

CARBOHYDRATE COMPOSITION AND ETHANOL CONVERSION OF HERBACEOUS BIOMASS

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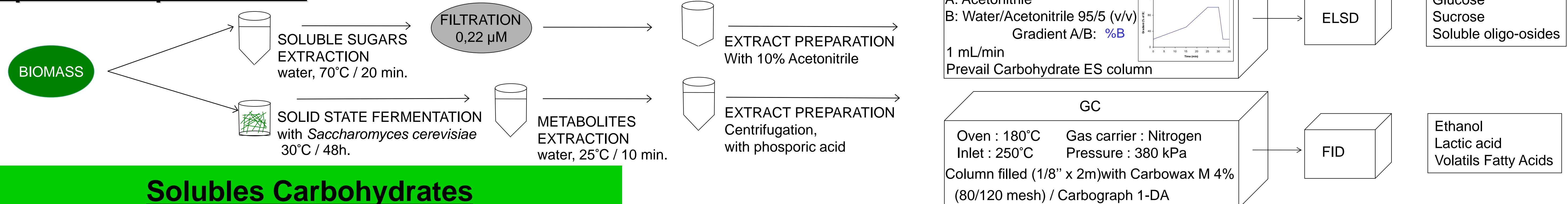
Introduction: Herbaceous biomass consists mainly of structural polysaccharides, reserve polyfructans and soluble sugars that can be converted by micro-organisms to ethanol.

Aim: - To examine the composition of Perennial ryegrass (*Lolium perenne*), Hybrid ryegrass (*L. hybridum*) and Italian ryegrass (*L. multiflorum*)

