Società Italiana di Agronomia
XLV Convegno Nazionale

A.D. MDLXII

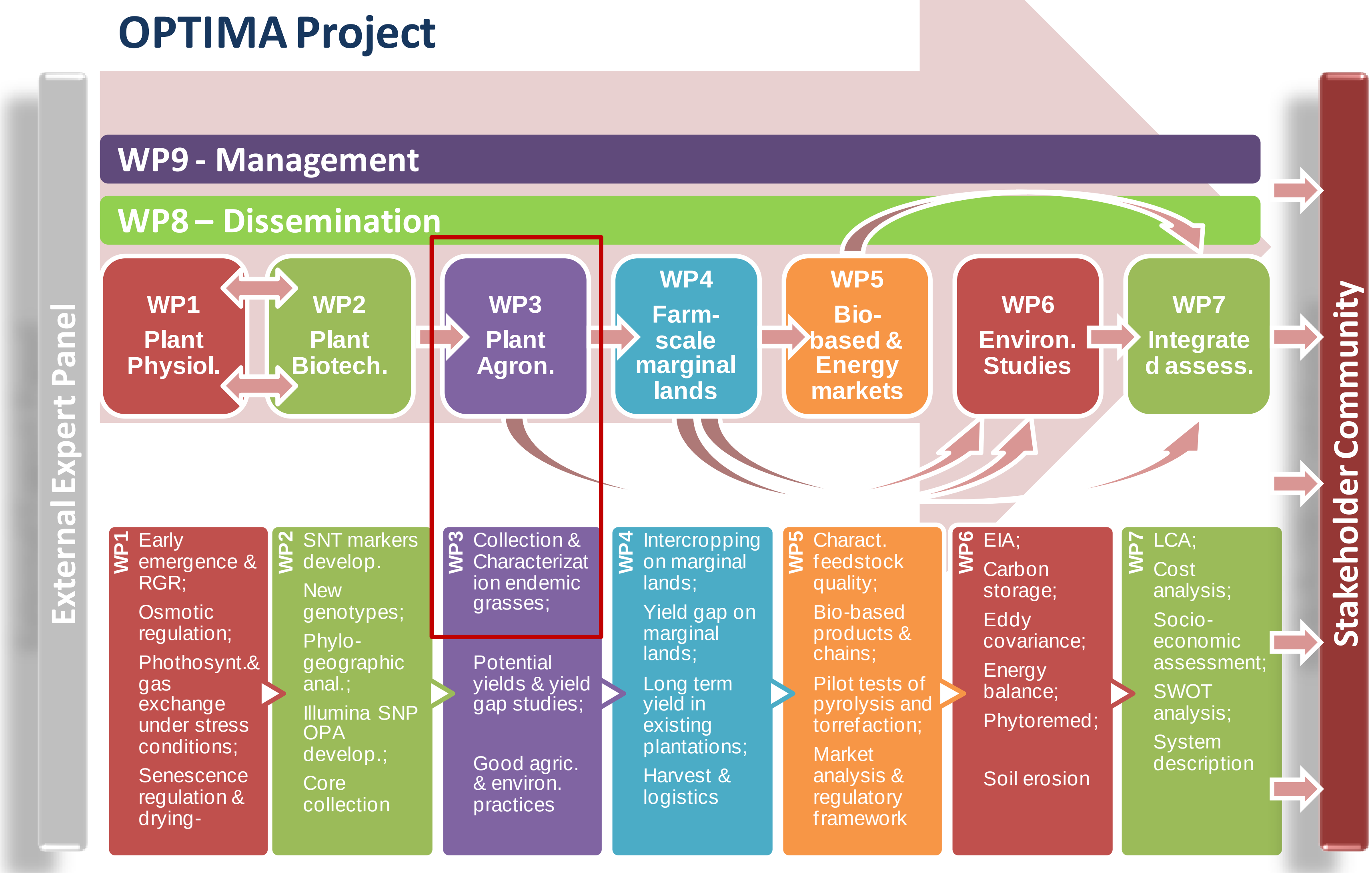
Side-by-side comparison of Mediterranean perennial grasses for lignocellulosic feedstock production

Danilo Scordia[1], Giorgio Testa[1], Silvio Calcagno[1], Giancarlo Patanè[1], Venera Copani[1], Cristina Patanè[2], Salvatore L. Cosentino[1,2]

[1]Dipartimento di Agricoltura, Alimentazione e Ambiente – Di3A, Università di Catania, Italia
[2]CNR - IVALSA, Sesto Fiorentino (FI), Sede di Catania, Italia

Università degli Studi di Sassari, 20-22 settembre 2016

Optimization of Perennial Grasses for Biomass Production in Mediterranean Area



Several perennial grasses are widespread in unused or marginal lands in Mediterranean area

Saccharum spontaneum

Arundo donax

Oryzopsis miliacea

Ampelodesmos mauritanicus

Cymbopogon hirtus

Photos UNICT and CNR-ISPAAM

Aim of the work:

- To collect, identify, and test widespread perennial grass species with a potential biomass yield under Mediterranean conditions.
- To enhance knowledge on the morphological and physiological traits, biomass yield and quality of feedstock of native perennial grasses.

