TOLERANCE TO HYDRIC STRESS ON CULTIVARS OF SILICON-FERTILIZED CORN CROPS: ABSORPTION AND WATER-USE EFFICIENCY

TOLERÂNCIA AO ESTRESSE HÍDRICO EM CULTIVARES DE MILHO ADUBADAS COM SILÍCIO: ABSORÇÃO E EFICÊNCIA NO USO DA ÁGUA

Hudson Carvalho BIANCHINI[1]; Douglas José MARQUES[1]

1. Professor do Curso de Agronomia, Universidade José do Rosário Vellano – UNIFENAS, Alfenas-MG, Brasil, hudson.bianchini@unifenas.br; douglasjmarques81@yahoo.com.br

ABSTRACT: Silicon (Si) plays specific functions in agriculture. Si is a beneficial element, as it accumulates at high amounts in plant tissue. Si accumulation in cell walls reduces water loss by transpiration and may be an adaptation factor to water stress. This study evaluated the efficiency of different corn crops using calcium silicate as a reducer of hydric stress. The experiment was organized in a factorial scheme, completely randomized, with two doses of calcium silicate (0 and 100 % according to soil liming) with two irrigation depths: (30 and 100 % of necessary water reposition in the soil) and two corn cultivars: (cv. BRS-1010) considered sensitive to hydric stress and (cv. DKB-390) tolerant to hydric stress. The study comprised four repetitions. We studied dry matter production on leaves and stem, weight of 1000 seeds and crop yield. We measured efficiency of gas exchange and water use to compare the different treatments. The results for stem and leaves dry matter were better in both cultivars when using calcium silicate, regardless of irrigation depth. Both corn cultivars cv. BRS-1010, sensitive to hydric stress, and cv. DKB-390, tolerant to hydric stress, had greater yield in the presence of calcium silicate, when at the smallest irrigation dose was applied. The treatment with calcium silicate was the most efficient in water use, using 30% of irrigation depth. Cv. DKB 390 was the most productive, with greater tolerance to water stress.

KEYWORDS: *Zea mays* L. Irrigation. Dry matter. Production. Hybrids.

INTRODUCTION

Recently, climatic phenomena have become extreme and long lasting, partially due to anthropic activities (YEPES; BUCKERIDGE, 2011). These changes affect plant cultivars because of temperature rises and shifts in rainfall regimes, directly affecting growth and yield of plants (NELSON et al., 2018). Water supply is an important factor in plant growth and water deprivation is one of the main causes of plant stress. According to Luna et al. (2012), hydric deficit occurs when the amount of water lost by the plant is greater than the amount of water absorbed. Plant tolerance to hydric stress depends on its intensity (GARAU et al., 2009).

Corn production in the main producing regions in Brazil is associated to water availability, especially during the critical period of the crop, from planting to the beginning of grain filling (BERGAMASCHI et al., 2004). The use of silicon (Si) in agriculture can reduce the abiotic stress caused by drought, enhancing water use (MA; YAMAJ, 2006). Si can reduce water stress and reduce transpiration in plants (EPSTEIN, 1994). In addition, the beneficial effect of Si is associated to ensuring the photosynthetic rate and plant stomatal conductance (HATTORI et al., 2005), due to transpiration reduction through the cuticle (MA; YAMAJ, 2006). In wheat, same corn family, Gong et al. (2005) reported no difference between water content in irrigated plant leaves and plant leaves cultivated under water deficit that was supplied with Si. Si accumulation in cell wall reduces water loss by transpiration and may be an adaptation to water stress. However, plants that did not receive Si showed symptoms of water deficit.

Corn (*Zea mays* L.), belongs to the Gramineae family (Poacea) and the genus Zea, is a C_4 plant, characterized by high productive potential. Corn cultivation is expressive in Brazil and is cultivated in all regions. Corn productivity is low in the northeastern region due to production systems that use little or no technology and because of insufficient and irregular rainfall (MELO et al., 2013).

