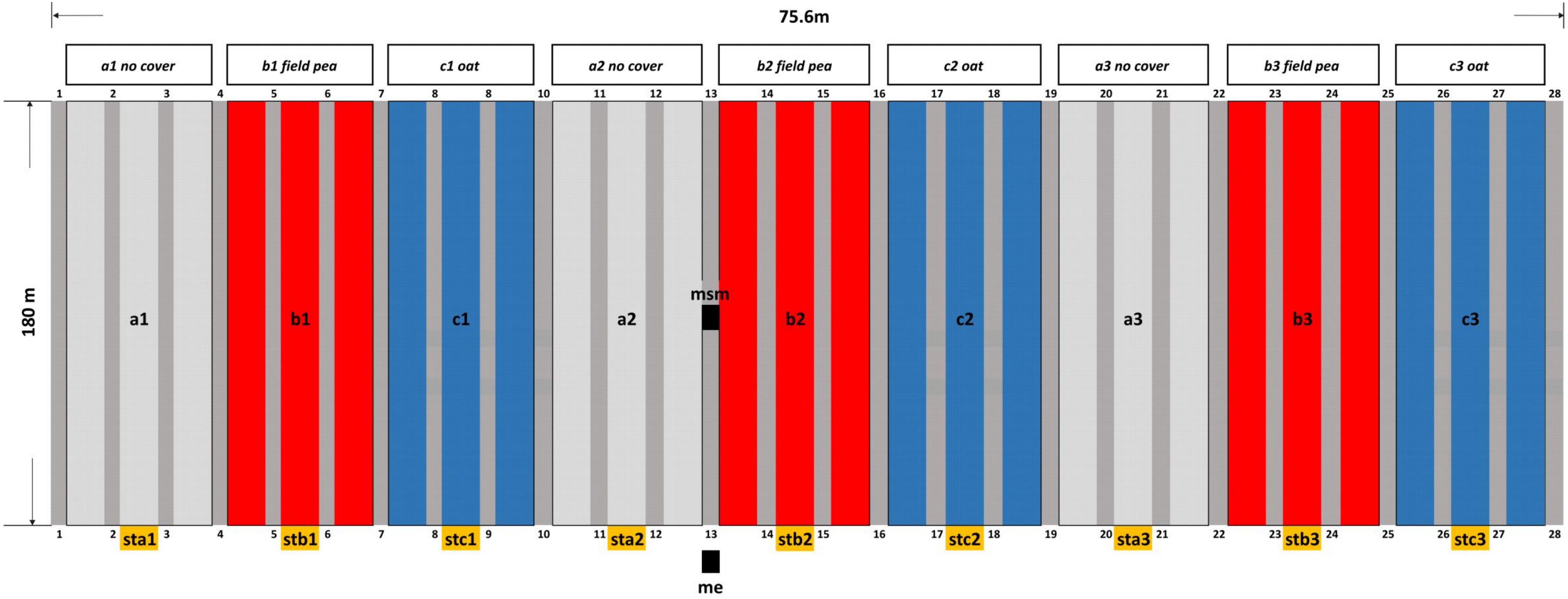
    methods: „horizontally”: to increase crop density – doubtful because of poor water availability

    „vertically”: to enhance surface roughness, to raise the height of boundary layer – plants of different development level at different dates = **crop diversification** (main topic of the Diverfarming project) – possibly useful

3. To enhance **soil aggregation** through adding organic matter

    method: incorporating plant residues into the soil – but: only with adequate soil humidity

Crop diversifications introduced to assess possible improvements in ecosystem services including wind erosion control