Family*: Poaceae*

Habitus: Perennial

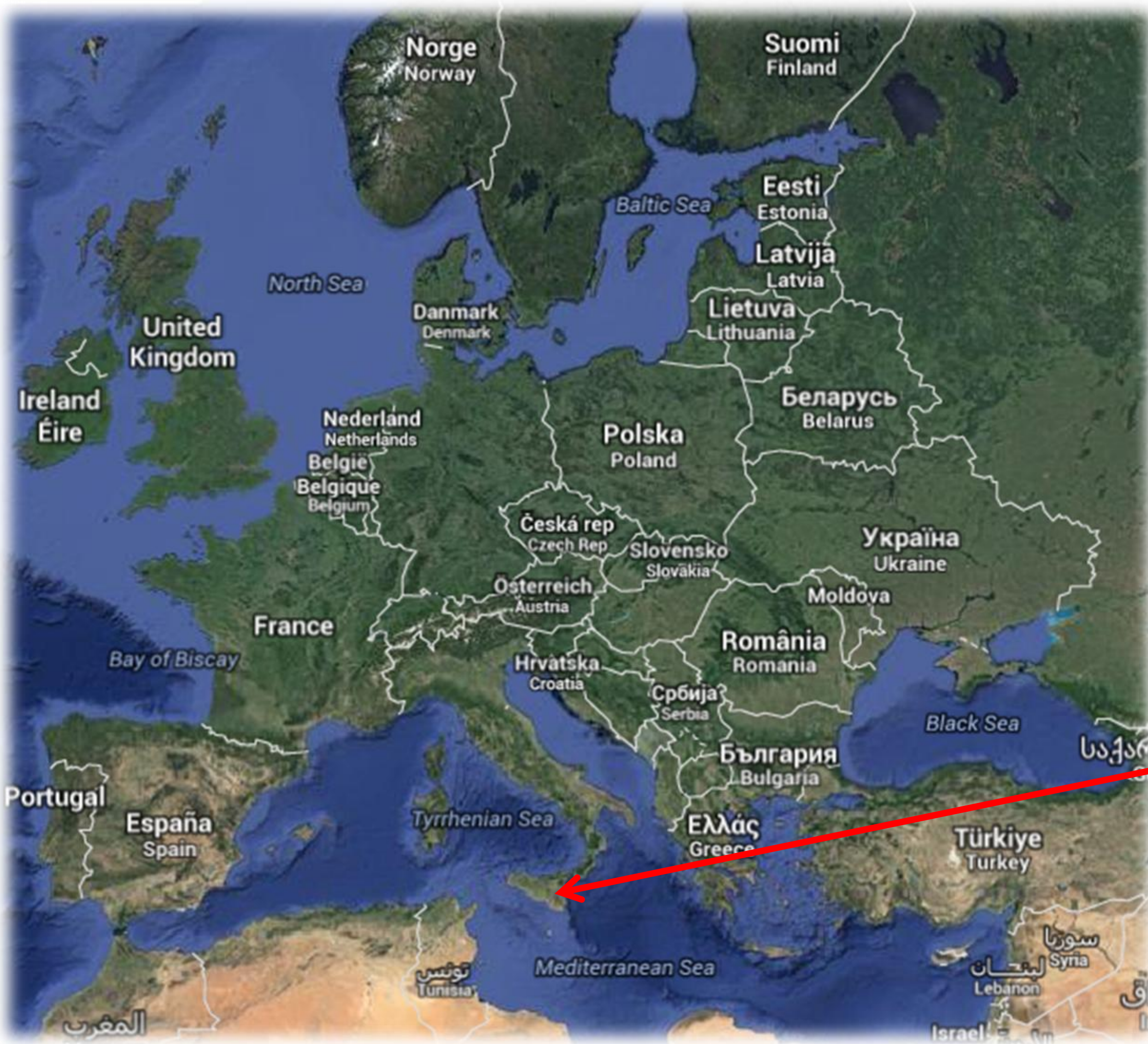
Hemicryptophyte

- *Oryzopsis miliacea* (L.) Asch. & Schweinf. (sin. *Piptatherum miliaceum* L. Coss.)
- *Cymbopogon hirtus* (L.) Janchen (sin. *Hyparrhenia hirta* (L.) Stapf.)

Cryptophyte (Geophyte rhizomatous)

- *Sorghum halepense* (L.) Pers.
- *Saccharum spontaneum* L. ssp. *aegyptiacum* (Willd.) Hackel

Materials and methods: Establishment site



The field trial was carried out from spring 2010 to winter 2015 at the Experimental farm of the University of Catania (South of Italy) (37°25’ N., 15°03’ E., 10 m a.s.l.).

