

ORIGINAL ARTICLE

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Growth and nutritional status and quality of *Khaya senegalensis* seedlings

Crescimento e qualidade nutricional de mudas de Khaya senegalensis

ABSTRACT: Due to the shortage of information on both mineral fertilizer and organic substrate in *Khaya senegalensis*, it was proposed in the current study to verify the potential of the use or not of addition of nutrient solution in the production of high quality seedlings of *K. senegalensis* as well as to obtain the total accumulation of macro and micronutrients in the seedlings. The experimental design was completely randomized in a factorial 2x6, being the first factor constituted by the presence and nutritious solution absence of and the second factor for times evaluation (0, 60, 80, 100, 120 and 140 days after transplanting) repetitions with four seedlings. The following growth traits (height, stem diameter and shoot and root dry mass) and seedling quality parameters (total dry mass and Dickson quality index). The addition of nutrient solution supported the increase of the determined morphological characteristics of the seedlings of *K. senegalensis* as well as the total accumulation of macro and micronutrients. The nutrient solution modifies the absorption dynamics of nutrients in *K. senegalensis* and the amount absorbed at 140 days after transplantation obeys according to the order: N>K>P>Ca>S>Mg> Fe>B>Mn>Zn>Cu.

RESUMO: Em razão da escassez de informações sobre fertilizante mineral e substrato orgânico em *Khaya senegalensis*, propôs-se no presente estudo verificar o potencial do uso ou não de adição de solução nutritiva na produção de mudas de *K. senegalensis* com alta qualidade, bem como obter o acúmulo total de macro e micronutrientes nas plântulas. O delineamento experimental utilizado foi o inteiramente casualizado, em esquema fatorial 2x6, sendo o primeiro fator constituído pela presença e ausência de solução nutritiva e o segundo fator pelas épocas de avaliação (0; 60; 80; 100; 120 e 140 dias após o transplantio), com quatro repetições. As plantas foram avaliadas características de crescimento (altura, diâmetro de caule e massa seca da parte aérea e radicular) e parâmetros de qualidade de mudas (massa seca total e índice de qualidade de Dickson). A adição de solução nutritiva favorece o incremento das características morfológicas determinadas das mudas de *K. senegalensis*, bem como no acúmulo total de macro e micronutrientes. A solução nutritiva modifica a dinâmica de absorção dos nutrientes em *K. senegalensis* e a quantidade absorvida aos 140 DAT segue conforme à ordem: N>K>P>Ca>S>Mg>Fe>B>Mn>Zn>Cu.

1 Introduction

The motive power of forest activity is the demand for its several products. According to FAO (2016), in 2012, the world forest sector contributed approximately US\$ 468 billion or 1% of the global gross domestic product. Together, the largest countries (Russia, Canada, China, United States and Brazil) account for over a half the global area of the terrestrial globe. The Brazilian participation in the world exports of the aggregate of forest products is growing over time, the most significant sectors of the aggregate of the world exports of forest products in decreasing order, were the segments of cellulose, sawn wood, paper and cardboard, wood boards, wood for industrial purposes and wood for energy (Coelho Junior et al., 2013).

One of the exotic tree-like species which has been gaining prominence is the Senegal mahogany. This species occurs place naturally in several countries of the African continent. The *K. senegalensis* wood is hard, heavy, durable and possesses drawings of great beauty, which justifies its use in furniture making as well as in interior decoration (Lamprecht, 1990). *K. senegalensis* begins to bear seeds between 15 and 20 years of age (Lamprecht, 1990).

For being an exotic plant and due to the long time for seed bearing, the commercial reforestations of *K. senegalensis* in Brazil have been done from imported seeds; which creates dependence on international stocks, generating importation costs. Owing to that, the countries with an expressive participation in the agenda of exports, as Brazil, should search new technologies in the production of high quality seedlings in order to raise the production of forest sites.

