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ABSTRACT

HOW WATER SAVING MEASURES WOULD AFFECT AGRICULTURAL PRODUCTION AND THE ENVIRONMENT

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Abstract

Many water saving strategies have been implemented in the southern Mediterranean countries during the last twenty years. Awareness for rapid adoption of efficient water delivery systems was triggered by solid arguments from research and a demonstrated interest from international funding institutions. Most countries in the region invested heavily in the water sector at different levels of utilization. By taking concrete actions, national governments were aiming to reduce the demand on this very scarce resource and at the same time to achieve better food security for their people. For instance in Tunisia, where water saving systems are subsidized by 40 to 60% of their total cost, drip irrigation is presently used at a large scale. Syria has become self-sufficient and even exporter for wheat by adopting supplemental irrigation programs. However while important production increases are observed for many commodities and more better water use efficiencies have been achieved, the effect of the adopted strategies on curbing down the demand on irrigation water is not obvious. In the contrary, there has been even an increasing pressure for more water for agriculture. Another probably indirect effect of too much focus on increasing the efficiency of the irrigated sector is touching the rainfed sector since competitive products from water rich lands might reduce the profitability of dry farming. Actually, changes in agriculture are not only produced by access to water but also by many prevailing conditions: market forces, government disengagement, and climate change. Irrigators are reacting differently to this environment characterized by uncertainty. Some are after a better control of the water resources which is leading to a greater number of individual wells and increased pressure on ground water resources. Others are seeking more benefit from opportunities offered by liberalization. As a result incoherent strategies and low equity for water access are observed in the region. This paper is in favor of addressing the various impacts of WUE improvements. Particularly those related to i) the sustainability of the irrigated systems, ii) the possible distortion in the rainfed sector and how the water basin framework could be adapted to the Mediterranean environment in order to produce appropriate WUE indicators.

EFFECT OF OZONE ON WATER USE EFFICIENCY OF SOYBEAN CROP GROWN UNDER DIFFERENT WATERING CONDITIONS

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Abstract

This study was realised in the southern Mediterranean region of Europe (Rutigliano, Bari-Italy). In other words under conditions favourable to ozone rise (Bussotti et Ferretti1998, Alonso *et al.*, 2001) together with soil and atmosphere drought (Rana and Katerji 2000). The objective was to analyse, under natural conditions and for the whole growing season, the effect of ozone on soybean cultivated during three consecutive years (2003, 2004, and 2005), under different watering conditions. The study period was characterised by an important inter-annual ozone variation during summer season (cumulated AOT40 index varied between 3392 ppb and 10236 ppb). Through the OTC (open top chamber) performance, it was possible to control ozone concentrations present in the air, and to overcome the large annual and inter-annual ozone variability. In fact, during the three years of study, we succeeded (through our experimental protocol) to reproduce in an accurate way, the extreme ozone concentrations observed in the natural open field.
The consequences of soybean exposure to different ozone concentration levels can be summarised as following:
Under well-watered conditions, the increase of ozone levels in the air induce a reduction of stomatal conductance (not reported in the present abstract), and affects significantly evapotranspiration, yield and WUE.
Under water stress conditions, stomatal conductance shows to be controlled mainly by soil water content than ozone concentration levels. Drought reduces stomatal opening and hence the effect of ozone concentrations on soybean crop.

MODELING IRRIGATION REQUIREMENTS OF INDIVIDUAL OLIVE TREES

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Abstract

Olive trees are traditionally planted with different densities, depending on local rainfall amounts and distribution. Presently, supplemental irrigation of this species is gaining popularity because it has been demonstrated that the supply of little amounts of water can improve growth and increase yield. However while water requirements of intensive plantations are relatively well known, there is little information on how to manage semi intensive orchards. The development of a methodology for calculating irrigation amounts per tree using data on ETo and effective rainfall is required to improve water use efficiency. The approach was applied to a semi intensive young orchard in the region of Tunis. Climatic data and measurements of tree growth were used to investigate consumptive use of trees during the first six years of development. Results show relationships between effective rainfall, irrigation water supply and canopy size. A generalized model for young orchard is therefore proposed.