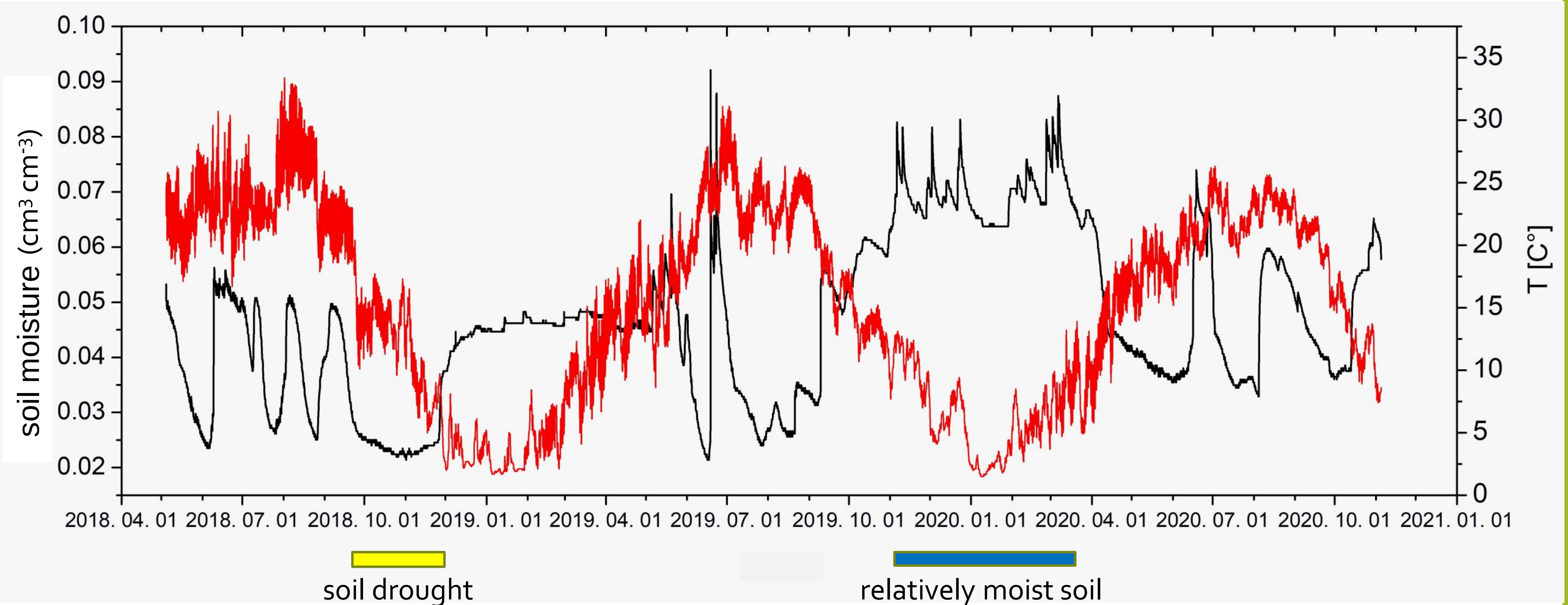


1, 2, 3, ...rows
me in situ monitoring for erosion
msm in situ monitoring for soil moisture
sta1,2,3.. sediment traps

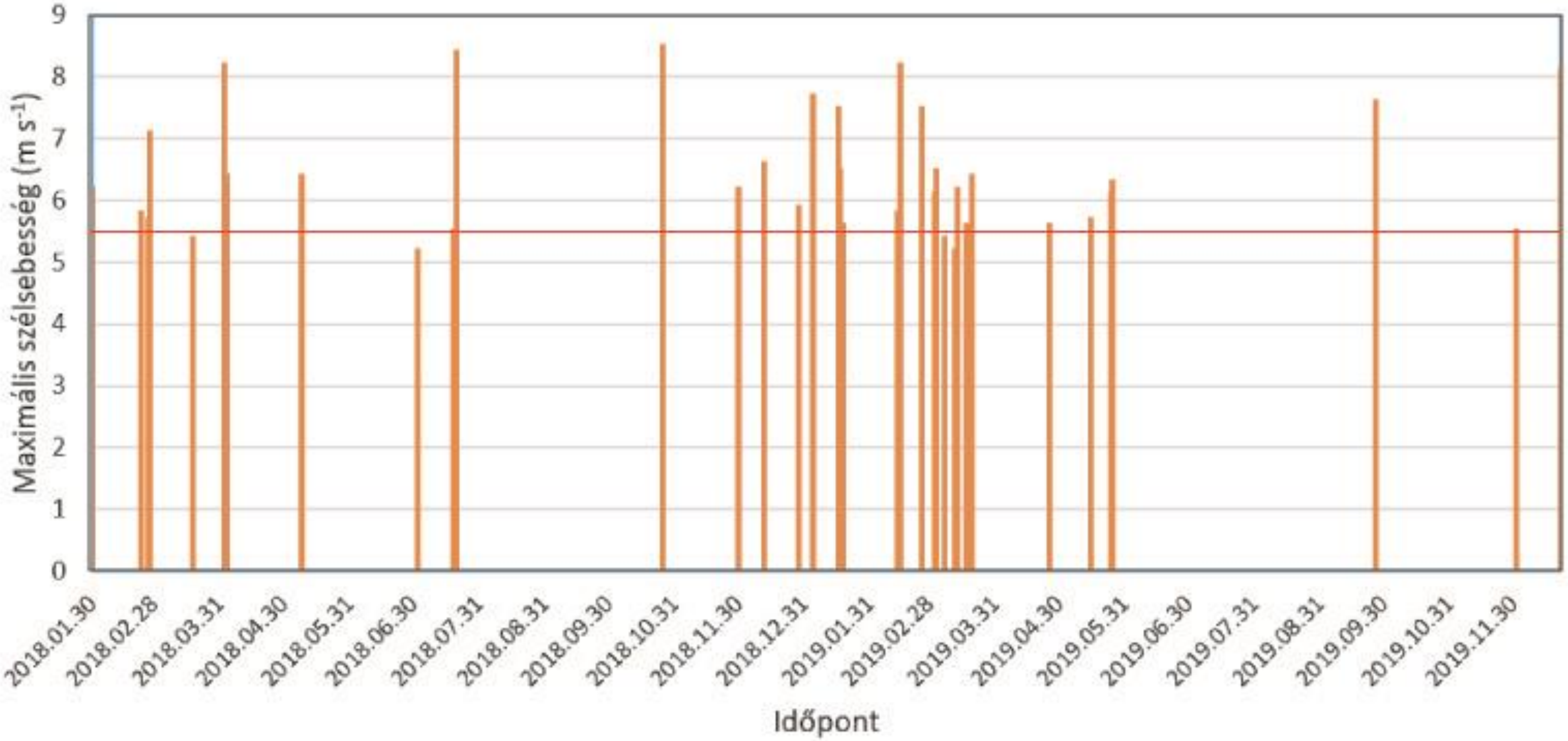
a: asparagus monocropping
b: asparagus + field pea intercrop
c: asparagus + oats intercrop

me: wind erosion monitoring site
msm: soil moisture monitoring site
sta: sediment traps