The great importance of the use of high quality inputs in all the production chain is known both in plant and livestock production and in the forest sector and when it is concerned with seedlings, this is no exception. High quality seedlings are essential to warrant the success of the revegetation action, germplasm rescue and establishment of forest stands, whether with commercial or conservationist purposes. Likewise, the definition of strategies which support the production of high quality seedlings in short time intervals is of outstanding importance (Cunha et al., 2005).

The quality pattern of seedlings can be evaluated and reached in a practical, fast and easy manner by following several morphological parameters. Cruz et al. (2016) suggest as main morphological parameters to determine the quality of forest seedling, the shoot height, the stem diameter in the root collar region, the ratio shoot height/root collar diameter and as physiological parameters, Medeiros et al. (2016) pointed out the nutritional status.

These developmental parameters can be put together into a single value through the Dickson Quality Index, increasing the safety in the selection of the most vigorous plants (Reis et al., 2016). The evaluation of those characteristics can be a useful tool to verify whether the seedlings are enough fit for survival after transplanting in field (Duarte et al., 2015).

Added to this, many times, in the process of seedling production, use of organic materials is done, aiming at the obtaining of greater increases in production (Antunes et al., 2016). The addition of nutrient sources in the composition of substrates, a example of nutrient solution containing the macro and micronutrients, is fast, practical and economical manner, being able to contribute towards the improvement of the

cultivation medium, having in mind, the greatest homogeneity and growth of seedlings with a high quality standard.

As far as the formation of seedlings is concerned, Corcioli et al. (2014) reported that the African mahogany presents marked reduction in the initial growth by means of the absence of phosphorus furnishing (P). The studies do not determine the optimal dose of that nutrient for the formation of the seedlings of that species. In addition, the results of the works about the response of the mahogany seedlings to the ideal fertilization are contrasting (Silva et al., 2007; Tucci et al., 2007; Santos et al., 2008; Souza et al., 2010; Silva et al., 2011), pointing out the need for further studies.

In this context the importance of mineral fertilization in the production of forest species, it was proposed in the present work to verify the utilization potential or not of addition of nutrient solution in the seedlings of *K. senegalensis* with high quality as well as to obtain the total accumulation of macro and micronutrients.

2 Materials and Methods

The research was conducted at Embrapa Roraima in the period of January to June of 2013 in the dependences of the seedling nursery, situated on BR 174, Km 8, Industrial District, under the geographic coordinates of reference 02°45'28"N and 60°43'54"W and 90 m of altitude. Boa Vista lies in the Tropical Climate Tropical Zone, the climate in the region is according to Köppen, of the Aw type: (rainy tropical with a short dry period) annual average rainfall between 1700-2000 mm. The rainy period occurs more often from April to August with monthly totals higher than 100 mm (Smiderle et al., 2015). From September on, reduction occurs with characteristically dry periods taking place more often from November to March (Tonini, 2011). The average annual temperature is of 27°C (Smiderle et al., 2015).

The species utilized was *K. senegalensis* A. Chev, with seedlings coming from seeds of stock plants of the Brazilian Institute of Forest (IBF). The experimental design was completely randomized in a factorial 2x6, being the first factor constituted by the presence and nutritious solution absence of and the second factor for times evaluation (0, 60, 80, 100, 120 and 140 days after transplanting) repetitions with four seedlings. The plants were grown in pots polypropylene pots with 4 L of capacity, containing as a substrate a thin layer (five cm) of pebble for better drainage and completed with ORG: Organoamazon® substrate (Table 1), commercial organic compound, which according Chagas et al. (2014) has in its composition (organic fertilizer 100% natural and regional, composed by cattle, horse, hen and sheep manure, aged and carbonized rice hull, peat, cane bagasse, grass clippings, galls and foliages).

The plants were conveniently spaced and maintained in nursery with 50% of shading (black shading 50%) with sprinkling irrigation at every five hours during day, each irrigation lasted five minutes. the plants were given weekly two waterings of 200 mL of nutrient solution according to Souza et al. (2015), at the end of the last watering to avoid nutrient leaching. Every 20 day, the seedlings of *K. senegalensis* were submitted to the data collection concerning both height and diameter. The height values of the seedlings were obtained by measuring with a millimeter ruler from soil level to the apical meristem whereas

for the collar diameter, the measures were taken with a digital from soil level.