- To investigate the influence of cultivar (early, intermediate, and late precocity degree; diploid and tetraploid), development stage (elongation, heading, flowering), harvest time in the day, and tedding on carbohydrate availability in the harvested biomass.

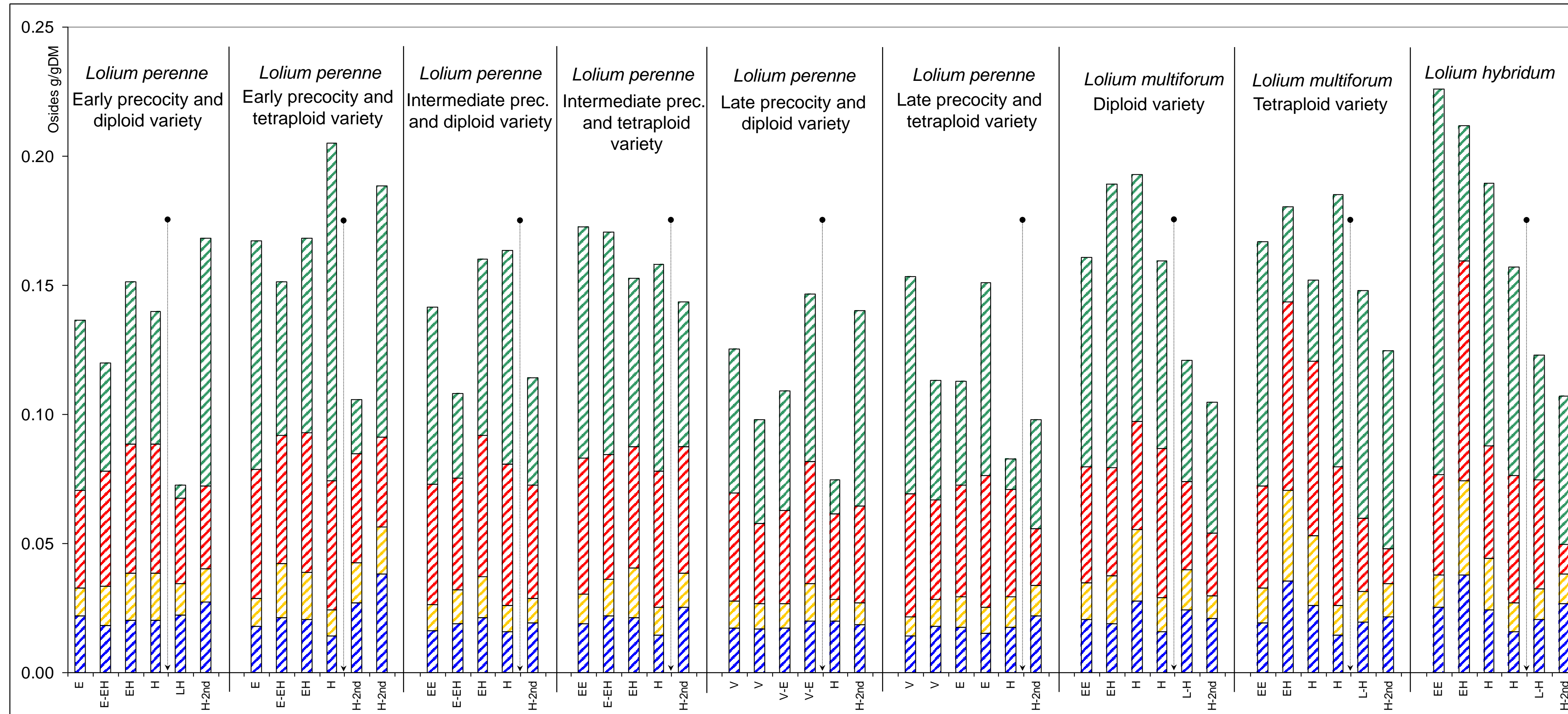
- To check their suitability for a direct conversion of the soluble sugars to ethanol.

