CNR SHORT TERM MOBILITY PROGRAM

REPORT

from Dr. Tsonko Tsonev

Title of the program: Photosynthetic responses, isoprene emission and water use of *Arundo donax* plants subjected to drought

Place of visit: CNR - IVALSA, Via Madonna del Piano 10, Sesto Fiorentino 50019 Firenze

Period: 22 April - 6 May 2015

The aim of the short-term mobility program was to analyse water stress-induced variations in photosynthesis and isoprene emission in different ecotypes of *Arundo donax* during progressive soil water shortage and after recovery from water deficit.

Experiments were carried out with two ecotypes of *Arundo donax*, one from Northern Italy (Sesto Fiorentino) and another from Morocco grown in 20 L pots at greenhouse conditions. Part of the plants were subjected to progressive drought by stopping irrigation while another part were regularly irrigated to 80% of water holding capacity. The photosynthetic rate, stomatal conductance, transpiration and water use efficiency were registered by a system for photosynthetic investigations with fluorescence head LI-6400XT (LI-COR Biosciences Inc., USA); maximal carboxylating efficiency, stomatal limitation of photosynthesis, CO_2 compensation point – from A/Ci response by the same apparatus; chlorophyll fluorescence induction kinetics – PSII activity, photochemical and non-photochemical quenching – by the fluorescence head of LI-6400XT; endogenous isoprene emission rate - by GC-MS. After reaching near to zero values of the photosynthetic rate, the stressed plants were allowed to recover by normal irrigation and the same parameters were measured on the recovered plants.

Some of the obtained data are presented in the next figures. The rate of photosynthetic CO_2 assimilation in control plants did not differ significantly between the ecotypes while under water stress the plants of Morocco (M) ecotype seem more resistant (Fig.1). The decline in photosynthesis in stressed Sesto Fiorentino (SF) plants was observed after 5^{th} day of treatment, while in M plants it appeared after 8^{th} day and in the next days the photosynthesis kept a little bit higher compared to stressed SF plants. However, when the photosynthesis is

plotted against the fraction of the transpired soil water (FTSW) the observed difference disappears (Fig.2). Apparently, the water loss is higher and earlier in SF plants (Fig.3). Since the trend and the differences in stomatal conductance (g_s, Fig.4) are similar to these of photosynthesis, the higher water loss in SF ecotype could be due to higher leaf area of the plants of this ecotype.

Regarding water use efficiency (WUE, Fig.5) in control plants, this parameter was higher but not significant in SF ecotype in comparison to M. In the earlier phase of drought stress WUE of SF plants was higher than in M plants, while at the late phase at strong water stress M plants have advantage.

Water stress had not effect on the quantum yield of photosystem II photochemistry (Φ_{PSII}) in both ecotypes until the 8^{th} day of treatment after that it dropped significantly, more abruptly in SF plants.

There were no significant differences in isoprene emission between the studied ecotypes (Fig.7). The decline of emission in water stressed plants was more than 50% in both ecotypes.

Overall, the effects of drought were highly significant in most parameters evaluated, however, no large differences between both ecotypes were evident under either water treatment. Drought resulted in significantly reduced photosynthetic/photochemical activities, whereas intrinsic WUE increased as the soil dried out. CO_2 assimilation were more sensitive to water deficits than transport of electrons across the photosystem II. In summary, both ecotypes have the ability to sustain a high stomatal control and WUE under drought conditions.

