Theme 3
Impacts of soil nutrient management on the environment and climate change

SUITABILITY OF PLANT GROWTH-PROMOTING BACTERIA TO DECREASE NITROUS OXIDE EMISSIONS: A CASE STUDY IN SUGARCANE

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INTRODUCTION

Sugarcane (*Saccharum spp.*) requires a high amount of synthetic nitrogen (N), generating concern because it is partially lost to the environment as nitrous oxide (N_2O), a powerful greenhouse gas. It could be mitigated by enhancing the nitrogen use efficiency (NUE) by using plant growth-promoting bacteria (PGPB). Bacteria could increase sugarcane biomass per unit of available N, allowing a replacement or reduction of synthetic N.

This study aims to determine the effect of PGPB on the growth, yield, and N_2O emissions compared to traditional N-fertilization in sugarcane.

MATERIALS AND METHODS

A greenhouse experiment was performed in a soil with a microbial activity 18 to 36% lower than the soil outside the greenhouse (FDA method), in the INTA experimental station of Salta, Argentina. Treatments were: *Gluconacetobacter diazotroficus* strain PAL5 (PAL5); *Pseudomonas fluorescens* and *Azospirillum brasilense* strain AZ39 (P+AZ39), each one (PAL5 and P+AZ39) with (+T) and without trace elements; urea (U1); urea with urease inhibitor (U2), both (U1 and U2) incorporated with a dose of 110 kg N ha^{-1}; and a reference treatment without any application (Control). Inoculation was performed at planting by immersion of one-bud stalks in inoculant with a concentration of 10^8 CFU ml^{-1} (each bacteria) for 10 minutes. A re-inoculation was applied at the N-fertilization moment (59 days after planting; dap) by located irrigation.

We evaluated the effects of these treatments on:

Daily plant population (Count of total sprouts up to 55 dap)

Coverage at 55 dap

$$\% Cov. = \frac{Green\ area}{Total\ area} * 100$$

Nitrous oxide emissions

Gas sampling: 1 day before and 3, 6, 10, and 28 days after N-fertilization

Static chamber method

RESULTS

In general, inoculation with PGPB increased plant population (p= 0.004) and sprouting rate (p= 0.009) with an interactive effect of trace elements (Fig. 1).

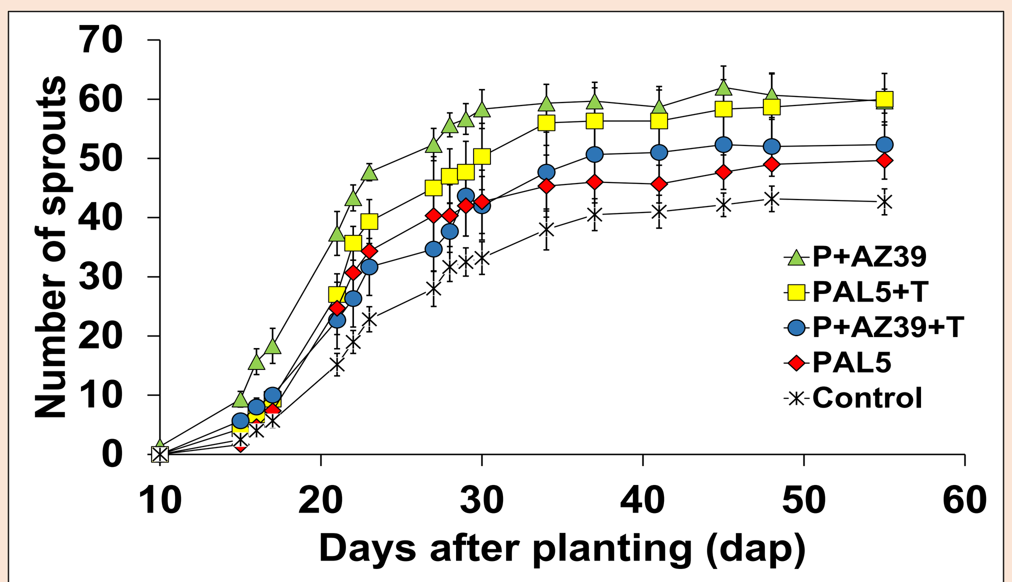

Figure 1. Dynamic of total sprouts through time for all treatments. Bars represent the standard errors.