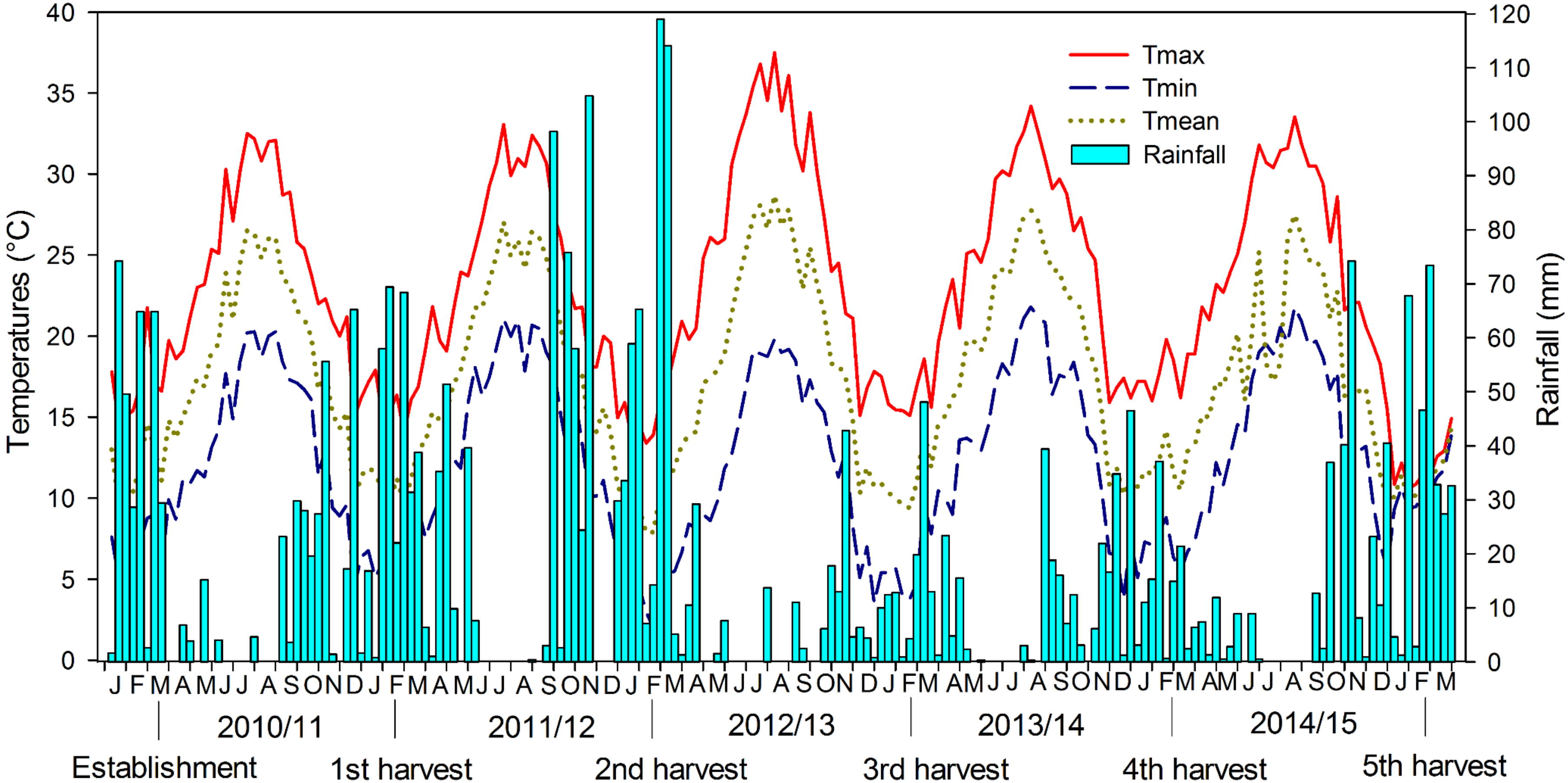
Materials and methods: agricultural practices

- Species: 4 (*S. spontaeum, S. halepense, O. miliacea, C. hirtus*);
- Time of transplant: spring 2010;
- Experimental design: randomized blocks with three replications;
- Single plot 100 m^{-2} (10 x 10 m);
- Plant density 1 plant m^{-2} (100-100 cm between row and inter row);
- Irrigation only from planting to complete establishment;
- Fertilization with N (50 kg ha^{-1}) and P (50 kg ha^{-1}) at establishment;
- Weed control (chemical before and manual after transplanting);
- No inputs after first harvest;
- Harvest time in winter (February) after removing edge plants in all plot sides.

Materials and methods: measurements, determinations and data elaboration

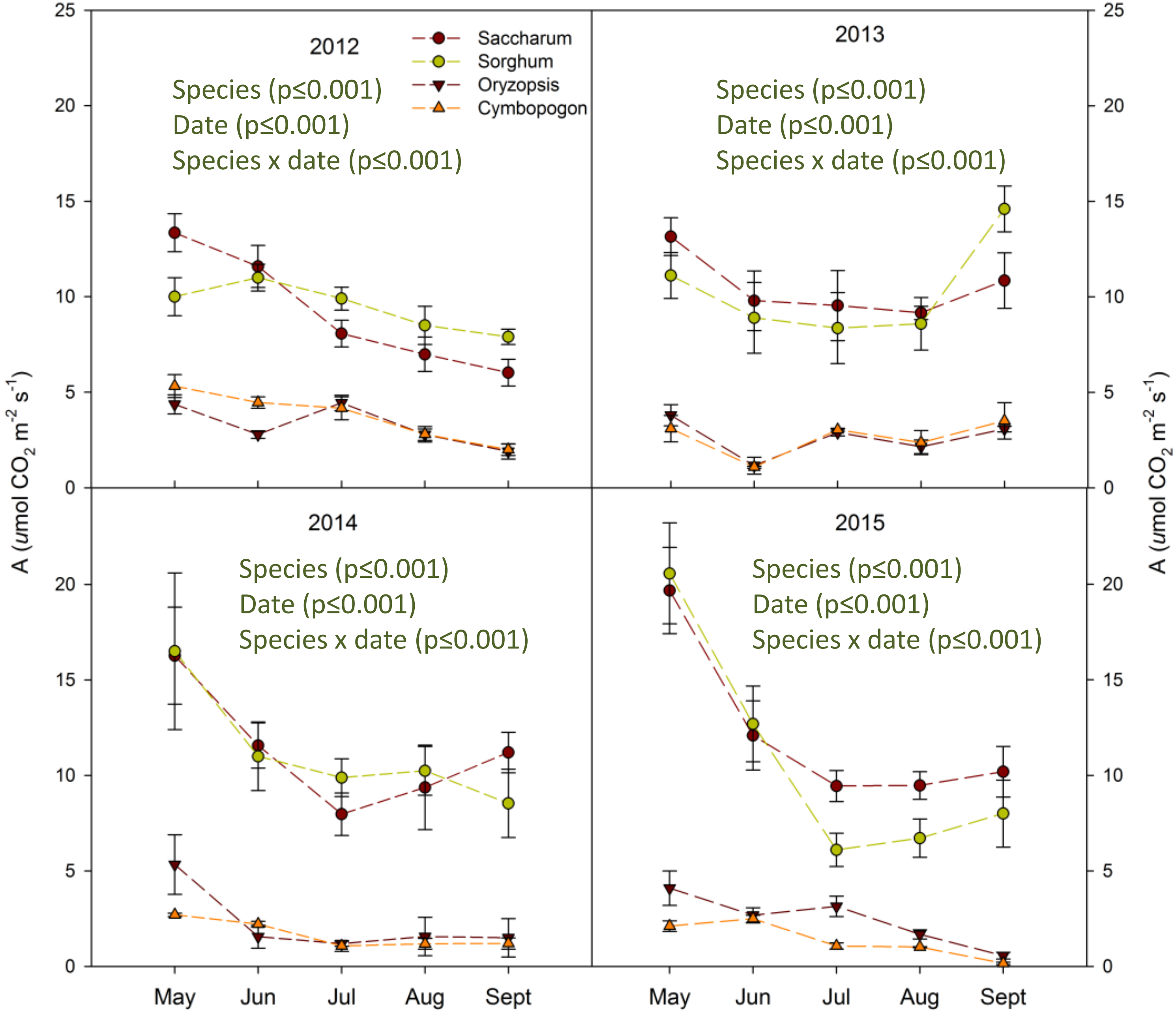
- Main meteorological parameters, as maximum, mean, minimum temperatures and rainfall (Delta-T, WS-GP1 Compact);
- Net photosynthesis (A, µmol CO_2 m^{-2} s^{-1}) and transpiration rate (E mol H_2O m^{-2} s^{-1}) (LI-COR 6400) during beginning of water stress (May), severe water stress (June, July and August) and the end of water stress (September);
- Dry biomass yield (t ha^{-1}) and Crop WUE (g L^{-1});
- Net energy yield (output-input) and energy efficiency (output/input);
- Biomass quality (NIR, SpectraStar™ 2500XL-R, Unity Scientific) using a Ucal InfoStar 3.11.0 program for sample calibration;
- Statistic: GLM repeated measurements ANOVA. Tukey test for mean separations ($p \leq 0.05$).

