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# Effect of *Azospirillum brasilense* on yield components of maize

## Efeito do *Azospirillum brasilense* nos componentes da produção do milho

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**Abstract**

Among the countless operations involved in the maize production system, nitrogen fertilization is essential for the crop yield and development. However, due to the costs and negative environmental impacts caused by chemical fertilization, the use of the bacterium *Azospirillum brasilense* is an alternative to reduce costs and increase yield. Thus, this study evaluates the effect of inoculation of *Azospirillum brasilense* on the yield components of synthetic varieties of maize. The experiments were carried out at UNESP – Jaboticabal Campus, state of São Paulo, Brazil. The randomized block design was used with two replicates, testing forty-six maize genotypes: forty-four synthetic genotypes and two checks. Experiments were performed without nitrogen topdressing and with *Azospirillum brasilense* inoculation and, with nitrogen topdressing and without *Azospirillum brasilense* inoculation. Grain yield, average weight of grains, prolificacy, ear length, ear diameter, number of rows and number of grains per row were evaluated. The analysis of combined variance of experiments was performed considering the effects of genotypes, experiments, and the Genotype x Experiment interaction. Using the means from the analysis of variance, the Scott-Knott test was applied at 5% probability for the cases in which the F test was significant. It was found that bacterial inoculation increased yield, average weight of grains, ear diameter, and number of rows, while nitrogen fertilization increased prolificacy, ear length, and number of grains per row.

**Additional keywords:** biological N fixation; diazotrophic bacteria; nitrogen fertilization; *Zea mays*.

**Resumo**

Dentre as inúmeras operações envolvidas no sistema de produção do milho, a adubação nitrogenada é fundamental para desenvolvimento e produtividade da cultura. No entanto, devido aos custos e impactos ambientais negativos que a adubação química promove, a utilização da bactéria *Azospirillum brasilense* constitui alternativa para diminuir custos e elevar a produtividade. Assim, objetivou-se avaliar o efeito da inoculação da bactéria *Azospirillum brasilense* nos componentes de produção de variedades sintéticas de milho. Os experimentos foram realizados na UNESP – Campus Jaboticabal, SP. O delineamento utilizado foi o de blocos casualizados com duas repetições, utilizando 46 genótipos de milho, sendo 44 genótipos sintéticos e 2 testemunhas. Foram instalados dois experimentos, sendo o primeiro, sem a realização de adubação nitrogenada de cobertura e com inoculação com *Azospirillum brasilense* e o segundo com adubação nitrogenada de cobertura e sem aplicação de *Azospirillum brasilense*. Avaliou-se a produtividade, peso médio de grãos, prolificidade, comprimento de espiga, diâmetro de espiga, número de fileiras, número de grãos por fileira. Foi realizada a análise de variância conjunta dos experimentos, considerando os efeitos de genótipos, experimentos e a interação GenxExp. Utilizando-se as médias obtidas das análises de variância, para os casos onde houve significância do teste F, foi aplicado o teste de médias de Scott-Knott a 5% de probabilidade. Verificou-se que a inoculação da bactéria proporcionou aumento na produtividade, peso médio de grãos, diâmetro de espiga e número de fileiras, enquanto a adubação nitrogenada promoveu melhoria na prolificidade, comprimento de espiga e número de grão por fileira.

**Palavras-chave adicionais:** adubação nitrogenada; bactérias diazotróficas; fixação biológica de N*; Zea mays.*

## Introduction

Maize is one of the main crops produced in Brazil accounting for approximately 30% of the cultivated area in the country, which is only surpassed by soybeans in cultivated area. The national production of the 2018/19 season totaled 99,984.1 thousand tons referring to the first and second crop seasons, which represents an increase of 23.9% in relation to the previous crop season and becoming the second largest crop season in history (CONAB, 2019).

The maize cultivation requires large amounts of nitrogen fertilizers to obtain high yields. Nitrogen (N) is essential for the growth and development of plants, being the nutrient with the most expressive results to increase grain yield (Costa et al., 2015). However, nitrogen fertilizers are obtained from non-renewable sources, besides being one of the most expensive fertilizers in crop production. If used in excess, they may leach, contaminating groundwater and causing environmental problems (Cantarella, 2007). Thus, alternatives are needed to reduce nitrogen fertilization in crops.