Then each seedling was divided into leaves, stem and root and each part of the plant was washed in running water and packed into paper bag, remaining in drying oven at 60- 65 °C, with air circulation to obtain constant mass (72 h). After dried, they were weighted in analytical balances with precision of 0.01 g for determination of the dry matter mass of the shoot (MSPA) and of the roots (MSSR) and through the summation of these, total dry matter mass of the plant (MST) They were, then, ground in Willey type grinder and sampled for quantification of the contents of macro (N, P, K, Ca, Mg and S) and micronutrients (B, Cu, Fe, Mn and Zn) in accordance with methodologies described in Malavolta et al. (1997). The amount of each nutrient absorbed by the plant was obtained by the summation of the amounts accumulated in the

shoot (leaves and stem) and contents in the root. The nutrient accumulation in each part was calculated e by multiplying the respective dry mass by the concentration of each nutrient. For quality of the seedlings, the Dickson quality index (IQD) was determined (Dickson et al., 1960).

The results of the variables evaluated were submitted to the analysis by the statistic program Sisvar (Ferreira, 2011), performing the variance analysis and regression analysis for the factor time and Tukey's test at 5% of probability.

3 Results and Discussion

The means obtained for all the morphological traits and the quality indices of the seedlings evaluated in this experiment (Table 2) presented significant effect with each other and in all the evaluation schedules. The average growth of the seedlings

Table 1. Chemical analysis, micronutrients and particle size of the substrate utilized in the growth of *K. senegalensis*.

Tabela 1. Análise química, micronutrientes e granulometria do substrato utilizado no crescimento da *K. senegalensis*.

Sub ⁽¹⁾	pH	Exchangeable cations ⁽²⁾								V	M	P	OM
		Ca ²⁺	Mg ²⁺	K ⁺	Al ³⁺	H+Al	S	t	T				
		----- cmol _e dm ⁻³ -----								--- % ---		mg dm ⁻³	g kg ⁻¹
ORG	5.8	10.5	7.9	1.6	-	2.08	20	20	22	90.6	-	176.77	69.2
Sub		Micronutrients ⁽³⁾						Particle size					
		Zn	Fe	Mn	Cu	B	S	Clay	Silt	Sand			
		----- mg dm ⁻³ -----						-----g kg ⁻¹ -----					
ORG		19.5	27.08	124	0.3	0.33	19.0				170	290	540

⁽¹⁾Substrate: ORG: Organoamazon®. ⁽²⁾pH in water (1:2,5); Ca²⁺, Mg²⁺ e Al³⁺: KCl 1 mol L⁻¹ extractor; K⁺ and P: mehlisch-1 extractor; H+Al: SMP extractor; M.O.: organic matter – oxidation Na₂Cr₂O₇ 4N + H₂SO₄ 10N; S: sum of exchangeable bases; t: effective cation exchange capacity (CTC); T: CTC at pH 7,0; V: basis saturation basis; m: aluminum saturation index. ⁽³⁾Zn, Fe, Mn and Cu: mehlisch-1 extractor; B: hot water extractor; S: monocalcium phosphate extractor in acetic acid.

Table 2. Height (H), collar diameter (CD, mm), shoot dry matter mass (MSPA, g), root dry matter mass (MSSR), total dry mass (MST) and Dickson quality index (IQD) obtained in seedlings of *K. senegalensis* with and without application of nutrient solution (NS) in different evaluation times.

Tabela 2. Altura (H), diâmetro do coleto (DC), massa de matéria seca da parte aérea (MSPA), massa da matéria seca da raiz (MSSR), massa seca total (MST) e índice de qualidade de Dickson (IQD) obtidos em mudas de *K. senegalensis* sem e com aplicação de solução nutritiva (SN) em diferentes épocas de avaliações.

