Geophysical Research Abstracts
Vol. 13, EGU2011-9242, 2011
EGU General Assembly 2011

Impacts of Climate Change on Durum Wheat Production in Sardinia (Italy)

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The high sensitivity of agriculture to climate conditions and the great uncertainty on the combined effects of increasing CO2 concentration and projected changes in temperature and especially in rainfall patterns on crops, reveals the necessity to better understand the impacts of future climate for implement appropriate adaptation and mitigation strategies in agriculture, to increase production and food security.

This study aimed to assess impacts of potential climate change in ambient carbon dioxide (CO2) level on production and phenology for two of the most important varieties of durum wheat at four experimental sites in Sardinia, Italy, assuming different soils, climate conditions and management practices, and to provide guidelines for realistic adaptation strategies in a typical Mediterranean area.

The CERES-Wheat (Ritchie et al., 1985) model in combination with a stochastic Weather Generator (WG), recently developed (M&Rfi, available from: http://www.ufa.cas.cz/dub/wg/marfi/marfi.htm), was used to quantify the climate change impacts on wheat development and production. Synthetic weather series representing possible future climates were generated by modifying the WG parameters according to a set of GCM based climate change scenarios. To take into account the uncertainties in future climate development, we used a set of 9 climate change scenarios derived by the pattern scaling technique (Santer et al., 1990, Dubrovsky et al., 2005). In particular, three GCM-based (HadCM3, NCAR and ECHAM) standardised scenarios were multiplied by three values (low, middle, high) of changes in global mean temperature (ΔTG). The values of ΔTG were obtained by MAGICC climate model assuming various combinations of climate sensitivity (1.5, 3 and 4.5 °C) and four emission scenarios (SRES B1, B2, A1B, A2). For each experimental site, 27 climate change scenarios (9 scenarios for 3 future periods: 2025, 2050, 2075) were developed. The use of three CGMs allows accounting for differences in annual pattern of change in individual climatic characteristics.

The linkage of M&Rfi Weather Generator with CERES-wheat was validated by comparing statistical characteristics of crop model output obtained using observed weather data versus synthetic weather series (generated by weather generator) for the present climate. Results showed no statistical differences, indicating that the use of CERES-Wheat coupled with the M&Rfi WG provides an efficient and reliable method for assessing the impacts on agricultural production.

In the climate change impact assessment, we explored separately the indirect CO2 effect (related to changed weather conditions) and the direct CO2 effect (known as a fertilization effect), for the three future periods. In general, the results show that the indirect effect of CO2 concentration is negative. Considering the four experimental sites and the high GCM-based scenarios, crop yield will decrease by 2-6% for 2025, and by 10-18% for 2075, due in particular to the higher temperatures and more frequent drought projected. On the other hand, considering both direct and indirect effects of CO2 concentration, the wheat yield will increase by 5-7% for 2025 and by 16-21% for 2075. This means that the positive fertilisation effect of increased CO2 concentration could be sufficient to level out the negative impact of indirect effects (Mereu, 2010). Moreover the higher CO2 concentration is able to improve the WUE (Water Use Efficiency) of the crop, by reducing the stomatal conductance.

The analyses made for this region shows that the shift of the ordinary sowing date could be a reliable and efficient adaptation strategy for wheat cultivation in this Mediterranean area. Indeed, an earlier planting date would produce an additional increase in wheat yield, reducing the negative effect on yield due to changed climate change conditions (Mereu, 2010).

Dubrovsky, M., Nemesova, I., Kalvova, J., 2005. Uncertainties in climate change scenarios for the Czech Republic. Climate Research 29, 139-156.

Mereu V., 2010. Climate Change Impact on Durum Wheat in Sardinia. PhD thesis.
Ritchie, J.T., Otter, S., 1985. Description and performance of CERES-Wheat: a user-oriented wheat yield model. In: ARS Wheat Yield Project. ARS-38. Natl Tech Info Serv, Springfield, Missouri, pp. 159-175.
Santer, B.D., Wigley, T.M.L., Schlesinger, M.E., Mitchell, J.F.B., 1990. Developing climate scenarios from equilibrium GCM results. Report No.47, Max Planck Institute für Meteorologie, Hamburg.