Among the least impacting ways of production is the biological nitrogen fixation (BNF) with diazotrophic bacteria like *Azospirillum brasilense*. They are capable of fixing nitrogen mutually with the maize plant, increasing yields with decreased use of nitrogen fertilizer in crops, contributing to reduce production costs and to develop less impacting and less polluting agricultural practices (Milléo & Cristófoli, 2016).

Bacteria of the *Azospirillum* genus have the potential to stimulate plant development by multiple mechanisms, including the synthesis of phytohormones, improvement of nitrogen nutrition, stress mitigation, and biological control of the pathogenic microbiota (Bashan & De-Bashan, 2010).

Hungria (2011) reported several studies using *Azospirillum* spp. That promoted effects on maize plants such as weight gain, increased nitrogen content in leaves, seeds and flowers, early silking, increased number of ears, number of grains, plant height, leaf area, leaf area index, and germination rate.

Kotowski (2015) also reported increased yield in studies with the presence of *Azospirillum brasilense*, although it did not have the capacity to meet all the demand of available N for the maize plant, acting as a complement for better absorption of available N.

Thus, the search for understanding the effects of *Azospirillum brasilense* on the agronomic performance of maize genotypes is growing. Therefore, this study evaluates the effect of *Azospirillum brasilense* on the yield components of synthetic varieties of maize.

## Material and methods

The research was carried out in the 2018/2019 summer harvest at the Teaching, Research and Extension Farm of the School of Agricultural and Veterinary Sciences of UNESP - Universidade Estadual Paulista, Jaboticabal Campus, São Paulo State, Brazil (21°15’17’’ S latitude and 48°19’20’’ W longitude, altitude of 605 m). The climate corresponds to the Köppen climate classification category Aw, characterized as subtropical with rainy summers, relatively dry winter, and average annual temperature of 23 ºC. The soil is classified as Eutroferric Red Latosol.

Two experiments were installed in the same area and under the same conditions, namely: experiment A - without nitrogen topdressing and with *Azospirillum brasilense* inoculation; and experiment N - with nitrogen topdressing and without *Azospirillum brasilense* inoculation.

The experimental design was a randomized block with two replicates, using forty-six maize genotypes consisting of forty-four synthetic genotypes with broad and narrow genetic base from the company Phoenix Agricola Ltd. and two checks, a commercial variety ALBAND (TEST A) and a single-cross hybrid DKB390 (TEST B). The experimental plots consisted of four 4-m long rows, spaced at 0.45 m between rows and 0.30 m between plants. Only the two central rows of each plot were considered usable for evaluation.

The experiments were sown with manual planters on October 18, 2018 and, based on soil analysis and crop requirements, 350 kg ha$^{-1}$ of 8-28--16 were applied as base fertilizer.

Topdressing was performed on November 12, 2018 using urea as the N source, in the amount necessary to supply 140 kg ha$^{-1}$ nitrogen. The inoculation of genotypes was performed on November 13, 2018 with the commercial product QualyFix Gramínea® (mixture of Ab-V5 and Ab-V6 strains of *Azospirillum brasilense*) via soil at a dose of 600 mL ha$^{-1}$, according to the recommendations by the manufacturer. The plants were in the phenological stage V5.

In each experimental plot, the following characteristics were evaluated:

- Grain yield (GY): obtained by threshing the harvested ears and weighing the grains of each plot, correcting the moisture to 13% and converting the values to tons per hectare (t ha$^{-1}$);
- Ear length (EL): measured with a graduated ruler, using six ears per plot, expressed in cm;
- Ear diameter (ED): measured in the center of the ear with the aid of a digital caliper, using six ears per plot, expressed in mm;
- Number of rows per ear (NR): counting of the number of rows of grains per ear, using a sample of six ears per plot;

- Number of grains per ear row (NGR): counting of the number of grains in the ear row, using a sample of six ears per plot;
- Average weight of 500 grains (AW): weight of 500 grains of each plot, expressed in grams (g);
- Prolificity (PROL): obtained by the ratio of the number of ears harvested in the plot and the number of plants in the plot, carried out before harvest.