COMPREHENSION OF THE EVOLUTION TRENDS OF THE OASIS SYSTEM AND ITS RELATION TO WATER MANAGEMENT- CASE OF FATNASSA NORD OASIS (NEFZAOUA, KÉBILI, SOUTH OF TUNISIA)

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Abstract

To understand the functioning of an oasis ecosystem with complex problems and fragile equilibrium, we draw its history, the water and land resources uses evolution. The study concerns Nefzaoua region in the south of Tunisia representing about half of the Tunisian oases surface. Data and documents related to the region have been collected and analysed. Examples from the present situation of Fatnassa nord, historical oasis and concerned with the changes and complexity of socio-economic and technical features, were exposed. The objective is to approach the public decisions during these decades to improve water management and farmers strategy to cultivate this environment. Factors that affect the sustainability of oases have been identified.

A MOLECULAR AND PHENOTYPIC SURVEY OF THE ELITE DURUM WHEAT GERMPLASM FOR CHROMOSOME REGIONS ASSOCIATED TO YIELD AND MORPHO-PHYSIOLOGICAL TRAITS UNDER A RANGE OF MEDITERRANEAN ENVIRONMENTS

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Abstract

Germplasm collections of adapted materials enclose useful alleles for yield, yield stability and its components and the underlying chromosome regions can be identified using association mapping studies. A germplasm collection of 189 elite durum wheat accessions was selected within materials from several Mediterranean countries as well as from the CIMMYT and ICARDA breeding programs.
Sixteen field trials were carried out in 2004 and 2005 in Italy, Spain, Morocco, Tunisia, Syria and Lebanon. The accessions were arranged in un-replicated field trials, with 4 m^2 plots, using a modified augmented design that included three check cultivars present in each row and column of the field scheme. Across the environments, the materials showed an average yield ranging from 0.9 to 8.3 ton/ha. Yield, yield components, agronomic and physiological traits were recorded and tested for significant associations with the allelic profile of 97 SSR markers distributed over the 14 linkage groups. SSR markers were previously tested for polymorphism and most of them showed from two to four frequent alleles in the collections. Population structure was evaluated using the SSRs and 166 AFLP fragments and the clustering data were used as covariates in the association test (number of subgroups = 6). The general linear model (in the TASSEL software) was used for the analysis, with 10,000 permutations. For each of the traits characterized by the highest heritability values among those measured, i.e. plant height, heading date, peduncle length and thousand kernel weight, it was possible to identify some SSR markers showing significant associations in four to six up to 8/10 environments, with R^2 values ranging from 5 to 10%. As to yield and yield components, the majority of the markers could be identified only in two to four env.s , with an average R^2 values lower than 5%.
The detailed results, including the co-location of significant SSRs for the different traits and the allelic effect of some of the most interesting markers will be presented, as well as the comparison between the chromosome regions found in this study and those found in a parallel study using a RIL populations.

DESCRIBE THE COMPLEX PROCESSES

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Abstract

At now it is impossible to think a research without the software support. The best methodology is the connecting experimental data and experience with a model that can describe these data in order to understand the physical process analysed. This physical process is comprised only after we can translate it with a sequence of functions. The complex processes are a sum of simpler processes with a specific hierarchy. At now the objects oriented programming OOP implemented by newest languages as VB, C#, JAVA, gives a large potentiality to describe the complex system like links among simpler physical processes. This type of programming allows for researchers to exchange the knowledge more easy because we can exchange the small part and not all the system. The objects oriented programming allows for us to have a lot of different approaches for the same aspect, too. If this aspect doesn't give the answers attended then the researcher can use each of the different approaches to choose the best one, leaving the rest of the model unchanged. An example, to simulate the soil water balance you can use Richards' approach or cascading model and this choice affects the estimation of the evapotranspiration and the WUE . The irrigation can be considered as a height of water or can be modelled considering the irrigation method, the crop interception etc.
In order to disseminate the own knowledge it is important to document each algorithm and define the input and output variables of the model (the concept of ontology). A good documentation allows for other researchers to use our component stand-alone or in their models. Also, it can allow for us to remember our work with time.
In order to implement a good software and to document it, saving time, is useful to use the instruments of graphical planning as UML (Unified Modelling Language). This tool helps the research to outline the structure and dynamics of his model before the implementation and independently from the chosen code. UML is a good way to communicate in every time the state of the model among the project partners, too.