SN**	TT	Times***	H		CD		MSSR		MSPA		MST		IQD	
			cm		mm				g					
S	T1	0	8.20	e*	3.50	f	0.271	e	0.269	f	0.540	f	0.16	f
S	T2	60	26.00	d	7.11	e	1.480	d	3.885	e	5.365	e	0.85	e
S	T3	80	33.00	c	8.27	d	1.945	c	9.240	d	11.185	d	1.28	d
S	T4	100	45.25	b	10.16	c	4.275	b	13.895	c	18.170	c	2.36	c
S	T5	120	48.75	b	11.87	b	5.765	a	21.740	b	27.505	b	3.49	b
S	T6	140	74.25	a	13.35	a	5.810	a	27.845	a	33.655	a	3.25	a
mean			39.24	B*	9.04	B	3.26	B	12.81	B	16.07	B	1.90	B
C	T7	0	8.20	f	3.50	f	0.281	f	0.269	f	0.550	f	0.17	f
C	T8	60	19.00	e	5.95	e	0.870	e	3.885	e	4.685	e	0.62	e
C	T9	80	32.50	d	8.26	d	2.815	d	9.910	d	12.725	d	1.71	d
C	T10	100	44.75	c	12.94	c	4.850	c	15.395	c	20.245	c	3.05	c
C	T11	120	65.75	b	13.71	b	8.590	b	35.465	b	44.055	b	5.01	b
C	T12	140	91.00	a	16.99	a	12.470	a	52.300	a	64.770	a	6.78	a
mean			43.53	A	10.22	A	4.98	A	19.53	A	24.51	A	2.88	A
CV%			3.36		2.77		1.12		0.56		0.54		2.19	

*Means followed by the same small letter in the column and capital letter in the line not differ from one another by the Tukey test at 5% of probability.

Nutrient solution (SN) with (C) and without (S) application. *Evaluation times of seedlings of *K. senegalensis*.

of *K. senegalensis* without the application of nutrient solution was significantly inferior to the other treatments in which the application was done, demonstrating that the application of the nutrient solution favored the greatest plants' growth (Table 2).

From the evaluation schedules in the period 0 till 80 DAT all the morphological traits and the quality indices of the seedlings of *K. senegalensis* presented no differences in the event of the presence or absence of application of nutrient solution, indicating that the species under study possibly has low nutrient requirement in these schedules, indicating that in these treatments likely there was luxury consumption, resulting into fertilizer wastage.

The superiority of the treatment with the addition of nutrient solution can be explained by the immediate availability of nutrients contained in the fertilizers compared with organic ones, which need firstly to be mineralized for nutrient release to occur. As regards the effect of the addition of nutrient solution, greater increases in the morphological characteristics and the quality indices of the seedlings of *K. senegalensis* from the 100 DAT onwards (Table 2).

The greatest shoot yield of dry mass (MSPA), root dry mass (MSSR) and total dry matter mass (MST) were ascribed with the application of nutrient solution at 140 DAT (T12) with values 53.24, 46.59 and 51.96% higher than the T6 without the application of nutrient solution (Table 2), respectively, stressing its high potential as mineral fertilization. Such characteristics are important to reach fast the growth and development of the seedling, being able to the differing parameter in order to warrant improved yield and quality of the seedlings of *K. senegalensis*.

Antunes et al. (2016) reported that mineral and organic fertilization in cultivations of *Acacia mearnsii* presented significant response to total dry matter mass yield of the seedlings and ascribed not only to the mineral contents contained in the fertilizer as well as to a combination of the effects stimulated by the presence of organic and matter and minerals like the increase of microbial activity.

Cruz (2006) working with seedlings of *Samanea inopinata* found that one should consider that the higher the value of total dry mass of the seedling is, the better the quality of the seedlings produced will be, therefore, one can infer that the treatments which were given nutrient solution obtained interference directly and positively in the production of better quality seedlings and therefore, with greater probability of surviving in field.

