Effect of different Plant Growth Promoting Rhizobacteria (PGPR) on maize seed germination and seedling development

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Introduction

PGPR is a group of bacteria that actively colonize plant roots and increase plant growth and yield. Nowadays, the plants inoculation with PGPR is a major asset for biological agriculture to reduce chemical fertilizer doses without affecting crop yield. The aim of our study was to assess the effects of three different PGPR either singly or in combination on maize seed germination and growth development under laboratory and greenhouse growth conditions.

Material and methods

PGPR : The bacteria species used were *A. lipoferum*, *P. fluorescens* and *P. putida* isolated from maize rhizosphere in southern Benin [1].

Maize seed : The maize seeds used were a composite of 85 - 90 days cycle variety called EVDT 97 STR C1S.

Seed inoculation with PGPR : The surface sterilized seeds (0.024% NaCLO/2min) were treated with different PGPR suspensions of about 1×10^8 CFU/30min (Figure 1) [2].

Figure 1. Seed inoculation.

Experimental design : Block of Fischer to 3 repetitions with 8 treatments (CTL = Control; Azo: *A. lipoferum*; P1: *P. fluorescens*; P3: *P. putida*; AzoP1: *A. lipoferum-P fluorescens*; AzoP3: *A. lipoferum-P. putida*; P1P3: *P. fluorescens-P. putida*; AzoP1P3: *A. lipoferum-P. fluorescens- P. putida*). The PGPR combinaisons were realize to mix same proportion of differents PGPR suspensions.

***In Vitro* seeds germination :** Twenty seeds of maize inoculated with PGPR were arranged in an equidistant manner in a sterile square Petri dish (Figure 2). The parameter evaluated was Vigor Index = %Germination x (root length + shoot length).


Figure 2. Seed germination device.

PGPR effect on maize growth : The PGPR effect on maize growth were evaluated in the greenhouse into plastics pots (Figure 3). The substratum is a deep reddish ferrous soil, sterilized twice at 120°C for 20 min with 24 hours times' interval [3]. The pots were watered daily at 1/9 of the maximal retention capacity of the substratum.
The parameters measured were Height, circumference, leaves/plant, leaf area, biomass and dry matter from the 14th up to the 30th DAS.


Figure 3. Maize growing device.

Results and Discussion

Effect of the PGPR on seeds germination

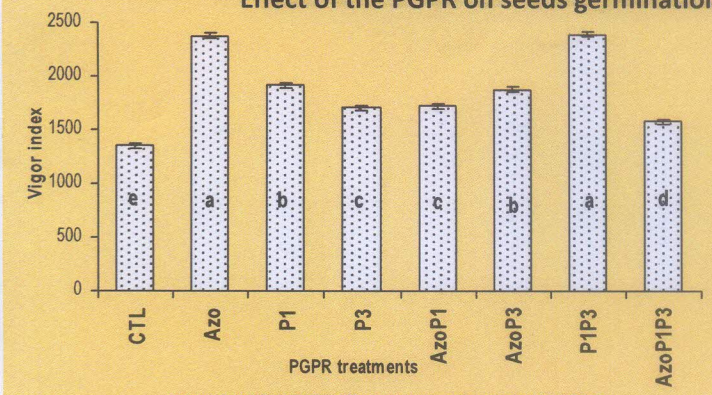

Figure 4. ***In vitro*** **PGPR effect on maize vigor index at 7 DAG.**

- The best vigor index (Figure 4) was obtained from seeds inoculated with the combination *P. fluorescens-P. putida* followed by that inoculated with *A. lipoferum*.
- This high vigor index may be due to a better production and metabolism of auxin, hormones responsible of the cellular elongation or cytokinin, hormones that stimulate the cellular division triggered by PGPR treatment [3].

Effects of PGPR on plant growth

Table 1. PGPR effects on plants height, circumference, leaves, biomass and dry matter at 30 DAG

Traitments	Heigth (cm)	Circufe-rence (cm)	Leaves/ Plant	Biomass (g)		Dry matter (%)	
				Aerial	Underground	Aerial	Underground
CTL	11.60^{e}	3.10^{b}	5.00^{b}	15.30^{d}	19.62^{g}	11.25^{e}	8.71^{c}
Azo	15.93^{a}	3.90^{a}	6.33^{ab}	21.35^{b}	37.89^{b}	15.10^{cd}	13.59^{a}
P1	14.23^{bc}	3.73^{a}	5.33^{b}	19.54^{bc}	35.37^{c}	14.75^{d}	5.93^{e}
P3	12.80^{d}	3.70^{a}	5.00^{b}	18.65^{c}	32.47^{d}	14.35^{d}	6.09^{e}
AzoP1	13.63^{cd}	3.83^{a}	5.33^{b}	18.17^{c}	24.59^{f}	16.25^{b}	7.07^{de}
AzoP3	14.50^{bc}	3.73^{a}	5.33^{b}	18.81^{c}	34.67^{c}	16.60^{b}	7.93^{cd}
P1P3	15.11^{ab}	3.93^{a}	6.66^{a}	23.52^{a}	40.95^{a}	17.90^{a}	10.16^{b}
AzoP1P3	10.98^{e}	3.60^{a}	5.00^{b}	16.94^{cd}	29.93^{e}	14.40^{d}	6.44^{de}
Signification	***	**	**	***	***	***	***

m = Means, Cv = Coefficients of variation, * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$. In a column, the means with different letters are significantly different with probability level of 5 % according to Student Newman-Keuls test.

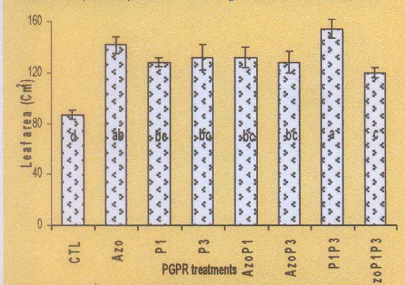

Figure 5. Effects of PGPR on maize leaf area 30 DAS.

- *A. lipoferum* increased plant height of 37.32% of control (Table 1).
- *P. fluorescens-P. putida* highest increased plant circumference, numbers of leaves and leaf area respectively to 22%, 33.2 % and 78.06 % (Table 1, Figure 5).

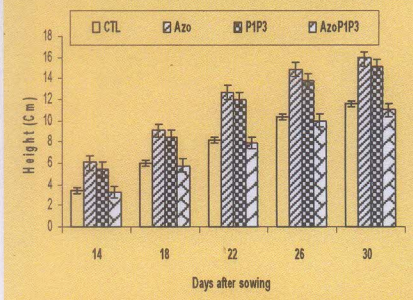

Figure 6. Maize plants inoculated with PGPR height evolutionary tendency.

- The highest increase of 53.72% and 108.71% for shoot and root biomass respectively was obtained in plants inoculated with *P. fluorescens -P. putida.*
- The improvement order in growth parameters observed at 14 DAS was maintained until 30 DAS (Figure 6, for height example).
- This improvement in plant growth triggered by seed inoculation with PGPR on crops has been attributed to locally increasing of available nutrients, facilitating nutrient absorption, detoxifying heavy metals, production of phytohormones and biopesticide activity [4].

Conclusion

A. lipoferum, *P. fluorescens*, *P. putida* and their different combinations improved considerably the maize seed *in vitro* germination and in the greenhouse. The combination of rhizobacteria from the same species is therefore more efficient than the combination of rhizobacteria from different speciés.

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