Results: meteorological trend

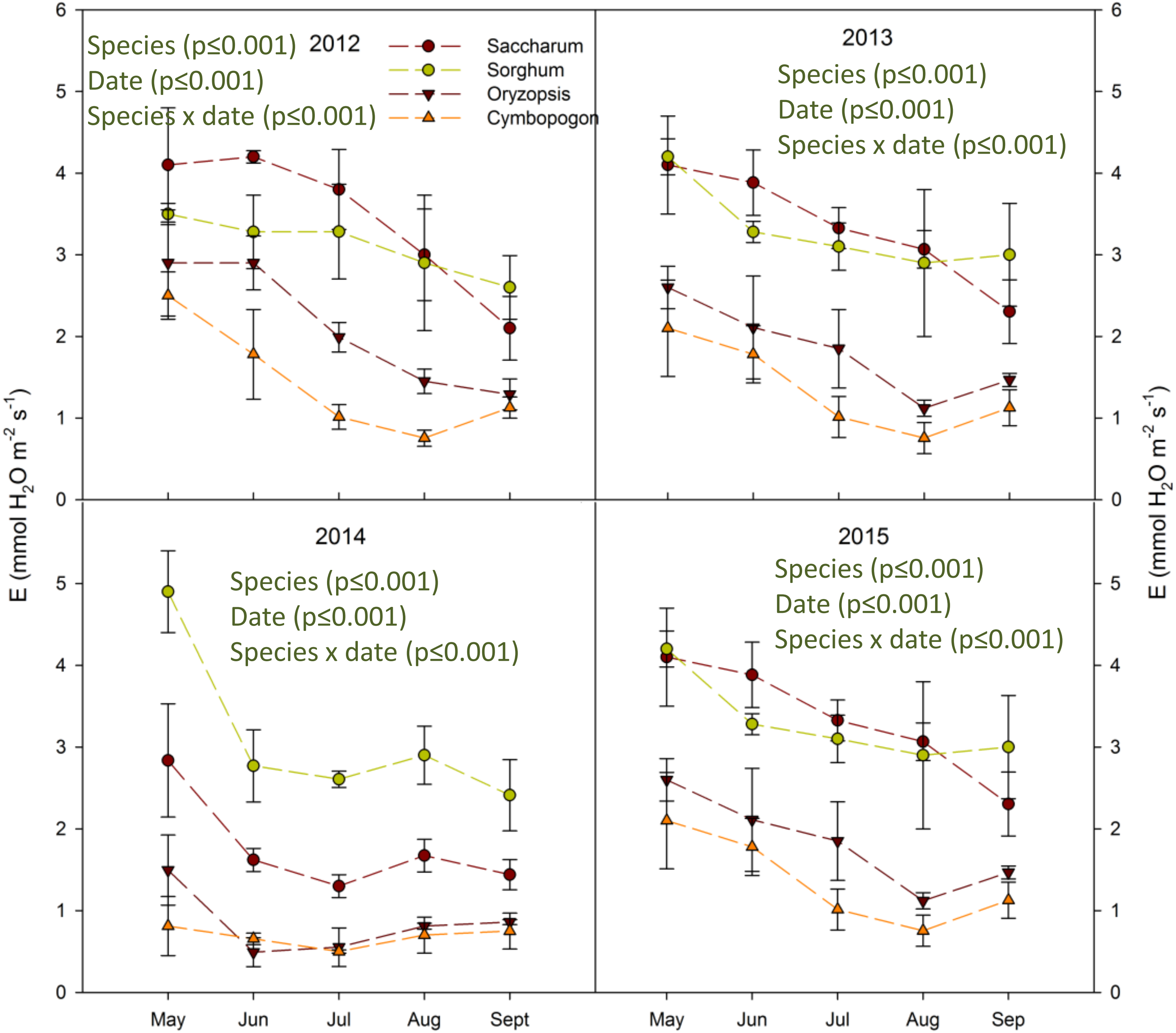


- Maximum temperatures from June to August, between 28.4 and 36.8 °C;
- Minimum temperatures in January-February, between 2.0 and 3.1 °C;
- Yearly mean temperature between 17.7 and 18.9 °C;
- Rainfall between 365.2 (2013/14) and 775.9 mm (2011/12).

