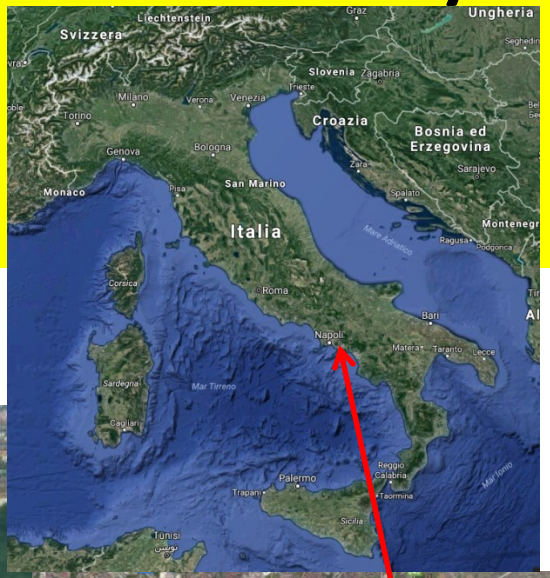
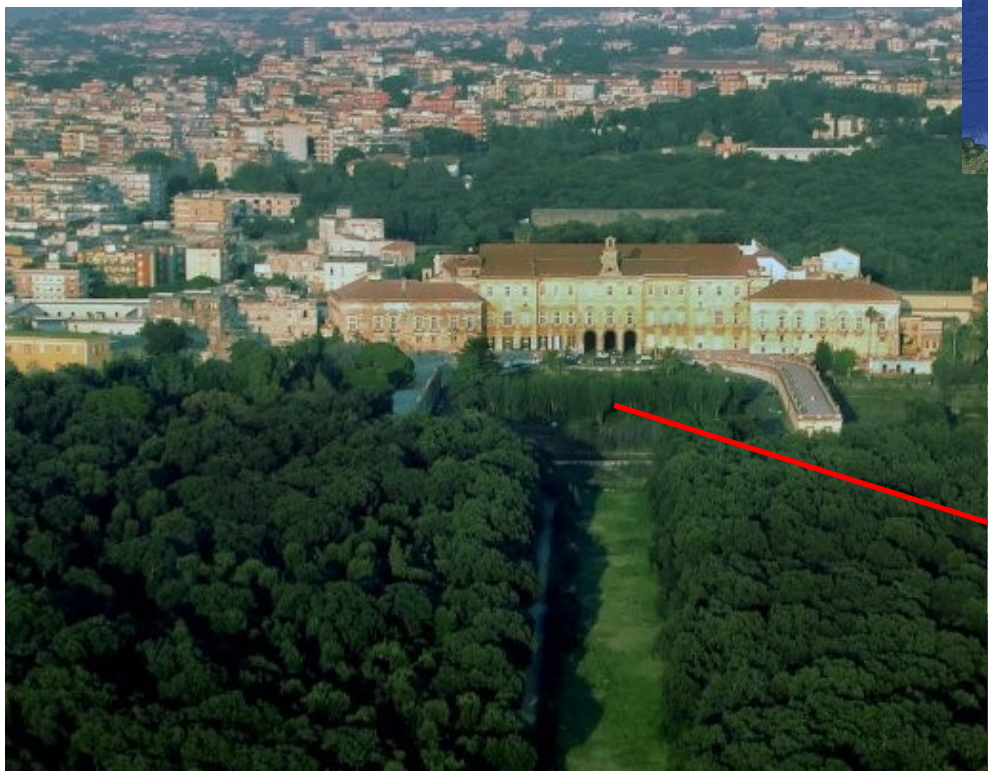
Effects of ozone pollution on crops subjected to the typical stresses of Mediterranean Environments: experiments in Southern Italy.