Corn cultivation is of great economic importance for the Brazilian agriculture and its productivity is linked to the use of potential cultivars, as well as edaphoclimatic conditions and

crop management (SANTOS et al., 2002). Genetic improvement to increase plant tolerance to biotic and abiotic stress aims to develop anatomical and physiological mechanisms that help plants thrive in those conditions. Cultivar cv. DKB-390 stands out for its tolerance to hydric deficit, high productivity/yield, and excellent stalk and root quality (PARENTONI et al., 2016). On the other hand, cv. BRS-1010 is sensitive to hydric deficit, with early cycle, and highly efficient on phosphorus use.

In plants, beneficial effects of silicon are attributed to the high Si accumulation in the tissues (FENG, 2004). The mechanical protective effect in plants is attributed to its deposition as amorphous silicon ($SiO_2 H_2O$) onto the cell wall.

Si accumulation in transpiration organs forms a double layer of Si cuticle (silica), which reduces water requirement of plants by reducing transpiration (KORNDÖFER, 1999; MARQUES et al., 2014). Evaluation of different irrigation depths in a corn crop showed that the application of 100% of calcium silicate increased water potential in the xylem. In addition, calcium silicate benefited stomatal conductance, net photosynthesis rate and water use efficiency.

The effect of Si application on corn crops needs further studies, since research results are discordant (FREITAS et al., 2016). The low use of Si in agriculture is also attributed to the lack of knowledge about the advantages of its use, both by technicians and producers (MA; YAMAJ, 2006).

In this sense, the development of technical procedures that improve resistance to water stress in arid and semi-arid regions can be a sustainable alternative to mitigate the negative impacts of global climate changes.

This research evaluated the efficiency of different corn crops using calcium silicate as a reducer of hydric stress.

MATERIAL AND METHODS

The study was conducted under greenhouse conditions. Two contrasting corn cultivars were used two corn genotypes, distinct in terms of drought tolerance, more specifically cv. DKB-390 (tolerant) and cv. BRS-1010 (sensitive). The seeds were obtained from Embrapa Milho and Sorgo, located in the municipality of Sete Lagoas, Minas Gerais State, Brazil.

The soil was classified as Oxisol (EMBRAPA, 2013) and samples were collected at a depth of 0-20 cm. The samples were placed to dry, crushed through a 5-mm sieve and mixed to describe the chemical and physical compositions. Chemical and physical compositions of the soil used in this study, according to Raij (2001), were: pH in water (1:2.5)= 5.2; level of organic matter (OM)= 1.42 (dag kg^{-1}); P and K by Mehlich I extraction = 3.69 and 30.41 (mg dm^{-3}); Mg, Ca and Al extractable by 1 M KCl solution= 7.59, 1.12 and 0.20 (cmol dm^{-3}); Si= 3.29 (mg dm^{-3}); Zn= 1.05 (mg dm^{-3}); Cu= 1.38 (mg dm^{-3}); S= 13.24 (mg dm^{-3}); B= 0.07 (mg dm^{-3}); Fe= 53.62 (mg dm^{-3}); T = cation exchange capacity at pH 7.0 (3.62 %); t= cation exchange capacity effective (5.02 %); m = aluminum saturation index (12.50 %); V = Base saturation index (27.85 %). Soil granulometry was the soil physical composition used in this study, determined by the pipette method (sand, silt and Clay = 60 %, 11 % and 29 %). After incubation of limestone and calcium silicate, fertilization was performed for macro and micro-nutrients following the recommendation of Novais et al. (1991) and Marques et al. (2014) adapted for experiments conducted in pots for corn crops.

The experiment was organized in a factorial scheme completely randomized with two doses of calcium silicate: 0 (absence) and 100% (presence) of calcium silicate indicated to soil liming at two irrigation depths: 30 and 100 % of necessary water replacement in this soil and two seed cultivars of *Zea mays* L., cv. BR-1010, considered sensitive and cv. DKB-390, tolerant to water stress, planted in 23 dm^{-3} pots. The study was composed of four repetitions.

The treatments comprised the application of 0 % (control) and 100 % (rec-recommended) calcium silicate and two water irrigation depths (30 % and 100 % of the recommended blade) and two seed cultivars of *Zea mays* L., cv. BR-1010, considered sensitive and cv. DKB-390, tolerant to water stress. Calcium silicate and limestone doses were applied in the liming process to balance the amount of calcium silicate in the treatments. After application, the soil remained under incubation for 45 days (Table 1).