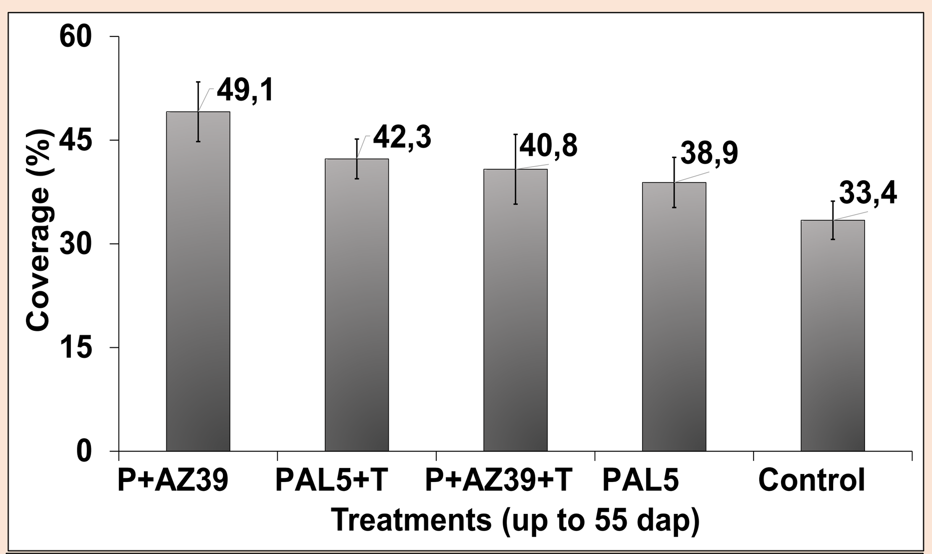

Figure 2. Percentages of coverage reached at 55 dap for all treatments. Bars represent the standard errors.

This resulted in differences in coverage among treatments (p= 0.007) (Fig. 2).

Overall, N_2O emissions were low and steady; they picked up 10 days after N fertilization for U1 and U2 treatments (Fig. 3). The mean of N_2O emissions (adjusting a mixed model) for 87 dap were 30.4 ± 3.9, 13.5 ± 9.8, and ≤ 4.5 µg N_2O-N m^{-2} h^{-1} for U2, U1, and the average of the rest of the treatments, respectively.

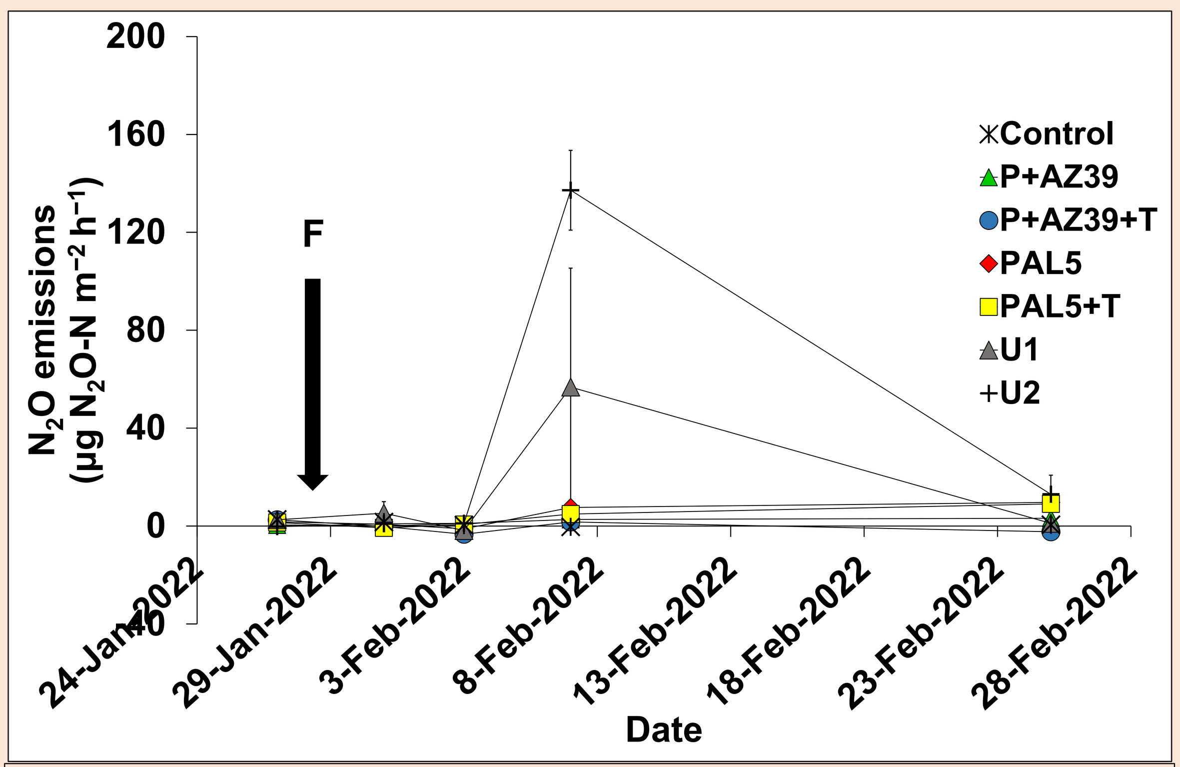

Figure 3. Dynamics of N_2O emissions for the N fertilization period around N-fertilization of sugarcane in experiment, Argentina. Arrow indicates N-fertilization (F). Bars represent the standard errors.

DISCUSSION

Although the roles of PAL5 and P+AZ39 [1,2] on N and phosphorus nutrition and plant growth are well recognized, this work is one of the few that studied its effect on N2O emissions [3]. However, additional treatments to explore the interaction between reduced rates of synthetic N fertilizer and PGPB will be required [3].

Our results suggest that the enhanced initial growth promoted by PGPB without external N could mitigate N_2O emissions while maintaining crop yields. Measurements and analyses need to be continued to determine the impact of PGPB on yield components and cumulative N_2O emissions.

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