Daily soil moisture (at 0-10 cm, black) and air temperature (at 200 cm, red)



Daily maximum wind velocities (at 10 m above ground) above the starting velocity of sand movement, 2018-2019

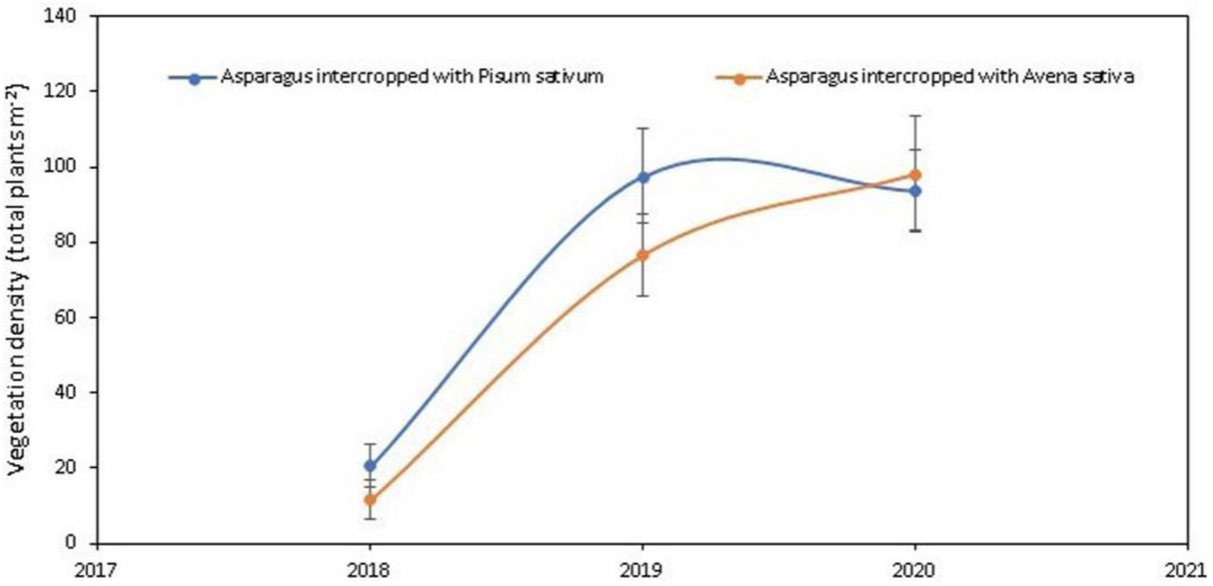


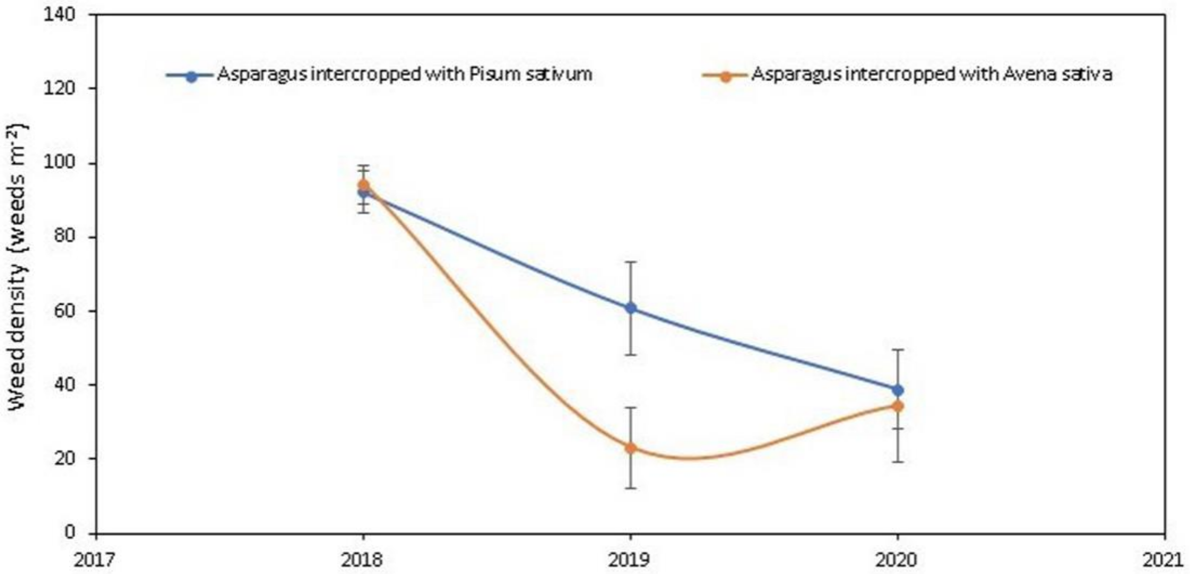
Critical starting wind velocity at 10 cm height estimated from wind tunnel experiments for the region: 5.5-6 m s^{-1} – often reached during passing weather fronts

Benefits of cover cops: increasing ground cover

Maximum ground cover and weed density of alleys in the different diversifications of the experiment

Blue curve: D1 = field pea, D2: brown curve: oats





The difference in ground cover is negligible.

