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Behavior of Cuban Tomato Cultivars (*Solanum lycopersicum* L.) under Different Salinity Conditions

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Abstract

Context: Soil salinization is currently one of the most serious problems facing agriculture, as it significantly affects food production; for this reason, it is necessary to study cultivars that are tolerant to these conditions for their inclusion in the country's production schemes.
Aim: To select 14 tomato cultivars (*Solanum lycopersicum* L.), based on their tolerance to salinity.
Methods: The tolerance of 14 tomato cultivars to different concentrations of sodium chloride (NaCl) (50 mM, 150 mM, 200 mM) was studied under *in vitro* conditions. For this purpose, the germination percentage (GP) and the germination rate index (GRI) of the seeds were determined, as described by the Maguire index.
Results: Among the 14 tomato cultivars (Solanum lycopersicum L.) studied, T60 and FL-5 were selected as promising in terms of germination percentage (GP) at a concentration of 50 mM NaCl, with no significant differences between them compared to the others. It was followed by M-78, with an 80% germination rate at this salt concentration, making it a promising material for use in agroecosystems affected by this condition. All of them showed differences in the seed germination rate index. Regarding the germination rate index (GRI), T60 and M-78 stood out in the control group, with no significant differences between them. At 50 mM, FL-5 led, followed by T60, M-78, and CV-28, with no significant differences among the latter. The remaining cultivars studied did not tolerate the salinity levels evaluated.
Conclusions: Among the 14 cultivars studied for germination percentage (GP) at 50 mM NaCl, the T60 and FL-5 cultivars stood out with superior results, showing no significant differences between them compared to the others. M-78 follows, with an 80% germination rate at this salt concentration, making it a promising candidate for use in agroecosystems affected by salinity.

Keywords: *germination, cultivars, salinity*.

Introduction

Climate change and the severity of extreme weather events, including droughts and heatwaves, are conditions that promote increased use of groundwater for consumption and irrigation, which in turn leads to greater depletion of the water table and facilitates salt infiltration into the soil (Hassani et al., 2021). Moreover, the lack of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K) in soils with these characteristics further limits their fertility (Casas & Galvan, 2019). Salinity likewise causes major damage, which totally or partially restricts the proper growth of crops (Martínez et al., 2020). Global estimations say that approximately 830 million hectares (ha) are affected by salinization, which represents more than 6% of the total global surface area and around 20% of the total cultivable land (Courel, 2019).

In Cuba, 14.9% of the agricultural land is affected by salinity and sodicity, and it is estimated that 15% or more of the irrigated area is at risk of becoming salinized (ONEI, 2021). Therefore, salt stress represents a growing threat to the development of agriculture in the country, as it significantly affects productivity (Egamberdieva et al., 2019). This phenomenon limits the development of horticultural crops, as it causes disruptions both in plant growth and in the absorption and distribution of nutrients to their various organs (Saddiq et al., 2020). An issue that threatens food security and the increase in vegetable production in the country. To help address this issue, the possibility of producing vegetables on a small scale is being evaluated, using available yards and organoponic systems, and on a larger scale through land lease, among other approaches. In recent years, these family-based vegetable systems have become a significant alternative for meeting nutritional demands in both rural and urban areas (Vila Pérez et al., 2021).

Among the most important horticultural crops is the tomato, which is the second most consumed fruit worldwide (Calvo-Polanco et al., 2016). Nevertheless, the search for cultivars with greater tolerance to this type of stress is essential, as they would enable food production in various scenarios (İbrahimova et al., 2021).

Considering all these factors, the present study aims to select 14 tomato cultivars (*Solanum lycopersicum* L.) based on their tolerance to salinity.

Materials and methods

Biological material The study used 14 tomato cultivars (*Solanum lycopersicum* L). T60, M44, FL-5, Densus, Escarlata, V-18, H-6, M-6, C-15, M-78, V-28, M-23, C-28V y C-38. Sourced from the Central Germplasm Bank of the Institute of Fundamental Research in Tropical Agriculture "Alejandro de Humboldt", INIFAT.