Massimo Fagnano
Dept. Agricultural Sciences
University of Naples Federico II

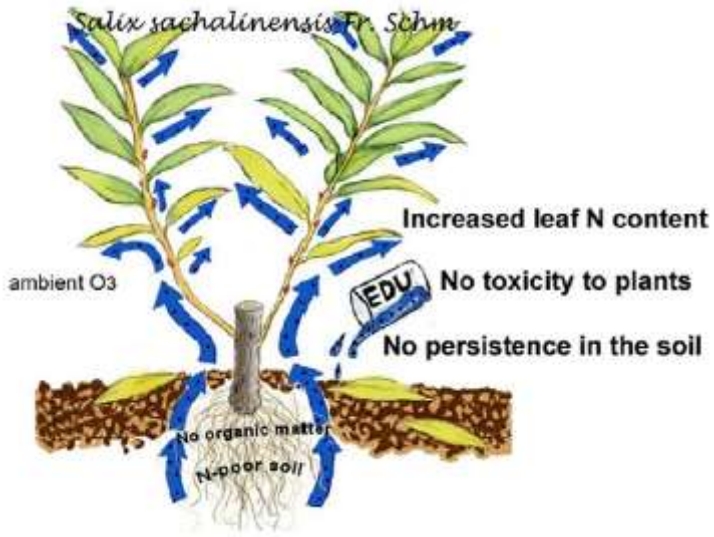




Methods for assessing yield losses due to ozone

Ethylene diurea treatments

(Carnhan et al., 1978.Phytopathology, 68, 1225-1229)



uncertainties about the mechanism of its protective action, its phytotoxicity or its role as a source of nitrogen for plants, reduced the interest about his method.

Science of the Total Environment 566–567 (2016) 841–850

Contents lists available at ScienceDirect

Science of the Total Environment

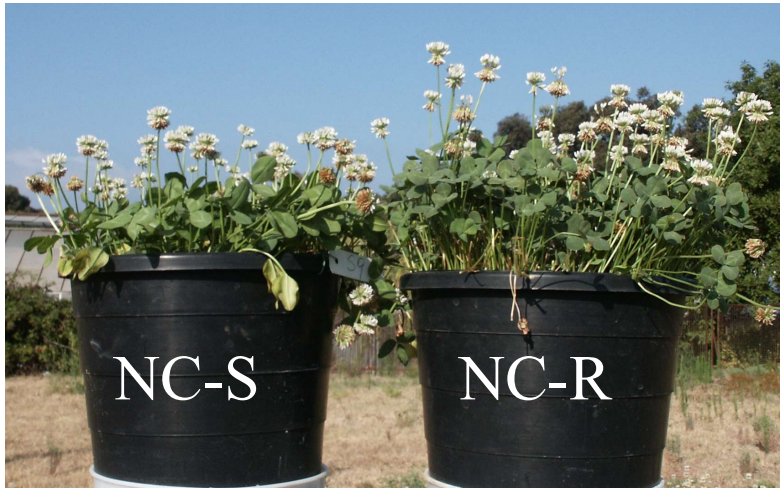
journal homepage: www.elsevier.com/locate/scitotenv

High doses of ethylene diurea (EDU) are not toxic to willow and act as nitrogen fertilizer

Evgenios Agathokleous [a,*], Elena Paoletti [b], Costas J. Saitanis [c], William J. Manning [d], Cong Shi [a], Takayoshi Koike [a]

	Advantages	Disadvantages
EDU	Possibility of using in both open field conditions and controlled environments. Possibility to couple with other techniques (i.e. fumigation). Easy to use. Extensive bibliography.	Difficulty to identify the right dose in relation to species, phenological stages, ozone levels. Low solubility at high concentration. Difficulty to find (it is not available in the regular market of chemicals). Treatments are not standardized (irrigation, stem injection, ...).

Sensitive and Resistant clover biotypes (Heagle et al. 1991. New Phytologist 119:61-68) and **Open top chambers** (Sanders et al., 1991. New Phytologist 117:439-447)



Water, Air, and Soil Pollution **155:** 383–398, 2004.

MONITORING YIELD LOSS FROM OZONE POLLUTION IN A MEDITERRANEAN ENVIRONMENT: A COMPARISON OF METHODS

M. FAGNANO[1]*. G. MEROLA[1]. A. FORLANI[1]. L. POSTIGLIONE[1] and J. FUHRER[2]

	Advantages	Disadvantages
OTC	Full control of meteorological conditions (T°C, RH, etc.). Full control of ozone levels (from 0, filtered air, to X, ozone enriched air). Consideration of the chamber effect through comparison with ambient air data. Possibility to use the normal cropping techniques. Possibility to split the chambers with the aim of studying the interaction with other stressors (i.e. drought or salinity). Relatively less expensive than other systems	Modification of microclimatic conditions (chamber effect). Need of ventilation (2–3 change of air per minute) that could not be representative of the field conditions. Relatively more expensive than other systems for field experiments (i.e. EDU).