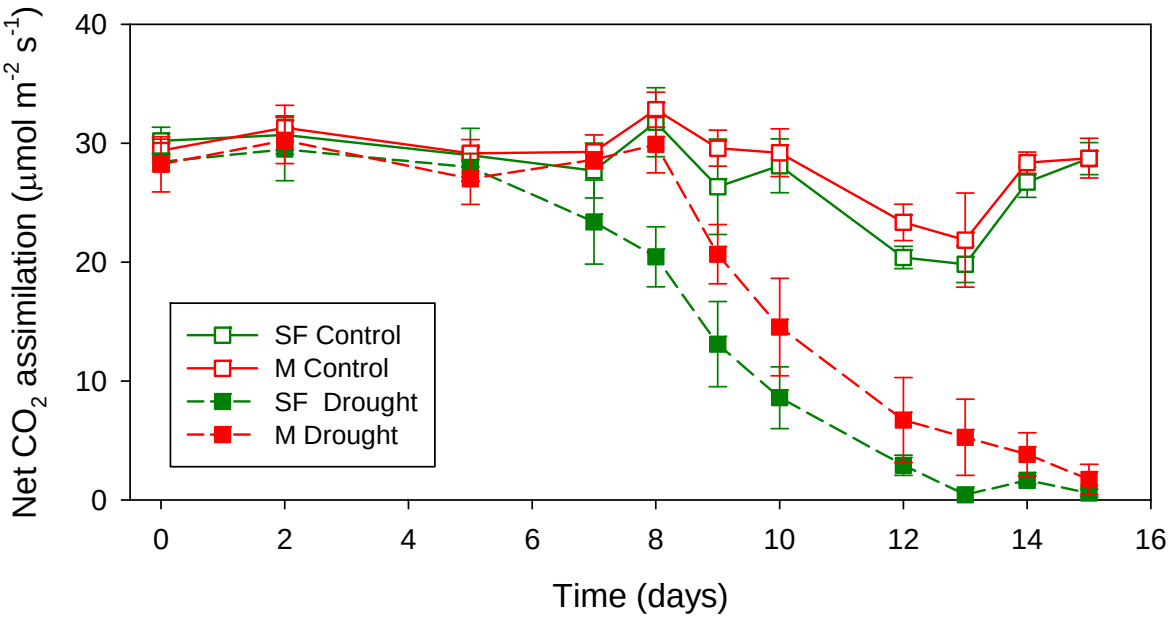

Fig. 1. Changes in net photosynthetic rate in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) during progressive drought. Open symbols – control plants, closed symbols – drought).

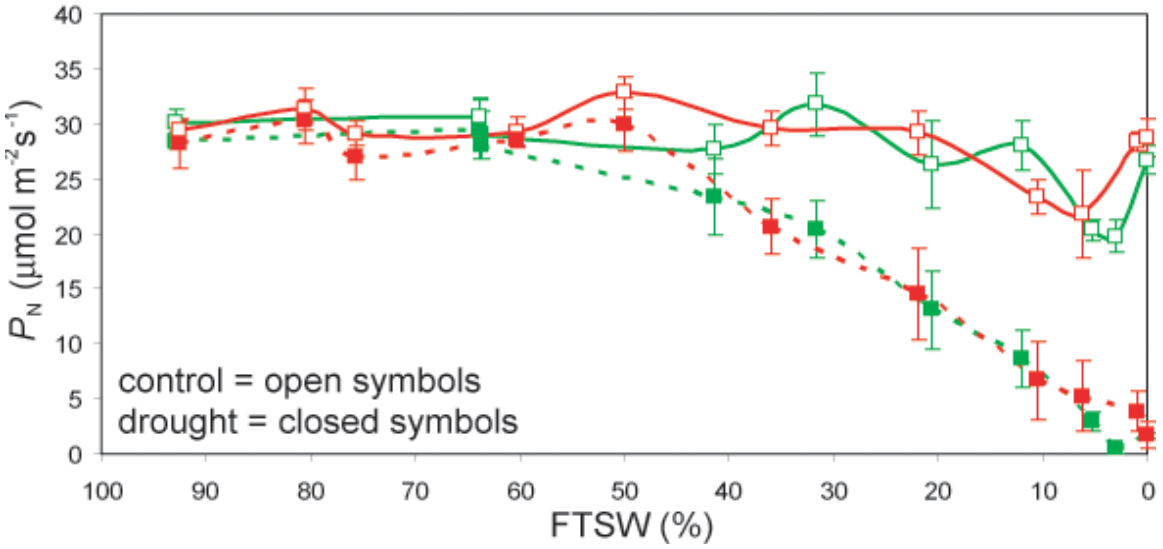

Fig. 2. Changes in net photosynthetic rate in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) in dependence on the fraction of transpired soil water (FTSW). Open symbols – control plants, closed symbols – drought).

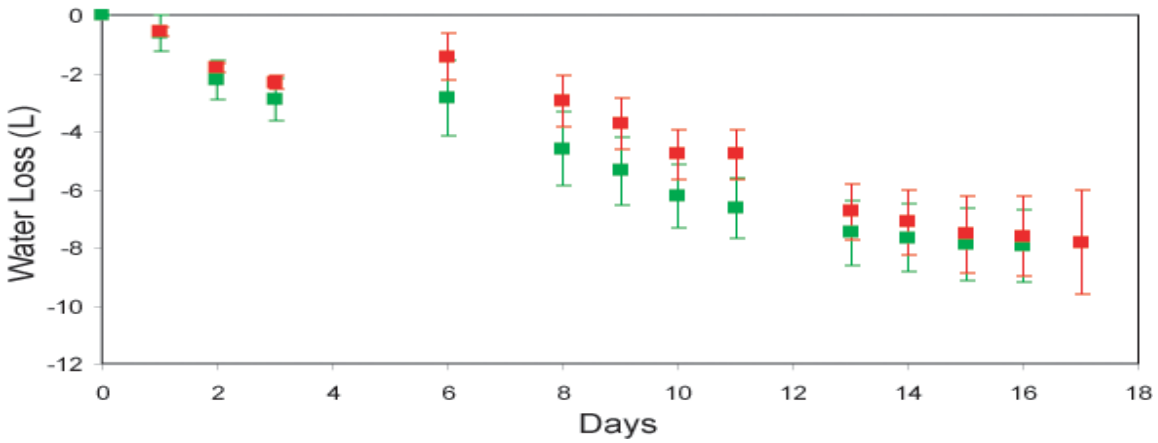

Fig. 3. Water loss in in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) subjected to progressive drought.