Even in a relatively humid period for oats intercropping weeds were less abundant than for pea.

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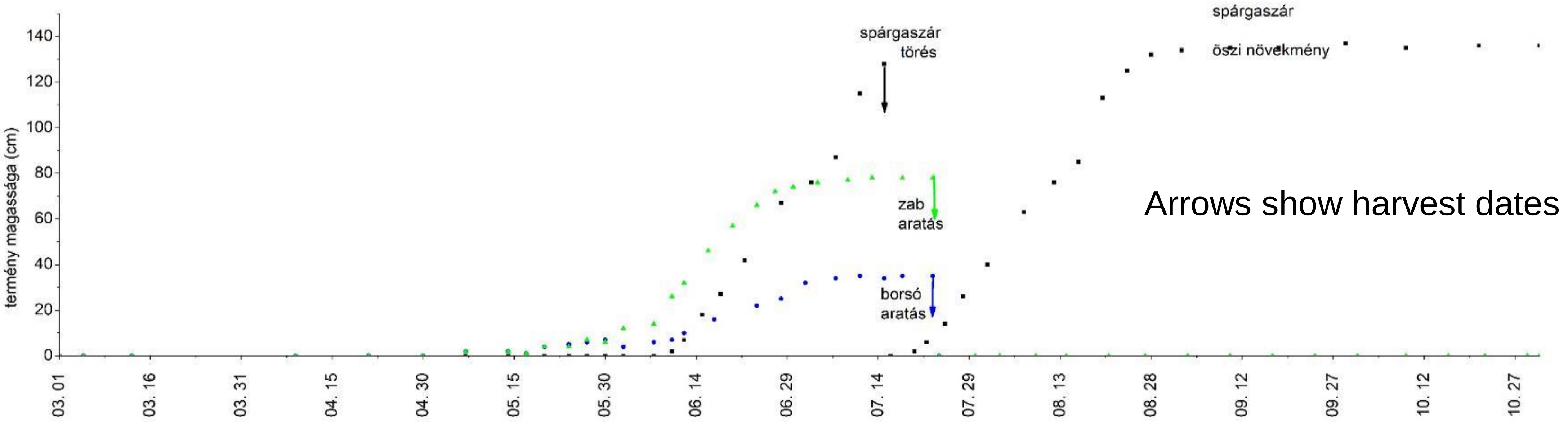
Benefits of cover crops: Increasing crop height (surface roughness)

Crop height in the growing season for different diversifications



The main crop and the cover crops together ensure proper surface roughness – unfortunately with the exception of the period March and April (usually strong winds in Hungary)

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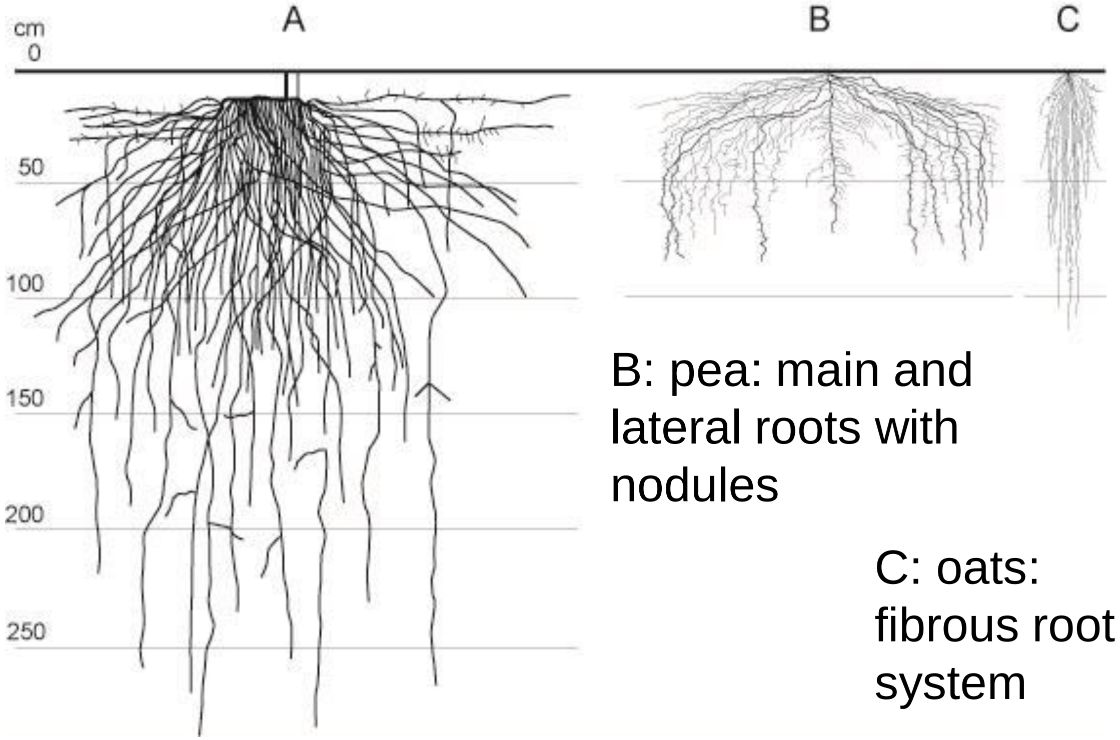
Benefits of cover crops: adding to shallow below-ground biomass (roots) and organic matter to the soil