We determined the soil water retention curve (Figure 1). Parameters of the soil water retention curve used in the irrigation blade quantification and irrigation management were obtained based on the model proposed by Genuchten (1980) with the aid of the solver application of Microsoft Office Excel® software (θ= 0.4215 x [1+ (0.2040 x |Ψml|)1.8757]-0.4669 + 0.2670). Field capacity was estimated using the equation proposed by Dexter (2004). The moisture value in field capacity was 0.3458 m^3 for voltage -40 kPa.

Table 1. Doses of calcium and limestone silicate applied to a 23 dm^{-3} pot.

Treatment	CaSiO$_3$	Treatment	CaCO$_3$
CaSiO$_3$	----g pot----	CaCO$_3$	----g pot----
0	0	0	23.3
100	27.02	0	0

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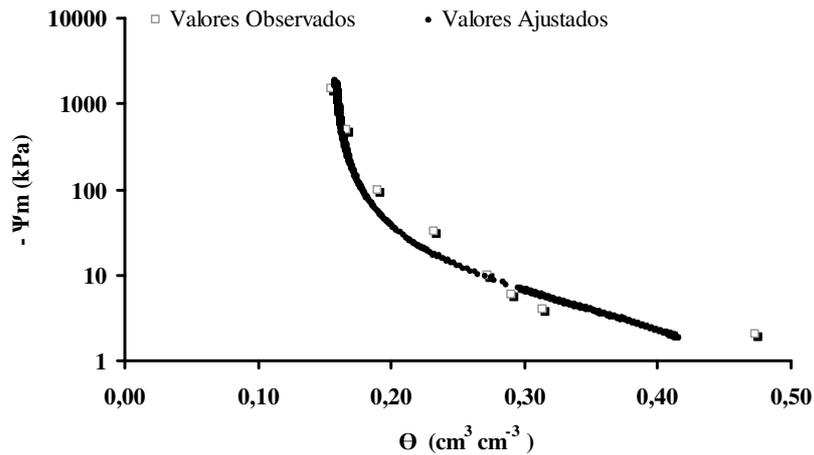
Figure 1. Water retention characteristic curve of Oxisol used in the research.

Irrigation management was carried out based on the water retention curve in the soil and in Watermark readings (Soil Moisture Meter) installed at depth 0.15 m. It was performed whenever soil water stress reached -40 kPa in each treatment, as recommended by Guerra (1994). The readings were taken daily at 17h00. In addition, devices were installed to quantify the matrix potential at the greatest tensions 30 and 100 % of the ideal lamina.

The irrigation was based on the water retention curve linked to soil and tensiometer measurements installed at depth 0.15 m. Irrigation was implemented when water tension in soil reached -40 kPa and at irrigation depth (30 and 100 % of necessary rate for water reposition in the soil). All measurements were carried daily, at 17h00, and soil moisture meters (Watermark, model 200SS-5) were installed to quantify the matric potential (Figure 2) only in three higher tensions (30 and 100% of ideal soil depth). The water volume applied to irrigation was calculated by equation: $V = (\theta_c - \theta_{treat.}) \times V_{soil}$, where V = water volume applied (mL), θc = humidity in yield capacity (cm^3. cm^{-3}), θ_{treat} = humidity in treatment (cm^3.cm^{-3}), and V_{soil} = volume of soil (mL).

A drip irrigation system, with auto-compensating drippers and water flow of 4 L h^{-1}, was installed to ensure a precise application of depths. Flexible tubes of 80 cm long were used on the side lines, which were initiated at the distribution control, while water was pressurized by gravity. The uniformity coefficient linked to water flow in this study was measured by: CU = (q 25 % / q average) proposed by Bralts and Kesner (1982). Where, UC = uniformity coefficient, q 25 % = average of 25 % of minor flows (L h^{-1}), and q average = average total (L h^{-1}). In this study, the UC value was 0.93.

To determine the dry matter (DM) weight of corn plants, stems and leaves were collected. The leaves were separated from the stem by a plant cut and washed in running water. Leaf and stem were oven dried at 60 °C with forced ventilation until a constant mass was reached and the mass was then weighed.

