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INOCULATION AND COINOCULATION OF *Azospirillum brasilense* AND *Bacillus* sp. IN MAIZE GENOTYPES UNDER WATER DEFICIT

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ABSTRACT – Aiming to evaluate the effects of isolated and joint inoculation of rhizobacteria in corn hybrids under different water regimes, strains of *Azospirillum brasilense* and *Bacillus* sp. were inoculated in seeds of two maize hybrids with contrasting drought characteristics and exposed to Field Capacity and Water Deficit. During pre-flowering, the plants were kept under water deficit for 14 days. After this period, the root system morphology, relative leaf chlorophyll content, maximum quantum efficiency of photosystem II (PSII), and production parameters were analyzed. Regarding root morphological characteristics, the hybrids showed opposite responses: DKB390 increased all evaluated factors when inoculated with *Azospirillum*, whereas P30F53 did not. The inoculants promoted beneficial effects in maize genotypes under water-deficit conditions, resulting in increased grain production. Coinoculation promoted higher averages across all evaluated parameters for the drought-sensitive hybrid. In irrigated plants, the inoculant *Azospirillum* conferred higher chlorophyll content in both maize genotypes. Photosystem II inhibition was observed in plants exposed to water deficit after 7 days of stress; however, the inoculant *Azospirillum* showed higher values for both hybrids. Thus, these results suggest that the plant-bacteria interaction is linked to genetic material, as corn hybrids with divergent drought behaviors exhibit different responses to plant growth-promoting rhizobacteria (PGPR) inoculation.

Keywords: Root morphology, production, PGPR, *Bacillus* sp., *Zea mays* L.

In the current scenario, crops face a variety of stresses, both biotic and abiotic. Among these challenges, water deficit stands out as a major abiotic stress, a crucial factor limiting agricultural production. This phenomenon disrupts plant development, leading to yield reductions and significant economic losses, and contributing to a decline in food availability. Previous studies show that drought-induced grain losses account for more than half of the total damage caused by natural disasters (Jaleel et al., 2009).

Maize is one of the world's fundamental crops (FAO, 2025), serving as an important food and industrial resource (Ibrahim et al., 2016). Its production can be limited by drought. Based on data published between 1980 and 2015, maize yield globally decreased by up to 39% due to water deficit (Daryanto et al., 2016). Therefore, it is of utmost importance to find mitigation strategies to minimize the impact of water scarcity on maize production.

The root is the main organ that anchors the plant in the soil and is essential for absorbing water and nutrients. Its development is highly plastic and flexible, acting as a sensory system in a constantly changing environment by adjusting its morphology and reducing exposure to stress (Pierik & Testerink, 2014). Most genetic selection studies focus primarily on improving aboveground tissue traits to tolerate these stresses. At the same time, roots (the "hidden half" of a plant's architecture) remain an underutilized source of crop improvement (Koevoets et al., 2016).

To date, the development of new genotypes (Atkinson & Urwin, 2012; Bakhsh & Hussain, 2015; Das et al., 2021), as well as the application of inorganic and organic chemical products, are the most used practices to improve maize drought tolerance. However, these approaches have disadvantages, as they are often time-consuming, costly, and labor-intensive (Atkinson & Urwin, 2012). The application of beneficial microorganisms as bioinoculants emerges as one of the environmentally sound and sustainable biotechnological tools.

The abundant rhizosphere microbial community includes beneficial microorganisms that exhibit traits that promote plant growth. These organisms, including bacteria, fungi, and algae, have favorable effects on plants under diverse environmental stresses (Gouda et al., 2018; Tiwari & Lata, 2018). Plant growth–promoting rhizobacteria (PGPR) colonize roots, increase root length and the number of lateral roots, and, in some plants, form nodules on the roots, among other properties. PGPR also modifies the functioning of this organ and improves plant nutrition by enhancing water uptake, nitrogen fixation, and phosphate solubilization, thereby increasing the growth and yield of various crops and resulting in higher production (Singh & Seneviratne, 2017).

Microorganisms of the genus *Azospirillum* colonize the interior and surface of grass roots (Baldani et al., 1997; Huergo et al., 2008). They are known for their ability to produce plant growth–regulating phytohormones

such as Indole-3-Acetic Acid (IAA), auxins, gibberellins, and cytokinins and to release them onto the root systems of colonized plants, altering their morphology and physiology (Hartmann & Zimmer, 1994). PGPR, such as those of the genus *Bacillus*, like *Azospirillum*, are important for plant development, since they release IAA, leading to increased biomass and consequently greater capacity to explore soil water and nutrients, produce siderophores, and act antagonistically against phytopathogenic microorganisms (Gazola et al., 2015; Khan, 2017).