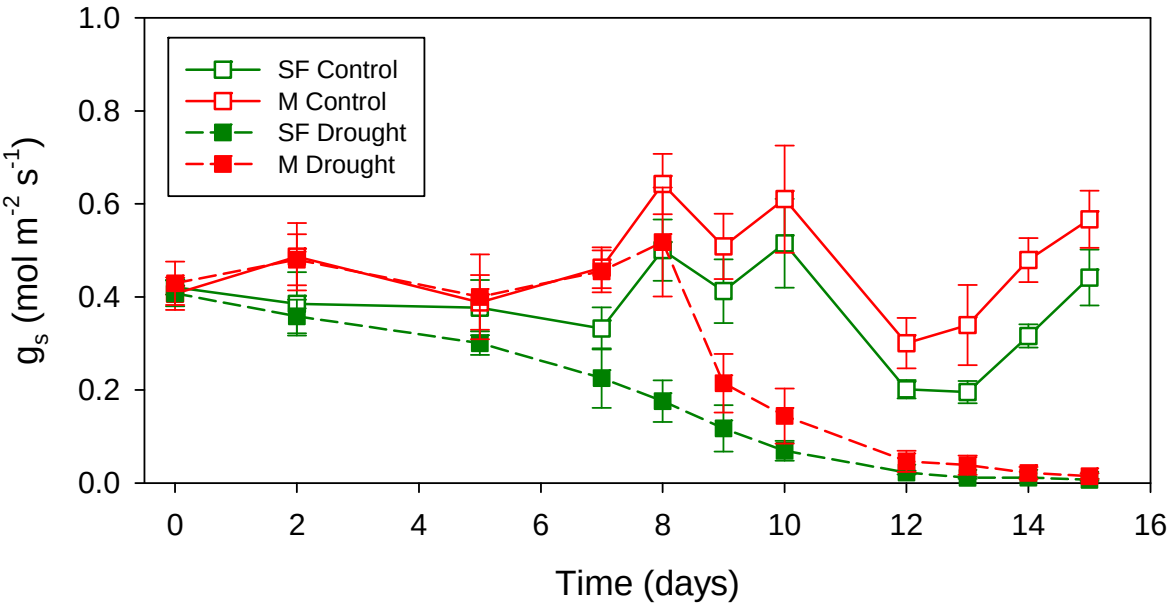

Fig. 4. Changes in stomatal conductance (g_s) in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) during progressive drought. Open symbols – control plants, closed symbols – drought).

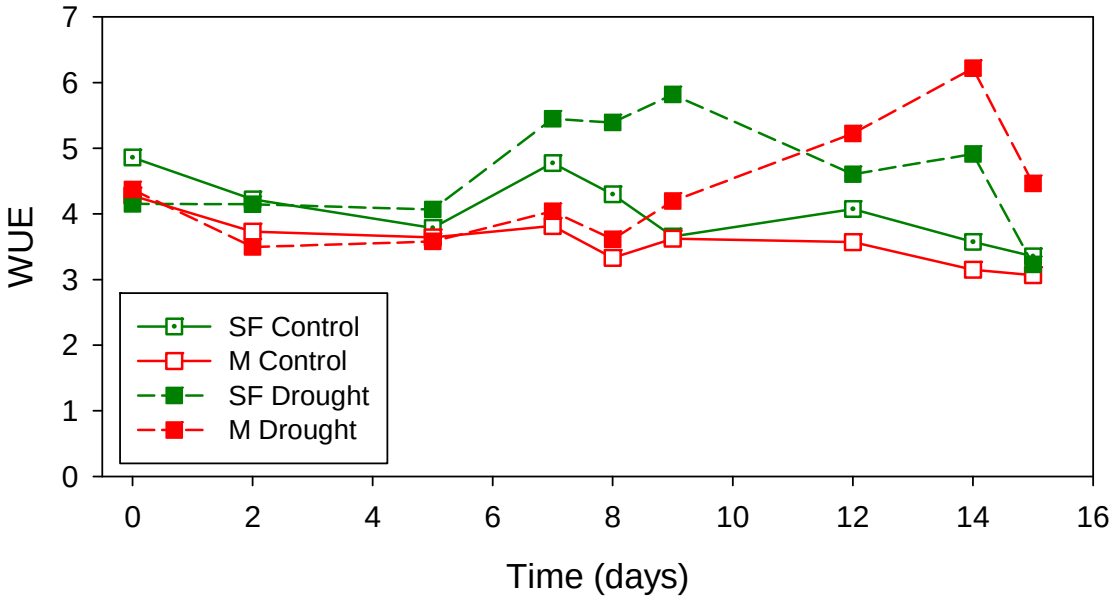

Fig. 5. Changes in water use efficiency (WUE) in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) during progressive drought. Open symbols – control plants, closed symbols – drought).