In all these experiments, plants were grown with water reservoirs

for avoiding water limitations and the consequent closure of stomata

The response of plants to ozone pollution is not representative of the realistic response of cropping systems of those areas characterized by other environmental stresses

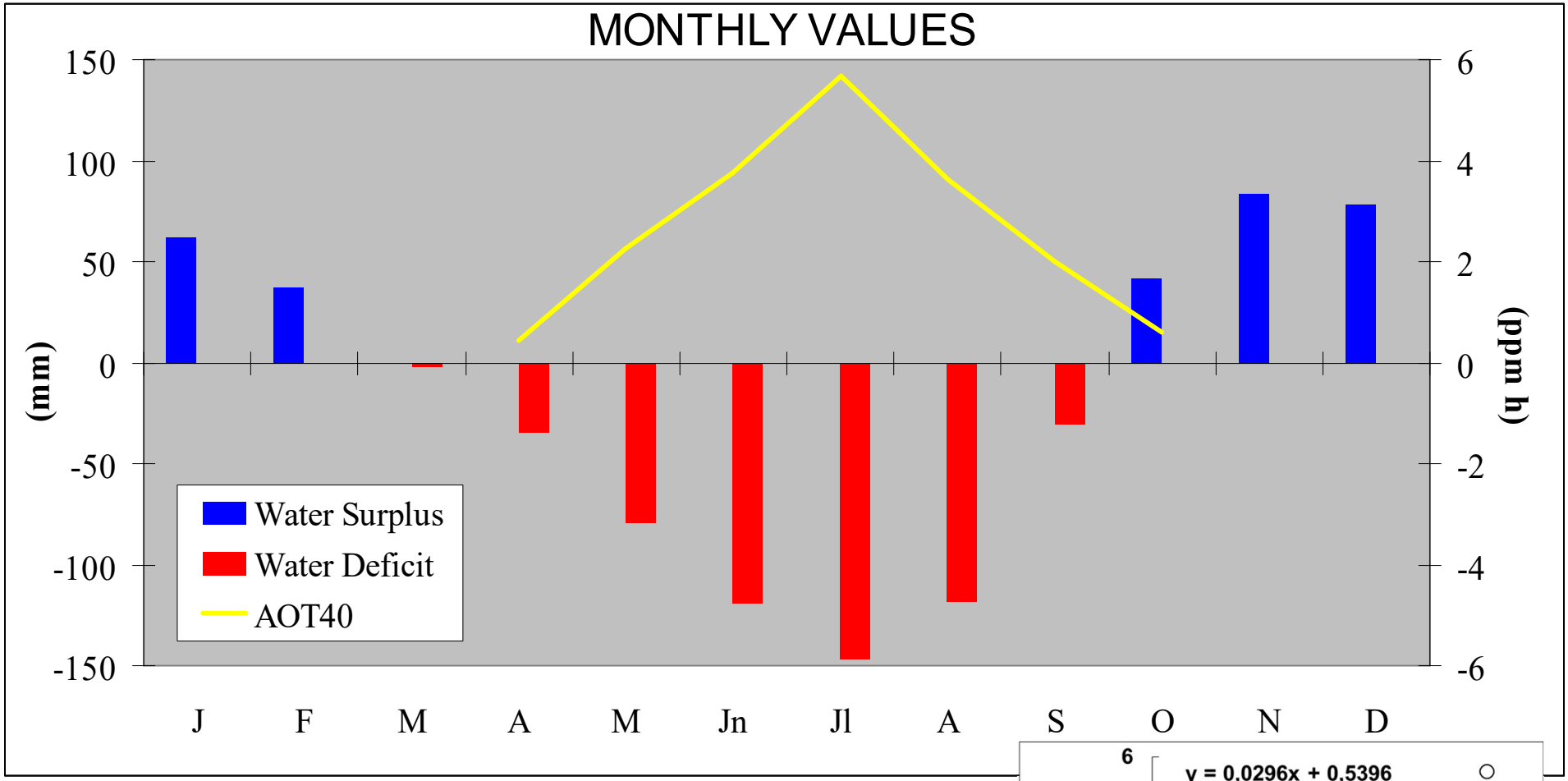
IN MEDITTANEAN CROPLANDS, PLANTS ARE CONTEMPORARILY EXPOSED TO MORE THAN ONE STRESS

