environmental sciences proceedings

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Proceeding Paper

Sustainable Irrigation and Abiotic Tolerant Crops in South Italy within TRUSTFARM Project †

Cataldo Pulvento [1,*], Osama Ahmed [2,3], Mohamed Houssemeddine Sellami [4,5], Antonella Lavini [4] and Giuseppe De Mastro [1]

1 Department of Agricultural and Environmental Science (DISAAT), University of Bari, 70121 Bari, Italy; giuseppe.demastro@uniba.it
2 Department of Agricultural Markets, Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 06120 Halle (Saale), Germany; naser@iamo.de
3 Agricultural Economics Department, Faculty of Agriculture, Cairo University, Giza 12613, Egypt
4 Institute for Mediterranean Agricultural and Forestry Systems, National Research Council of Italy (CNR-ISAFOM), 80055 Portici, Italy; mohamed.sellami@isafom.cnr.it (M.H.S.); antonella.lavini@cnr.it (A.L.)
5 Interdepartmental Research Centre on the “Earth Critical Zone”, University of Naples Federico II, 80055 Portici, Italy
* Correspondence: cataldo.pulvento@uniba.it
† Presented at the 2nd International Laayoune Forum on Biosaline Agriculture, 14–16 June 2022; Available online: https://lafoba2.sciforum.net/.

Abstract: Today, irrigated agriculture is even more influenced by climate change with consequent negative effects on food security. The Mediterranean area is most affected by climate change, leading to greater exposure to uncertainty and production risks. In these environments, water stress, rainfall variability, and soil salinization have been accentuated. Improving crop productivity by minimizing such effects is possible through intelligent climate farming practices (CSFP). Towards resilient and sustainable integrated agro-ecosystems through appropriate climate-smart farming practices (TRUSTFATM) is a project funded by the European Union’s Horizon 2020 research and innovation program with the aim to design integrated agro-ecosystems by conserving natural resources and using the principles of the circular economy for developing climate-resilient production systems in Egypt, Morocco, Italy, France, and Senegal. The Department of Agricultural and Environmental Science (DISAAT) of the University of Bari is responsible for coordinating the activities (starting in 2022) related to the introduction of new crop varieties and management of water and efficient irrigation systems, such as deficit irrigation, use of marginal quality (saline water) irrigation water, and introduction of abiotic stress-tolerant crops.

Keywords: salinity; climate change; tolerant crops

Citation: Pulvento, C.; Ahmed, O.; Sellami, M.H.; Lavini, A.; De Mastro, G. Sustainable Irrigation and Abiotic Tolerant Crops in South Italy within TRUSTFARM Project. *Environ. Sci. Proc.* **2022**, *16*, 8. https://doi.org/10.3390/environsciproc2022016008

Academic Editor: Abdelaziz Hirich

Published: 16 June 2022

1. Introduction

Globally, climate change is one of the biggest challenges. It is causing a significant change in the average values of meteorological elements, such as precipitation and temperature, and rainfall, while negatively affecting agriculture, such as causing biotic (increased insect, pest, and disease populations, uplifting weed growth, declining beneficial soil microbes, and threatening pollinators) and abiotic stresses, occurrence of severe drought or flood, extremes of temperature, salinity, and alkalinity, etc. [1]. The Mediterranean region is most affected by the impact of climate change, leading to greater exposure to uncertainty and production risks. In these environments, water stress, rainfall variability, and soil salinization have been accentuated. Extreme climatic events enhance the risk of desertification in Southern Italy, where extreme weather conditions are increasing tornadoes, and sudden hailstorms, alternating with persistent drought periods. Southern Italy has recorded a decrease in rainfall of up to 20%, with an increase in the number of highly intensive precipitation events [2]. The reduction in rainfall and the increase in precipitation intensity without a doubt affects the total availability of water resources in the soil and the extension of agricultural areas, resulting in higher runoff, soil erosion, less accumulation of water in the reservoirs, and reduced availability of water for irrigation purposes. Furthermore, a warmer climate and drought lead to an increase in evapotranspiration demand from crops.

Under these conditions, it is urgent to improve the productivity of the agricultural system through intelligent climate farming practices (CSFP) using the principle of soil and water conservation when introducing new crops that tolerate drought and salinity stress into these systems and managing them.

The adverse effect of climate change on crops could be mitigated, by the introduction of adapted cultivars with adjusted planting date, and changing fertilizer and irrigation practices [3,4]. It has been demonstrated that cultivar adaptation is the most effective, followed by irrigation.