Tolerance to different sodium chloride (NaCl) concentrations The seeds were disinfected with 4% sodium hypochlorite for 15 minutes and rinsed three times with sterile distilled water. The experiment was based on glass Petri dishes measuring 140 mm in diameter and 20 mm in height, with filter paper moistened with distilled water at the bottom and 25 seeds from each cultivar placed inside.

Each dish received 25 mL of different sodium chloride (NaCl) solutions (50 mM, 150 mM, 200 mM), along with a control treatment in which only sterile distilled water was added. The dishes were arranged following a completely randomized experimental design, at 25 °C and 80% humidity. Each variant consisted of three repetitions.

The germinated seeds were counted from the time of establishment until stabilization, and the data obtained were used to determine:

Germination percentage (GP): Seeds were counted as germinated daily, using the emergence of a radicle equal to or greater than 2 mm as the criterion. The equation described by Ruiz et al. (2018) was used to calculate the germination percentages in each block

GP (%) = Number of germinated seeds / Number of seeds sown × 100

Germination Speed Index (GSI): represents the germination rate calculated through a weighted time of cumulative germination. Where G is the percentage of seedlings that germinated during the time interval t, according to Maguire (1962) and cited by Vieira Ferraz et al. (2016).

Experimental design and statistical analysis: A completely randomized design was used in the experiment. The results (GP, GSI) were subjected to an analysis of variance (ANOVA) with Duncan's Multiple Range Test (5% error probability) to detect differences among treatment means. For this purpose, the STATGRAPHICS Plus software version 5.0 was used.

Results and Discussion

Upon analyzing the results, significant differences were observed among species and cultivars, with a reduction in germination percentages in most of the genotypes studied as salinity levels increased.

Fig. 1. shows the germination percentage (GP) results in the crop show including cultivars T60 and FL-5 at 50 mM NaCl, which stood out with superior performance, without significant differences between them, compared to the other evaluated cultivars. Notwithstanding, M-78 was next, although with differences between them, as it showed only 80% germination. At the remaining evaluated salinity levels, none of the cultivars showed a positive response (Fig.) 1.).

Regarding the Germination Speed Index (GSI), T60 and M-78 stood out in the control treatment, with no significant differences between them. At 50 mM NaCl, FL-5 led the group, followed by T60, M-78, and CV-28, also without significant differences among the latter cultivars. (Fig. 2).

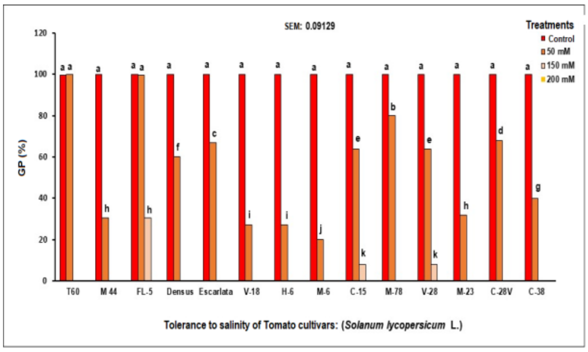

Fig. 1. Germination percentage (GP) of tomato cultivars (*Solanum lycopersicum* L.): T60, M44, FL-5, Densus, Escarlata, V-18, H-6, M-6, C-15, M-78, V-28, M-23, C-28V, and C-38 were evaluated under different concentrations of sodium chloride (NaCl) (50 mM, 150 mM, 200 mM) and an absolute control.

In this crop, the most drought-sensitive stages in tomato are described as those occurring during plant establishment (germination and seedling phase), immediately after transplanting, during flowering, and during fruit development (Florido Bacallao & Bao Fundora, 2014).