Transpiration rate, stomatal conductance and net photosynthetic rate were evaluated using an infra-red gas analyzer (LICOR, model LI-6400) in adaxial surface of fully expanded leaves. Photosynthetic water use efficiency was estimated according to Fischer and Maurer (1978). Gas exchange was evaluated between 9:00 and 12:00 h in all plants, and irradiance was kept at 1000 μmol m^{-2} s^{-1} during the measurements.

At the end of the study, corn production and weight of 100 corn seeds were measured.

Water use efficiency (WUE) was quantified considering the relationship between CO_2 assimilation rate and corn transpiration rate (FISCHER; MAURER, 1978). The infrared gas analyzer (IRGA) portable meter (Model - LI-6400) was used for this analysis.

Results were submitted to analysis of variance and, when there was a significant difference, the most appropriate test (Scott-Knout or t-test) was applied according to the theories recommended by Steel et al. (2006). In addition, standard deviations of all treatments were calculated and regression and correlation estimators (Pearson or Spearman) were applied using SISVAR software (FERREIRA, 2014).

RESULTS AND DISCUSSION

Regardless of the absence or presence of calcium silicate, the highest production of leaf and stem dry matter of corn cultivars BRS-1010 (sensitive to water stress; Figures 2 A and C) and

DKB-390 (tolerant to water stress; Figures 2 B and D) were obtained at 100% irrigation depth.

When the calcium silicate was applied, a 12% increase in values was obtained compared to the control group (absence) at both irrigations depths, for cv. BRS-1010 (Figures 2A and C) and cv. DKB-390 (Figures 2 B and D). Cv. DKB-390 produced 19% more leaf dry matter than cv. BRS-1010 (Figures 2A and 2B). For dry matter stem, 30 % irrigation depth had significantly higher production in presence of calcium silicate. The net assimilation rate estimates photosynthetic efficiency of plants (SHIPLEY, 2006). This variable is directly related to the relative growth rate (GALMES et al., 2005). These two variables are therefore determinant to explain plant growth. They are also used in the evaluation of plant responses to water stress (SHAO et al., 2008). Marques et al. (2014) evaluated different irrigation depths in maize and concluded that the application of 100% of calcium silicate increased the xylem water potential. In addition, calcium silicate promoted beneficial effects on stomatal conductance, net photosynthesis rate and water use efficiency (MARQUES et al., 2016).
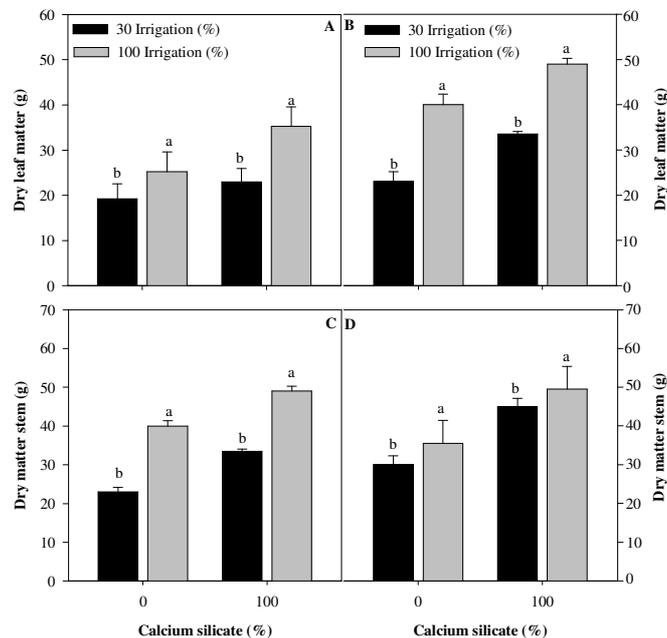

Figure 2. Dry matter of leaves and stem in *Zea mays* plants cv. BR-1010 (A and C) and DKB-390 (B and D) exposed to two calcium silicate levels (0 and 100 % of $CaSiO_3$ indicated by soil liming) and two irrigation depths (30 and 100 % of water necessity reposition in the soil). Means followed by the same letter to each irrigation depth are not significantly different by the Scott-Knott test at 5 % probability (P > 0.05). The bars represent the mean standard error.