SUGGESTED APPROACH FOR IMPROVING WATER USE EFFICIENCY

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Abstract

Converting water to agricultural products involves many steps, each a process or a combination of several processes. Consequently, substantial improvement in water use efficiency (WUE) needs to be comprehensive and not narrowly focused only on one or two of the components. A quantitative yet simple approachchain of efficiency-stepsis suggested here for that purpose.

Starting at the source of water, a series of steps or events, taking place sequentially, leads to the final crop or animal product. Each step in the sequence is characterized by its own efficiencyoutput per unit of input. Using the simple sequence of conveyance of water from a reservoir to a farm and the application of the water to the crop, it will be shown that the overall efficiency of getting the water to the root zone of the crop is the product of the efficiencies of each sequential step. That is, efficiencies of individual process steps are multiplicative in determining the overall efficiency. Thus, a fractional improvement in any one of the steps has equal effect in improving the overall efficiency, and the overall improvement is more than the sum of the individual improvements. This principle provides a simple and quantitative framework to assess WUE of any system and for making improvements.

The efficiency steps that transform root zone water to the final product are also described. These involve evapotranspiration, crop photosynthesis in exchange with transpired water, conversion of assimilated carbon dioxide to crop biomass, and partition of the biomass into yield component. Crop production in relation to water use is analyzed in terms of these steps, for both irrigated and rain-fed conditions, and the likely improvements are assessed quantitatively for some scenarios. Specific improvement in individual steps are considered, including reduced runoff, reduced soil evaporation, higher biomass production relative to transpiration, and higher harvest index. The huge potential of improving range land animal production and water use by better grazing management is elaborated on and the social and political changes necessary to facilitate the improvements are discussed.

OPTIONS FOR IMPROVING WATER USE EFFICIENCY AT THE LEAF LEVEL

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Abstract

Water use efficiency (WUE) is often equated with drought resistance and improvement of crop yield under stress, which is not necessarily the case, although improving WUE of both irrigated and rainfed crop production is considered a strategic objective. Breeding crop varieties with higher WUE is seen as providing part of the solution. Breeding to address a specific objective implies first, that the objective has been well defined and, second, that heritable traits have been identified that can come some way towards achieving the breeding objective. 'Water-use efficiency' as a breeding target could be defined in many ways, depending on the scale of measurement and the units of exchange being considered. A physiological definition might equate, at its most basic level, to the instantaneous WUE of leaf gas exchange (A/T). Crop yield can be constructed from a framework of relatively simple components [Yield=ETxT/ETxWxHI]. In this framework, grain yield is described as being a function of the amount of water used by the crop (evapotranspiration, ET), the proportion of that water actually transpired by the crop (T/ET), the transpiration efficiency of biomass production (W), i.e. how much biomass is produced per millimetre of water transpired, and, lastly, how effectively the achieved biomass is partitioned into the harvested product, i.e. the ratio of grain yield to standing biomass termed the harvest index (HI). Leaf-level water-use efficiency, A/T, is directly related to only one of these components, W, the transpiration efficiency of biomass production. However, A/T also has the potential to influence each of the other three components in the yield framework. Exploiting high A/T in breeding for greater agronomic water-use efficiency is complicated for cereals by an association between high A/T and slow crop growth rate. This seems not to be the case for other crops.
Success in improving WUE of crops under stress has been limited perhaps in part because the trait is not easy to measure directly. For example, at the canopy level (as opposed to leaf level) estimation of WUE involves quantification of moisture fluxes between the soil (at all relevant depths) and atmosphere, occurring both by transpiration from leaves as well as evaporation from the soil surface.
Elevated CO_2 is expected to increase the productivity of C_3 plants and enhance WUE at the leaf level through a simultaneous increase in photosynthesis and a decline in stomatal conductance.
For C3 species, measuring carbon isotope discrimination provides a powerful means of improving WUE of leaf gas exchange, but experience has shown that improvements in leaf-level WUE may not always translate into higher crop WUE or yield.