(drought, salinity, high temperature, waterlogging and root anoxia)

The other major stresses typical of Mediterranean cropping systems

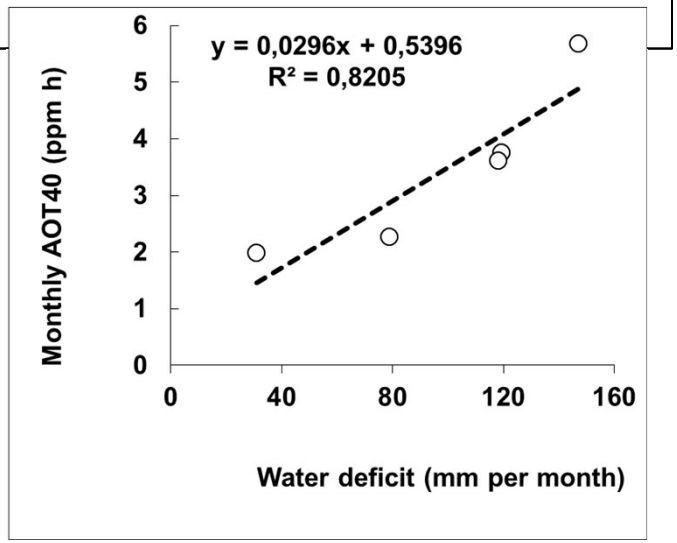
- **Summer drought**
- **Salification of coastal groundwater**

(both are predicted to increase in Climate Change scenarios)



In Italy, summer rainfalls compensate from 20 % (in the South) to 35% (in the north) of crop water requirements.

During spring-summer AOT40 is significantly correlated with water deficit



Ital. J. Agron. / Riv. Agron., 2008, 1:7-12

Ozone Damages to Italian Crops: Environmental Constraints

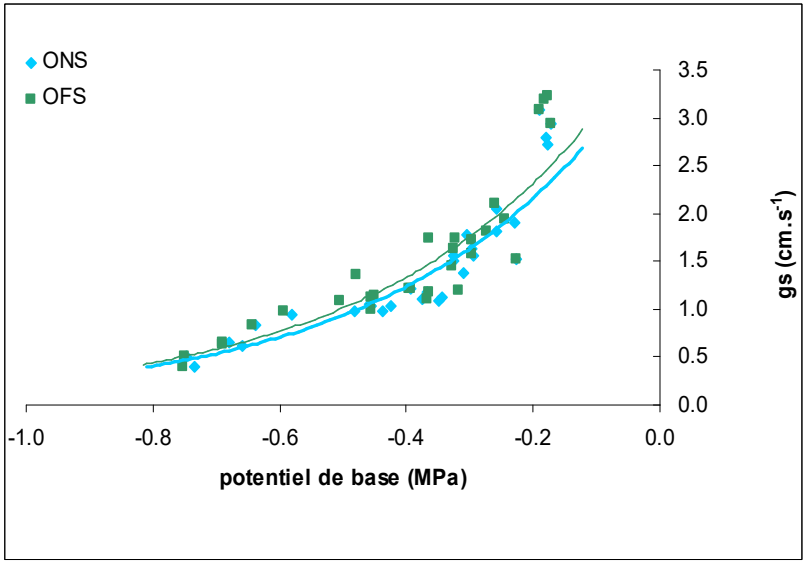
Massimo Fagnano*, Albino Maggio

ETc Replacement (%)	Ryegrass Biomass (g pt^{-1}) OTC NF		OTC AF
100	15.3 bc	<	20.8 a
66	17.8 ab	=	15.0 bc
33	12.9 b	=	14.7 bc

Plants grown with water deficit show:

- lower stomata conductance
- very lower biomass yield
- no responses to ozone

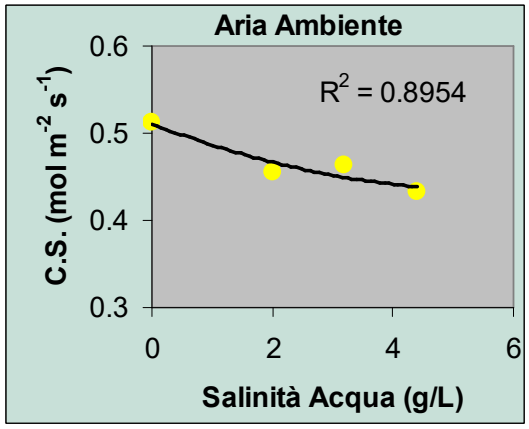
Fagnano M, Merola G (2007) Italian J Agron 2:3-12
Bou Jaoudé et al. (2008a,b) Eur J Agron 28:508-18; 519-25

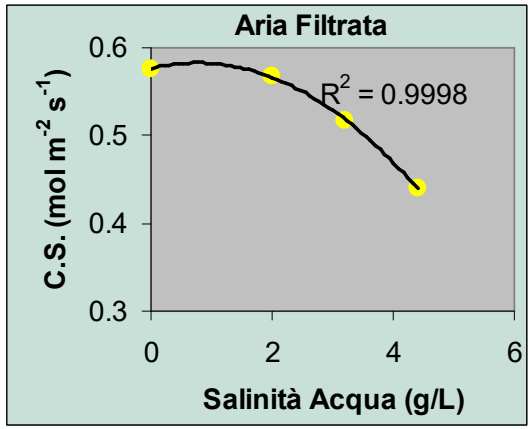


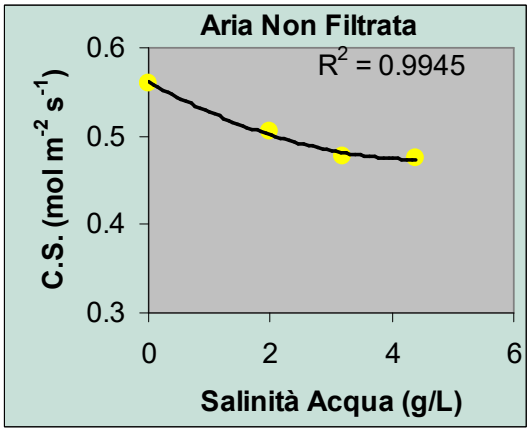
Stomatal conductance: average values

	2001	2002
Ambient		
NF-OTC	**0.32**	**0.35**
CF-OTC	0.38	0.39
Date		
July	0.43 a	0.33 b
August	0.32 b	0.32 b
September	0.27 b	0.37 b
October	0.39 a	0.46 a
Hour		
9-10	0.36 b	0.36
13-14	0.42 a	0.39
17-18	0.28 c	0.36
Water supply		
100%	0.39 a	0.39 a
50%	**0.31 b**	**0.34 b**
Biotype		
Resistant	0.32 b	0.36
Sensitive	0.38 a	0.38
Grand mean	**0.35**	**0.37**

Both ozone and water stress (and soil Ψ) reduce gs and yield

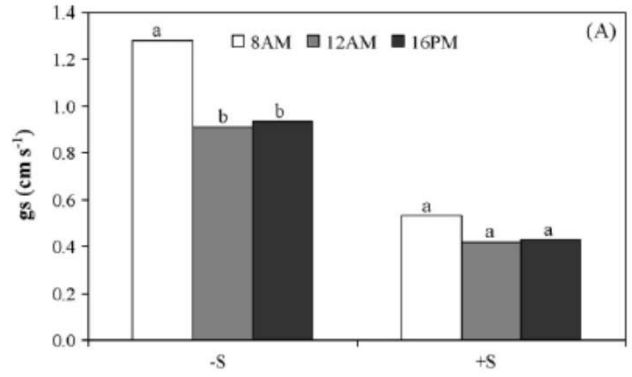






$$(Gs = 0.6 - 0.127\ dS\ m^{-1};\ R^2 = 0.99,\ P \leq 0.01)$$

Also irrigation with saline water, and soil salinization, reduces GS (in alfalfa, **Maggio et al., 2009**) and increases antioxidant activity (+33% in tomato, **Maggio et al., 2007**)

