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PHYSIOLOGY AND MINERAL COMPOSITION OF JUÇARA PALM CONSORTIATED WITH DIFFERENT ARBOREAL SPECIES

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ABSTRACT

The present study was carried out in an agroforestry system (SAF) with the objective of evaluating the physiological aspects of plant growth and the nutritional status of Juçara Palms. The forest stand was made up of blocks at random, with five treatments and four replications, in the scheme of subdivided plots, which constituted the treatments. Each plot was composed of 100 trees, 100 palm trees and 200 coffee trees, distributed in 10 lines with 10 trees, 10 palm trees and 20 coffee trees. The spacing was 3 x 2 m between trees and palm trees and 3 x 1 m between coffee trees, totaling 600 m² per plot and 1.2 ha in total. The observed variables were: internal carbon concentration, stomatal conductance, liquid photosynthesis rate, transpiration rate and water use efficiency (WUE), performed at 180 and 240 days after planting. For the *Ci* and $g_s$variables there was an interaction between the treatment and season factors and that only the treatment with Ipê-tobacco did not show any difference in the internal CO_2 concentration in the analyzed Juçara plants. For the other treatments, the Ci verified in March 2020 was higher than that of September 2019. For variables *A, E* and *A* / E there was no interaction, but an isolated effect of the season factor. The internal concentration of carbon, the rate of liquid photosynthesis, the rate of transpiration and the stomatal conductance of plants in Juçara increases with the increase in water availability, and the treatments with Araribá and Ipê-tabaco presented, in general, the best results. The treatment with Ipê-tabaco showed the best nutritional status, considering all the evaluated nutrients together, and the joint evaluations of January 2020 showed results superior to the evaluations of September 2019.

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INTRODUCTION

Agroforestry systems (SAFs) appear as an agroecological activity of food production, combining tree species; fruit and / or timber, concomitantly or in a time sequence, providing ecological and economic benefits, mainly in the style of family farming, presenting as main advantages, when compared to conventional agriculture, the better use of available areas in rural properties, the recovery soil fertility, increased biodiversity, the provision of green manure and the control of invasive plants (PALUDO & COSTABEBER, 2002). Within this concept, agroforestry systems (SAF's) can contribute to the carbon sequestration process due to their stratified and diversified structural attributes in the use of plant species. The Juçara palm (*Euterpe edulis Martius*), a fruit native to the Atlantic Forest, represents one of the most used species in agroforestry systems, being used in these management systems in the south and southeast of Brazil, in consortia with exotic and native tree species, (FAVRETO, 2010; GODINHO, 2014), as a way to enhance the use of land during the initial phase of development of the species and generate Forestry Wood Products (PFM) and Non-Wood Forestry Products. The concern with extinction has led to the appreciation of Juçara for fruit production and pulp extraction, very similar to that of Açaizeiro fruits, produced in the Amazon (FARIAS, 2009). However, plants are subject to the most diverse environmental influences. Regardless of the discussions about tolerance or the need for shade in the first three years of planting the Juçara palm, studies show that light levels and soil moisture conditions are determining factors in limiting the growth of plants, which present a better development at the same time. half shade in the initial phase of life, but show accelerated growth with increased brightness from the fourth year of planting. What can be safely said is that the Juçara palm needs a certain level of humidity to survive (GUIMARÃES & SOUZA, 2017). Generally, water, as an essential factor for the growth and development of plants, functions as one of the main metabolic reagents (TAIZ & ZEIGER, 2017). Thus, in circumstances of water deficit, palm trees exhibit a certain intolerance to the condition, presenting responses that seek their preservation. Among such responses, in the morphological aspect, it is probable that a reduction in the vegetative growth, in the diameter, in the number of leaves emitted, less production of dry matter and even mortality of plants is observed. (MAR et al. 2013; SILVESTRE et al., 2016; SILVESTRE et al., 2017; OLIVEIRA et al., 2017). The physiological adaptation necessary for survival causes a decrease in the rate of CO_2 assimilation, stomatal conductance and the rate of transpiration as a way to avoid dehydration and, consequently, plant mortality (SILVESTRE et al., 2016). According to Silva et al. (2010), with regard to water relations and gas exchanges, the influx of CO_2 necessarily occurs through the stomata via the photosynthetic process, which also occurs, through transpiration, the efflux of water, which has the stomatic movement as main mechanism for controlling gas exchange in higher plants. So, the possible limitation of stomatal conductance and transpiration is due to stomatal closure caused by the low availability of water in the soil, favoring the reduction of photosynthesis rate. Research results involving physiological and nutritional aspects of the Juçara palm are scarce. Seeking to fill this gap, the experiment conducted in an agroforestry system (SAF), from Juçara in consortium with Araucaria, Jatobá, Araribá, Ipê-tabaco and Eucalyptus, was carried out with the objective of evaluating the physiological aspects of plant growth and the nutritional status of palm Juçara in different treatments and times.