Soil PGPR can act alone or in association with other PGPR. Beneficial interactions among organisms can confer numerous advantages to plants (Dartora et al., 2016). There are several examples of co-inoculation with *Azospirillum* in various crops, such as with *Bradyrhizobium* in soybean (Hungria et al., 2013; Chibeba et al., 2015), with *Rhizobium tropici* in common bean (Hungria et al., 2013; Peres et al., 2016), and with *Paenibacillus polymyxa* in wheat (Yegorenkova et al., 2016), among others.

Despite numerous studies addressing co-inoculation of different microorganisms in plants, few explore the effects of inoculation containing two or more combined PGPR strains, and the plant–bacteria interaction, a key factor due to the influence of the rhizosphere environment on the survival and activity of growth-promoting bacteria (Marini et al., 2015; Zeffa et al., 2019). The identification and selection of genotypes responsive to inoculation are essential to ensure repeatability and increased plant yield (Martins et al., 2012).

In view of the above, the objective of the study was to evaluate the effects of inoculation with *A. brasilense* and co-inoculation with *Bacillus* sp. on root development, physiological traits, and productive performance of two maize hybrids contrasting in drought tolerance under different water regimes.

Material and Methods

The experiment was conducted in a greenhouse at Embrapa Maize and Sorghum Research Center in Sete Lagoas, MG, Brazil (coordinates: 19°28′ S, 44°15′08″ W; mean altitude 732 m). The experimental design was completely randomized (CRD) in a 3 × 2 × 2 factorial arrangement, consisting of two inoculants one composed of two strains of *A. brasilense* (CMS11 + CMS1626, "Azos"), the other composed of a mixture of *Bacillus* sp. strains + *A. brasilense* (Azos+Bac), and a control (no inoculant); two maize hybrids (DKB390 PRO 3 and P30F53 VYHR); and two water regimes (Field Capacity and Water Deficit). Each treatment had four replications, and the experimental unit consisted of two plants per pot. The strains used belong to the Collection of Multifunctional and Phytopathogenic Microorganisms of Embrapa Maize and Sorghum.

The selected strains were cultured in tryptone–soy broth for 72 h at 29°C under continuous shaking. After that period, cultures

of each strain were centrifuged, resuspended in saline solution (0.85% NaCl), and adjusted to an optical density of 1.0 at 500 nm, which corresponds to approximately 10^8 viable cells per mL (Reis, 2015). The inoculants used were obtained from a 1:1 mixture of two homologous *A. brasilense* strains (CMS11 and CMS1626) and from a 1:1 mixture of *A. brasilense* strains with preselected *Bacillus* sp. Strains, which are efficient producers of exopolysaccharides in vitro. Seed inoculation was performed using powdered charcoal as the carrier and cassava starch gum as the adhesive.

Seeds of maize hybrids DKB390 PRO3 and P30F53 VYHR, contrasting for water deficit tolerance (tolerant and sensitive, respectively), were sown in 20-kg pots filled with a previously corrected and fertilized dystrophic Red Latosol. Soil water potential was monitored daily in the morning and afternoon (09:00 A.M. and 3:00 P.M.) using a tensiometer (Watermark model 200SS, Irrometer, California, USA) installed at the center of the pots in each replication at a depth of 20 cm. These sensors detect soil water tension via electrical resistance and are connected to digital meters (Watermark meters) from the same company. Irrigation to field capacity (FC) was performed according to the soil water retention curve.

Water treatments were imposed at the pre-flowering stage. In the Field Capacity (FC) treatment, soil water was replenished daily to restore FC. In the Water Deficit treatment, stress was induced by providing only 50% of the total water required to reach FC daily, i.e., until the soil matric potential reached approximately −100 kPa; this deficit was maintained for 14 days.

On the first and seventh days after imposing the water treatments, the following ecophysiological parameters were measured: relative chlorophyll content in the leaf (SPAD units) (MINOLTA SPAD 502, Osaka, Japan) and maximum quantum efficiency of Photosystem II (FV/FM) (Pocket PEA chlorophyll fluorimeter).

After 14 days of water deficit, irrigation for all plants was restored and maintained at an adequate level (field capacity) until the end of the cycle. Ears were harvested, and the following parameters were analyzed: ear length (EL), ear diameter (ED), number of kernels per row (NKR), ear mass (EM), and grain mass (GM).

