Title	**Arbuscular Mycorrhizal Fungi Alleviate Ozone Stress on Nitrogen Nutrition of Field Wheat**
Author	X. C. Cui, J. L. Hu, X. G. Lin, F. Y. Wang, R. R. Chen, J. H. Wang, J. G. Zhu
Journal	Journal of Agricultural science and Technology
Abstracts	The nitrogen (N) nutrition, crop yield, and responses of wheat to arbuscular mycorrhizal fungi (AMF) were tested in an experimental field under free-air ozone concentration [O_3] enrichment (FACE) conditions. The experiment included three treatments: ambient [O_3] (Ambient), elevated [O_3] (FACE, targeted at ambient [O_3]×1.5), and elevated [O_3] inoculated with an AMF consortium consisting of several *Glomus* species (FACE+AMF). AMF inoculation responsiveness of wheat was estimated by comparing plants grown in unsterilized soil inoculated with the exogenous AMF and in untreated soil containing indigenous AMF. Compared with the Ambient, relatively higher N contents but lower shoot biomasses of wheat plants were observed in the FACE treatment without AMF inoculation from the tillering stage in February and heading stage in April, respectively, which significantly ($P< 0.05$) decreased grain yield by 28% at harvest in June. Under the FACE condition, compared with the non-inoculated treatment, AMF inoculation significantly ($P< 0.05$) increased root colonization rates both at the tillering stage and heading stage, and also significantly ($P< 0.05$) increased shoot biomass at the heading stage and, hence, significantly ($P< 0.05$) increased grain yield by 40% at harvest. However, AMF inoculation significantly ($P< 0.05$) decreased total N content in wheat shoots at the tillering stage, suggesting that AMF consortia may enhance plant tolerance to elevated [O_3] by elevating root colonization rate rather than plant total N content at early growing stages.
Year	September 2013
Volume and Issue	15, 5
Pages	1043-1052
Keywords	AMF consortia; Crop yield; Free-air ozone concentration enrichment (FACE); Nitrogen content; Soil urease activity

Title	**Combined cadmium and elevated ozone affect concentrations of cadmium and antioxidant systems in wheat under fully open-air conditions**
Author	Hongyan Guo, Ran Tian, Jianguo Zhu, Hui Zhou, Daping Pei, Xiaorong Wang
Journal	Journal of Hazardous Materials
Abstracts	Pollution of the environment with both ozone (O_3) and heavy metals has been steadily increasing. An understanding of their combined effects on plants, especially crops, is limited. Here we studied the effects of elevated O_3 on oxidative stress and bioaccumulation of cadmium (Cd) in wheat under Cd stress using a free-air concentration enrichment (FACE) system. In this field experiment in Jiangdu (Jiangsu Province, China), wheat plants were grown in pots containing soil with various concentrations of cadmium (0, 2, and 10 mg kg^{-1} Cd was added to the soil) under ambient conditions and under elevated O_3 levels (50% higher than the ambient O_3). Present results showed that elevated O_3 led to higher concentrations of Cd in wheat tissues (shoots, husk and grains) with respect to contaminated soil. Combined exposure to Cd and elevated O_3 levels strongly affected the antioxidant isoenzymes POD, APX and CAT and accelerated oxidative stress in wheat leaves. Our results suggest that elevated O_3 levels cause a reduction in food quality and safety.
Year	30 March 2012
Volume and Issue	209–210
Pages	Pages 27–33
Keywords	Elevated ozone, Cadmium, Oxidative stress, Wheat

Title	**Physiological and morphological changes in *Salix viminalis* L. as a result of plant exposure to copper**
Author	Monika Gąsecka, Mirosław Mleczek, Kinga Drzewiceka, Zuzanna Magdziak, Iwona Rissmann, Tamara Chadzinikolau & Piotr Golinski
Journal	Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering
Abstracts	The aim of this study was to assess the response of *Salix viminalis* L. under model conditions to different copper concentrations and, as a consequence, potential application of the experimental results in decontamination of water with heavy metal ions (phytoaccumlation). The 14-day experiment was conducted on one-year-old cuttings of *Salix viminalis* L. 'Cannabina' exposed, in a phytotron, to six different copper levels in hydroponic pots. The results showed that the capacity to accumulate heavy metals was of the following order: roots > rods > shoots > leaves. The linear relationships between the accumulation efficiency of particular *Salix* parts were confirmed. Together with an increase in copper sorption in above-ground organs, a decrease was observed in root biomass and the length of roots, shoots and leaves. The release of low molecular weight organic acids into solution was different under various Cu levels. Glucose, fructose and sucrose contents in leaves of *Salix* in all treatments were higher than in control plants. Higher concentration of sugars (4 times higher compared to the control) was detected for fructose in a 2 mM Cu treatment. The total phenolics content rapidly increased only at 3 mM Cu level. Free and total salicylic acid and the glutathione contents in plants treated with copper in relation to the control were always higher and changed with increasing concentration of copper ions in the medium.
Year	29 Feb 2012
Volume and Issue	Volume 47 Issue 4
Pages	548-557
Keywords	Elevated ozone, Cadmium, Oxidative stress, Wheat