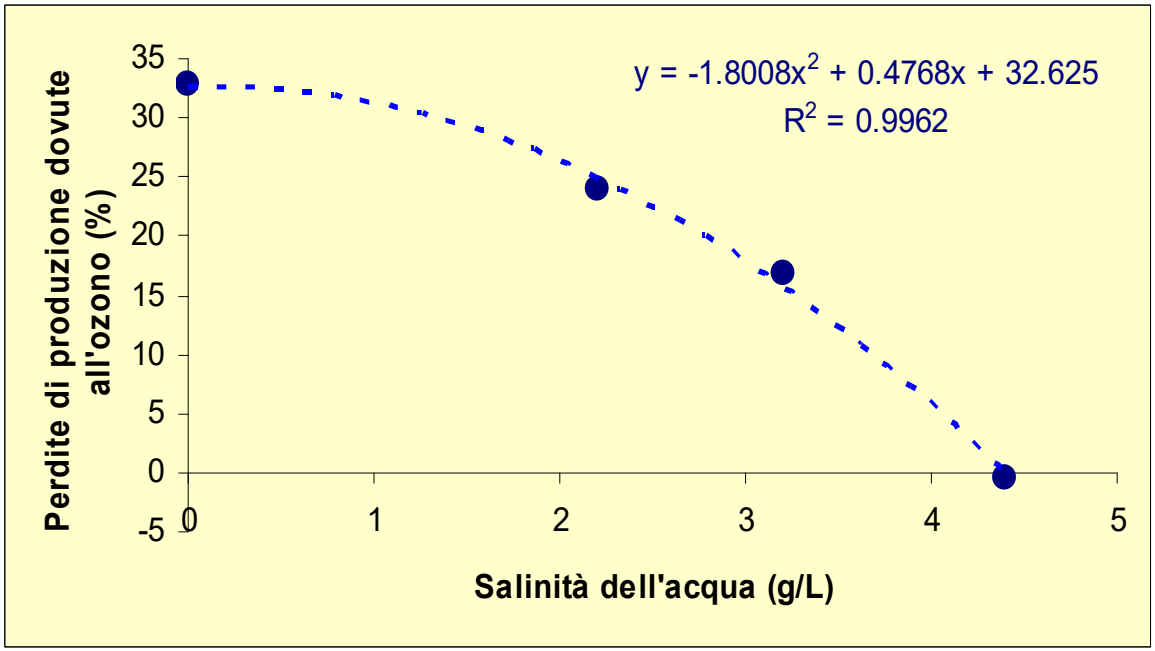


ELSEVIER
Available online at www.sciencedirect.com
ScienceDirect
Europ. J. Agronomy 26 (2007) 454–461
European Journal of Agronomy
www.elsevier.com/locate/eja

Can salt stress-induced physiological responses protect tomato crops from ozone damages in Mediterranean environments?

Albino Maggio*, Stefania De Pascale, Massimo Fagnano, Giancarlo Barbieri

Plant species	Salinity (dS/m)	Stomatal conductance (cm/sec)	LAA (BHT µg/ml)	HAA (AA µg/ml)
Eggplant	0.5	0.53	-	-
	8.5	0.36	-	-
	15.7	0.33	-	-
Pepper	0.5	0.75	-	-
	4.4	0.41	-	-
	8.5	0.40	-	-
Tomato[1]	0.5	2.73	12.1	5.5
	4.4	2.18	13.0	5.7
	15.7	1.61	14.2	6.7
Tomato[2]	2.5	0.33	-	-
	6.0	0.22	-	-
	9.6	0.15	-	-
	15.0	0.08	-	-



Environmental Pollution 157 (2009) 1445–1452

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Responses to ozone pollution of alfalfa exposed to increasing salinity levels

Albino Maggio, Fabrizio Quaglietta Chiarandà, Roberto Cefariello, Massimo Fagnano*

Yield losses due to ozone decrease (from 33% to 0) as water salinity increases (from 0 to 4,4 g/L) with a rate of -7,8% per g/L.

