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The use of bacterial consortia improves seed tuber production in potato varieties for frying

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INTRODUCTION & AIM

Potato (*Solanum tuberosum* L.) is among the main crops in Latin America and due to environmental and regulatory aspects, the use of potential biocontrol agents is considered the safest way for potato management in greenhouse and field conditions (Vilvert et al. 2022). Over the last few years, research in agricultural microbiology has increased, due to the efficacy of rhizobacteria as plant growth promoters (PGPR) to induce seedling emergence, promote plant height increase, as well as crop yield (Ogata et al. 2016).

Azotobacter sp. is a rhizobacterium that is used as an inoculant in agricultural production worldwide, because it provides up to 50% of the plant's nitrogen needs through associative fixation of atmospheric nitrogen, in addition to producing substances that stimulate plant development (Leon et al. 2012); it is also capable of combating pathogens through antagonism mechanisms (Jiménez et al. 2011).

Under greenhouse conditions, inoculation of strain *Bacillus* sp. PM31 improved the growth of potato plants under the fungal stress of *Fusarium solani*, while reducing the development of wilt, foot rot, chlorosis, and necrosis of potato plants inoculated with this pathogen (Mehmood et al. 2023).

In experiments *in vitro* and in pots under greenhouse conditions Mehmood et al. (2021) showed the efficacy of *B. subtilis* PM32 as a promising biocontrol agent for *Rhizoctonia solani* infection, together with increased growth of potato plants, by higher biomass accumulation and chlorophyll a, b and carotenoid contents, indicating that *B. subtilis* may serve to induce tolerance to biotic and abiotic stresses.

The objective of the research was to determine the effect of growth-promoting rhizobacterial consortia on potato varieties for frying under controlled conditions.

METHOD

The experiment was carried out in a greenhouse at Universidad Nacional José Faustino Sánchez Carrión Huacho (Lima,Peru), coordinates 10°11'12"S and 75°12'12"W. Bacterial consortia or strains used for inoculation in potato genotypes were: *Azotobacter* sp., *Azotobacter* sp. + *B.simplex, Azotobacter* sp. + *B.subtilis, Azotobacter* sp. + *B.simplex* + *B.subtilis* and a control without inoculation. A commercial cultivar ("Bicentenaria") and three advanced clones (CIP 396311.1, CIP 399101.1 and UH-09) were used for evaluating vegetative vigor, plant height (cm), number of stems per plant, number of leaves per plant, fresh and dry weight of foliage per plant (g), tuber diameter (cm), number and weight of tubers per plant (g). A 5x4 factorial arrangement in a completely randomized design with six replications was used to evaluate the interaction of potato genotypes and inoculant treatments. The evaluations for each variable were statistically analyzed using a 95% confidence level. The results obtained were subjected to ANOVA and the Scott-Knott (SK) statistical test. Likewise, multivariate analysis was performed to determine the association between the variables under study, using Principal Component Analysis (PCA).

Procedures

All bacterial strains (Table 2) used in the research were isolated by the Laboratorio de Biotecnologia de la Produccion (Huacho, Peru). The inoculation of the strains was performed on the seed tubers according to Arcos & Zúñiga (2016) for which, 100 mL of each of the strains under study at the concentration of 1 x 10^8 CFU mL^{-1} were dissolved in 1.0 L of filtered water. Potato seed tubers of each variety were dipped in this suspension for 10 min and then left to aerate; seed tubers of control plants were dipped in filtered water. The tubers were then sown in pots corresponding to each inoculation treatment. After sowing, the seed tubers were sprayed with the remaining suspension and some substrate was placed on the seed tubers to cover them. Forty-five days after sowing, when the plants were approximately 20 cm high, the rhizobacteria strains were reinoculated with the same concentration for each strain. After reinoculation, the plant collar was covered with a layer of substrate.

Crop management under greenhouse conditions

The pots were arranged on tables inside the net house and received 250 mL irrigation every two days with running water. Nitrogen, phosphorus and potassium fertilizers were applied at the following levels per pot: urea 4.0 g fractionally at three times (at sowing, then at 15 and 30 days after sowing); diammonium phosphate 9.6 g and potassium sulfate 6 g per pot, both at sowing. At 60 days, the substrate was added to the pots to complete 4.5 L of volume per pot.