Root system morphology was analyzed using the WinRhizo Pro 2007 image analysis system (REGENT INSTRUMENTS, Sainte-Foy, QC, Canada) coupled to a professional scanner (EPSON Expression 10000 XL, Epson America, Inc., USA) equipped with an additional light unit (TPU). Image acquisition procedures followed Souza et al. (2012). The following root traits were determined: total root length (TRL), root surface area (RSA), mean root diameter (MRD), root volume (RV), and root length and volume by diameter class. Roots were classified into three diameter classes: very fine roots (Ø < 0.5 mm), fine roots (0.5

≤ Ø < 2.0 mm), and coarse roots (Ø ≥ 2.0 mm). These class definitions were based on the root classification criteria proposed by Böhm (1979). Root dry mass was determined after drying roots in a force air oven at 65°C until constant weight, followed by weighing.

For statistical analysis, a one-way analysis of variance (ANOVA) was performed, and means were compared using the Scott-Knott test at 5% significance ($P \leq 0.05$) using the Sisvar statistical program version 4.3 (Ferreira, 2011).

Results and Discussion

In general, the inoculants promoted beneficial effects in both maize genotypes under water-deficit conditions, increasing yield (Table 1). Co-inoculation with Azos+Bac promoted higher means across all evaluated parameters for both drought-sensitive and drought-tolerant hybrids, except for EL. When plants were maintained under optimal irrigation throughout the crop cycle, inoculation with an isolated *Azospirillum* (Azos) strain increased the means of all parameters for DKB390. The combination of Azos+Bac resulted in higher EM and GM for the P30F53 hybrid (Table 1).

Regarding relative leaf chlorophyll content, there was no statistical difference in DKB390 under water deficit. For P30F53, plants inoculated with Azos showed a higher SPAD index at the beginning of the water-deficit period (1DTH), but this result did not persist as the stress progressed (Figure 1A). When plants were irrigated throughout the crop cycle, the Azos inoculant conferred higher relative chlorophyll values for both genotypes at both evaluation times (Figure 1B).

In general, considering that Fv/Fm values below 0.75 indicate inhibitory conditions of PSII, such inhibition occurred only in plants exposed to water deficit after seven days of stress (7DTH); however, the Azos inoculant provided higher values for both DKB390 and P30F53 (Figure 2A). For treatments grown at Field Capacity, there were no statistical differences among treatments (Figure 2B).

In the analysis of root morphological traits under water deficit, for the drought-tolerant hybrid DKB390, inoculation with *Azospirillum* (Azos) increased the mean of the evaluated parameters except for MRD. Coinoculation with *Azospirillum* + *Bacillus* (Azos+Bac) increased only MRD and RV. However, under this stress condition, the opposite was observed for the susceptible hybrid P30F53, in which only the non-inoculated treatment (Control) had means statistically higher than those of the inoculated treatments. When grown under optimal irrigation (Field Capacity), hybrid DKB390 showed no differences in root morphology between control and inoculant treatments, except for RDM, which had higher values in the presence of inoculants. For hybrid P30F53, Azos+Bac inoculation increased TRL, RSA, and RV compared with the other treatments (Table 2).

By separating genotype roots into

Table 1. Ear Length (EL), Ear Diameter (ED), Number of Grains per Row (NGR), Ear Mass (EM), and Grain Mass (GM) of two maize hybrids (DKB390 and P30F53) subjected to two water regimes (Water Deficit and Field Capacity) and treated with different inoculants (Cont = Control, Azos = *Azospirillum brasilense*, Azos + Bac = Combination of *Azospirillum brasilense* and *Bacillus* sp.).

	Water Deficit									
	EL (cm)		**ED (cm)**		**NGR**		**EM (g)**		**GM (g)**	
	DKB390	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**
Cont	10.75Ba	10.37Ba	45.54Aa	37.04Bb	27.50Ba	14.25Bb	135.66Aa	125.43Ba	125.17Aa	96.40Bb
Azos	12.87Aa	12.50Aa	42.51Aa	41.38Aa	26.50Ba	24.75Aa	128.94Aa	126.85Ba	113.35Ba	104.19Ba
Azos+Bac	11.12Ba	11.75Aa	42.91Aa	45.07Aa	29.00Aa	26.00Aa	143.55Aa	154.04Aa	129.95Aa	139.49Aa
CV%	7.78		6.99		8.84		6.36		6.81	
	Field Capacity									
	EL (cm)		**ED (cm)**		**NGR**		**EM (g)**		**GM (g)**	
	DKB390	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**
Cont	11.12Bb	13.87Aa	46.29Ba	47.26Aa	24.25Ba	26.00Ba	115.95Ca	92.30Cb	102.20Ca	69.76Cb
Azos	13.25Aa	13.62Aa	49.10Aa	46.21Ab	27.00Aa	21.25Cb	178.92Aa	124.91Bb	155.62Aa	110.46Bb
Azos+Bac	11.62Bb	12.50Ba	47.19Ba	46.31Aa	29.50Aa	30.25Aa	134.94Bb	156.64Aa	118.43Bb	136.68Aa
CV%	5.74		3.06		9.76		5.88		7.87	