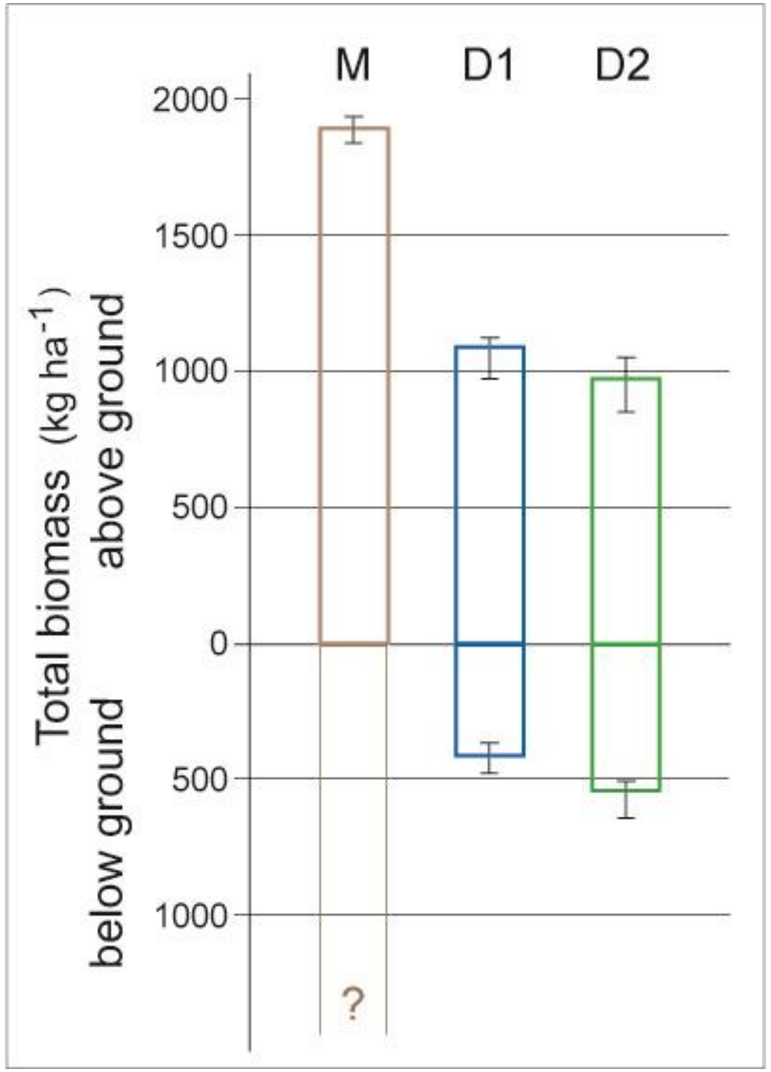


B: pea: main and lateral roots with nodules

C: oats: fibrous root system

A: asparagus: rhizome + lateral roots

Root depth and mass (average total below-ground biomass) at harvest



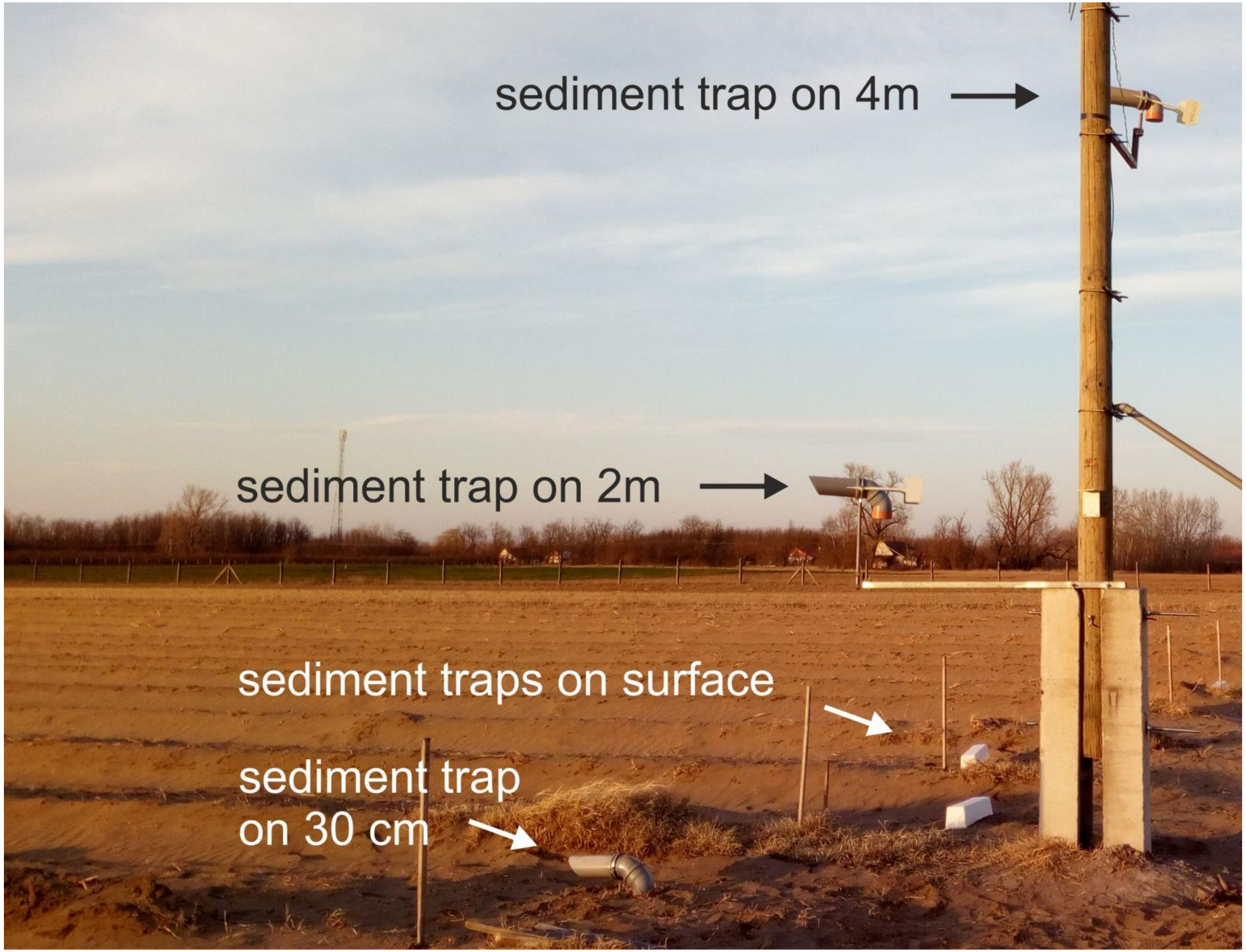
Root depths vary – moderate competition for moisture and nutrients