Initially, an analysis of variance was performed for each experiment to verify the homogeneity of the residual variance. Subsequently, as the ratio between the mean squares of the two experiments was within the appropriate range, analysis of combined variance was performed considering the effects of genotypes, experiments, and the genotype x experiment interaction. Using the means from analysis of variance, the Scott-Knott test was applied at 5% probability for the cases in which the F test was significant.

## Results and discussion

The genotype variation factor (GEN) showed significant differences at 1% through the F test for all parameters of the yield components. In the case of the environment variation factor (ENV), only the average grain weight (AW) was not significant, with the other components being significant at 1%. There was no genotype x experiment interaction (G*E) (Table 1).

**Table 1 -** Joint analysis of variance for the grain yield components.

| Sources of variation | FD | Mean square | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | GY | AW | PROL | EL | ED | NR | NGR |
| Genotype (G) | 45 | 1.40** | 520.45** | 0.06** | 3.70** | 21.03** | 6.95** | 32.46** |
| Experiment (E) | 1 | 2.99** | 34.86$^{ns}$ | 0.21** | 20.61** | 135.21** | 7.78** | 236.12** |
| G*E | 45 | 0.40$^{ns}$ | 143.79$^{ns}$ | 0.03$^{ns}$ | 0.83$^{ns}$ | 5.62$^{ns}$ | 0.83$^{ns}$ | 18.51$^{ns}$ |
| Error | 90 | 0.38 | 102.69 | 0.03 | 0.90 | 6.32 | 0.94 | 16.14 |
| Mean | - | 4.89 | 147.23 | 1.02 | 15.13 | 45.85 | 14.89 | 29.64 |
| CV (%) | - | 12.68 | 6.88 | 16.97 | 6.30 | 5.48 | 6.54 | 13.55 |

** Significant by F test ($p < 0.01$), $^{ns}$ Not significant by F test ($p > 0.05$), CV = Coefficient of variation. FD = Freedom degrees, GY = Grain yield; AW = Average weight; PROL = Prolificacy; EL = Ear length; ED = Ear diameter; NR = Number of rows; NGR = Number of grains per row.

A 5% increase in GY with the inoculation of *Azospirillum* was observed when compared with nitrogen application. In the evaluated genotypes, 65% had a better response when inoculated with the bacteria, and genotypes one and twenty stood out, demonstrating that the N fixation response may be related to the genotype used. The yield increase when inoculated with *Azospirillum* is probably due to the increase in ear diameter and number of rows per ear, which can be explained by the increased biological fixation that the bacterium offers to the plant, favoring the development of roots, growth, and structure in the plant, besides favoring the photosynthetic process, increasing yield. According to Bashan et al. (2004), these bacteria can fix $N_2$ for the plant and produce growth hormones, such as auxins and gibberellins, which stimulate plant growth, mainly of roots, by increasing the absorption of nutrients and water.

Cunha et al. (2014) proved that maize inoculated with the bacterium produced 5.5 more bags (0.33 t $ha^{-1}$) than without inoculation while evaluating the effect of inoculation of the bacterium *Azospirillum brasilense* on maize genotypes, stating the bacterium efficiency to increase the yield of this crop.

There was a 2% increase in AW with application of *Azospirillum* when compared to that of nitrogen. Of the evaluated genotypes, 54% showed better response with bacterial inoculation.

Inoculation with *Azospirillum* resulted in a 4% increase in ED when compared to chemical fertilization. Among genotypes, 74% performed better in the treatment with inoculation. Different results were obtained by Cunha et al. (2014), who did not observe significant differences in ear diameter (ED) of plants inoculated with *Azospirillum brasilense.*

The NR increased by 3% in the treatment with *Azospirillum* inoculation, and 65% of the genotypes performed better with bacterial inoculation. Genotypes fourteen and twenty performed better in the treatment with *Azospirillum brasilense.*