In presence of calcium silicate (Figure 3A), cv. BRS-1010 (sensitive) showed a higher photosynthetic rate at 30% of irrigation depth, while for cv. DKB-390 (tolerant), the highest

photosynthetic rate was in the presence of calcium silicate and at 100% irrigation depth (Figure 3 B), which showed photosynthetic rate 16% higher than cv. BRS-1010 did (Figure 3A).

The highest value of corn plants transpiration rate was observed for cv. DKB-390 (tolerant) and 100% irrigation depth, in presence of calcium silicate (Figure 3D). Figure 3C shows that cv. BRS-1010 (sensitive) had greater transpiration rate with the lowest water application (30 % irrigation depth).

The stomatal conductance in both cultivars was higher in presence of calcium silicate in cv. BRS-1010 (sensitive) and in cv. DKB-390 (tolerant), 30% of irrigation depth (Figure 3 E) and 100% irrigation depth (Figure 3 F), respectively. Cv. DKB-390 showed the highest photosynthetic rate (16 %), stomatal conductance (17 %) and transpiration rate (22%) when compared to cv. BRS-1010. When water deficit occurs gradually, plants need acclimatization, which is possible due to changes in morphological and physiological characteristics, mainly in leaves and roots (CUTLER et al. 2011). The mechanisms used by plants in stress situations include the activation of enzymes involved in protection against oxidative stress, such as catalase, superoxide dismutase, peroxidases, and glutathione (SOUZA et al., 2013). Water deficiency affects plant growth, which may be a reflection of changes in plant physiology, causing leaf area decrease, senescence acceleration, leaf abscission, reduction of intercellular spaces and mesophyll in cell size (GHANNOUM, 2009), decrease of intracellular CO_2 concentration, and reduced photosynthesis (MITTLER, 2002). Changes in photosynthetic reactions caused by water stress lead to the formation of reactive oxygen species (ROS), causing oxidative reactions (MITTLER, 2002); however, these ROS can be very important in defense responses in plants to water stress (SILVA et al., 2006). In addition, water stress promotes stomatal closure, reduces photosynthetic efficiency and limits nutrient absorption (ZARCO-PERELLÓ et al., 2005), causing losses to biomass and grain yields (RIBAUT et al., 2009).

Despite the high productive potential, corn cultivation presents great sensitivity to abiotic stresses and water deficit is the main cause of production losses. Thus, plant breeders have sought to develop genotypes with high yield under normal growing conditions and that are capable of maintaining good performance even under conditions of water scarcity, minimizing losses. In corn genotype cv. DKB-390 (drought tolerant), there is an increase in exoderm thickening, a greater number of metaxylem elements, a smaller diameter of the vessel elements and in leaves 17, a greater number of stomata occurs and as well as a smaller

distance between the vascular bundles (MAGALHÃES et al., 2012). Other studies have shown increases in internal carbon concentration (Ci) and concentration increases of abscisic acid (ABA) under water stress in corn genotypes cv. BRS-1010 (AVILA et al., 2015).

However, some acclimatization mechanisms can be activated when the plant is exposed to water stress (NILSEN; ORCUTT, 1996). The root system can increase the formation of adventitious roots with longitudinal interconnections of gas spaces called aerenchym (TAIZ; ZEIGER, 2006). Another mechanism of tolerance is stomata closure, which are responsible for transpiration control in plants (CUSHMAN, 2005). Closure occurs when the mesophyll begins to suffer dehydration and is regulated by abscisic acid (ABA). At the cellular level, another response is the osmotic adjustment that decreases water potential by promoting water entry into the plant (LIANG et al., 2015). Physiological and anatomical changes can be adaptations of plants to reduce metabolic costs for soil growth and exploration, favoring survival in these environments.