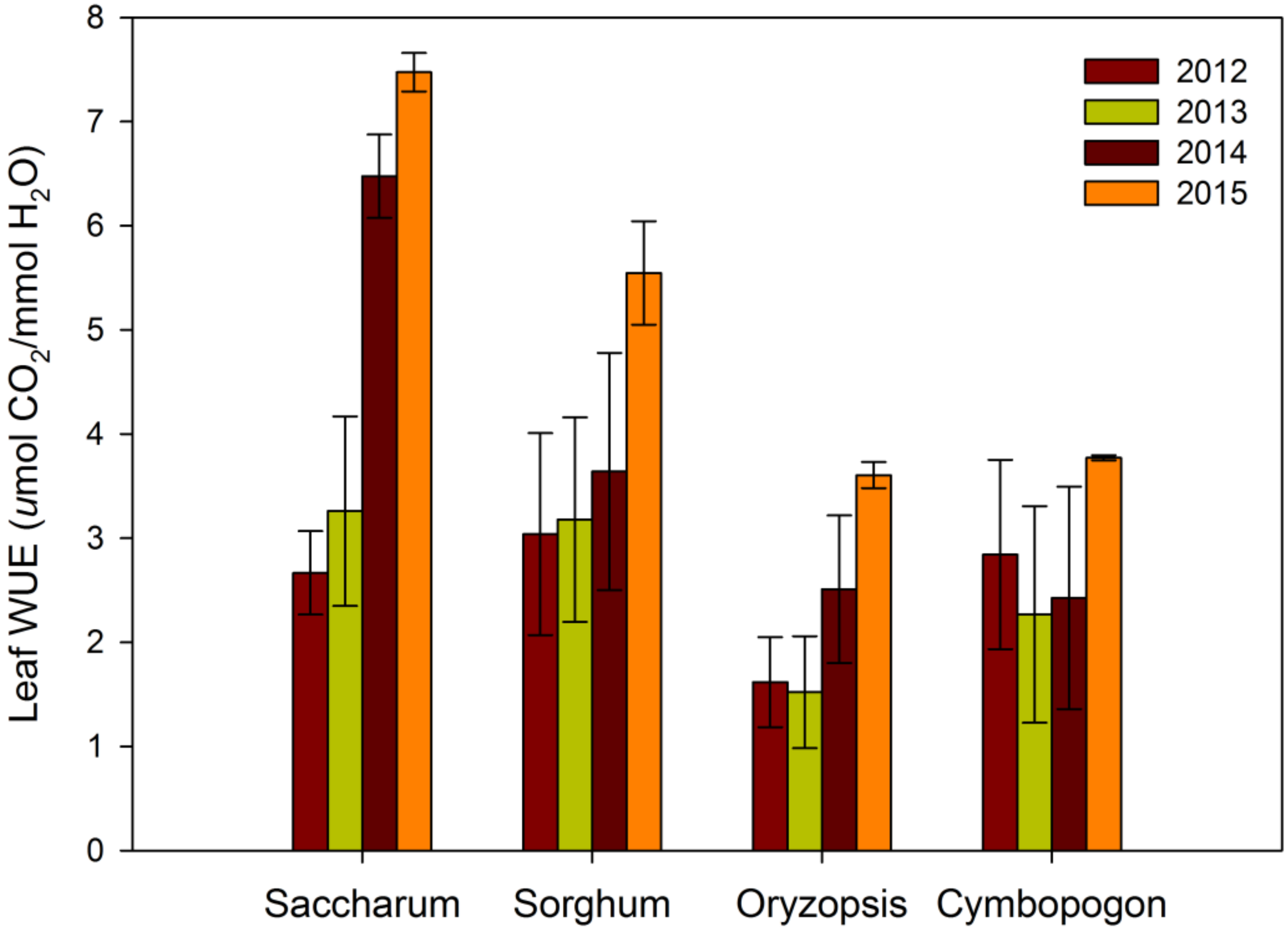
Physiology: net photosynthesis (A, µmol m^{-2} s^{-1})



Physiology: transpiration rate (E, mol m^{-2} s^{-1})