**Table 2 -** Averages values of grain yield components in maize. Jaboticabal-SP. Agricultural year 2018/2019.

| GEN | GY | | AW | | PROL | | EL | | ED | | NR | | NGR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N |
| 1 | 5.66* | 4.39 | 140.95b | 129.35b | 0.96a | 1.03a | 15.80ª | 16.15a | 49.91a | 45.26a | 16.40a | 16.50a | 29.40a | 32.60a |
| 2 | 5.77a | 5.61a | 143.50b | 143.30b | 0.86a | 1.09a | 13.90 | 15.85* | 48.80a | 48.11a | 15.80a | 14.60b | 28.70a | 31.50a |
| 3 | 4.12b | 4.92b | 125.95b | 135.95b | 1.04a | 0.93a | 14.80ª | 15.40a | 44.05b | 40.43b | 14.20b | 14.60b | 32.40a | 29.90a |
| 4 | 4.66b | 4.77b | 144.00b | 131.45b | 0.96a | 0.89a | 14.25b | 15.00b | 42.48b | 40.07b | 12.75b | 13.37b | 26.00a | 33.25a |
| 5 | 4.67b | 4.56b | 146.40b | 145.85b | 0.93a | 0.89a | 15.47ª | 15.55a | 45.23b | 42.26b | 14.90b | 14.80b | 30.55a | 30.60a |
| 6 | 6.15a | 5.28a | 161.75a | 145.25b | 0.99a | 1.22a | 13.80b | 13.60b | 48.98a | 45.64a | 15.50a | 16.40a | 27.80a | 24.80a |
| 7 | 4.66b | 4.81b | 165.20a | 169.45a | 0.99a | 1.09a | 15.65ª | 16.30a | 43.32b | 42.94b | 13.70b | 12.40b | 26.90a | 30.70a |
| 8 | 4.11b | 4.63b | 138.30b | 143.45b | 0.80a | 1.01a | 13.85 | 15.85* | 45.59b | 47.75a | 14.20b | 15.20a | 23.00a | 33.00* |
| 9 | 3.91b | 3.83b | 161.55a | 141.05b | 1.11a | 1.52* | 11.35 | 13.60* | 44.80b | 44.84a | 13.10b | 12.40b | 20.90a | 26.40a |
| 10 | 4.63b | 5.52a | 142.85b | 139.15b | 1.08a | 1.00a | 15.55ª | 16.65a | 48.61a | 47.10a | 16.60a | 15.30a | 29.00a | 28.60a |
| 11 | 5.15b | 5.11a | 148.50b | 131.35b | 0.94a | 1.00a | 15.80ª | 15.60a | 46.57b | 46.23a | 15.60a | 16.20a | 28.60a | 28.70a |
| 12 | 6.14a | 5.46a | 154.60a | 160.75a | 0.99a | 1.18a | 16.45ª | 18.00a | 49.33a | 50.88a | 16.30a | 17.80a | 32.00a | 34.00a |
| 13 | 5.86a | 5.70a | 137.10b | 139.00b | 1.09a | 0.91a | 16.05ª | 16.10a | 47.86* | 41.3 | 16.30a | 16.60a | 30.00a | 33.20a |
| 14 | 5.61a | 5.85a | 126.80b | 144.25b | 1.05a | 0.87a | 16.35ª | 16.75a | 46.19b | 47.67a | 18.20* | 16.00 | 30.80a | 31.00a |
| 15 | 4.95b | 5.71a | 136.95 | 158.15* | 0.80a | 0.84a | 14.37b | 15.05b | 46.92a | 47.96a | 17.00a | 16.80a | 27.90a | 31.60a |
| 16 | 4.35b | 4.93b | 130.65b | 150.10a | 1.36a | 1.24a | 14.15b | 14.30b | 46.76a | 46.88a | 15.20a | 13.90b | 25.80a | 32.50a |
| 17 | 4.20b | 3.98b | 157.40* | 122.45 | 1.17a | 1.10a | 14.80ª | 15.01b | 44.91* | 39.53 | 14.30b | 13.05b | 25.80a | 28.12a |
| 18 | 4.67b | 3.55b | 158.95a | 152.65a | 0.55a | 1.03* | 14.70ª | 14.16b | 43.81b | 42.07b | 14.20b | 12.27b | 26.50a | 25.97a |
| 19 | 4.72b | 4.91b | 164.05a | 162.05a | 0.82a | 1.10a | 13.20 | 15.40* | 46.60b | 46.06a | 14.20b | 14.80b | 24.30a | 27.60a |
| 20 | 6.82* | 5.26 | 147.55b | 146.30b | 1.03a | 1.05a | 14.55b | 14.45b | 49.56a | 45.54a | 15.80* | 13.40 | 28.80a | 29.50a |
| 21 | 4.20b | 3.82b | 147.95b | 153.80a | 0.89a | 0.90a | 13.30b | 14.80b | 45.46b | 46.31a | 13.40b | 13.60b | 26.80a | 32.40a |
| 22 | 3.98b | 4.56b | 145.35b | 133.95b | 1.08a | 0.93a | 13.20b | 14.15b | 45.85b | 42.20b | 13.80b | 13.20b | 28.70a | 29.20a |
| 23 | 5.39a | 4.41b | 146.55b | 141.20b | 0.95a | 1.06a | 14.40b | 14.45b | 48.56a | 45.27a | 15.20a | 13.30b | 30.80a | 29.20a |
| 24 | 5.01b | 4.61b | 131.10b | 134.85b | 1.23a | 1.28a | 14.05b | 15.30a | 48.94* | 43.95 | 16.70a | 15.80a | 25.90a | 35.30* |
| 25 | 5.79a | 4.84b | 154.00a | 138.05b | 0.87a | 1.15a | 16.00a | 14.25b | 48.54a | 45.51a | 15.20a | 14.60b | 32.50a | 28.50a |