Title	**Estimates of potential ozone stomatal uptake in mature trees of Quercus ilex in a Mediterranean climate**
Author	Fausto Manes, Marcello Vitale, Angelica Maria Fabi, Franco De Santis and Donatella Zona
Journal	Environmental and Experimental Botany
Abstract	This paper is focused on evaluation of the potential ozone stomatal fluxes (FO3) under seasonally varying microclimatic conditions at two levels of the canopy of an evergreen Mediterranean plant species, Holm oak (Quercus ilex L.), and on comparing them with ozone hourly averages, in order to assess what are the main

	environmental/physiological variables that most affect the definition of critical levels for Mediterranean vegetation. Microclimatic factors such as radiation, temperature and wind velocity greatly affected gas exchange rates and stomatal conductance to water vapour measured at different heights. O3 concentration values highlight a daily cycle with higher nocturnal O3 concentrations above the canopy than below it. Similar O3 trends have been observed by using passive diffusive samplers. As a consequence, potential O3 stomatal fluxes calculated for the upper layer of the canopy are higher than those below the canopy. Moreover, O3 concentration values show an opposite seasonal trend compared to FO3. These opposite trends are clearly due to the stomatal closure in drier months, as a protection against excessive water losses that yield low FO3 values during high O3 concentration. This paper highlights the different contribution of different Holm oak canopy portions to overall O3 uptake impact, attributing important roles to microclimatic conditions and to physiological activity related to stomata opening, which in turn is affected by internal and external effectors (hormones, water availability, hydraulic conductance, etc.). We cannot exclude an O3 effect on stomatal cell guards and on the carbon assimilation process working in the mesophyll cells. Further research needs to be considered to evaluate more clearly the risk of O3 on Mediterranean vegetation taking into consideration microclimatic conditions, plant physiology and possible plant canopy defensive reactions to O3, so as to define an air quality standard to protect the vegetation.
Year	2007
Pages	235- 241
keywords	

Title	**Study of ambient ozone phytotoxicity in Ukraine and ozone protective effect of some antioxidants**
Author	Oleg Blumand Nataliya Didyk
Journal	Journal of Hazardous Materials
Abstract	The aim of the study was to assess ambient ozone phytotoxicity in Kyiv (Ukraine) using bioindicator clover plants (Trifolium subterraneum cv. Geraldton) and to test some natural and synthetic antioxidants as ozone protectants. The results obtained showed that ambient ozone concentrations were high enough to cause visible leaf injury in clover. All used substances showed partial ozone protective effect on clover. Water extracts from the leaves of plants, known to contain flavonoids–antioxidants showed weaker ozone protective effect and were less stable in the field conditions than synthetic antioxidants. Among the studied extracts, those from Ocimum basilicum and Tagetes patula were more effective as ozone protectants than the one from Salvia sclarea.
Year	2007
Pages	598- 602
keywords	

Title	**Suitability of Nicotiana tabacum 'Bel W3' for biomonitoring ozone in São Paulo, Brazil**
Author	Silvia M.R. Sant,Anna Marisia P. Esposito, Marisa Domingosand Silvia R. Souza
Journal	Environmental Pollution
Abstract	Nicotiana tabacum Bel W3 is a widely used sensitive bioindicator for ambient ozone, but it is rarely used in tropical countries. Our goal was to determine the suitability of this plant for biomonitoring ozone in the city of São Paulo by evaluating the relationships between leaf necroses and ozone under field conditions and measurements of chlorophyll a fluorescence and antioxidants in plants exposed to different concentrations of ozone in closed chambers. While a weak linear relationship between leaf injury and ozone concentrations (R2 = 0.10) was determined in the field, a strong linear relationship was observed in the chamber experiments. Maximum leaf injury was observed in plants submitted to 40 ppb, which coincided with a significant decrease in fluorescence and total ascorbic acid. The relationship between leaf damage observed in the field and ozone was improved when the concentrations were limited to 40 ppb (R2 = 0.28).
Year	2007
Pages	0- 0
keywords	

Title	**Ozone uptake (flux) as it relates to ozone-induced foliar symptoms of Prunus serotina and Populus maximowizii × trichocarpa**
Author	T. Orendovici-Best, J.M. Skelly, D.D. Davisand R.E. Stevenson
Journal	Environmental Pollution
Abstract	Field studies were conducted during 2003 and 2004 from early June to the end of August, at 20 sites of lower or higher elevation within north-central Pennsylvania, using seedlings of black cherry (Prunus serotina, Ehrh.) and ramets of hybrid poplar (Populus maximowizii × trichocarpa). A linear model was developed to estimate the influence of local environmental conditions on stomatal conductance. The most significant factors explaining stomatal variance were tree species, air temperature, leaf vapor pressure deficit, elevation, and time of day. Overall, environmental factors explained less than 35% of the variation in stomatal conductance. Ozone did not affect gas exchange rates in either poplar or cherry. Ozone-induced foliar injury was positively correlated with cumulative ozone exposures, expressed as SUM40. Overall, the amount of foliar injury was better correlated to a flux-based approach rather than to an exposure-based approach. More severe foliar injuries were observed on plants growing at higher elevations. Within heterogeneous environments, ozone flux does not completely explain the variation.
Year	2007

Pages	-
keywords	

Title	**Exemplifying whole-plant ozone uptake in adult forest trees of contrasting species and site conditions**
Author	Angela J. Nunn, Gerhard Wieser, Ursula Metzger, Markus Löw and Rainer Matyssek
Journal	Environmental Pollution
Abstract	Whole-tree O3 uptake was exemplified for Picea abies, Fagus sylvatica and Larix decidua in stands at high and low altitude and contrasting water availability through sap flow measurement in tree trunks, intrinsically accounting for drought and boundary layer effects on O3 flux. O3 uptake of evergreen spruce per unit foliage area was enhanced by 100% at high relative to low elevation, whereas deciduous beech and larch showed similar uptake regardless of altitude. The responsiveness of the canopy conductance to water vapor and, as a consequence, O3 uptake to soil moisture and air humidity did not differ between species. Unifying findings at the whole-tree level will promote cause–effect based O3 risk assessment and modeling. Sap flow-based assessment of whole-tree O3 uptake reflects similar responsiveness of canopy conductance and O3 uptake across contrasting tree species and site conditions.
Year	2007
Pages	629- 639
keywords	