All terrestrial plants contain Si in their tissues and Si concentration in the aerial part varies greatly between species (0.1 to 10% Si in dry weight), showing an extremely unequal distribution in plants (Kraus; Arduin, 1997). Studies on Si use in fertilization have shown innumerable benefits to plants, such as increasing plant tolerance to water stress. These data are relevant, as they highlight the benefit of Si as water stress enhancer in corn crops. These results show that in Brazil, silicon becomes part of essential micronutrients (OSMOND et al., 2008). According to observations (SCHOLANDER, 1964) in corn plants under water stress, the presence of Si increased dry matter of the aerial, corroborating with the observed increased sorghum growth (*Sorghum bicolor*) submitted to water stress with increasing Si doses. On the other hand, OM production is monitored in the plant to elucidate or understand morphological processes linked to plant growth and their influence on plant productivity, characterized the quantitative analysis method (TURNER, 1988). The Si application as tolerance inducer in genotypes *Vigna unguiculata* shows that the genotypes assessed increased growth and development when cultivated under hydric stress of 50% and treated with Si, also reporting that the antioxidant activity of enzymes SOD, CAT and APX were boosted by the foliar application of Si (ARAUJO, 2017).
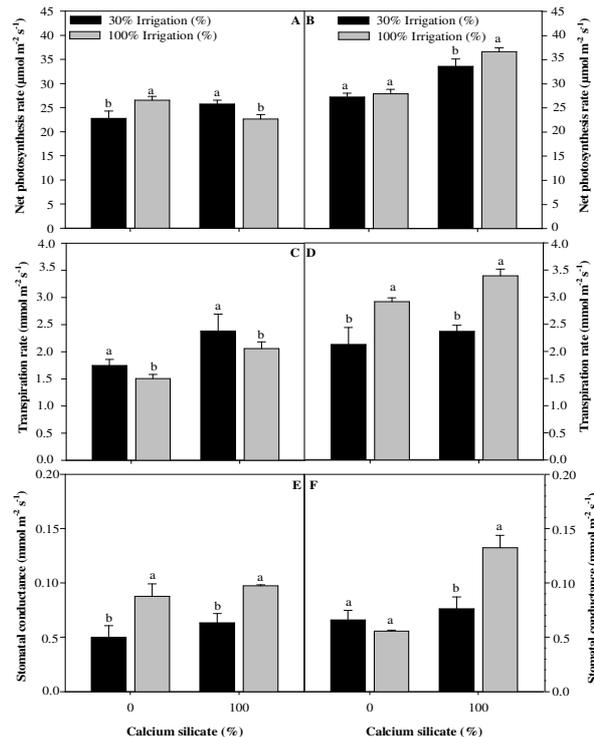
Figure 3. Net photosynthetic rate cv. BR-1010 (A) and cv. DKB-390 (B), transpiration rate cv. BR-1010 (C) and cv. DKB-390 (D), stomatal conductance cv. BR-1010 (E) and cv. DKB-390 (F) in *Zea mays* plants exposed to two calcium silicate levels (0 and 100 % of $CaSiO_3$ according to soil liming) and two irrigation depths (30 and 100 % of necessary water reposition in the soil). Means followed by the same letter to each irrigation depth are not significantly different by the Scott-Knott test at 5 % of probability (P > 0.05). The bars represent the mean standard error.

The highest weight obtained from 100 corn seeds (Figures 4A and 4B) and grain production (Figures 4C and 4D) was achieved using 100% irrigation depth, both in the presence or absence of calcium silicate. Cv. DKB-390 produced 15.6 % more grains than cv. BRS-1010 did. Plant species vary greatly in their ability to absorb and accumulate Si in tissues and may be classified, depending on percentages of SiO_2 in the dry matter, as: (a) accumulating plants, which include grasses, such as rice, containing more than 4 % SiO_2; B) intermediates, with SiO_2 contents ranging from 2 to 4 % (cereals, sugarcane and few dicots); C) non-accumulating plants, including most dicotyledons, with values lower than 2 % SiO_2, such as beans (HODSON et al., 2005).

Plant absorb water to meet their physiological needs and supply their nutrients, which are transported along water in the form of mass flow (BÄNZINGER et al., 2006). The technique of x-ray, microanalysis and mapping of Pozza et al. (2004) shows a uniform distribution of the element on all abaxial surface of coffee leaves.

Many studies have been developed for a better adaptation of crops to regions with water limitations and make them more tolerant to acidity

(MARQUES et al., 2014). However, the production of most of the cultivated plants is impaired under stress conditions, especially maize that is sensitive to water deficit (RAIJ et al. 1998) and whose cultivation in semi-arid regions, such as the Brazilian northeast, is of great importance not only to directly supply food needs to the population, but also for the regional agro-industry. Si absorption benefits crops, such as increased lodging resistance and photosynthetic efficiency. Si is a chemical element involved in the physical functions of evapotranspiration regulation and is capable of forming a barrier of mechanical resistance to invasive fungi and bacteria into the plant, hindering insect pests attack (LUX et al., 2002).