An increasing number of research projects have been funded in recent years, with the aim to innovate traditional agricultural systems and to improve their resilience to climate change. A recent one is the TRUSTFATM project "Towards resilient and sustainable integrated agro-ecosystems through appropriate climate-smart farming practices", developed with the aim to design integrated agro-ecosystems by conserving natural resources and using the principles of the circular economy in order to develop more climate-resilient production systems in Egypt, Morocco, Italy, France, and Senegal. The project was funded by the European Union's Horizon 2020 research and innovation program. The main aim of the TRUSTFARM project is to design integrated crop–livestock agro-ecosystems in order to improve productivity and make production systems more resilient to climate change. The project includes a series of activities aimed at the construction of resilient cropping systems; in Italy, in particular, field trials will be carried out aimed at identifying new varieties resistant to abiotic stresses and sustainable irrigation practices that will make high yields even in changing climatic conditions.

2. Field Trials

Biannual experimental field trials starting from 2022 to evaluate the production performance of climate-resilient crops and best irrigation practices will be carried out for the Italian case study.

2.1. Evaluation of Climate Resilient Crops

The effect of environmental stresses on crop physiology is highly variable. The response that each plant gives to single specific stress, such as drought, depends on numerous variables (time of onset, severity, and duration). In addition, plants employ different environmental stress response strategies, such as avoidance of stress, stress tolerance, and escape from stress [3].

Furthermore, the growing negative impact of climate change on a given environment increases the probability of plants being exposed to several stresses simultaneously, such as drought and salinity; in this case, the response of the plant to a combination of stress cannot be explained by the sum of the single effects, but it is a unique and different response.

In marginal environments where the production of traditional crops is compromised, attempts have been made in recent years to introduce new resistant crops. Extremophiles have evolved and reproduced in very marginal habitats, such as highly saline environments, which can also be prone to drought and heat, floods, sodium, and alkalinity [5].

There are several promising species that have interesting characteristics both from the point of view of resistance to abiotic stress and from the point of view of the quality characteristics of the seeds produced.

Examples are quinoa (*Chenopodium quinoa* Willd.) and grain amaranth (*Amaranthus* spp.) (Figure 1), of which the cultivation in recent years has expanded to several countries out of its area of origin due to increasing interest, market development, research, and promotion [6]. Thanks to their high-quality protein content, these crops are considered promising candidates for enhancing high-quality plant protein food production in the world. Quinoa and amaranth are important for the high tolerance to abiotic stresses and for their nutritious characteristics [7].

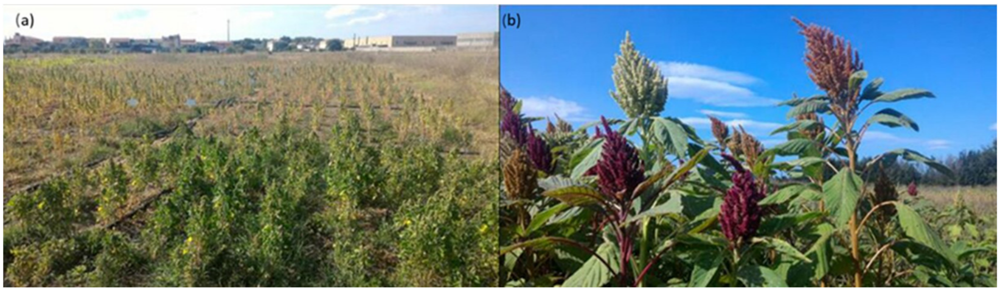

Figure 1. Quinoa (**a**) and amaranth (**b**).

2.2. Deficit Irrigation Practices

Improvement of irrigation management is one of the main options in Mediterranean cropping systems to increase the efficiency of water use [8]. Besides improving agricultural practices under dryland farming, water saving is important to sustain high productivity under more arid conditions in the future.

Many trials have been carried out in the past years aimed towards finding the best solution to manage irrigation with saline water.

Sprinkler irrigation is not suitable because salts may cause injury to leave tissues, while subsurface and drip irrigation appear to be ideal methods. In particular, drip irrigation reduces the water use resulting in less salt deposited in the soil layers, avoiding leaf burn; furthermore, in drip irrigation, the high frequency of irrigation interventions prevents the soil from drying out, thus preventing the salts from concentrating in the soil and ensuring their leaching below the root system [9].

Among the sustainable irrigation strategies, supplementary irrigation consists in the application of small quantities of irrigation water to crops that are normally grown in dry conditions [10]. A very interesting approach is related to deficit irrigation, which consists of the use of irrigation volumes lower than the optimal ones with water savings of up to 50/70% of the quantity used for full irrigation and with the same levels of yields. Deficit irrigation could also be applied only during drought-sensitive growth phases characteristic of each plant species.

Author Contributions: Conceptualization, C.P.; methodology, C.P.; writing—original draft preparation, C.P. and O.A.; writing—review and editing, O.A., G.D.M., M.H.S., A.L. and C.P.; visualization, C.P.; supervision, C.P. and G.D.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the European Union's Horizon 2020 Research and Innovation Program (TRUSTFARM project).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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