*Means followed by the same uppercase letter vertically, or lowercase letter horizontally, do not differ from each other by the Scott–Knott test at 5% significance (P>0.05).

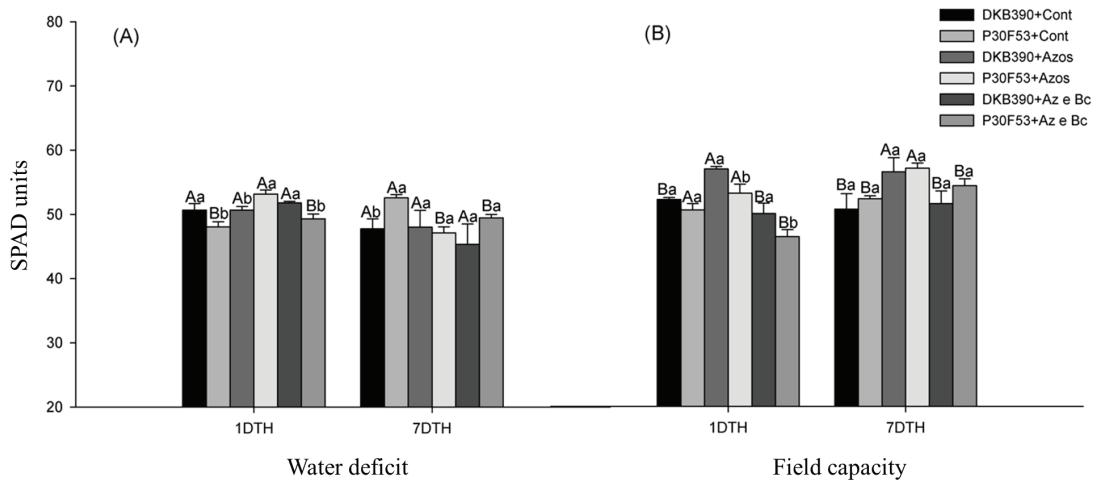

Figure 1. Relative leaf chlorophyll content (SPAD units) of two maize hybrids (DKB390 and P30F53), treated with different inoculants (Cont = Control, Azos = *Azospirillum brasilense,* Azos+Bac = *Azospirillum brasilense* + *Bacillus* sp.) and maintained under two water regimes (Water deficit and Field capacity). Evaluations at one (1DTH) and seven days (7DTH) of water treatment.
Means followed by the same uppercase letter for inoculant, or lowercase letter for hybrids, do not differ from each other by the Scott–Knott test at 5% significance (P>0.05).