In other studies that evaluate the effect of salt stress on tomato (*Solanum lycopersicum* L.) seed production and quality at different concentrations, the germination index was observed to have significantly decreased, as NaCl concentrations increased (Eitel, 2021), which is also confirmed in the present study. On the other hand, Ruiz et al. (2014) evaluated the germination of eight tomato genotypes exposed to different NaCl levels; in this case, the fresh and dry biomass of the aerial part increased in the presence of NaCl. Similarly, when evaluating the impact of tomato cultivars under different concentrations, the results show variation among them. In the Florada cultivar, germination rate decreased by 14% at a concentration of 50 mM NaCl. Contrary to the previous findings, a concentration of 25 mM NaCl increased root length by 19%, while at 50 mM NaCl, dry biomass increased by 19%, both compared to the control (Enríquez-Acosta et al., 2023).

Our results are consistent with those obtained by González et al. (2020), who observed that the germination rate of tomato seeds from the ‘Río Grande’ cultivar significantly decreased compared to the control treatment as NaCl concentrations increased. Likewise, Aazami et al. (2021) reported similar effects, not only on germination in this crop, but also stated that salinity impacted the metabolic and photosynthetic processes involved in chlorophyll production.

In the ‘Río Grande’ tomato cultivar, NaCl concentration affected stem length, with a reduction in size observed as NaCl concentration increased (Abdel-Farid, 2020).

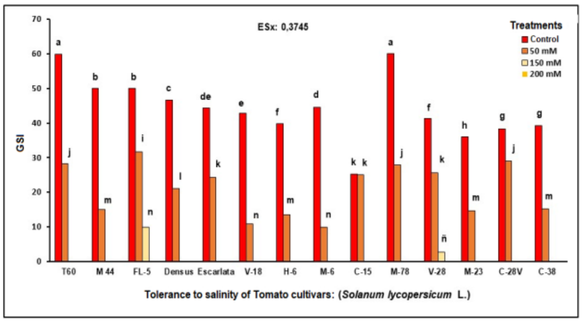

Fig. 2. Germination Speed Index (GSI) of Tomato Cultivars (*Solanum lycopersicum* L.): T60, M44, FL-5, Densus, Escarlata, V-18, H-6, M-6, C-15, M-78, V-28, M-23, C-28V, and C-38 were evaluated under different concentrations of sodium chloride (NaCl) (50 mM, 150 mM, 200 mM) and an absolute control.

The study led to the conclusion that both germination percentage and germination speed index are important indicators for evaluating seed tolerance to different salt levels, and thus selecting the most promising ones for further research.

At 50 mM NaCl, the germination percentage (GP) was highest in the T60 and FL-5 cultivars, which showed superior results with no significant differences between them compared to the others. Next is M-78, with an 80% germination rate at this salt concentration. At the remaining evaluated salt levels, none of the studied cultivars showed a positive response.

Regarding the germination speed index (GSI), T60 and M-78 stood out in the control treatment, with no significant differences between them. At 50 mM NaCl, FL-5 led the performance, followed by T60, M-78, and CV-28, also without significant differences among these latter cultivars.

The effect of salinity on cultivar germination was differentiated using the Maguire index, a variable that expresses cumulative germination over time (percentage), serving as a measure of germination speed and seedling vigor.

There is high genetic variability among the studied germplasm regarding its level of salinity tolerance, with differences observed in both germination percentage and germination speed index.

The results obtained in this research represent an important contribution, as they facilitate the selection of promising cultivars for conducting this type of work in agroecosystems affected by salinity, thereby helping to increase grain diversity for food and agriculture in the country.

Conclusions

Among the 14 cultivars studied for germination percentage (GP) at 50 mM NaCl, T60 and FL-5 stood out with superior results, showing no significant differences between them compared to the rest. Next is M-78, with an 80% germination rate at this salt concentration.

Author contribution statement

Marisel Ortega García: Research conception, experimental design, data analysis, writing of the manuscript, final review.