GENOMICS APPROACHES TO ENHANCE WATER-USE EFFICIENCY AND DROUGHT TOLERANCE IN MEDITERRANEAN CROPS

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Abstract

The genetic basis of the molecular and developmental processes regulating water-use efficiency (WUE) and drought tolerance of crops involves many genes whose expression is largely influenced by water availability and other concurrent environmental factors (e.g. heat). Genomics-based approaches provide access to agronomically desirable alleles present at the quantitative trait loci (QTLs; Tuberosa et al. 2002, Annals of Botany, 89:941-963) that affect WUE and the adaptive response to drought, thus enabling us to better understand and manipulate the morpho-physiological basis of crop yield and its stability under water-limited conditions. QTLs can be identified through the evaluation of a mapping population derived from biparental crosses (Talame et al. 2004, Annals of Applied Biology 144:309-319) and/or by means of association mapping based on a panel of unrelated accessions (Maccaferri et al. 2006, Plant Genetic Resources 4:79-85). Examples on the identification of QTLs for WUE, grain yield and related traits in durum wheat grown in Mediterranean environments will be presented. The EU-funded IDuWUE (Improving Durum wheat for Water-Use-Efficiency; www.distagenomics.unibo.it/iduwue/index.html) project has led to the identification of major QTLs controlling grain yield under both rainfed and irrigated conditions. Validation of the effects of these QTLs is presently underway as a prerequisite toward marker-assisted selection and, eventually, QTL cloning (Salvi and Tuberosa 2005, Trends in Plant Science 10:297-304). It is expected that the analysis of sequence data that will be produced in crops and model species coupled with the analysis of gene products through the so-called “omics” platforms (e.g. transcriptomics, proteomics, metabolomics, etc.) will facilitate the identification of candidate genes and cloning target QTLs. Reverse-genetics approaches (e.g. TILLING) will provide additional opportunities to test for gene function at candidate loci. Based on such premises, we envision a quick broadening of our understanding of the genetic and functional basis of drought tolerance (Tuberosa and Salvi 2006, Trends in Plant Science 11:405-412). Novel opportunities will be generated for tailoring new genotypes “by design” based on the molecular information at target loci. This notwithstanding, harnessing the full potential of genomics-assisted breeding will only be possible within a multidisciplinary, integrated knowledge of the molecular and physiological processes influencing WUE and tolerance to drought coupled with an accurate phenotyping at the field level in the target environment.

FURTHER INVESTIGATION ON NORMALIZED BIOMASS WATER USE EFFICIENCY

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Abstract

The need to normalize biomass water use efficiency (B_WUE) for different climatic conditions and, mainly, for the evaporative demand of the atmosphere, has been largely established. Physiologically comparison of B_WUE can not disregard normalization especially in dealing with crop modelling. Normalization of B_WUE can take two routes: a) normalizing through the "transpiration gradient", namely vapour pressure deficit (VPD); b) normalizing through the "reference transpiration flux", namely reference evapotranspiration (ETo). The first route has shown to be extremely reliable when applied at leaf scale, while, when applied at canopy scale, it shows drawbacks particularly related to the approximation into assuming the same value for both leaf (or canopy) and air temperature. The second route has demonstrated to be more effective than the first at canopy scale, especially if the Penman-Monteith equation, to compute ETo, is used, because both the "energy" and the "aerodynamic" components are combined in it. Thus, the normalization of B_WUE by ETo (B_WUE_{ETo}), as compared to VPD, has proved to be more reliable for application across a range of conditions differing in the evaporative demand and appropriate from well-irrigated to rainfed conditions.
In this work, both examples from the scientific literature and data re-elaborated from previous experiments have shown the robust capacity of B_WUE, normalized by ETo, for C_3 - C_4 grouping. Moreover, within each group, a general consistency among B_WUE_{ETo} values of different crops has been found. In fact, many C_3 crops position on values of about 13 g m^{-2}, while C_4 crops on values about 29 g m^{-2}. The quite well-unified values allow to be extremely suitable for modelling purposes, aiming to predict crop growth through the "water driven growth-engine".
The collection of some recent data of many different crops from the same experimental site in the Southern Italy (Policoro, MT, 40°17'N, 4°25'E) have confirmed the greater reliability of the "reference transpiration flux" as compared to the "transpiration gradient" approach for normalization. Furthermore, the range of B_WUE_{ETo} values for crops such as sugar beet, tomato, eggplant, pepper, rocket (C_3) and sweet maize (C_4) have been found similar to the figures reported above. Nevertheless, some winter crops (durum wheat, broad bean, celery, broccoli, broccoli raab) have a much lower biomass WUE value (about 7.2 g m^{-2}). This specific behaviour might be explained on the basis of a much lower thermal regimes during the winter season, interfering with a proper crop development, and of a higher root/shoot ratio. Further investigations are needed to pinpoint the underlining causes for such a low value of B_WUE_{ETo} in these crops.

