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Physiological Properties of Tomato Varieties and Hybrids in Sheltered Structures

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Annotation: Tomatoes (Solanum lycopersicum) are among the most economically important crops cultivated globally, particularly in sheltered structures such as greenhouses. These environments enable precise control over growing conditions, optimizing physiological traits like photosynthesis, nutrient absorption, and stress tolerance. This article explores the physiological properties of different tomato varieties and hybrids, focusing on growth, yield, and adaptation under controlled environments.

Keywords: Tomato varieties, hybrids, physiological characteristics, protected structures, greenhouse cultivation, photosynthesis efficiency, nutrient uptake, stress tolerance, yield improvement, fruit quality.

Introduction. The tomato is reported as the most vegetable crop grown in home garden and the second greatly consumed after worldwide. According to the Food and Agriculture Organization (2017), tomato crop is grown in open field, greenhouses and screenhouses. The open-field production may be for the fresh market or the processing industry, while the greenhouse production is only for the fresh market. The leading producers worldwide are China, India, Turkey, USA, Egypt, Iran, Italy, Spain, Brazil and Nigeria respectively. Ideally, tomato requires a relatively cool

and dry climate for high yield and premium quality but it is also adapted to a varied range of climatic conditions (CABI, 2019). The optimum temperature range for growth and development is 21-24°C while long exposure of tomato plants to the temperatures below 12°C can produce the chilling injury. The temperature has a large effect on all aspects of crop development. Leaf and truss initiation rates reduce linearly with reducing temperature. The production of thicker leaves for young plants grown at sub-optimal temperatures result in reduced light interception and therefore cause the plant to have a lower relative growth rate. At that type of temperature, fruit set is reduced as a result of poorer pollen quality.

Sheltered cultivation, including greenhouses and high tunnels, provides an optimal environment for tomato production, allowing year-round growth. The physiological performance of tomato varieties and hybrids under such conditions depends on genetic characteristics and environmental interactions. Understanding these dynamics can help enhance productivity, improve fruit quality, and ensure resource-efficient practices.

On a worldwide basis, tomato is the most important horticultural crop, with a total production and cultivated area estimated at 164 Mt and 4.76 Mha, respectively. China is the main producer, with 31.0% of the total world production and 20.6% of the total cultivated area1, while Spain is the country with the highest mean tomato yield (81.3 $t \cdot ha^{-1}$). In Spain, as in other countries, tomato crops are grown mainly in areas having an arid or semi-arid Mediterranean climate, characterized by an average annual rainfall of less than 300 mm. Since tomato is a plant that requires a large amount of water for its development in areas with a shortage of good-quality water for irrigation farmers use poor-quality water - from wells or groundwater aquifers - containing a high concentration of soluble salts, mainly NaCl, which decreases the agronomic yield.

Soilless production of tomato crops in greenhouses has increased dramatically in recent years. Thus, in Southeastern Spain there are approximately 5,500 ha of soilless culture. This is due to the fact that these systems allow nutrition and irrigation to be controlled more efficiently, which generates higher yields. In addition, they reduce the incidence of pathological problems considerably, implying lower initial investment costs, and avoid contamination of soils and aquifers by nitrate and pesticides, thus contributing to the practice of sustainable agriculture. In countries with environmental legislation, the use of these systems has been encouraged in the last 10 years, to minimize the damage to natural ecosystems caused by excessive use of fertilizer.

FIGURE 1.

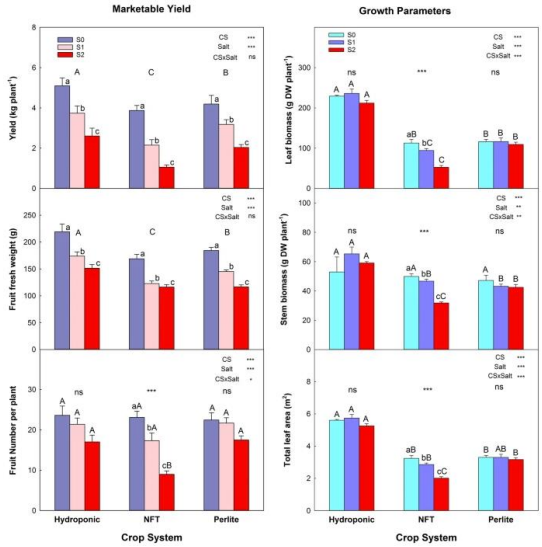
Fruit morphological diversity of the 42 accessions evaluated in two organic farms under nitrogen and water stress conditions in this study. BL = Breeding lines, CL = Elite cultivars, FM = Landraces for the fresh market, HL = Heirlooms, LS = Long shelf-life cultivars. The pictures are not in the same scale.

Hybrids showed superior growth metrics compared to traditional varieties. Enhanced genetic traits led to increased leaf area, promoting efficient light capture and higher photosynthetic activity. Hybrids yielded 20–30% more fruit compared to varieties. Sheltered conditions facilitated uniform fruit size and enhanced sugar-acid balance, improving taste and marketability.

Among the soilless culture systems most used in Southeastern Spain for tomato cultivation, the use of perlite, watered with NS but without recirculation, is of particular note. However, the lack of water forces farmers to optimize irrigation management, to maximize production with the lowest water consumption. In this area a new type of NFT system, called the New Growing System is being commercialized, which reduces the water consumption due to the recirculation of the NS. This system is frequently used in crops such as strawberry or lettuce20. Recently, the manufacturer of

this new system has optimized its management to produce tomatoes with a saving of water, obtaining a mature and competitive technology. However, the behavior of tomato in different soilless culture systems has not been compared in the conditions typical of the Southeast of Spain, where irrigation with saline water predominates. Therefore, the objective of this work is to compare the agronomic and physiological response of tomato plants in a traditional soilless culture system (perlite) and in this new NFT system, using saline water with EC values similar to those used in the southeast of Spain. In addition, a non-commercial hydroponic crop deep flow technique, has been used as a control system that allows us to know the maximum potential of water use efficiency for this crop.

Fruit yield and quality: The marketable yield (kg·plant^{-1}) was estimated from the total yield, by excluding the fruits having a fresh weight of less than 70 g and those showing symptoms of apical rot, cracking, or any type of deformation or mechanical damage (Fig.2).



Parameters of marketable yield and vegetative development of tomato plants grown in three soilless culture systems and three salt treatments. The error bar indicates the standard error of the mean (n = 4–8). *, **, ***, and “ns” indicate significant differences at $p < 0.05$, $p < 0.01$, $p < 0.001$, and non-significant differences, respectively. Values with different letters differ significantly at the 95% level, according to Tukey’s HSD test. Lowercase letters compare salinity treatments for each culture system. Uppercase letters compare culture systems for each salinity treatment.

Conclusion. Tomato cultivation is very common in the world today. Tomatoes are mostly open it is grown in the field and in protected places, i.e. in greenhouses. But always the population it's a bit difficult to get this great tasting vegetable. Definitely fall for it It is one of the reasons that it comes hard. One of the solutions to this problem is replanting tomatoes operation and maintenance. Therefore, a lot of scientific work is done on tomato storage, drying, etc aimed at scientifically researching the production of assortment products aimed at the rapid development of the introduction of technologies.

The study highlights the advantages of tomato hybrids in sheltered cultivation. Their physiological adaptability to controlled environments results in higher productivity and quality. Future research should focus on breeding efforts that combine stress tolerance with resource efficiency to address global food security challenges.

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