Water use efficiency (WUE) at different irrigation depths, using each proportion of calcium silicate, for both cultivars is shown in Figures 5A and 5B. Cv. BRS-1010 (Figure 5A) presented the highest WUE at 100 % irrigation depth in the absence of calcium silicate. However, in the presence of calcium silicate, this cultivar was more efficient at 30 % irrigation depth. For cv. BRS-390, the highest WUE was at 30 % irrigation depth in the presence of calcium silicate.
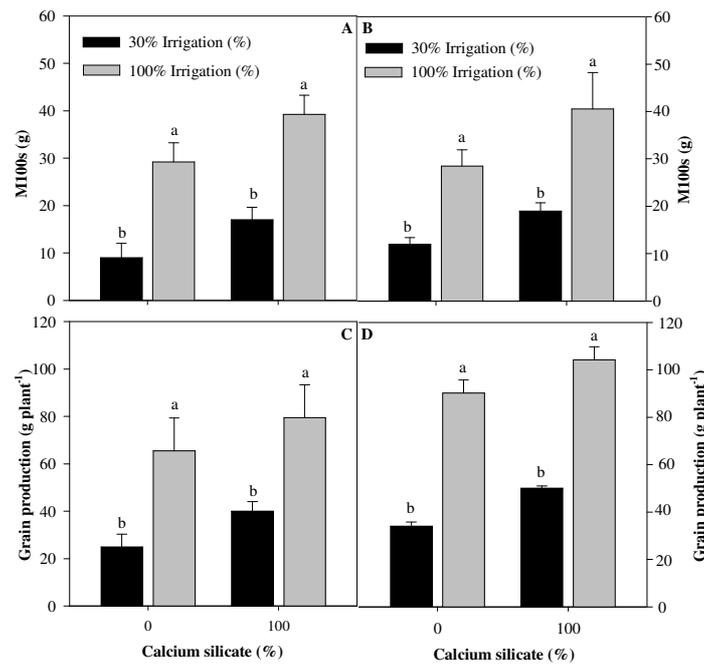
Figure 4. Weight of 100 corn seeds cv. BR-1010 (A) and cv. DKB-390 (B), and Grain production BR-1010 (C) and cv. DKB-390 (D) in *Zea mays* plants exposed to two calcium silicate levels (0 and 100 % of CaSiO₃ indicated to soil liming) and two irrigation depths (30 and 100 % of necessity for water reposition in this soil). Means followed by the same letter to each irrigation depth are not significantly different by the Scott-Knott test at 5 % of probability (P > 0.05). The bars represent the mean standard error.
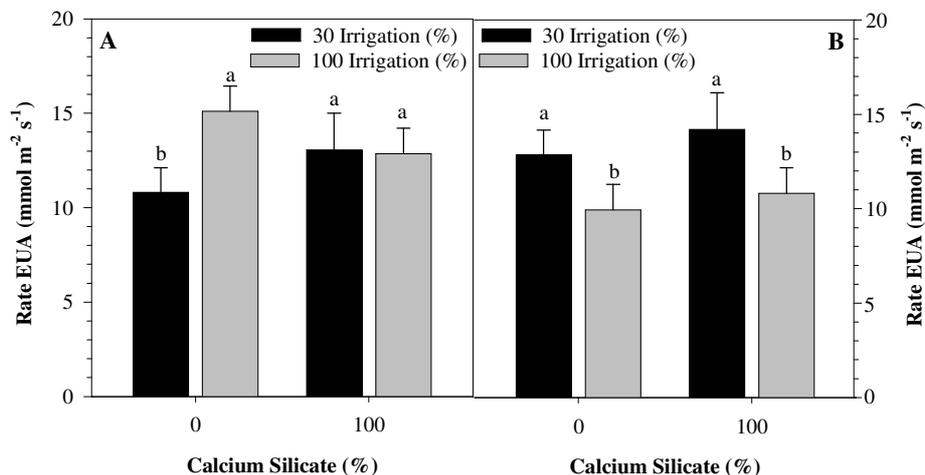

Figure 5. WUE in cv.BR-1010 (A) and DKB-390 (B) in *Zea mays* plants exposed to two calcium silicate levels (0 and 100 % of CaSiO₃ indicated to soil liming) and two irrigation depths (30 and 100 % of necessary water replacement in the soil). Means followed by the same letter to each irrigation depth are not significantly different by the Scott-Knott test at 5 % of probability (P > 0.05). The bars represent the mean standard error.