PERFORMANCE AND EFFICIENCY: INTERACTION BETWEEN LARGE SCALE DISTRIBUTION SYSTEM AND ON-FARM SPRINKLER IRRIGATION

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Abstract

The influence of the pressurized distribution irrigation system on the performance of on-farm sprinkler network is presented in this study. The pressure values at the hydrants were calculated by means of a stochastic simulation model using a random procedure to generate a large number of different operating conditions.
An iterative model was developed for generating the characteristic curve of the on-farm sprinkler irrigation network. The pressure variation downstream the hydrant was computed by intersecting the characteristic curve of the latter with the generated on-farm characteristic curve.
An application of such a methodology was carried out on an existing irrigation system operating in Southern Italy.
This study highlighted that the performance of the on-farm sprinkler network is greatly affected by the variation in the hydrant pressure head, which is strongly related to the farmers' behaviour.

VII FRAMEWORK PROGRAMME: CHALLENGES AND OPPORTUNITIES FOR THE ENVIRONMENTAL SECTOR

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Abstract

The VII Framework Programme is the main financial tool by which the European Union supports research and development activities covering almost all scientific disciplines. It contributes to strengthening the science base and its link with industry, creating poles of excellence, developing key technologies for the industrial competitiveness and enhancing the training and mobility of researches.
The policy context and objectives of the VII Framework Programme are those set out by the European Research Area: creating a more integrated approach to European research, with Member States and EU initiatives completing each other so as to create an environment where world class research can be successfully commercialised, for the benefit of all. To meet these targets and implement in full the specific programmes will require a doubling of the budget as proposed by the Commission it should be EUR 50 521 million for the period. The modalities of the VII Framework Programme are based on three new principles: flexibility in management, rationalization of the administrative issues and controls, and coherence in the information flow. Indeed, despite the previous framework programmes, this one runs for seven years, starting from January 2007.
The VII Framework Programme is organized in four main specific programmes: Cooperation, Ideas, People and Capacities - each corresponding to a major objective of European research policy; a further specific programme is for the direct actions of the Joint Research Centre. The **Cooperation** specific programme is designed to gain leadership in key scientific and technological areas by supporting cooperation between universities, industry, research centres and public authorities across the European Union as well as the rest of the world. This impact is reached by acting across 9 thematic priorities, which are: health; food, agriculture and biotechnology; information/communication technologies; nanosciences and nanotechnologies, materials and new production technologies; energy; environmental and climate change; transport; socio-economic sciences and humanities; space and security. In particular - reflecting the interest of the event a special focus is reserved to “Environmental and Climate Change” priority, and mainly on water priorities derived from the Strategic Research Agenda of Water Supply Technology Platform. The Cooperation programme involves crucial elements of novelties, that contribute to the implementation of: the Joint Technologies Initiatives, ERA-NET and ERA-NET schemes; Article 169 initiatives, International Cooperation.
The **Ideas** specific programme represents the vehicle to spur the creativeness of scientists, allowing them the scope to propose their own topics “investigator driven” topics. Grants will be provided for individual teams, leaving the flexibility for a team to consist of any grouping of researchers appropriate for the conduct of the projects, from one single institution or several institutions, in one country or across national borders, driven only by scientific excellence requirements. The **People** specific programme is directed to foster the human resources by stimulating people to embark on and pursue research careers, encouraging researchers to stay in Europe, and attracting the best brains to Europe.

Finally, the **Capacity** specific programme has got the objective to support research infrastructures, research for the benefit of SMEs and the research potential of European regions (Regions of Knowledge) as well as to stimulate the realisation of the full research potential (Convergence Regions) of the enlarged Union and build an effective and democratic European Knowledge society.