Experimental procedures:

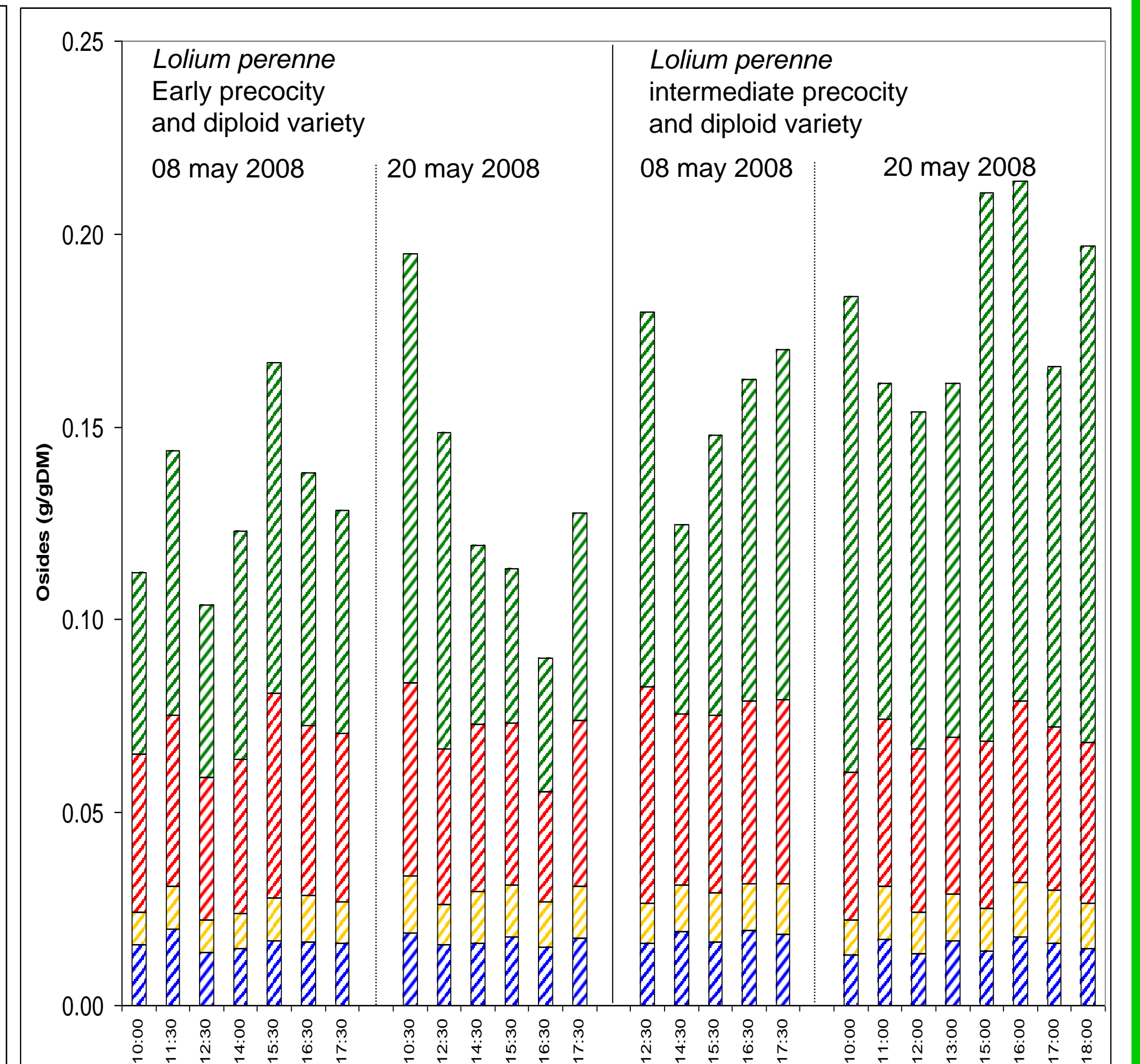


Solubles Carbohydrates

Evolution of soluble carbohydrates with plant development



Evolution of soluble carbohydrates during the day



H-2nd : 2nd Heading
L : Leafy
H : Boot head
emergence
EH : Boot stage
E : Elongation
EE : Early elongation
V : Vegetative

←..... Harvest
others oligosides
Sucrose
Glucose
Fructose

Figure 1a et 1b: Soluble sugar concentrations is in the range 0.1 g/gDM and 0.2 g/gDM (corresponding to 0.02 g/gFM to 0.03 g/gFM) with fructose and glucose: 0.01 to 0.04 g/gDM (0.003 to 0.005 g/gFM), sucrose: 0.03 to 0.07 g/gDM (0.007 to 0.011 g/gFM) and others soluble carbohydrates 0.03 to 0.10 g/gDM (0.011 to 0.022 g/gFM). Furthermore, the figure shows a decrease of total soluble oligosides in biomass regrown after first harvest.

• The total soluble carbohydrates contained in herbaceous biomass do not seem to vary significantly either during its development or during the day (no significant effect of photosynthesis). Soluble carbohydrates concentrations in *Lolium* would theoretically enable an ethanol conversion to 10 to 15 gEthanol/kgFM.