MATERIAL E MÉTODOS

The experiment was installed at Sítio Highland located in the district of Victor Hugo, in the municipality of Marechal Floriano, ES, central mountain region, in the territory of the mountains and waters of Espírito Santo. The climate is tropical in altitude, with mild temperatures over most of the year averaging 18.6°C, ranging from 9.3°C to 28°C (INCAPER, 2019). The index of rainfall is 1,525.60 mm per year, well distributed, with the rainiest months from November to April and the least rainy months being June, July and August (INCAPER, 2019). According to the Köppen classification, the climate is Cfb (ALVARES et al., 2013). The region has a steep slope. The soil is basically Latossolo Vermelho-Amarelo Distrófico sandy and sandy-clay, and its chemical composition is expressed in Table 1. The main water source is the Jucú River South Arm and its affluent Rio Fundo. The study area is located at a height of 940 m, with a total area of 1.2 ha (Latitude 40º51'25,99 ”W - Longitude 20º25’43,11” S). The forest stands consisted of random blocks, with five treatments and four replications, totaling 20 experimental plots, being installed in an experiment in the sub-subdivided plot scheme, where the plots constituted the treatments: Araucária (Araucaria angustifolia) intercropped with Palmeira Juçara (Euterpe edulis) and Café Arabica (Coffea arabica); Jatobá (Hymenaea courbaril) combined with Palmeira Juçara and Café Arabica; Araribá (Centrolobium tomentosum) combined with Palmeira Juçara and Café Arabica; Ipê-tabaco (Zeyheria tuberculosa) combined with Palmeira Juçara and Café Arabica; Eucalyptus (Eucaliptus cloeziana) intercropped with Palmeira Juçara and Café Arabica. Each plot was composed of 100 trees, 100 palm trees and 200 coffee trees, distributed in 10 lines with 10 trees, 10 palm trees and 20 coffee trees. The spacing was 3 x 2 m between trees and palm trees and 3 x 1 m between coffee trees, totaling 600 m² per plot and 1.2 ha in total.

For measurements, a double border was considered, with the useful portion of 6 lines with 6 trees, totaling 36 useful trees and 6 lines with 6 palm trees, totaling 36 useful palm trees. Coffee plants have not been evaluated, they have only been maintained in the area to provide better microclimate growth conditions for trees and palms. The seedlings of the trees and palm trees were planted in the same planting line as the coffee, avoiding modifying the accessibility in the treatments. This arrangement of trees and palms in the treatments facilitated the cultural treatment between the planting lines, as carried out in commercial plantations.

Table 1. Chemical and textural composition of the soil at a depth of 0 to 20 cm from the soil at the experiment site, Marechal Floriano, ES

Soil Atributes	Location
	Marechal Floriano
pH	5.6
P Mehlich 1 (mg dm^{-3})	5.9
K (mg dm^{-3})	59.1
Na (mg dm^{-3})	15.5
Ca ($cmol_c$ dm^{-3})	3.35
Mg ($cmol_c$ dm^{-3})	1.42
Al ($cmol_c$ dm^{-3})	0.20
H + Al ($cmol_c$ dm^{-3})	7.13
SB ($cmol_c$ dm^{-3})	4.99
t ($cmol_c$ dm^{-3})	5.19
CTC ($cmol_c$ dm^{-3})	12.11
V (%)	41.24
m (%)	4.69
ISNa (%)	1.36
MO (dag kg)	4.63
P-rem (mg L)	8.68
Zn (mg dm^3)	2.63
Fe (mg dm^3)	127.09
Mn (mg dm^3)	5.88
Cu (mg dm^3)	0.43
B (mg dm^3)	0.91
Thick sand (g kg)	447
Thin sand (g kg)	130
Silt (g kg)	116
Clay (g kg)	307

* Average of four repetitions. pH in water - Ratio 1: 2.5; P - Na - K - Fe - Zn - Mn - Cu - Mehlich-1 Extractor; Ca - Mg - Al - KCL Extractor - 1mol.L-1; H + Al - Correlation with pH SMP; B - Hot water extractor; SB - Sum of exchangeable bases; t - Capacity of effective cation exchange; T - Cation exchange capacity at pH 7 (CTC); V - Base saturation index; m = Aluminum saturation index; ISNa - sodium saturation index; MO - Organic matter (C.org x 1.724); P-rem - Remaining or equilibrium phosphorus. Source: the authors.