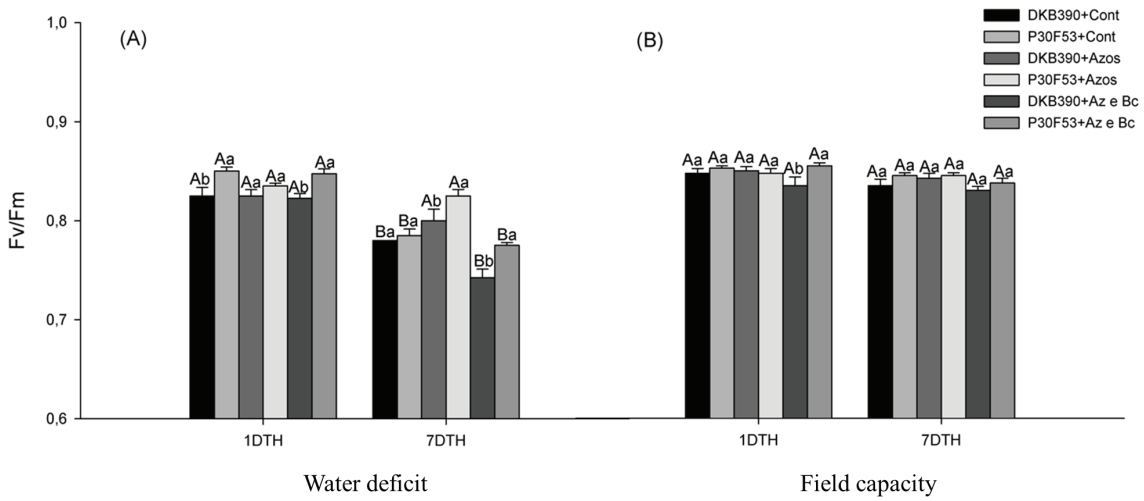

Figure 2. Maximum quantum efficiency of photosystem II (Fv/Fm) of two maize hybrids (DKB390 and P30F53) treated with different inoculants (Cont = Control, Azos = *Azospirillum brasilense*, Azos+Bac = *Azospirillum brasilense* + *Bacillus* sp.) and maintained under two water regimes (Water deficit and Field capacity). Evaluations at one (1DTH) and seven days (7DTH) of water treatment.
Means followed by the same uppercase letter for inoculant, or lowercase letter for hybrids, do not differ from each other by the Scott–Knott test at 5% significance (P>0.05).

diameter classes, it was possible to characterize the root systems of both hybrids in detail. Hybrid P30F53 showed higher means for all root parameters evaluated when plants were exposed to drought (Water Deficit) and not inoculated (Control). For DKB390, inoculation with *Azospirillum* strains resulted in longer very fine roots (VFRL) and fine roots (FRL) than other treatments under water restriction (Fig. 3A, C, and E). Plants of the same genotype grown under optimal irrigation (Field Capacity) showed lower development of very fine and fine roots (VFRL and FRL), investing instead in coarse root length (CRL) (Fig. 3B, D, and F). Root system images are shown in Figure 4.

Water stress affects maize metabolic activity, reduces biomass accumulation, and lowers photosynthetic rate by decreasing leaf chlorophyll content, thereby inevitably leading to a decline in maize yield (Song et al., 2019). Coinoculation with *Azospirillum* + *Bacillus* resulted in increases in ear length (EL), ear diameter (ED), number of kernels per row (NKR), ear mass (EM), and grain mass (GM). In a study on the use of plant growth-promoting rhizobacteria (PGPR) in maize, Brum et al. (2016) reported positive effects on yield and productivity traits across growth stages and genotypes. According to Naseri et al. (2013), coinoculation of two diazotrophic bacteria (*Azotobacter* and *Azospirillum*) increased the number of kernels per ear, possibly by producing growth-promoting compounds, such as the phytohormones auxins and gibberellins. Díaz-Zorita et al. (2015) showed, in several field trials mainly in Latin America and Asia, an approximate 10% increase in cereal grain yield in response to inoculation with *Azospirillum* sp.

The reduction in chlorophyll content is a commonly observed phenomenon (Pirbalouti et al., 2017) and a negative consequence of water deficit, which, however, has been considered an adaptive trait in plants grown under drought conditions. In this study, inoculating maize with *Azospirillum* under water deficit increased the leaf chlorophyll index, resulting in higher values than in non-inoculated maize. Plants grown under full-cycle irrigation also showed higher relative leaf chlorophyll content following inoculation with this bacterium. This result corroborates those described by Longhini et al. (2016), who evaluated the plant–*Azospirillum* interaction and found increases in several photosynthetic pigments. Barassi et al. (2006) reported improvements in leaf photosynthetic parameters, including chlorophyll content and stomatal conductance, with greater biomass production and increased plant height in maize inoculated with *Azospirillum brasilense*.

The effects of water stress and PGPR on plant photosynthesis were assessed by measuring changes in the Fv/Fm ratio. The Fv/Fm ratio is the maximum efficiency with which PSII uses light and is a sensitive indicator of plant photosynthetic performance. Thus, a reduction in this parameter (less than 0.75) indicates destructive effects of stress on PSII and a decline in plant photosynthesis (Yaghoubian et al., 2016).

Table 2. Total Root Length (TRL), Root Surface Area (RSA), Mean Root Diameter (MRD), Root Volume (RV), and Root Dry Mass (RDM) of maize hybrids DKB390 and P30F53 subjected to two water regimes (Water Deficit and Field Capacity) and treated with different inoculants (Cont = Control, Azos = *Azospirillum brasilense*, Azos+Bac = combination of *Azospirillum brasilense* and *Bacillus* sp.).