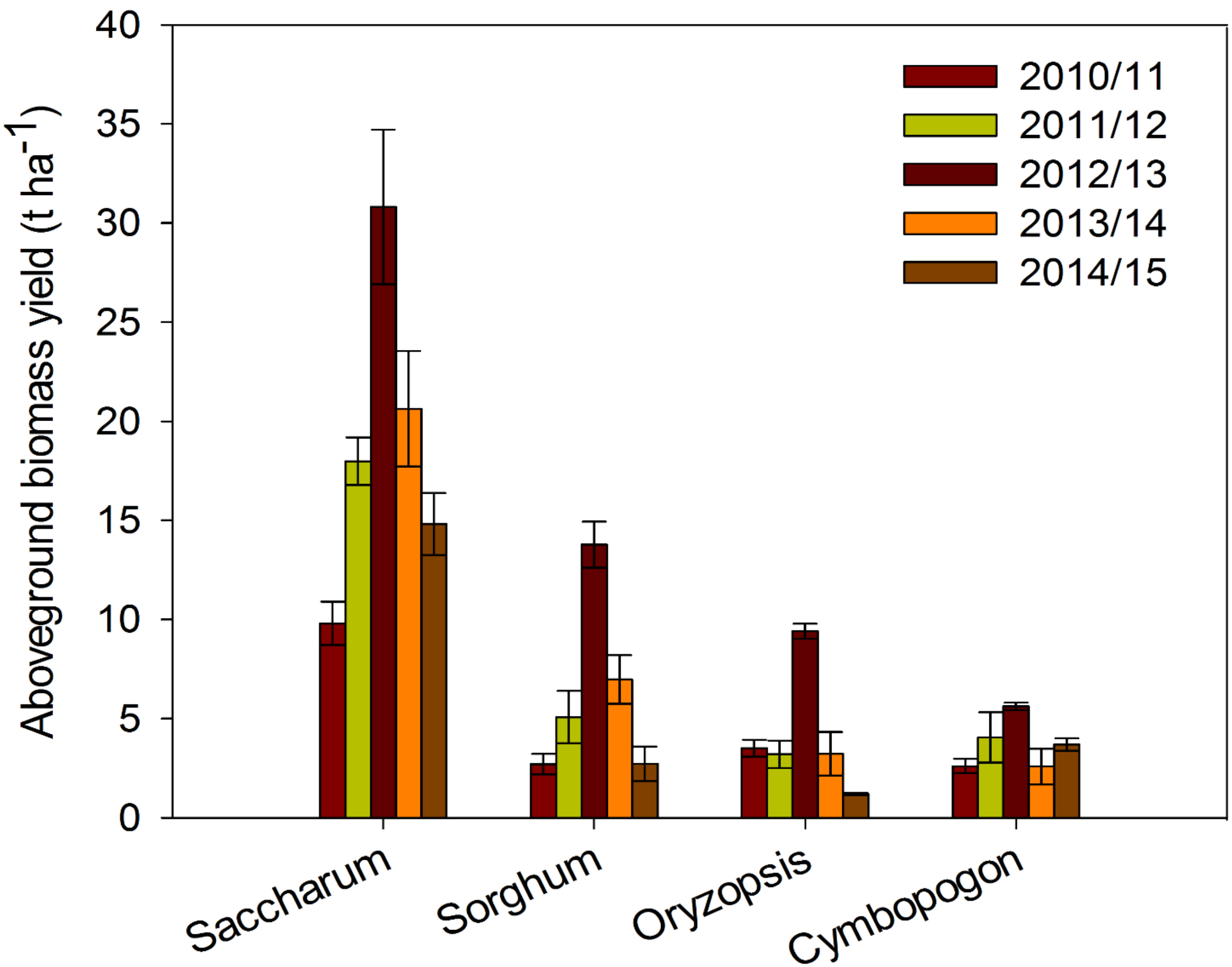


Crop physiology: instantaneous WUE (A/E)



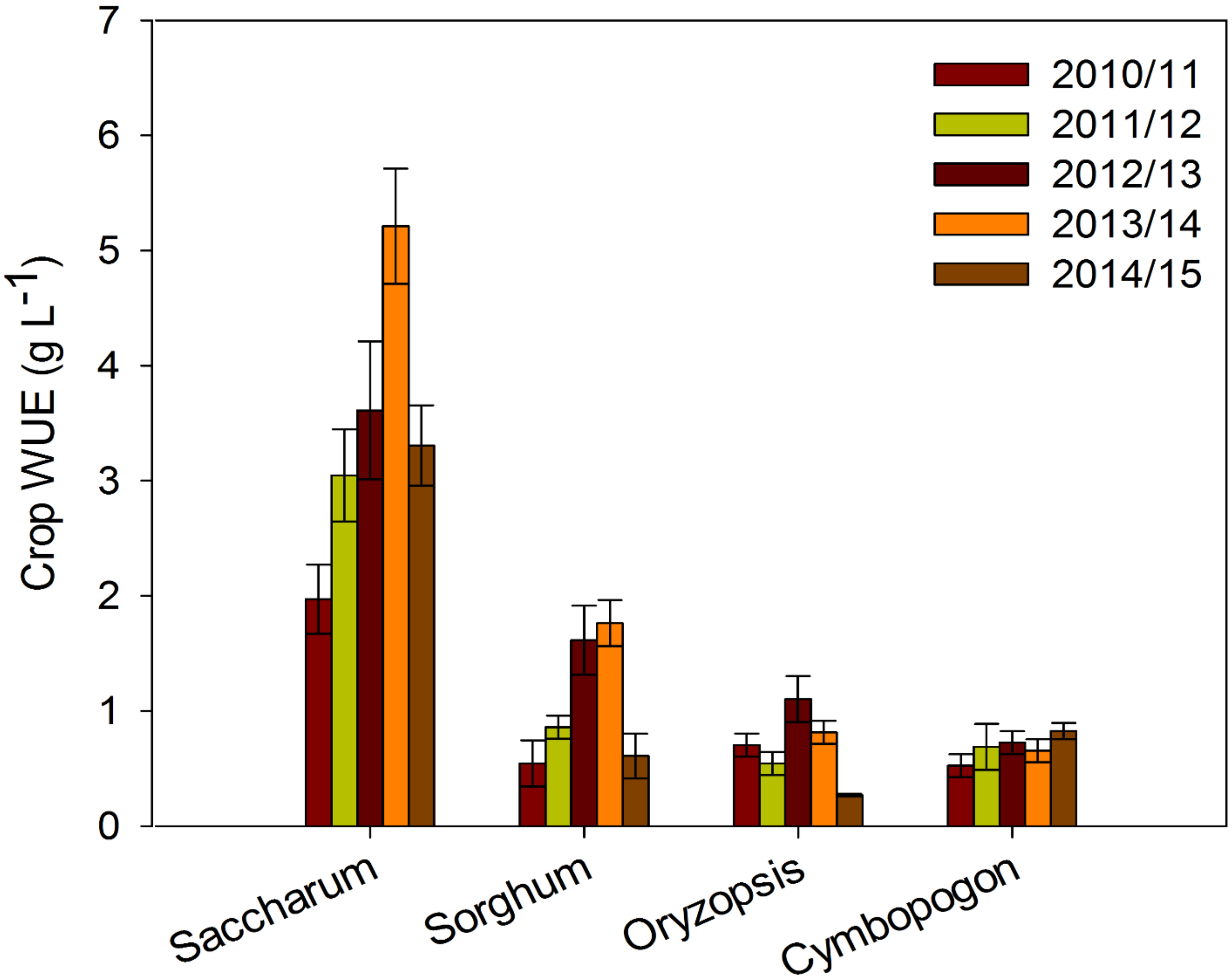
ANOVA	P-value
Species (S)	≤0.001
Date (D)	≤0.001
S x D	≤0.001
Mean (Tukey, p≤0.05)	
Species	
Saccharum	5.0 a
Sorghum	3.9 b
Cymbopogon	2.8 c
Oryzopsis	2.3 d
Date	
I	2.5 c
II	2.6 c
III	3.8 b
IV	5.1 a