CL based on accumulated stomatal fluxes (that take into account all the environmental limitation to Gsto) is a better predictor of ozone risk than concentration-based CL. (**Ferretti et al., 2007**)


Available online at www.sciencedirect.com
ScienceDirect
Environmental Pollution 146 (2007) 648–658
ENVIRONMENTAL POLLUTION
www.elsevier.com/locate/envpol

Measuring, modelling and testing ozone exposure, flux and effects on vegetation in southern European conditions—What does not work? A review from Italy

M. Ferretti [a,*], M. Fagnano [b], T. Amoriello [c], M. Badiani [d], A. Ballarin-Denti [e], A. Buffoni [f], F. Bussotti [a], A. Castagna [g], S. Cieslik [h], A. Costantini [c], A. De Marco [i], G. Gerosa [e], G. Lorenzini [j], F. Manes [k], G. Merola [b], C. Nali [j], E. Paoletti [l], B. Petriccione [m], S. Racalbuto [i], G. Rana [n], A. Ranieri [g], A. Tagliaferri [o], G. Vialetto [i], M. Vitale [k]

Nevertheless, the flux-based approach has to be weighted by the physiological defense capacity of the different genotypes. (**Tausz et al., 2007**)


Available online at www.sciencedirect.com
ScienceDirect
Environmental Pollution 147 (2007) 525–531
ENVIRONMENTAL POLLUTION
www.elsevier.com/locate/envpol

Defense and avoidance of ozone under global change

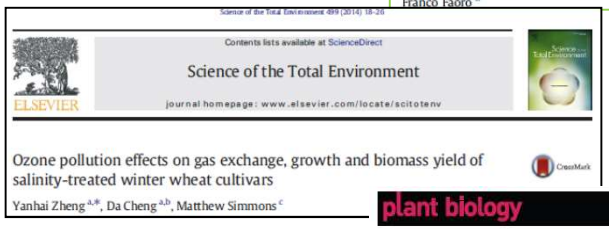
Michael Tausz [a,*], Nancy E. Grulke [b], Gerhard Wieser [c]

Because not only inter-, but also intra-specific differences are reported about the interactions between ozone and other environmental stresses (drought and salinity). (**Alonso et al., 2014; Gerosa et al., 2014; Zheng et al., 2014,…..**)


Environmental Pollution

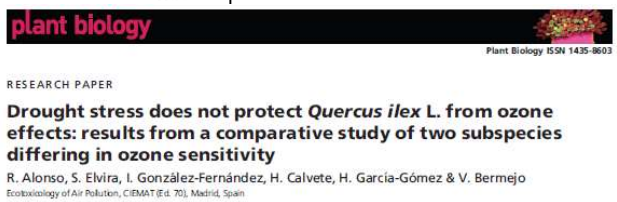
Contrasting effects of water salinity and ozone concentration on two cultivars of durum wheat (*Triticum durum* Desf.) in Mediterranean conditions

Giacomo Gerosa [a], Riccardo Marzuoli [a,*], Angelo Finco [a], Robert Monga [b], Isa Fusaro [c], Franco Faoro [b]


Science of the Total Environment

Ozone pollution effects on gas exchange, growth and biomass yield of salinity-treated winter wheat cultivars

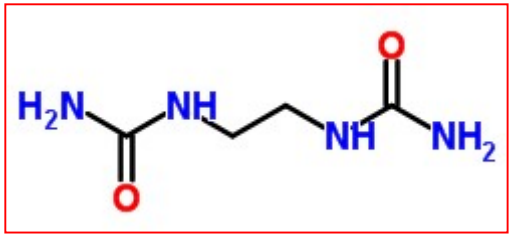
Yanhai Zheng [a,*], Da Cheng [a,b], Matthew Simmons [c]


plant biology
Plant Biology ISSN 1435-8603

RESEARCH PAPER

Drought stress does not protect *Quercus ilex* L. from ozone effects: results from a comparative study of two subspecies differing in ozone sensitivity

R. Alonso, S. Elvira, I. González-Fernández, H. Calvete, H. García-Gómez & V. Bermejo



Thank you for your kind attention !!!!