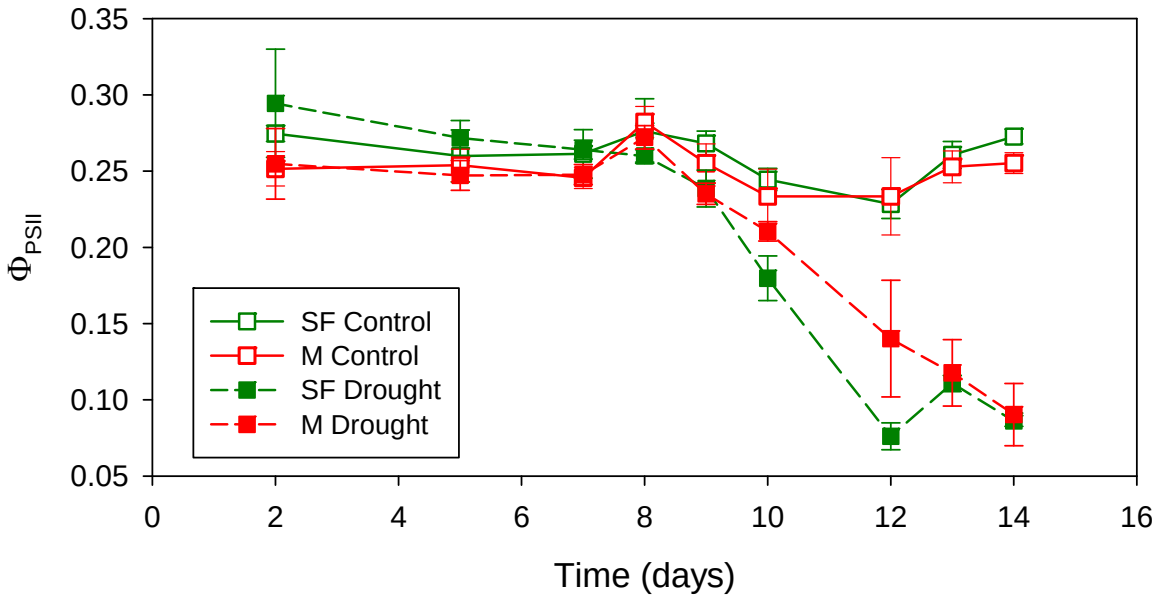

Fig. 6. Changes in the quantum yield of photosystem II photochemistry (Φ_{PSII}) in *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) during progressive drought. Open symbols – control plants, closed symbols – drought).

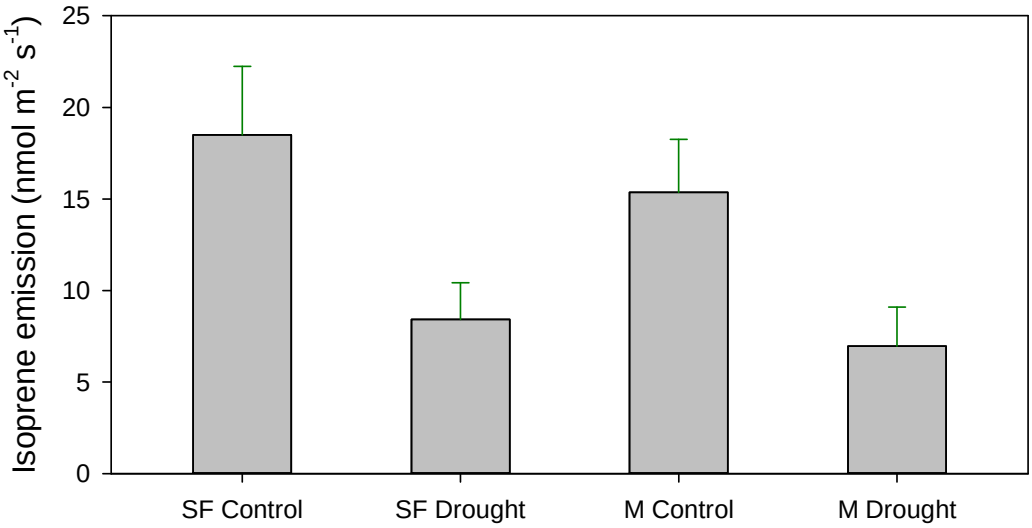

Fig. 7. Average isoprene emission rate from *Arundo donax* ecotypes from Sesto Fiorentino, Italy (SF) and from Morocco (M) during the treatment period.

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