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INCREASING DROUGHT TOLERANCE IN TOMATO: AN INTEGRATED APPROACH TO CULTIVAR SELECTION, SEED TREATMENT, AND WATER MANAGEMENT

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Abstract
This paper examines approaches to improving drought tolerance in tomato (Solanum lycopersicum L.) through cultivar selection, seed treatment, and irrigation optimization. The need for locally adapted technologies to improve crop yield and water-use efficiency is substantiated.

Keywords: Tomato, drought tolerance, cultivar selection, agronomic practices, irrigation, soil moisture, soil, yield.

INTRODUCTION

Limited water resources necessitate the adoption of technologies that ensure stable tomato yields while enabling the rational use of irrigation water. Drought disrupts transpiration, photosynthesis, plant growth, and fruit development. Plant tolerance depends on genotype, stress intensity, temperature, and developmental stage [2, 3]. The aim of this study is to review scientific approaches to improving drought tolerance in tomato and identify prospects for their application in irrigated agriculture.

MATERIALS AND METHODS

An analytical review of publications on the genetic and physiological mechanisms of drought tolerance, pre-sowing seed priming, and deficit irrigation was conducted [1, 4]. No original experiments were performed; quantitative data are drawn from

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published studies. The review considers cultivar selection, seed treatment, soil moisture conservation, and irrigation management.

RESULTS OF THE LITERATURE REVIEW AND DISCUSSION

Cultivar Selection and Seed Treatment. Genotype selection determines the potential drought tolerance of tomato plants. When evaluating cultivars, it is necessary to consider root system development, leaf water status, stomatal conductance, photosynthesis, fruit number and weight, marketable yield, and the stability of fruit set [2]. Reduced transpiration can help conserve water; however, excessive stomatal closure restricts photosynthesis. Earliness may also reduce exposure to drought, but it does not, in itself, provide direct evidence of tissue-level drought tolerance.

Under the conditions prevailing in Uzbekistan, locally adapted and promising genotypes should be evaluated under different water-supply regimes using comparable growing conditions. Seed priming is the controlled pre-sowing hydration of seeds and can promote the activation of germination processes. The effectiveness of hydropriming, osmopriming, and other seed treatments depends on genotype, seed quality, and growing conditions [1]. Improved germination does not necessarily guarantee yield maintenance under prolonged drought. Therefore, treated seeds should be compared with untreated controls in terms of germination, root and shoot development, seedling establishment, yield, and fruit quality.

Agronomic Practices for Soil Moisture Conservation. Appropriate tillage practices promote root development and help reduce moisture losses. Soil compaction restricts root growth, whereas excessive tillage may damage soil structure and increase evaporation. Mulching with organic materials or suitable covering materials reduces evaporation and suppresses weeds. Weeds should be controlled in a timely manner, particularly during the early stages of tomato development.

Balanced nutrient management supports plant growth and stress tolerance. Excessive nitrogen fertilization may stimulate foliage development and increase

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crop water requirements, whereas additional potassium application is advisable primarily when potassium deficiency is present. Planting dates and plant density should be adjusted to cultivar characteristics and prevailing temperature conditions.

Irrigation Management at Different Growth Stages

Irrigation should be adjusted according to the phenological stage, moisture content of the root zone, temperature, and plant water status. Adequate moisture is essential for seedling establishment, while during vegetative growth, irrigation should support the development of roots and foliage. Bud formation, flowering, and fruit set are particularly critical stages: water deficit under high temperatures can reduce fruit set. During fruit enlargement, water stress reduces fruit weight and marketable yield.

During ripening, irrigation should be adjusted according to the intended use of the produce. Under certain conditions, moderate water deficit may alter the concentration of soluble solids; however, severe stress reduces fruit size and total yield [3]. Drip irrigation delivers water directly to the root zone, but its effectiveness depends on water distribution uniformity and the appropriate determination of irrigation rates.

In a two-year study, S. Mukherjee and co-authors reported that drip irrigation at a soil water tension of −10 kPa reduced water use by 22.6% and 19.8% in 2020 and 2021, respectively. Yields were 28% and 22% higher than those obtained under furrow irrigation [4]. These findings reflect the conditions of a specific experiment and require validation under other soil and climatic conditions.

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Table 1. Key irrigation management objectives for tomato at different growth stages

Growth stage	Irrigation objective	Consequences of water deficit
Seedling establishment	Ensure successful root establishment	Delayed establishment
Vegetative growth	Maintain root and leaf development	Reduced biomass accumulation
Flowering	Preserve reproductive function	Reduced fruit set
Fruit enlargement	Ensure fruit growth	Reduced fruit weight and yield
Ripening	Adjust irrigation to the intended product quality	Reduced fruit size under severe stress

Soil moisture sensors or tensiometers are recommended for irrigation scheduling. These devices should be installed with due consideration of rooting depth and soil properties. Irrigation rates cannot be reliably generalized without local validation.

Evaluating the Effectiveness of Integrated Technologies

Drought tolerance should be assessed using a combination of physiological and agronomic indicators, including yield, the proportion of marketable fruits, mean fruit weight and number, soil moisture, irrigation water volume, and water productivity. Additional measurements may include leaf relative water content, leaf temperature, stomatal conductance, and photosynthetic activity.

Field trials should include an appropriate control treatment, replication, and comparable growing conditions. When cultivars, seed treatments, and irrigation regimes are investigated simultaneously, the individual effects of each factor and their interactions must be considered. In Uzbekistan, locally adapted trials evaluating cultivars under different water-supply regimes, with monitoring of yield, product quality, and water use, are particularly promising.

CONCLUSION

Improving drought tolerance in tomato requires an integrated combination of genetic and agronomic approaches. Cultivar selection, pre-sowing seed priming, soil moisture conservation, balanced nutrient management, and rational irrigation can help reduce yield losses. Ensuring adequate water supply during flowering,

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fruit set, and fruit enlargement is particularly important. Under the conditions of Uzbekistan, locally adapted technologies should be developed and experimentally validated, with their performance assessed in terms of yield, product quality, and water productivity.

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