Yoania Ríos Rocafull: Collaborated with the research and analysis of the results, final review.

Yarelis. Ortiz Nuñez: Collaborated with the research and analysis of the results, final review.

Lianne Fernández Granda: Contributed with data about cultivars, final review.

José Francisco Gil Vidal: Provided and identified the grain cultivars studied, analysis of resulting data.

Conflict of interest statement

Not declared.

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References

Aazami, M. A., Rasouli, F., & Ebrahimzadeh, A. (2021). Oxidative damage, antioxidant mechanism and gene expression in tomato responding to salinity stress under in vitro conditions and application of iron and zinc oxide nanoparticles on callus induction and plant regeneration. *BMC Plant Biology*, *21*(1), 597. https://doi.org/10.1186/S12870-021-03379-7

Abdel-Farid, I. B. Marghany, M.R., Rowezek, M.M., & Sheded, M.G. (2020). Effect of salinity stress on growth and metabolomic profiling of Cucumis sativus and Solanum lycopersicum. *Plants*, *9*(11), 1626. https://doi.org/10.3390/plants9111626

Calvo-Polanco, M., Sánchez-Romera, B., Aroca, R., José Asins, M., Declerck, S., Dodd, I. C., Martínez-Andújar, C., Albacete, A., & Ruiz-Lozano, J. M. (2016). Exploring the use of recombinant inbred lines in combination with beneficial microbial inoculants (AM fungus and PGPR) to improve drought stress tolerance in tomato. *Environmental and Experimental Botany*, *131*, 47-57. https://doi.org/10.1016/j.envexpbot.2016.06.015

Casas, N., & Galvan, A.F. (2019). *Eficiencia de las enmiendas orgánicas en la recuperación de suelos salinos en el distrito de San Vicente De Cañete – Lima*. (Tesis presentada para optar el Título Profesional de Ingeniero Ambiental, Universidad Peruana Unión). Repositorio Institucional - Universidad Peruana Unión https://repositorio.upeu.edu.pe/server/api/core/bitstreams/e28baa76-c54b-49e1-803c-17b6e2f7ef0f/content

Courel, G.F. (2019). *Guía de estudio. Suelos Salinos y Sódicos. Cátedra de Edafología*. Facultad de Agronomía y Zootecnia. Universidad Nacional de Tucumán. https://www.studocu.com/es-ar/document/universidad-siglo-21/clima-y-suelo/suelos-salinos-y-sodicos-2019/38942169

Egamberdieva, D., Wirth, S., Bellingrath-Kimura, S.D., Mishra, J., & Arora, N.K., (2019). Salt-Tolerant Plant Growth Promoting Rhizobacteria for Enhancing Crop Productivity of Saline Soils. Frontier Microbiology. *10*, Article 2791. https://doi.org/10.3389/fmicb.2019.02791

Eitel, C. C. (2021). Efecto del estrés salino en la producción y calidad de semillas de tomate. (Tesis para optar al grado de Magister en Fisiología y Producción Vegetal). Pontificias Universidad Católica de Chile. https://doi.org/10.7764/tesisUC/AGR/52676

Enríquez-Acosta E. A., Ruiz-Espinoza F. H., Carballo-Méndez F. de J., Beltrán-Morales F. A., Vázquez-Vázquez C., & García-Sánchez H. D. (2023). El silicio como mitigador a salinidad en las variables fisiológicas de germinación de tres variedades de Solanum lycopersicum. *Revista Mexicana de Ciencias Agrícolas*, *14* (1), 85-96. https://www.scielo.org.mx/pdf/remexca/v14n1/2007-0934-remexca-14-01-85.pdf

Florido Bacallao, M, & Bao Fundora, L. (2014). Tolerancia a estrés por déficit hídrico en tomate (Solanum lycopersicum L.). *Cultivos Tropicales*, *35*(3), 70-88. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0258-59362014000300008&lng=es&tlng=es