**Table 2** – Cont....

| GEN | GY | | AW | | PROL | | EL | | ED | | NR | | NGR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N | AZOS | N |
| 26 | 5.13b | 4.26b | 139.15b | 127.85b | 0.92a | 0.99a | 12.75 | 15.45* | 48.04a | 43.40b | 15.80a | 15.70a | 30.60a | 30.00a |
| 27 | 5.28a | 4.86b | 129.95b | 133.30b | 0.83a | 0.92a | 14.05b | 14.60b | 47.54a | 45.97a | 15.60a | 15.30a | 30.20a | 33.90a |
| 28 | 4.33b | 5.15a | 149.45a | 137.20b | 1.24a | 1.28a | 13.85b | 15.55a | 47.24a | 49.47a | 15.50a | 16.80a | 26.20a | 32.40a |
| 29 | 4.32b | 4.09b | 142.15b | 147.55b | 0.77a | 1.03a | 15.15ª | 15.65a | 45.61b | 42.62b | 15.30a | 14.20b | 28.70a | 30.80a |
| 30 | 5.07b | 4.38b | 133.40b | 132.10b | 0.96a | 1.25a | 17.25ª | 16.60a | 45.74b | 42.10b | 14.70b | 13.80b | 30.10a | 37.10a |
| 31 | 5.06b | 4.56b | 154.70a | 148.60a | 1.07a | 1.13a | 15.55ª | 15.92a | 46.05b | 43.81b | 13.60b | 13.55b | 30.70a | 29.55a |
| 32 | 5.44a | 4.74b | 132.05b | 134.20b | 1.05a | 1.05a | 15.07ª | 15.15b | 47.15a | 43.43b | 16.00a | 15.60a | 37.20a | 35.30a |
| 33 | 5.95a | 5.08a | 154.35a | 147.15b | 0.93a | 0.86a | 16.20ª | 16.20a | 50.42a | 48.00a | 15.50a | 14.70b | 31.10a | 29.50a |
| 34 | 4.65b | 5.05a | 133.80b | 150.20a | 1.07a | 0.90a | 13.00b | 14.15b | 47.61a | 47.46a | 16.60a | 15.60a | 25.50a | 28.20a |
| 35 | 5.65a | 4.89b | 154.80a | 158.00a | 0.95a | 1.02a | 15.00a | 13.90b | 50.00a | 45.77a | 15.80a | 16.10a | 27.90a | 33.70a |
| 36 | 5.04b | 3.92b | 165.20a | 152.25a | 0.86a | 1.02a | 14.40b | 15.65a | 42.09b | 44.29b | 13.50b | 13.60b | 24.80a | 30.90a |
| 37 | 4.89b | 4.20b | 150.10a | 166.50a | 0.97a | 1.14a | 14.80ª | 15.80a | 44.94b | 42.27b | 14.80b | 13.80b | 24.90a | 28.70a |
| 38 | 4.80b | 3.95b | 177.40a | 166.15a | 0.89a | 1.30* | 15.30ª | 14.70b | 45.26b | 41.81b | 12.80b | 11.90b | 24.60a | 29.90a |
| 39 | 4.31b | 4.46b | 147.50b | 161.00a | 1.18a | 1.08a | 14.70 | 16.60* | 41.58b | 43.72b | 13.80b | 14.00b | 27.20a | 32.40a |
| 40 | 5.20b | 4.26b | 154.20a | 153.05a | 1.00a | 1.12a | 15.00a | 16.40a | 42.71b | 43.95b | 14.30b | 13.60b | 27.50a | 31.20a |
| 41 | 4.37b | 3.89b | 156.20a | 151.95a | 0.97a | 0.97a | 14.80ª | 15.60a | 44.72b | 43.41b | 14.50b | 14.40b | 25.20a | 30.40a |
| 42 | 5.12b | 4.20b | 135.80 | 157.25* | 1.09a | 0.87a | 15.60ª | 16.25a | 48.62a | 46.86a | 15.40a | 14.98a | 28.81a | 29.86a |
| 43 | 5.05b | 4.84b | 120.55b | 135.10b | 0.94a | 0.90a | 14.75ª | 15.30a | 49.58a | 45.64a | 17.60a | 16.70a | 30.50a | 30.20a |
| Check A | 5.33a | 6.02a | 178.60a | 172.80a | 1.37a | 1.36a | 16.25ª | 17.25a | 48.63a | 48.79a | 14.20b | 14.80b | 29.07a | 32.30a |
| Check B | 6.41a | 6.78a | 160.30a | 162.20a | 0.99a | 1.13a | 16.15ª | 16.40a | 53.51a | 49.39a | 18.00a | 16.50a | 29.10a | 31.70a |
| 46 | 4.44b | 4.66b | 165.15a | 165.15a | 0.92a | 1.02a | 15.25ª | 16.60a | 44.01b | 45.88a | 12.60b | 13.00b | 26.70a | 29.50a |
| Mean | 5.02 | 4.77 | 150.06 | 146.79 | 0.99 | 1.06 | 14.80 | 15.47 | 46.71 | 45.00 | 15.1 | 14.68 | 28.13 | 30.78 |