Variables studied

The variables studied were vegetative vigor, plant height (cm), number of stems per plant, number of leaves per plant, fresh and dry weight of foliage per plant (g), tuber diameter (cm), number and weight of tubers per plant (g); in the latter case, the data were transformed to Ln. For plant vegetative vigor, the phenotypic scale from 1 (poor) to 9 (very good) was used according to the methodology of Bonierbale et al. (2010).

Arcos, J., & Zúñiga, D. (2016). Rizobacterias promotoras de crecimiento de plantas con capacidad para mejorar la productividad en papa. *Revista Latinoamericana de la Papa, 20* (1), 18-31. doi:10.37066/ralap. v20i1.241

Bonierbale, M. W., Haan, S. D., Forbes, A., & Bastos, C. (2010). Procedimientos para pruebas de evaluación estándar de clones avanzados de papa: Guia para cooperadores internacionales. Centro internacional de la Papa. Lima.

León, Y., Martínez, R., Hernández, J. & Rodríguez, N. (2012). Aplicación *de Azotobacter chroococcum* en la producción de plántulas de tabaco negro. *Cultivos tropicales*, 33(3), 29-32.

Mehmood, S., Khatoon, Z., Amna, Ahmad, I., Muneer, M. A.,.. & Munis, M. F. H. (2023). Bacillus sp. PM31 harbouring various plant growth-promoting activities regulates Fusarium dry rot and wilt tolerance in potato. *Archives of Agronomy and Soil Science*, 69(2), 197-211. https://doi.org/10.1080/03650340.2021.1971654

Ogata, K., Alvarado, D., Chumpitaz, C. & Zúñiga, D. (2016). Characterization of plant growth-promoting rhizobacteria isolated from the rhizosphere of Peruvian highlands native crops. *International Journal of Plant & Soil Science*, 11(1), 1-8. doi:10.9734/IJPSS/2016/24573

Vilvert, E., Stridh, L., Andersson, B., Olson, Å., Aldén, L., & Berlin, A. (2022). Evidence based disease control methods in potato production: a systematic map protocol. *Environmental Evidence,* 11(1), 1-8. https://doi.org/10.1186/s13750-022-00259-x

RESULTS & DISCUSSION

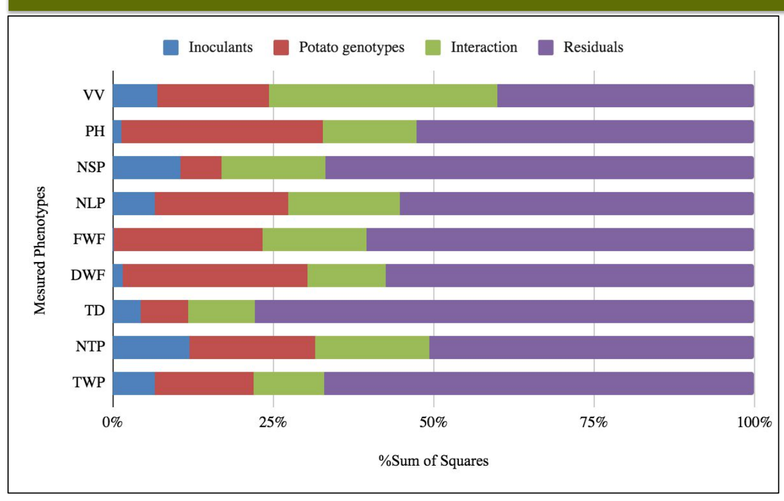

Figure 1 Proportion of sum of squares for potato agronomic traits under interaction with bacterial inoculants (PGPR). VV vegetative vigor, PH plant height, NSP number of stems per plant, NLP number of leaves per plant, FWP fresh weight of foliage per plant, DWP dry weight of foliage per plant, TD tuber diameter, NTP number of tubers per plant, TWP tuber weight per plant.