Our results show that the use of calcium silicate favors higher WUE when soil moisture is a limiting factor, as at 30 % of irrigation depth. The use of WUE indicators is one way of analyzing crop response to different water availability conditions because it relates dry biomass production or commercial production to the amount of water applied or evapo-transpired by the crop (COSTA; MORAES, 2009). The effect of mechanical protection is mainly attributed to Si deposition in the form of amorphous silica ($SiO_2.nH_2O$) on cell wall (Feng, 2004). Si accumulation in the stomata forms a double layer of cuticle silica by reducing transpiration (DANTAS et al., 2011).

Si increased photon capture, increasing excitation energy absorption to centers aimed at photochemical reactions, in addition to increasing efficiency of plastoquinone (FENG, 2004) and electron transport rates through the photosystems (LUX et al., 2002).

Si is a beneficial element for plants (BRAGA et al. 2010) and is the second most common mineral in the soil (HODSON et al., 2005), occurring in the form of Si or silicate, which can be combined with various metals (POZZA et al., 2004). Si can be absorbed by the roots in the form of silicic acid [$Si(OH)_4$] and transported to the shoot via xylem (MA; YAMAJ 2006). The contents of this element in the shoot of the plant range between 0.1 and 10 % dry matter (RAIJ et al., 1988). Si mitigates biotic and abiotic stresses (SILVA et al., 1984) in corn (MARQUES et al., 2014), such as infection caused by a pathogen (CAO et al., 2015), saline stress [69], and drought stress (Puppala et al., 2005), besides increasing plant tolerance to metal toxicity, such as Al in *Zea mays* (CHEN et al., 2005).

CONCLUSIONS

The two corn cultivars studied, cv. BRS-1010 water-stress tolerant, and DKB-390 water-stress tolerant, presented higher production in the presence of calcium silicate, when the smallest water layer was applied.

The highest efficiency in water use was obtained in the treatment with calcium silicate, with the application of a 30% lamina irrigation. Cv. DKB 390 was the most productive, with greater tolerance to water defict.

ACKNOWLEDGEMENTS

RESUMO: O silício (Si) desempenha funções específicas na agricultura, sendo considerado um elemento benéfico, pois se acumula em quantidades elevadas no tecido da planta. O acúmulo de Si nas paredes celulares reduz a perda de água pela transpiração e pode ser um fator de adaptação ao estresse hídrico. Este estudo avaliou a eficiência de diferentes cultivares de milho utilizando o silicato de cálcio como amenizador do estresse hídrico. O experimento foi organizado em esquema fatorial, inteiramente casualizado, com duas doses de silicato de cálcio (0 e 100% de acordo com a calagem do solo), com duas lâminas de irrigação (30 e 100% de reposição de água necessária no solo) e duas cultivares de milho: a (cv. BRS-1010) considerada sensível ao estresse hídrico e a (cv. DKB-390) tolerante ao estresse hídrico, com quatro repetições. Estudamos a produção de matéria seca em folhas e caule, o peso de 1000 sementes e o rendimento da cultura. Medimos a eficiência das trocas gasosas e do uso da água para comparar os diferentes tratamentos. Os resultados para matéria seca do caule e das folhas foram melhores em ambas as cultivares, quando utilizadas o silicato de cálcio, independente da lâmina de irrigação. As duas cultivares de milho estudadas, cv. BRS-1010 tolerante ao estresse hídrico e o DKB-390 tolerante ao estresse hídrico apresentaram maior produção na presença de silicato de cálcio, quando a menor lâmina de água foi aplicada. A maior eficiência no uso da água foi obtida no tratamento com silicato de cálcio, utilizando 30% de irrigação. A cv. DKB 390 foi a mais produtiva, com maior tolerância ao déficit hídrico.

PALAVRAS-CHAVE: *Zea mays* L. Irrigação. Matéria seca. Produção. Híbridos.

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