GEN = Genotype; AZOS = *Azospirillum*; N = Nitrogen. Means values followed by the same lowercase letter in the column do not differ significantly from each other, using the Scott-Knott test ($p > 0.05$); * significant difference between the experiments by the Scott-Knott test ($p < 0.05$); GY = Grain yield; AW = Mean grain weight; PROL = prolificacy; EL = Ear length; ED = ear diameter; NR = Number of rows; NGR = Number of grains per row.

Nitrogen fertilization increased the EL by 4%, and 83% of the genotypes performed better with nitrogen. The genotypes that stood out were two, eight, nine, nineteen, twenty-six, and thirty-nine. Different results were obtained by Cavalleti et al. (2000), who observed an increase of 17% in the mean length of the ears, from 13.6 to 14.4 cm, with the inoculation of *Azospirillum*. However, these authors did not observe the effect of inoculation on the number of rows per ear.

The results of PROL and NGR increased in the treatment with nitrogen, 7% and 9%, respectively. Of the genotypes used, 67% performed better using chemical fertilization when evaluating PROL and 78% of the genotypes had better responses regarding NGR in the treatment with nitrogen. Cadore et al. (2016) observed that inoculation did not increase the variables analyzed, such as ear length, grains per row, and grain yield while studying the effect of inoculation with *Azospirillum brasilense* on hybrid maize under different nitrogen doses. According to Leben et al. (1987), the inconsistency of positive results is frequent with rhizobacteria that promote plant growth, especially in field conditions. According to Antoun et al. (1998), the possible causes include the complexity of the interactions involved between plants, the bacteria introduced, and other components of the rhizospheric microbiota, among other factors.

The inoculation of the bacteria Azospirillum brasilense resulted in increased yield (YIELD), average grain weight (AW), ear diameter (ED), and number of rows (NR), while prolificacy (PROL), ear length (EL), and the number of grains per row (NGR) had better responses with nitrogen application.

## Conclusions

It is possible to replace the chemical application of nitrogen in topdressing by bacterial inoculation of *Azospirillum brasilense* in synthetic varieties of maize.

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