Pea and oat cover crops well utilized the moisture derived from occasional thunderstorms

Sediment trapping

The flux of eolian transport captured by sediment traps in a 1-metre high and 100-metre wide cross section.

Traps were at four heights: on the ground surface, at 30 cm, 200 cm and 400 cm heights.



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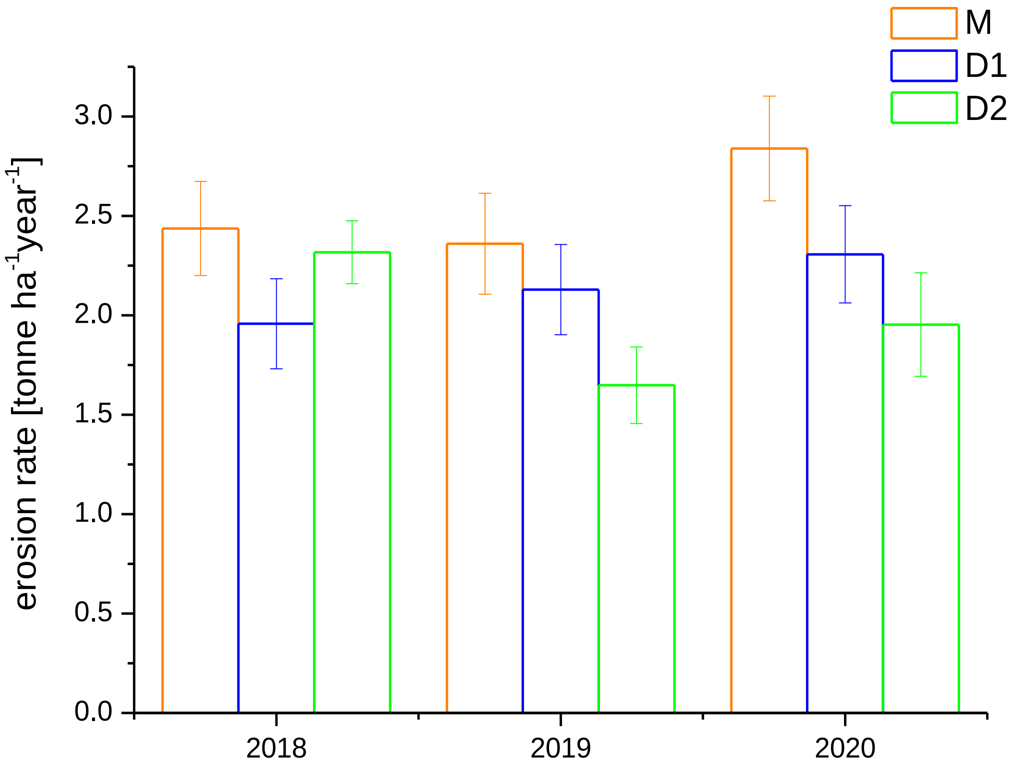
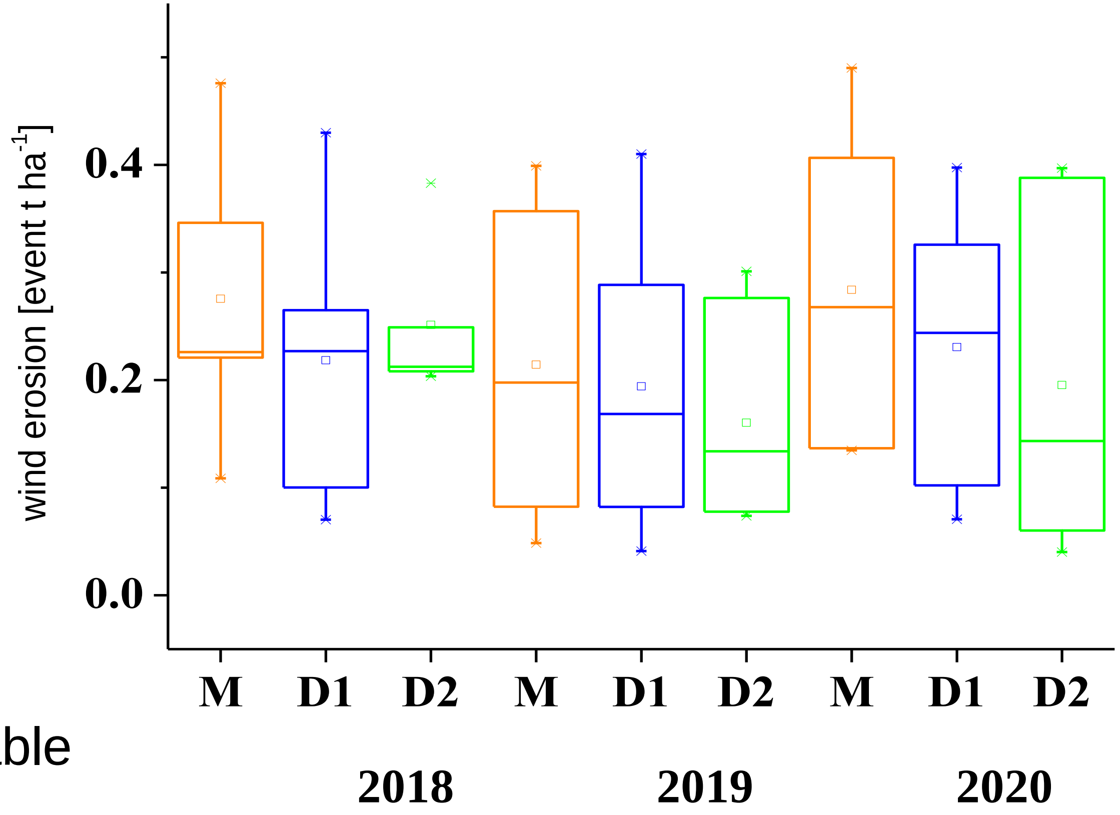
Results: Rates of wind erosion in the different diversifications and during individual erosion events