González, G. P., Suárez, N. T. & Marín, J. O. (2020). Effect of salinity and seed salt priming on the physiology of adult plants of Solanum

Lycopersicum cv. 'Río Grande'. *Braz. J. Bot.* *43*(4), 775-787. https://doi.org/10.1007/s40415-020-00636-1

Hassani, A, Azapagic, A, & Shokri, N. (2021). Global predictions of primary soil salinization under changing climate in the 21 St century. *Nature communications*. *12*(1), Article 6663. https://www.doi.org/10.1038/s41467-021-26907-3

İbrahimova, U., Kumari. P., Yadav, S., Rastogi, A., Antala, M., Suleymanova, Z., Zivcak, M., Tahjib-Ul-Arif, M., Hussain, S., Abdelhamid, M., Hajihashemi, S., Yang, X., & Brestic, M. (2021). "Progress in Understanding Salt Stress Response in Plants Using Biotechnological Tools", *Journal of biotechnology*. *329*, 180–191. https://doi.org/10.1016/j.jbiotec.2021.02.007

Maguire, J. D. (1962). Speed germination-aid in selection and evaluation for seedling emergence and 101 vigor, *Crop Sci., Madison*. *2*, 176-177. http://dx.doi.org/10.2135/cropsci1962.0011183X000200020033x

Martínez Villavicencio, N., López Alonzo, C.V., Basurto-Sotelo, M., & Pérez Leal, R., (2020). Efectos por salinidad en el desarrollo vegetativo. *Tecnociencia Chihuahua*, *5*(3), 156-161. https://www.studocu.com/es/document/universidad-de-cordoba-espana/fisiologia-vegetal-ambiental/efectos-por-salinidad-en-el-desarrollo-vegetativo/1156304

ONEI, (2021). Agricultura, ganadería y pesca. En *Anuario Estadístico de Cuba*. (Edición 2022). Oficina Nacional de Estadística e Información (ONEI). https://www.onei.gob.cu/sites/default/files/publicaciones/2023-04/aec-2021-edicion-2022_compressed.pdf

Ruiz, F.H., Villalpando, R. L., Murillo, B., Beltrán, F. A., & Hernández, L. G. (2014). Respuesta diferencial a la salinidad de genotipos de tomate (*Lycopersicon esculentum* Mill.) en primeras etapas fenológicas. *Terra Latinoam*, *32*(4), 311-323. https://www.scielo.org.mx/pdf/tl/v32n4/2395-8030-tl-32-04-00311.pdf

Ruiz Sánchez, M., Muñoz Hernández, Y., Guzmán, D., Velázquez Rodríguez, R., Díaz López G.S., Martinez, A.Y., & Almaida, F.M. (2018). Efecto del calibre semilla (masa) en la germinación del sorgo. *Cultivos Tropicales*, *39*(4), 51-59. http://scielo.sld.cu/pdf/ctr/v39n4/ctr07418.pdf

Saddiq, M.S., Afzal, I., Basra, S., Iqbal, S., & Ashraf, M. (2020). Sodium exclusion affects seed yield and physiological traits of wheat genotypes grown under salt stress. *J. Soil Sci. Plant Nutr.*, *20*, 1442–1456. https://www.doi.org/10.1007/s42729-020-00224-y

Vieira Ferraz, M., Facincani Franco, C., Sales Batista, G., & Fernandes Lopes Pivettta, K. (2016). Salinity on the germination of seed and index of germination speed of three ornamental species. *Ornamental Horticulture*. *22*(2), 196-201. https://www.doi.org/10.14295/oh.v22i2.919

Vila Pérez, O. L., & Moya Padilla, N.E. (2021). Las políticas públicas: una nueva mirada del envejecimiento poblacional en las condiciones actuales de Cuba. *Revista Universidad y Sociedad*, *13*(3), 512-524. http://scielo.sld.cu/pdf/rus/v13n3/2218-3620-rus-13-03-512.pdf