Water Deficit

	TRL (cm)		RSA (cm^2)		MRD (mm)		RV (cm^3)		RDM (g)	
	DKB390	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**
Cont	1806.95Bb	9857.05Aa	639.12Bb	2389.17Aa	1.36Ab	2.15Aa	123.77Bb	338.62Aa	10.74Bb	21.66Aa
Azos	3409.20Aa	3386.17Ba	1167.30Aa	1124.72Ba	1.21Aa	1.22Ba	159.27Aa	170.37Ba	12.97Aa	12.77Ca
Az+Bac	2345.20Bb	3979.95Ba	824.52Bb	1358.10Ba	1.21Aa	1.25Ba	146.82Aa	198.72Ba	11.21Bb	17.26Ba
CV%	12.24		20.92		13.63		19.37		11.45	

Field Capacity

	TRL (cm)		RSA (cm^2)		MRD (mm)		RV (cm^3)		RDM (g)	
	DKB390	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**	**DKB390**	**P30F53**
Cont	2881.82Aa	3086.21Ba	952.70Ab	1136.84Ba	1.25Ab	1.58Aa	180.22Aa	189.29Ba	12.09Bb	13.56Aa
Azos	2378.87Ab	3519.38Ba	993.48Aa	1103.08Ba	1.42Aa	1.30Ba	183.54Aa	205.52Ba	13.83Aa	13.12Aa
Az+Bac	2520.85Ab	4042.89Aa	1031.12Ab	1541.52Aa	1.34Aa	1.21Ba	186.16Ab	311.13Aa	13.45Aa	13.73Aa
CV%	13.07		9.28		10.35		8.05		7.19	

*Means followed by the same uppercase letter vertically, or lowercase letter horizontally, do not differ from each other by the Scott–Knott test at 5% significance (P>0.05).