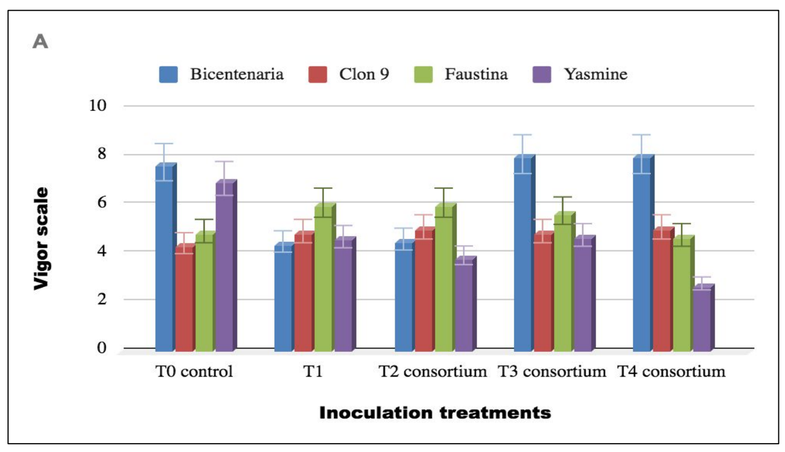

Figure 2A Interaction effect for variety and inoculation treatments for vegetative vigor.

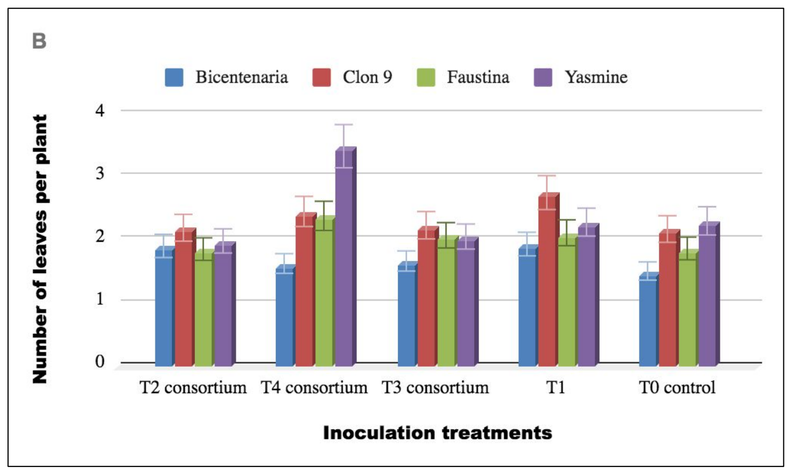

Figure 2B Interaction effect for variety and inoculation treatments for number of leaves per plant

T0 control: no inoculation,
T1: *Azotobacter* sp.,
T2 consortium: *Azotobacter* + *Bacillus simplex*,
T3 consortium*: Azotobacter sp.* + *B. subtilis,*
T4 consortium*: Azotobacter sp.* + *B. subtilis* + *B. simplex* .

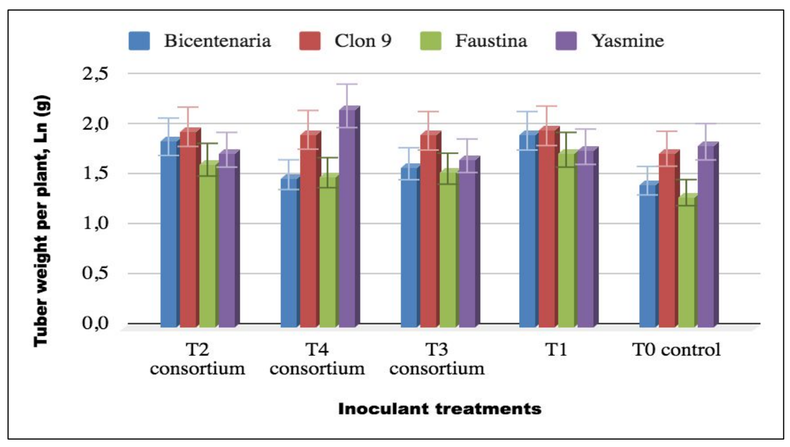

Figure 2C Interaction effect for variety and inoculation treatments: tuber weight per plant

CONCLUSION

Inoculation of seed tubers with *Azotobacter* sp. or the *Azotobacter* sp.+ *B. simplex*+ *B. subtilis* consortium under greenhouse conditions significantly promoted potato growth with respect to number of stems and number of leaves per plant, as well as weight and number of tubers per plant. For plant height, number of shoots, foliage weight and tuber diameter, there were no significant differences due to the effect of the inoculation. A significant interaction was found between potato genotypes and inoculant treatments for vegetative vigor, the number of leaves and number of tubers per plant, being positive for the inoculation with some bacterial consortia, which was corroborated by principal component analysis.

FUTURE WORK / REFERENCES

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