Aboveground biomass yield (t DM ha^{-1})



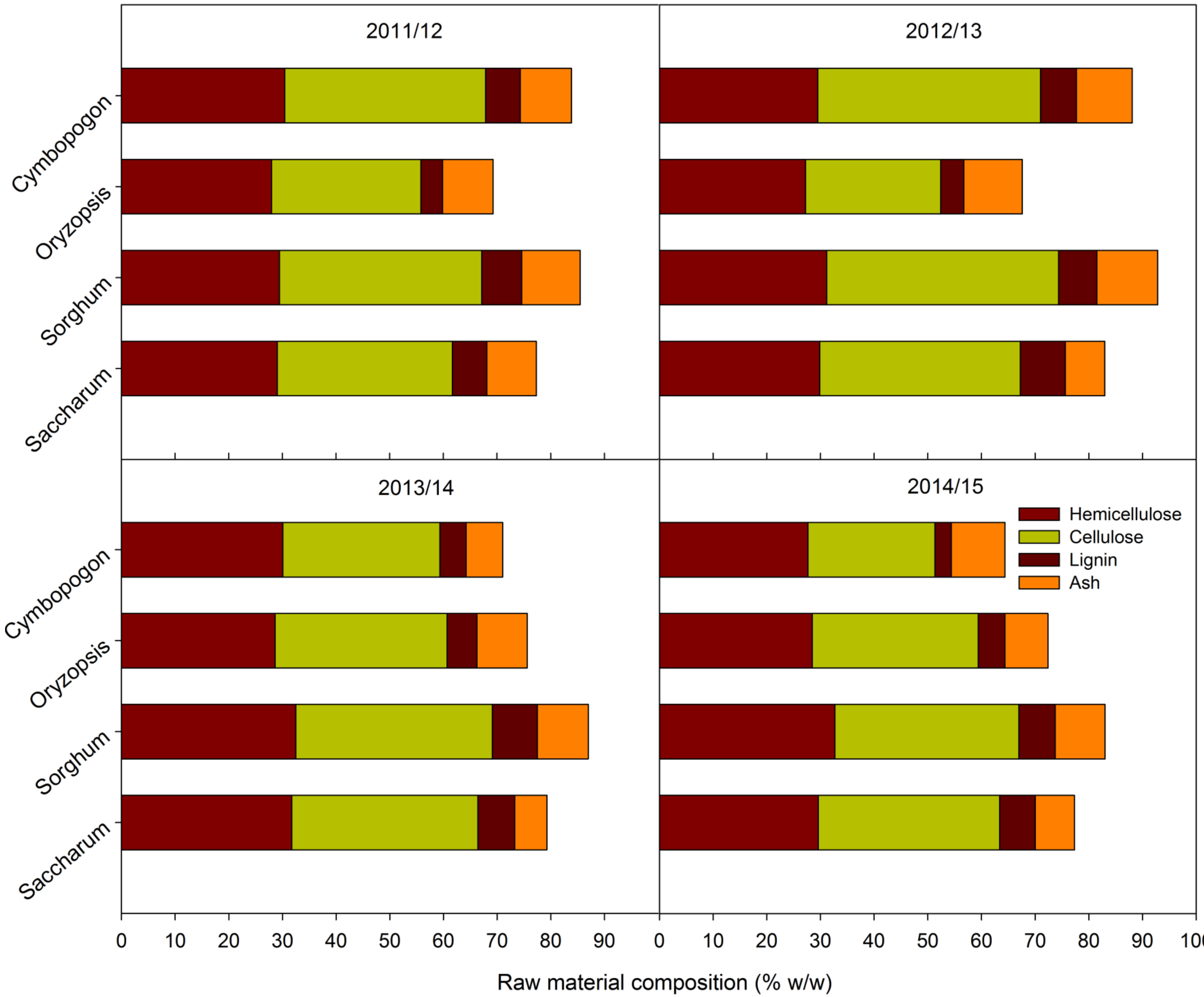
ANOVA	P-value
Species (S)	≤0.001
Harvest (H)	≤0.001
S x H	≤0.001
Mean (Tukey, p≤0.05)	
Species	
Saccharum	18.8 a
Sorghum	6.2 b
Cymbopogon	3.7 c
Oryzopsis	4.1 c
Harvest	
I	4.7 d
II	7.6 b
III	14.9 a
IV	8.3 a
V	5.6 c

Crop Water Use Efficiency (g L^{-1})



ANOVA	P-value
Species (S)	≤0.001
Harvest (H)	≤0.001
S x H	≤0.001
Mean (Tukey, p≤0.05)	
Species	
Saccharum	3.4 a
Sorghum	1.1 b
Cymbopogon	0.7 c
Oryzopsis	0.7 c
Harvest	
I	0.9 d
II	1.3 c
III	1.8 b
IV	2.1 a
V	1.3 c