The experimental design adopted was that of random blocks (DBC), in the scheme of sub-subdivided plots, with the treatment associated with the plot, the subplot associated with the season and the subplot associated with the time, with each evaluated plant representing a repetition. The following physiological variables were quantified: internal carbon concentration (C_i, em µmol m^{-2} s^{-1}), stomatal conductance (g_s, em mol de H_2O m^{-2} s^{-1}), liquid photosynthesis rate (*A*, em µmol de CO_2 m^{-2} s^{-1}) and the transpiration rate (*E*, em mmol de H_2O m^{-2} s^{-1}). Gas exchange assessments were carried out at two times and two times; two evaluations were carried out in September 2019 and another two in March 2020, always in the middle region of the last fully expanded leaf, always at 8:00 am and 12:00 pm. The results presented are the averages of the two readings at each time. In addition to the variables analyzed, the instantaneous efficiency in the use of water USA was also calculated, through the ratio between the values of the liquid photosynthesis rate and the respiration rate (*A/E*) [(µmol de CO_2 m^{-2} s^{-1}) / (mmol de H_2O m^{-2} s^{-1})]. Gas exchange determinations were performed using an infrared gas analyzer (IRGA), model LCPro-SD from ADC BioScientific Ltda, with an air flow of 300 mL min-1 and a coupled light source of 1200 µmol m^{-2} s^{-1}.During the period in which the gas exchange assessments were carried out, the average temperature was 17.8 ° C in the first assessment and 19.9 ° C in the second assessment and the average relative humidity of the air was 77.5 % and 82%, respectively. To determine the levels of N, P, K, Ca, Mg, S, Fe, Cu, Ni, Mn, Mo and Zn, the leaflets were cleaned and dried in an oven at 65°C, with forced air circulation. After drying, the leaves were ground in a Willey-type micro mill, sieved at 20 *mesh* and homogenized. For nutrient analysis, five leaflets were collected, in fully expanded leaves (second pair of leaves counted from the apex), from five palm trees in each treatment, using scissors, always sectioning them when inserting the leaflets and petioles, collected in the months of September 2019 and March 2020. The result of the chemical and textural analysis of the soils (Table 1) was used for their characterization, being carried out according to the methodology described by Embrapa (2009). The result of the chemical and textural analysis of the soils (Table 1) was used for their characterization, being carried out according to the methodology described by Embrapa (2009). The levels of ammoniacal nitrogen (N) were determined after digestion of the material with sulfuric acid, by spectrophotometry, using a Nessler-type reagent and sodium tartrate for color development. The contents of phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), copper (Cu), nickel (Ni), manganese (Mn), molybdenum (Mo) and zinc (Zn) were determined after open digestion with concentrated nitric acid and hydrogen peroxide and quantified in plasma (ICPE-9000) of the Shimadzu® brand. The data collected were subjected to analysis of variance by the F test. The average values obtained for the species were compared by the Tukey test at a level of 5% probability.

RESULTS AND DISCUSSIONS

The analysis of variance revealed that, for the variables *Ci*andg_s, there was an interaction between the factors under study, Treatment and Period (Table 2). Table 2 shows that only the treatment with Ipê-tabaco showed a statistical difference in the internal CO_2 concentration in the analyzed Juçara plants. For the other treatments, the Ci verified in March 2020 showed no statistical difference, being greater than that of September 2019. In the period of greatest water availability, March 2020, the plants of the different treatments showed an increase in conductance stomata, contributing to the increase in assimilated carbon and perspiration. In September 2019, stomatal conductance showed no statistical difference between treatments. However, in the March 2020 evaluation, treatment with Araribá showed the best result with statistical difference for treatments with Jatobá and with Eucalyptus, but without statistical difference for treatments with Araucária and with Ipê-tabaco. In the period of greatest water availability, March 2020, the plants of the different treatments showed an increase in stomatal conductance contributing to the increase in assimilated carbon and transpiration. In the period of lowest rainfall, in September 2019, plants have limited stomatal opening, compromising the photosynthetic process (BARTELS & SUNKAR, 2005). This limitation, according to Flexas &Medrano (2002), portrays the main cause of the decrease in the photosynthetic rate and assimilation of CO_2 (*A*), and transpiration (*E*) under conditions of water scarcity, thus decreasing the speed of the other physiological processes, with less plant growth (SILVA et al., 2016). In March 2020, the plants analyzed in all treatments, showed higher values of internal CO_2 concentration and stomatal conductance, when compared with the values observed in September 2019, confirming the explanations of Silva (2010), stating that stomatal conductance it is closely associated with the net CO_2 assimilation rate, and the low values may be related to the limited opening of the stomata.