Experimental ethanol/carbohydrate yield

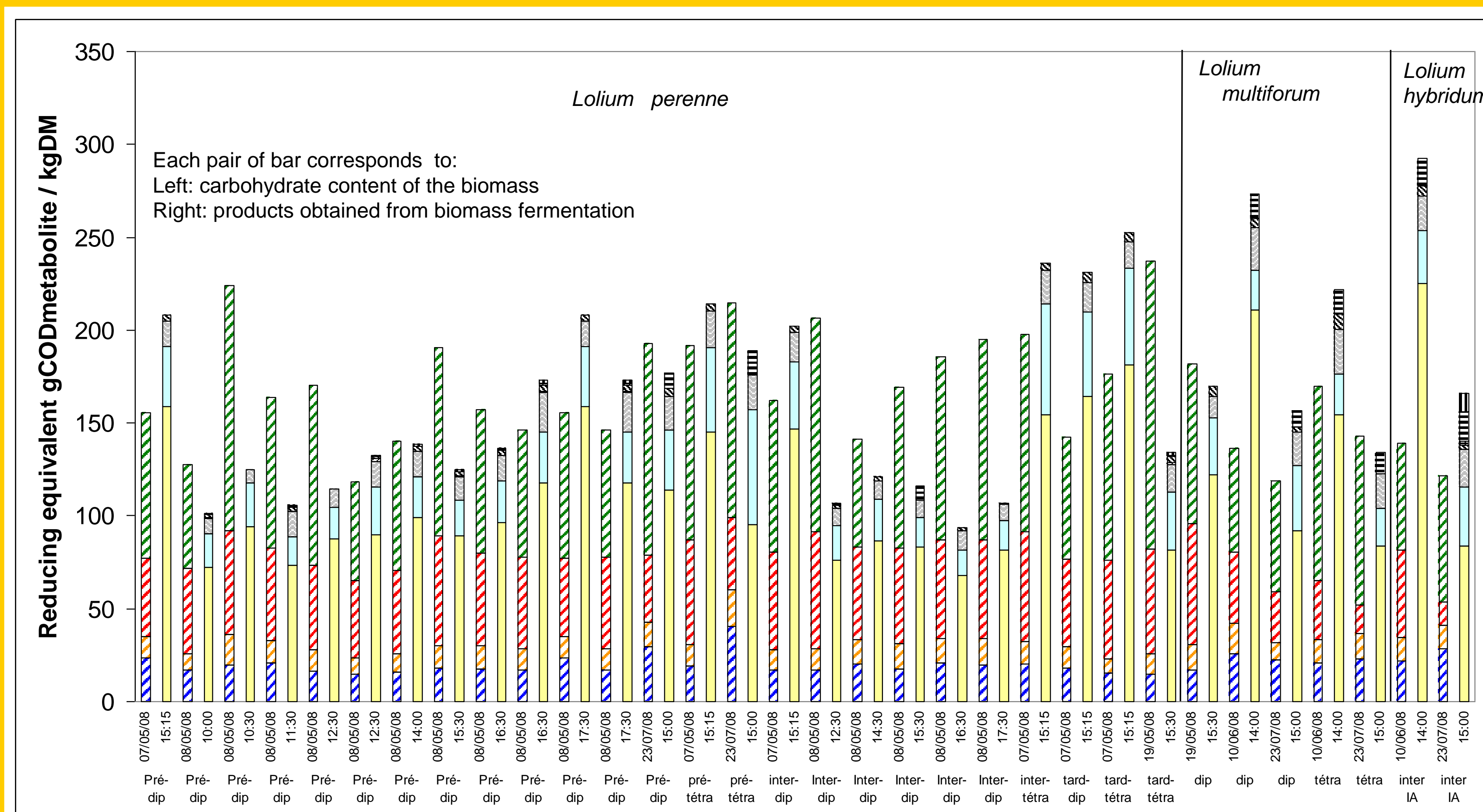


Figure 2: The conversion yields of total soluble carbohydrates to ethanol and lactic acid are between 50 to 100% (some results above 100% are not explained). During the ethanol fermentation, volatile fatty acids, mainly acetic acid, are also produced without clear negative influence on ethanol production.

- The total soluble carbohydrates are mainly converted into ethanol.
- The endogenous microbial flora (the biomass is not sterilized) is responsible for the production of lactic acid and other volatile fatty acids.
- The competition by the endogenous lactic acid microorganisms converts at most 20% to 25% of the total soluble carbohydrates.

Interpretation and Conclusion

- Herbaceous Biomass contains soluble carbohydrates (0.1 g/gDM to 0.2 g/gDM) that can be converted to ethanol
- Ethanol concentration obtained are 10 to 15 gEthanol/kgFM (1.0 to 1.5%w/w)
- The conversion yields of soluble carbohydrates to ethanol are good but the fermentation process have to be improved to limit competitions