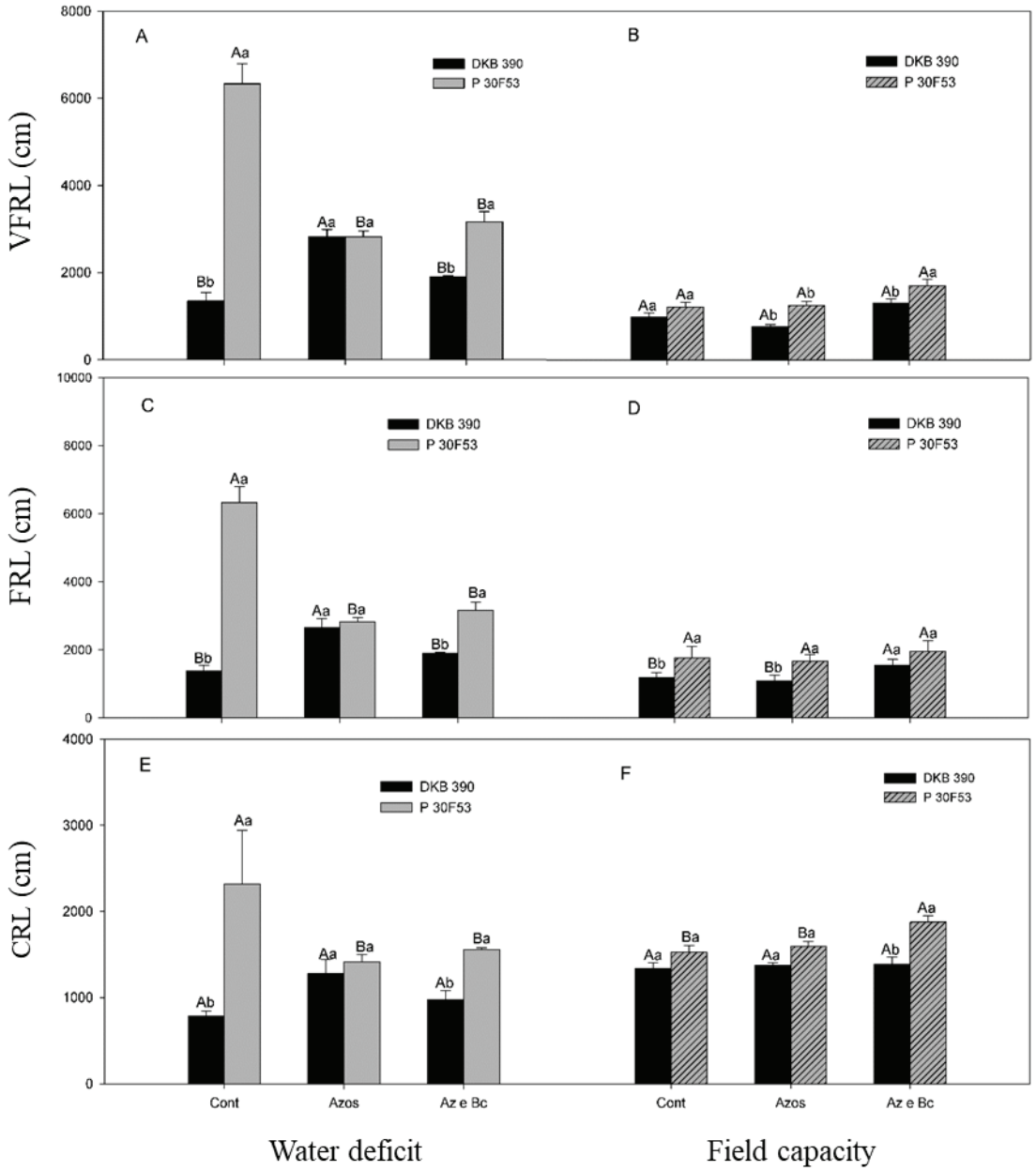

Figure 3. Root length by diameter class. VFRL – very fine root length, FRL – fine root length, CRL – coarse root length, of maize hybrids DKB390 and P30F53 treated with inoculants (Cont = Control, Azos = *Azospirillum brasilense*, Azos+Bac = *Azospirillum brasilense* + *Bacillus* sp.) and subjected to two water regimes: Water Deficit (A, C, and E) and Field Capacity (B, D, and F). Means followed by the same uppercase letter do not differ among inoculated treatments.

Means followed by the same lowercase letter do not differ between hybrids, by the Scott–Knott test at 5% significance (P>0.05).