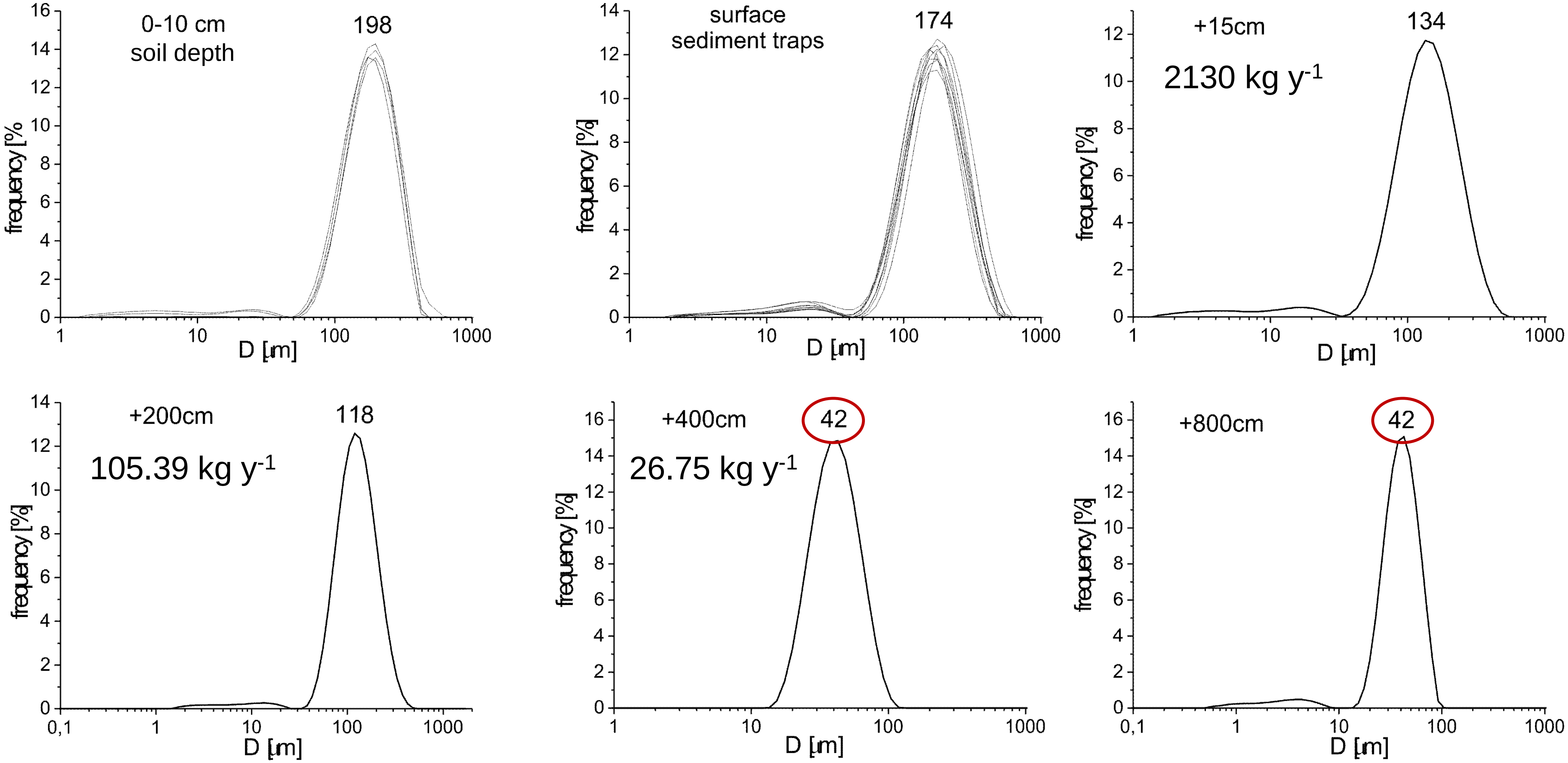


M: asparagus monocrop, D1: asparagus + pea, D2: asparagus + oats

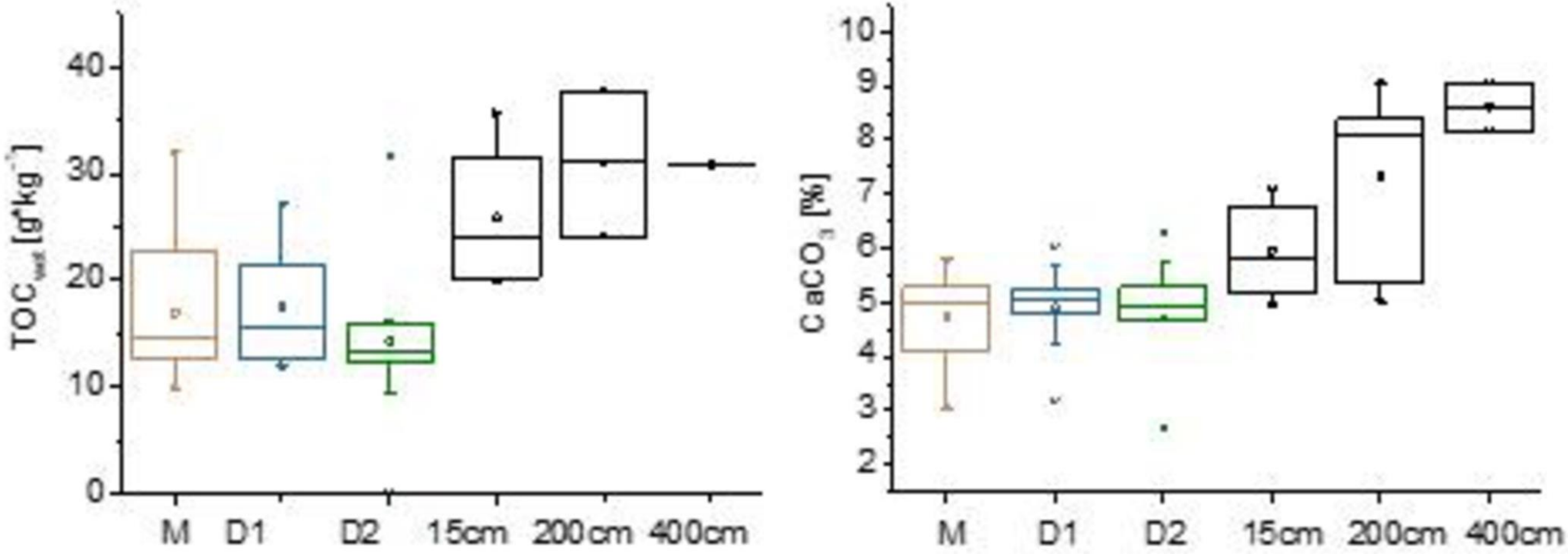


Erosion was invariably highest for monocrop, lowest for oats, although more and more variable with more continuous ground cover (?)

Particle size distribution and total amount of transported sediment: Differences between in situ soil and trapped sediment (median values shown)



Quality of blown sediment: Humus (total organic carbon, TOC) and carbonate losses due to wind erosion in the different diversifications



More severe losses in the form of dust with increasing height above ground.

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Conclusions

1. As the conditions of the ground surface were similar in every plot, differences in wind erosion and transport were due to diversification.

2. Close-to-surface transport (reptation, saltation) prevails. Particle size of dust stabilized at 4 m height, the proportion of fraction 0.7-8 μm (fine organic matter) remarkably increased with height.

3. In the case of complete desiccation of the ground surface no solution (neither diversification) can help. But if minimal wetting takes place (as in early 2020), crop diversification may be instrumental in moderating wind erosion.

4. With higher surface roughness and more continuous ground cover, oats were found to provide better protection and to prevent loss of humus. However, the root system of pea was also effective. A combination of several cover crops could improve the efficiency of crop diversification.

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Acknowledgements

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Thank you for your attention!