The correlation between CO_2 assimilation and stomatal conductance can be explained due to the high concentration of carbon dioxide in the plants' carboxylation sites, as reported by Campostrini and Yamanishi (2001). In conditions of low stomatal conductance, carbon fixation is decreased, in order to impair the metabolism and transport of carbohydrates throughout the tissues (BEL, 1992). In palm trees, the sensitivity of the net CO_2 assimilation rate to water deficiency is verified in species such as Pupunheira (*Bactris gasipaes Kunth*), Açaí (*Euterpe oleracea Mart.*), Coqueiro-anão (*cocos nucifera L.*), Buriti (*Mauritia vinífera Mart.)*and Dendê (*Elaeis guineenses Jacq.*), portraying reduced growth and accumulation of dry matter, according to Chaves et al. (2009). According to Tavares (2017), in shaded environments, species such as Juçara can invest more in leaves as a way to increase the capture of light, thus improving physiological processes. The results presented in Table 3 demonstrate statistical differences for the variables net photosynthesis rate (*A*) and transpiration rate (*E*) in the plants analyzed in the months of September 2019 and March 2020, respectively.

Table 2. Internal carbon concentration (c_i) and stomatal conductance (g_s)

Treatment	Period			
	Sep/2019	Mar/2020	Sep/2019	Mar/2020
	Ci		g_s	
Araucária	182.88 bB	303.81 aA	0.028 bA	0.062 aA
Jatobá	197.31 bB	271.88 aA	0.024 aA	0.037 aB
Araribá	198.69 bB	312.38 aA	0.023 bA	0.065 aA
Ipê-tabaco	277.75 aA	304.87 aA	0.025 bA	0.047 aAB
Eucalyptus	198.88 bB	306.94 aA	0.018 bA	0.045 aAB
CV%	18.60%		36,31%	

Ci - internal carbon concentration (in µmol m^{-2} s^{-1}), g_s - stomatal conductance (in mol ofH_2O m^{-2} s^{-1}); Average values followed by distinct letters, lower case in the lines and upper case in the columns differ by Tukey's test at 5% probability.

Table 3. Variables within the Period factor

Period	A	E	A/E
Set/19	2.57 a	0.58 b	4.57 a
Mar/20	2.07 b	0.87 a	2.43 b
C.V%	45.68	35.0	35.51

Rate of liquid photosynthesis (*A*, in µmol of CO_2 m^{-2} s^{-1}) and the rate of transpiration (*E*, in mmol of H_2O m^{-2} s^{-1}); A/E - instant water use efficiency. Average values followed by distinct letters in the columns differ by Tukey's test at 5% probability.

Table 4. Variables within the Treatment factor

Treatment	A	E	A/E
Araucária	3.12 a	0.796 a	4.16 a
Jatobá	1.88 b	0.723 a	2.80 b
Araribá	2.38 ab	0.780 a	3.52 ab
Ipê-tabaco	2.27 ab	0.729 a	3.16 ab
Eucalyptus	1.95 b	0.591 a	3.88 ab
CV%	45.68	35.10	35.51

Ci – internal carbon concentration (c_i, in µmol m^{-2} s^{-1}), liquid photosynthesis rate (*A*, in µmol of CO_2 m^{-2} s^{-1}) and the transpiration rate (*E*, in mmol de H_2O m^{-2} s^{-1}). Stomatal conductance (g_s, in mol of H_2O m^{-2} s^{-1}); A/E - instant water use efficiency. Average values followed by different letters differ by Tukey's test by 5% probability.