Quality of feedstock

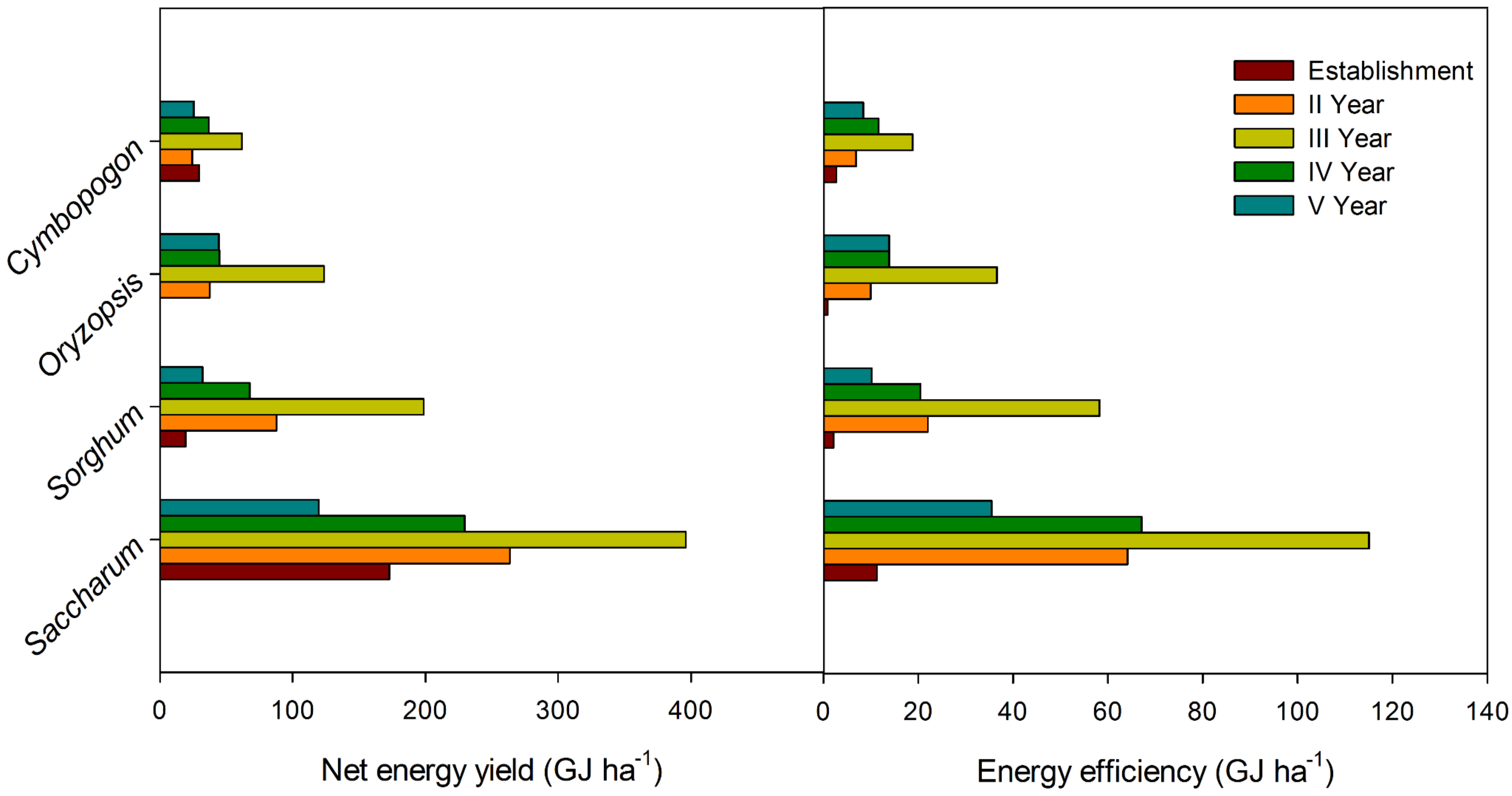


Quality of feedstock: main effect and mean grouping information

Main effect	Hemicellulose	Cellulose	Lignin	Ash
Species	≤0.001	≤0.001	≤0.001	≤0.001

Mean grouping				
Sorghum	32.1 a	38.5 a	7.4 a	10.0 a
Saccharum	29.9 b	35.2 ab	7.4 a	7.3 c
Cymbopogon	29.3 bc	32.1 bc	5.2 b	9.0 b
Oryzopsis	28.6 c	30.0 c	4.9 b	8.8 b

Energy balance: Net energy yield & Energy efficiency



Conclusions

- All grasses proved to be well adapted to semi-arid Mediterranean conditions, growing well in completely absence of agronomic input supply.

- Gas exchange between plant and atmosphere decreased as the water stress increased along the growing season.

- *S. spontaneum* overyielded the other species in the front of DM yield, instantaneous and crop WUE, net energy yield and efficiency. However, biomass yield and related efficiencies are mostly driven by the rainfall amount and distribution when perennial grasses are grown in rainfed conditions.

- The four species showed a comparable structural polysaccharides content (hemicellulose and cellulose) as other perennial grasses and annual monocot residues. Lignin was rather low in *C. hirtus* and *O. miliacea*, while ash content was quite high in these latter and *S. halepense*.

- In addition to bioenergy purpose, present perennial grasses deserve to be investigated as alternative crops for ecosystem services that might offer.

A.D. MDLXII

Thanks for your attention

Danilo Scordia
dscordia@unict.it

'OPTIMA'
'Optimization of Perennial Grasses for Biomass Production'
Project funded by the FP7 EU for research, technological development and demonstration under the grant agreement FP7-289642
www.optimafp7.eu

NARA

Training on Agriculture and Postharvest Fruit and Vegetables through Sustainable Best Practices

Erasmus+

Fundación AulaDei PARQUE CIENTÍFICO TECNOLÓGICO

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY

UNIVERSITÀ degli STUDI di CATANIA

Marketmentoro

Tecno packaging

NARA è realizzato grazie al contributo della Commissione Europea nell’ambito del programma ERASMUS+.

Lo scopo del progetto è quello di migliorare la professionalità di giovani agricoltori Europei attraverso corsi di formazione e training mirati ai bisogni attuali del settore agricolo.

I corsi includeranno le seguenti tematiche:

- Tecnologie di post raccolta;
- Migliori pratiche agronomiche ed ambientali;
- Packaging, logistica e marketing;
- Imprenditorialità e creazione di nuovo business.

Potete seguire gli sviluppi del progetto visitando il sito web del progetto NARA
http://naraproject.eu/en