v. 4, n. 6, 2024

International Journal of Biological and Natural Sciences

Acceptance date: 16/10/2024

EVALUATION OF HALOPHILIC BACTERIA IN THE MITIGATION OF SALINITY IN RASPBERRY (RUBUS IDAEUS) SOILS IN JOCOTEPEC, JAL

F. Ramirez Ramirez
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

A. Chávez Rodríguez
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

M.J. Ramírez Ramírez
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

L.A. Gama Moreno
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

J.A. Peralta Nava
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

F. Bejarano Rebolledo
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

O. Amador Camacho
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

D. Hernández Monreal
Tecnológico Nacional de México Campus Tlajomulco, Jal., Statistics Laboratory, Pilot Plant, Tlajomulco de Zúñiga, Jal

Ernesto Tapia Campos
Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco, A.C. (CIATEJ), Guadalajara, Jalisco, Mexico

Abstract: In the municipality of Jocotepec, known for its protected agriculture focused on the main crop of raspberry, the intensive application of chemical fertilizers is causing an increase in soil salinity, thus limiting the maximum development potential of the crop. In order to investigate the potential benefits of halophilic bacteria in decreasing salinity and their biostimulant effect on the vegetative development of raspberry (*Rubus idaeus* L). The present investigation was established in a production unit located in the municipality of Jocotepec, Jal, where the evaluation of the effect of halophilic bacteria was carried out at a dose of 6 L^1 plus a control without application, 4 applications were made in the irrigation saturating the furrow, with intervals of 7 days. The variables evaluated were: soil response time, pH, EC, salinity, temperature; plant chlorophyll measurement using a portable non-destructive measuring device (SPAD) at fruit filling; harvest number of boxes, average fruit per clamshell, Brix degrees of the fruit and yield/week. The results showed that the halophilic bacteria induced a positive response in the variables associated with the soil, such as pH, EC, salinity and temperature. The evaluated dose of 6 L/Ha proved to be statistically the best treatment.
Keywords: Halophytes, biostimulation, salinization, pH, salinity, electrical conductivity.

INTRODUCTION

Salinization is the main problem negatively affecting agricultural areas worldwide. Land affected by salinity comprises more than 6% of the world's total area (Bui 2013; Rengsamy 2002). In Mexico, mild sodium affectation was 3.43 million ha, representing one third (34.9%) of irrigated agriculture. The slight affectation by salinity was in 2.43 million ha, both affectations add up to 60% of the irrigated agricultural area (SADER 2022). Plant growth is generally reduced by an increase

in soluble ion concentrations in the soil, and photosynthesis and transpiration rate are reduced. High salt concentration also affects nutrient availability and plant metabolic pathways and ultimately has negative effects on plant growth. It also reduces soil aeration and permeability (Flowers and Colmer 2015). In the municipality of Jocotepec Raspberry is the main crop and being a municipality dedicated to protected agriculture, chemical fertilization is causing soil salinization which results in the crop not being able to develop to its full potential. Extremophilic PGPR have unique proteins and enzymes that allow them to survive in adverse conditions and promote plant growth (Flowers and Colmer 2015).

MATERIALS AND METHODS

The experiment was carried out in a production unit of Rancho Hnos. Ramirez, located in the municipality of Jocotepec, Jalisco, at an altitude of 1578 meters above sea level, at the geographical coordinates 20.16449N and 103.26859W. The hybrid cultivar of raspberry (*Rubus idaeus* L.) variety Kwanza was used. For which the research was divided into two phases: in phase 1 the doses of bacteria were determined through a biological effectiveness test evaluating 4 treatments in a randomized block design; in Phase 2, once the dose was obtained, the evaluation of the effect of halophilic bacteria was carried out at a dose of 6 L^1 plus a control without application, 4 applications were made in the irrigation saturating the furrow, with intervals of 7 days, the above to obtain and process the data in the SC. The variables evaluated were: soil response time, pH, EC, salinity, temperature; plant chlorophyll measurement using a SPAD during fruit filling; harvest number of boxes, average number of fruits per clamshell, Brix degrees of the fruit and yield/week. A factorial ANOVA test in completely randomized associated with the Tukey mean comparison test ($p<0.05$) was used to determine the effect on soil condition, as well as the biostimulant effect on vegetative development.

RESULTS AND DISCUSSION

Salt stress is an abiotic factor affecting raspberry (*Rubus idaeus* L.) cultivation worldwide, as it disrupts nutrient uptake, hinders plant growth, affects soil physicochemical properties and decreases crop yield.