The rate of net photosynthesis was higher and the rate of transpiration lower than the values found in March 2020 in the analyzed plants, reflecting in a better efficiency in the use of water, considering the average temperature and relative humidity of the air. For variables *A, E* and *A/E* there was no interaction, but it has an isolated effect of the Period factor. For variable *A*, there was an isolated effect for the Treatment and Time factors (Table 4) and (Table 5). In the evaluation of the internal carbon concentration, the treatment with Ipê-tabaco presented the best result with statistical difference for the treatments Araucaria and Jatobá, but without statistical difference for the treatments with Araribá and Eucalyptus. For liquid photosynthesis rate and stomatal conductance, the treatment with Araucaria showed the best result with statistical difference for treatments with Jatobá and Eucalyptus, but without statistical difference for treatments with Araribá and with Ipê-tabaco. There was no statistical difference in the transpiration rate between treatments (Table 4).

composition of the plants, the analysis of variance indicated that there were significant differences for the levels of N, P, Ca, Mg and Mn between treatments (Table 6), for the other mineral elements evaluated there was no statistical difference. It is observed in Table 6, that the treatment with Ipê-tabaco showed statistically superior results for all nutrients in general, but without statistical difference for some treatments. The treatments with species of the botanical family leguminosae, Araribá and Jatobá, presented higher values of nitrogen. Such N values can be explained by the possible symbiotic association of legumes with nitrogen-fixing bacteria, which can incorporate more than 500 kg.ha^{-1}year^{-1} of N to the soil-plant system, which, together with phosphorus, are the nutrients that most limit plant development (SIQUEIRA & FRANCO, 1988). For the P content, only the eucalyptus treatment was statistically inferior to the Ipê-tabaco treatment. For calcium, the treatments with Jatobá and Araribá showed a statistical difference for the treatment with Eucalyptus.

Table 5. Variables within the Time factor

Time	C.i.	A	E	g_s	A/E
8 h	242.09 b	2.72 a	0.717 a	0.040 a	4.04 a
12 h	268.99 a	1.92 b	0.731 a	0.035 a	2.97 b
C.V%	18.60	45.68	35.10	36.31	35.51

Ci – internal carbon concentration (c_i, in µmol m^{-2} s^{-1}), liquid photosynthesis rate (*A*, in µmol of CO_2 m^{-2} s^{-1}), transpiration rate (*E*, in mmol of H_2O m^{-2} s^{-1}), stomatal conductance (g_s, in mol of H_2O m^{-2} s^{-1}); A/E - instant water use efficiency. Average values followed by a distinct letter in the column differ by Tukey's test at 5% probability.

Table 6. Content of macronutrients in Juçara leaves, in g/kg of dry matter, in the different treatments

Treatment	N	P	K	Ca	Mg	S
Araucária	16.3 bc	1.87 ab	9.76 a	4.90 ab	2.44 a	2.30 a
Jatobá	18.5 ab	1.89 ab	10.01 a	4.18 b	1.99 b	2.35 a
Araribá	19.0 a	1.95 ab	9.43 a	4.22 b	2.15 ab	2.35 a
Ipê-tabaco	17.7 abc	2.11 a	10.40 a	5.12 ab	2.04 ab	2.56 a
Eucalipto	15.9 c	1.77 b	9.15 a	5.35 a	2.20 ab	2.57 a
CV%	10.88	11.32	10.32	10.33	13.24	11.97

N - Nitrogen g kg, P - Phosphorus g kg, Ca - Calcium g kg, Mg - Magnesium g kg, Mn - Manganese mg kg. Average values followed by distinct letters in the columns differ by Tukey's test at 5% probability.

Table 7. Content of micronutrients in Juçara leaves, in g/kg of dry matter, in the different treatments

Treatment	Fe	Cu	Mn	Mo	Ni	Zn
Araucária	153.8 a	9.69 a	20.3 ab	1.33 a	2.39 a	33.71 a
Jatobá	119.0 a	8.71 a	16.4 b	1.21 a	1.06 a	27.62 a
Araribá	112.6 a	9.69 a	19.5 ab	1.20 a	1.29 a	29.37 a
Ipê-tabaco	127.3 a	9.34 a	28.3 ab	1.30 a	1.34 a	33.30 a
Eucalipto	142.0 a	8.35 a	35.2 a	1.30 a	1.06 a	29.47 a
C.V.%	36.80	16.80	52.08	31.19	94.58	15.90

Cu - copper; Mn - manganese; Mo - molybdenum; Ni - nickel; Zn - zinc; Fe - iron.Average values followed by distinct letters in the columns differ by Tukey's test at 5% probability.