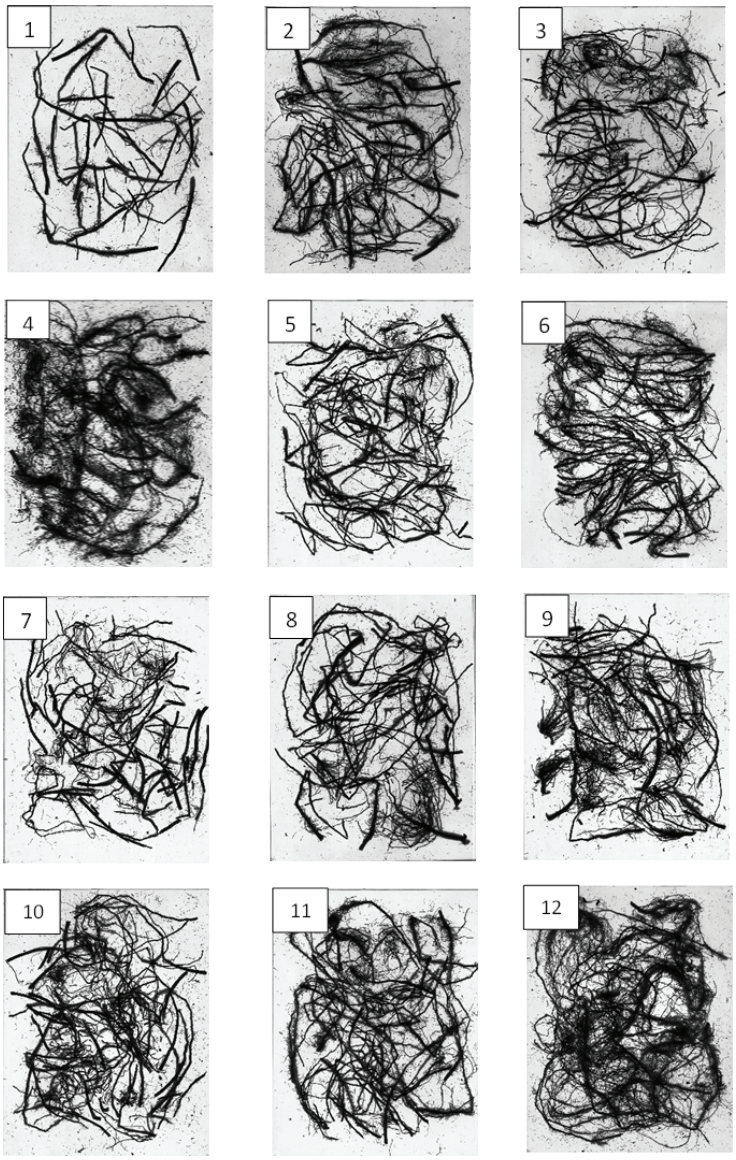

Figure 4. Root system images of maize hybrids (DKB390 and P30F53) treated with different inoculants (Cont = Control, Azos = *Azospirillum brasilense*, Azos+Bac = *Azospirillum brasilense* + *Bacillus* sp.) and maintained under two water regimes (Water Deficit and Field Capacity). (1) DKB390/Control/Water Deficit. (2) DKB390/Azos/Water Deficit. (3) DKB390/Azos+Bac/Water Deficit. (4) P30F53/Control/Water Deficit. (5) P30F53/Azos/Water Deficit. (6) P30F53/Azos+Bac/Water Deficit. (7) DKB390/Control/Field Capacity. (8) DKB390/Azos/Field Capacity. (9) DKB390/Azos+Bac/Field Capacity. (10) P30F53/Control/Field Capacity. (11) P30F53/Azos/Field Capacity. (12) P30F53/Azos+Bac/Field Capacity. Images digitized using a flatbed scanner and analyzed with WinRHIZO.

In the present study, PSII activity was impaired by long-term water stress; however, inoculation with *Azospirillum brasilense* improved the Fv/Fm ratio. This increase may be related to reduced photo-oxidative stress. Similar results have been reported previously in wheat (Singh & Jha, 2016), chickpea (Kumar et al., 2016), maize (Rojas-Tapias et al., 2012), and millet (Chandra et al., 2018).

Root distribution, length, and diameter, along with root system properties, determine a plant's access to water and thus set limits on its tolerance to water-restricted conditions. The maize root system is composed mainly of coarse and fine roots; coarse roots function in anchorage and typically establish the overall architecture of the root system, controlling plant depth and the ability to grow toward deeper soil layers (Henry et al., 2012). Fine roots are the most active part of the root system in water uptake and account for most of its length and surface area (Comas et al., 2013).

The hybrid P30F53 developed a longer root system with greater surface area and volume under water deficit conditions, without inoculation. These results are likely related to its genetic characteristics, which make it sensitive or tolerant to water-restriction conditions, since surface soil drying stimulates root expansion, driving roots deeper in search of moisture (Gonçalves, 2013). Under these conditions, more sensitive plants invest in root system development, increasing root length.

When P30F53 was cultivated under optimal irrigation, the root system tended to develop less and only superficially; however, coinoculation with *Azospirillum* + *Bacillus* increased its total root length (TRL), root surface area (RSA), and root volume (RV). Studies have shown that the beneficial effects of *A. brasilense* on plants can be potentiated by coinoculation with other microorganisms. In a study with maize seeds coinoculated with cyanobacteria and *Azospirillum brasilense*, Zambrano et al. (2019) found that coinoculation promoted greater development of the tested genotypes, mainly through its effect on root system growth, indicating high potential for use in maize cultivation.

According to Magalhães et al. (2014), unlike P30F53, the genotype DKB390 primarily invests in physiological mechanisms at the shoot level to maintain productivity by minimizing water loss, which reduces dependence on root-level investments to increase water capture. In this context, inoculation with *Azospirillum brasilense* strains improved the length of very fine roots (LVFR) and fine root length (FRL) of this genotype under water deficit. The soil volume explored by roots and the intimate contact between root surface and soil are necessary for effective water absorption by roots; this contact is maximized when the plant produces smaller-diameter roots, increasing surface area and water uptake capacity. According to Pedreira et al. (2017), root growth in grasses inoculated with *A. brasilense* is associated with the production and release of phytohormones, such as auxins, which

stimulate meristematic tissue differentiation.

Inoculation of maize with *Azospirillum* can stimulate root system development, increase resistance to water stress, promote higher leaf chlorophyll content and photosynthesis, and, consequently, result in greater production. In this work, as observed by Quadros et al. (2014), the hybrids studied responded differently to inoculation with *Azospirillum brasilense*, suggesting that plant genotype plays an important role in colonization by the bacteria, which may be related to the rhizosphere/bacterium relationship. Therefore, it is necessary to study maize hybrids that show good agronomic response to inoculation.

Conclusions

As previously reported by various authors, we observed in the present study positive responses to the use of *Azospirillum brasilense* in maize under water deficit, thereby mitigating this stress through improvements in plant physiological and morphological traits; however, coinoculation of *Bacillus* sp. and *Azospirillum brasilense* contributed, among other factors, to increased productive performance in both maize hybrids. For some evaluated traits, it was noted that the maize response to inoculation depends on the tested hybrid. Further investigations are needed to explore issues such as modes of action, formulation, application, field stability, and the screening of efficient, compatible strains for each plant genotype.

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