The variables evaluated showed a positive effect and significant statistical differences among the treatments evaluated, showing a direct effect of halophilic bacteria on the variables of interest (Table 1).

Salt-tolerant PGPRs have the potential to stimulate plant growth and productivity by increasing plant nutrient availability, phytohormone and nitrogen production. These bacteria also produce disease resistance in plants against bacterial, fungal or protist pathogens (Podell et al. 2013). In relation to agronomic variables, improvements were evidenced in the characteristics evaluated compared to the control (Table 2).

VARIABLE	Halophilic Bacteria 6Lt/Ha	No Halophilic Bacteria
pH	6.71**	5.23
CE	1.12**	1.64
SAL	0.60**	1.19
TEMP	23.78**	22.77
CLOR	31.12**	29.48
GBRI	10.19*	9.57*
NCC	62.42**	57.19
RKG	124.86**	114.38

Comparison of means of the physicochemical variables.

Source: SAS® Studio 2023

	G.L.	pH	CE	SAL	TEMP	CLOR	GBRI	NCC	RKG
Model	5	4.208**	1.439 **	0.855 **	2.374**	20.353**	0.865**	811.523**	43246.05 **
Error	24	0.1224	0.1228	0.0463	0.0485	4.4255	0.094	42.912	171.650

Mean squares and their statistical significance in the analysis of variance of the physicochemical variables.

Source: SAS® Studio 2023

pH - pH value in soil	SAL - Salinity	CHLOR - Chlorophyll value in leaf at fruit fill	GBRU.- Brix degrees in fruit at harvest
EC - Electrical conductivity in soil	TEMP - Temperature in soil	NCC - Number of harvested boxes	RKG - Yield in kilograms

Soil and water salinity is quantified through electrical conductivity (EC), measured in deciSiemens per meter (dS/m) (Talat, 2020). As such, EC acts as an accurate indicator of soil salt content; a reduction in EC values suggests a decrease in NaCl concentration. An increase in EC is associated with negative effects on the structural stability, bulk density and permeability of the soil (Tejada and González, 2006).

CONCLUSIONS

Based on the results presented, it is concluded that halophilic bacteria induced a positive response in the variables associated with the soil, such as pH, EC, salinity and temperature.

The evaluated dose of 6 L/Ha showed to be statistically the best treatment, since it induced a better response in the determination of chlorophyll in fruit filling, number of boxes, Brix degrees of the fruit, yield/week/treatment. Halophilic bacteria at the dose evaluated in the present study did not cause phytotoxic effects on raspberry plants, qualifying as 1 (No effect on the crop) according to the EWRS scale.

REFERENCES

Bui EN (2013) Soil salinity: a neglected factor in plant ecology and biogeography. J Arid Environ 92:14–25

Flowers TJ, Colmer TD (2015) Plant salt tolerance: adaptations in halophytes. Ann Bot 115:327–331

Hesham AE-L, Kaur T, Devi R, Kour D, Prasad S, Yadav N et al (2021) Current trends in microbial biotechnology for agricultural sustainability: conclusion and future challenges. In: Yadav AN, Singh J, Singh C, Yadav N (eds) Current trends in microbial biotechnology for sustainable agriculture. Springer, Singapore, pp 555–572. https://doi.org/10.1007/978-981-15-6949-4_22

Mapa Agrícola de afectación por salinidad en México. (2022). Recuperado 31 de diciembre de 2022, de https://www.gob.mx/agricultura/acciones-y-programas/mapa-agricola-de-afectacion-por-salinidad-en-mexico website: https://www.gob.mx/agricultura/acciones-y-programas/mapa-agricola-de-afectacion-por-salinidad-en-mexico

Podell S, Ugalde JA, Narasingarao P, Banfield JF et al (2013) Assembly-driven community genomics of a hypersaline microbial ecosystem. PLoS ONE 8:

Rengsamy P (2002) Transient salinity and subsoil constraints to dryland farming in Australian sodic soils: an overview. Aust J Exp Agric 42:351–361

Talat, N. (2020). Alleviation of soil salinization and the management of saline soils, climate change, and soil interactions. In Climate Change and Soil Interactions (pp. 305-329). Elsevier.

Tejada, M., y Gonzalez, J. L. (2006). The relationships between erodibility and erosion in a soil treated with two organic amendments. Soil and Tillage Research, 91(1-2), 186-198.