Table 8. Content of micronutrients in juçara leaves, in mg / kg of dry matter, at different times

Period	Fe	Cu	Mn	Ni	Zn
Sep/19	146.5 a	7.64 b	33.64 a	1.94 a	27.95 b
Jan/20	115.4 b	10.67 a	14.20 b	0.92 b	33.44 a
C.V%	36.77	16.80	52.08	94.58	15.90

Fe - iron mg kg; Cu - copper mg kg; Mn - manganese mg kg; Ni - nickel mg kg; Zn - zinc mg kg.Average values followed by distinct letters in the columns differ by Tukey's test at 5% probability

Table 9. Content of micronutrients in Juçara leaves, in g/kg of dry matter, in the different treatments

Treatment	Fe	Cu	Mn	Mo	Ni	Zn
Araucária	153.8 a	9.69 a	20.3 ab	1.33 a	2.39 a	33.71 a
Jatobá	119.0 a	8.71 a	16.4 b	1.21 a	1.06 a	27.62 a
Araribá	112.6 a	9.69 a	19.5 ab	1.20 a	1.29 a	29.37 a
Ipê-tabaco	127.3 a	9.34 a	28.3 ab	1.30 a	1.34 a	33.30 a
Eucalyptus	142.0 a	8.35 a	35.2 a	1.30 a	1.06 a	29.47 a
C.V.%	36.80	16.80	52.08	31.19	94.58	15.90

Cu - copper; Mn - manganese; Mo - molybdenum; Ni - nickel; Zn - zinc; Fe - iron. Average values followed by distinct letters in the columns differ by Tukey's test at 5% probability.

In the Time factor, the rate of transpiration and stomatal conductance did not show statistical difference between the hours evaluated, and the other variables analyzed showed a statistical difference between the hours of eight and twelve hours (Table 5). In the mineral

In the magnesium evaluation, only the treatments with Araucária and Jatobá showed a statistical difference, whereas for manganese the statistical difference was between Jatobá and Eucalyptus (Table 6). For nitrogen, phosphorus and sulfur evaluation, the values found in the January 2020 evaluation showed results statistically superior to the September 2019 evaluation (Table 7). The other macronutrients evaluated showed no statistical difference. In the micronutrient evaluation, Mn, Mo, Ni and Fe showed statistically higher values for the September 2019 evaluation, whereas in the January 2020 evaluation, Cu, and Zn were statistically higher than in the September 2019 evaluation. In the micronutrient evaluation, Mn, Mo, Ni and Fe showed statistically higher values for the September 2019 evaluation, whereas in the January 2020 evaluation, Cu, and Zn were statistically higher than in the September 2019 evaluation. Molybdenum there was no significant difference at different times (taBle 8). Regarding the micronutrient content in the different treatments, there was no study of mineral composition in Juçara leaves in consortium systems so that comparisons could be made. In the present study, only manganese showed a statistical difference between the average values of Jatobá and Eucalyptus (Table 9). Differences were found in the internal carbon concentrations, in stomatal conductance and in the liquid photosynthesis rate of Juçara plants depending on the consortium used. The levels of N, P, Ca, Mg and Mn varied in the leaves of Juçara according to the consortium used. Juçara plants with 2 years of planting, presented, in g / kg of dry matter of leaves: N = de 15.9 a 19.0; P = 1.77 a 2.11; K = 9.15 a 10.40; Ca = 4.18 a 5.35; Mg = 1.99 a 2.44; S = 2.30 a 2.57. Juçara plants with 2 years of planting, presented, in mg/kg of dry matter of leaves: Fe = de 119 a 153.8; Cu = 8.35 a 9.69; Mn = 16.4 a 35.2; Mo = 1.20 a 1.33; Ni = 1.06 a 2.39; Zn = 27.60 a 3370.

CONCLUSION

The internal concentration of carbon, the rate of liquid photosynthesis, the rate of transpiration and the stomatal conductance of Juçara plants increases with the increase in water availability, and the treatments with Araribá and Ipê-tabaco presented, in general, the best results. The treatment with Ipê-tabaco showed the best nutritional status, considering together all the evaluated nutrients, and the joint evaluations of January 2020 showed results superior to the evaluations of September 2019. The treatment with Araucaria showed the best index of net photosynthesis rate in the analyzed Juçara plants.

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