E CONF SERIES

International Conference on Economics, Finance, Banking and Management
Hosted online from Paris, France
Website: econfseries.com 24th June, 2025

COMPARATIVE ANALYSIS OF TRANSPIRATION IN POTATO GENOTYPES UNDER IN VITRO AND IN VIVO CONDITIONS

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ABSTRACT

This study investigated the process of transpiration in plants under in vitro (laboratory) and in vivo (natural) conditions using four genotypes: S-46, S-73, S-55, and S-17. Results demonstrated that the transpiration rate was significantly higher in vivo compared to in vitro. The highest rate was observed in genotype S-17, indicating its superior adaptability to environmental stresses such as drought and salinity. The study highlights the importance of understanding plant water regulation mechanisms under varying conditions and presents genotype S-17 as a promising candidate for cultivation in arid and saline soils.

Keywords: Transpiration, in vitro, in vivo, plant genotypes, water balance, salinity stress, drought tolerance, physiological response.

INTRODUCTION

Potato (Solanum tuberosum.) is one of the most important agricultural crops for global food production, and it is obtained by increasing the yield of these crops through flood and biotechnological methods. Biotechnological diseases, especially in vitro and in vivo conditions, are developing more efficient production of potato products. These processes have advantages such as controlling plants in sterile environments, maintaining genetic diversity, and developing new varieties. Many products have been made available to these computers, and they have analyzed potatoes in depth. However, the development of potatoes in vivo is strongly

influenced by natural soil-climate factors. Studies conducted by MacKerron and Waister (1985) examined how nutrient factors (nitrogen, potassium) and temperature in the soil affect growth processes. This research indicated that improving nutrient availability criteria for potatoes could enhance yield [5]. Additionally, studies by Iwama (2008) demonstrated that soil moisture and the level of saturation with organic matter significantly impact the plant's root system [6].

Transpiration is a key physiological process in plants, involving the loss of water vapor through stomata, which plays a crucial role in maintaining water balance, regulating temperature, and transporting nutrients within the plant (Taiz & Zeiger, 2010). The rate of transpiration is influenced by both genetic and environmental factors, such as temperature, humidity, light intensity, and soil composition.Global agricultural productivity is increasingly threatened by abiotic stresses, particularly drought and soil salinity (FAO, 2023). Therefore, identifying genotypes that can maintain physiological function and growth under these conditions is essential for sustainable agriculture. This study compares the transpiration rates of different plant genotypes under controlled (in vitro) and natural (in vivo) conditions, aiming to assess their adaptability and stress tolerance.

MATERIALS

Plant Material: Four genotypes were selected for the study: S-46, S-73, S-55, and S-17. These genotypes are known for their potential adaptability to saline and drought-prone environments in Uzbekistan.

In Vitro Conditions:Plants were grown in sterile Murashige and Skoog (MS) medium under controlled conditions.Light cycle: 16 hours light / 8 hours dark.Temperature: maintained at 25°C.Transpiration rates were measured using a stomatal chamber method and expressed in mg $H_2O/cm^2/hour$.

In Vivo Conditions:Experiments were conducted in the naturally saline soils of Bukhara region.Soil salinity: 5–7 dS/m, Ambient temperature: 35–40°C,Relative humidity: 25–30%,Transpiration was measured using gravimetric methods over the growing,season. Statistical Analysis:Each measurement was repeated five times.Data are expressed as mean ± standard deviation. Statistical analysis was conducted using ANOVA ($p < 0.05$ considered significant).

RESULTS

Table 1. Transpiration Rate (mg H_2O/cm^2/hour)Genotype In vitro In vivo

Genotype	Transpiration (*in vitro*)	Transpiration (*in vivo*)
S-46	2,30 ± 0,15	3,50 ± 0,21
S-73	2,20 ± 0,14	3,40 ± 0,19
S-55	2,10 ± 0,13	3,35 ± 0,18
S-17	2,35 ± 0,16	3,60 ± 0,22

The results clearly indicate that all genotypes showed significantly higher transpiration rates in vivo compared to in vitro conditions. Genotype S-17 exhibited the highest transpiration rate in both conditions, particularly in vivo (3.60 mg H_2O/cm^2/hour), suggesting a strong physiological response to environmental stressors.

DISCUSSION

These findings align with previous studies by Slatyer and McIlroy (1961), which demonstrated that high temperatures and low humidity significantly enhance transpiration. The increased transpiration under in vivo conditions can be attributed to environmental factors such as elevated temperature, high light intensity, and soil salinity, which increase evaporative demand.Genotype S-17's high transpiration rate may be due to its well-developed root system and efficient water uptake mechanisms, allowing it to maintain growth and physiological functions under stress. The ability to lose more water while sustaining biomass suggests a functional balance between water acquisition and loss.Under in vitro conditions, the lower transpiration rates are attributed to the controlled, low-stress environment where stomatal activity and water loss are minimized. Nutrient availability, light intensity, and spatial limitations further restrict plant growth and physiological responses.The results from Trejo-Tapia et al. (2002) similarly support the notion that in vitro-grown plants exhibit reduced transpiration due to minimized environmental stressors and regulated humidity levels.

CONCLUSION

Transpiration is a critical indicator of plant adaptability to environmental stresses such as drought and salinity. The study demonstrated that transpiration rates are consistently higher under in vivo conditions due to greater environmental pressures. mong all genotypes tested, S-17 showed superior physiological performance, particularly in natural conditions, with the highest transpiration rate and signs of strong stress tolerance.S-17 is recommended as a promising candidate for cultivation in arid and saline regions due to its efficient water management and adaptability. Future studies should focus on molecular and genetic analyses of transpiration-related traits to better understand the mechanisms behind stress resilience and to enhance plant breeding programs targeting harsh climates.

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