As far as the IQD is concerned, the same is a good indicator of quality of seedlings, because robustness (ratio H/DC) and the balance of the biomass distribution (ratio MSPA/ MSSR) are utilized for its calculation (Gomes et al., 2013), weighing the results of several important morphological traits employed for the evaluation of quality. Further, to Gomes et al. (2013), the greater the IQD, the better the quality of the seedling produced will be.

The results of the IQD obtained in the present study were similar to those found in *Tabebuia impetiginosa*, the average values of which ranged from 6.21 to 7.25 (Cunha et al., 2005), and are above the proposed by Gomes & Paiva (2006), who advised the IQD higher than 0.2 for seedlings of *Pseudotsuga menziesii* and *Picea abies*. In seedlings of treatment T11 the average value of IQD presented lower index, but not enough to classify them it as poor quality seedlings, since its result lies in the ideal range recommended by Gomes & Paiva (2006). Corroborating also, when compared with the experiment conducted by Gomes et al. (2013) in seedlings of *Tectona grandis*, which presented maximum value of IQD of 1.98 reaching 120 days after the experiment initial. Because, the addition of nutrient solution associated with organic substrate provided greater accumulations of both macro and micronutrients in the seedlings of *K. senegalensis* (Tables 3 and 4).

The accumulations of macro and micronutrients in the seedlings (Tables 3 and 4) resulted into significant differences among the means of the treatments which were not given applications of nutrient solution compared with the treatments which were given applications. As regards the nutrients N, P, K and Ca those were

Table 3. Total accumulation of macronutrients (mg plant⁻¹) in seedlings of *K. senegalensis* in the different evaluation times with and without addition of nutrient solution (SN).

Tabela 3. Acúmulo total de macronutrientes (mg planta⁻¹) em mudas de *K. senegalensis* nas diferentes épocas de avaliação sem e com adição de solução nutritiva (SN).

SN**	TT	Times***	N		P		K		Ca		Mg		S	
S	T1	0	0.062	f*	0.020	f	0.038	f	0.024	f	0.024	f	0.005	e
S	T2	60	10.592	e	2.520	e	6.027	e	3.443	e	1.062	e	1.496	d
S	T3	80	21.163	d	7.507	d	10.664	d	8.876	d	2.033	d	2.348	c
S	T4	100	32.621	c	16.809	c	21.009	c	12.016	c	2.911	c	4.166	a
S	T5	120	55.594	b	25.817	b	36.256	b	25.333	b	4.992	b	3.046	b
S	T6	140	58.916	a	51.070	a	43.607	a	22.287	a	6.416	a	3.040	b
mean			29.82	B*	17.29	B	19.60	B	12.00	B	2.91	B	2.35	B
C	T7	0	0.063	f	0.020	f	0.045	f	0.025	f	0.010	f	0.004	f
C	T8	60	10.749	e	1.740	e	5.068	e	3.893	e	0.858	e	0.746	e
C	T9	80	24.476	d	7.784	d	13.212	d	9.235	d	2.289	d	2.680	d
C	T10	100	41.361	c	18.604	c	18.607	c	21.997	c	4.110	c	4.995	c
C	T11	120	98.959	b	50.293	b	53.242	b	34.689	b	6.987	b	7.871	b
C	T12	140	107.124	a	70.540	a	70.444	a	68.674	a	9.676	a	10.274	a
mean			47.12	A	24.74	A	26.70	A	23.09	A	3.99	A	4.43	A
CV (%)			0.7		1.49		1.7		0.76		2.72		1.76	

*Means followed by the same small letter in the column and capital letter in the line not differ from one another by Tukey's test at 5% of probability. **Nutrient solution (SN), with (C) and without (S) application. ***Times in days, of evaluation of the seedlings of *K. senegalensis*.

Table 4. Total accumulation of micronutrients in seedlings of *K. senegalensis* in the different evaluation times with and without addition of nutrient solution (SN).

Tabela 4. Acúmulo total de micronutrientes em mudas de *K. senegalensis* nas diferentes épocas de avaliações sem e com adição de solução nutritiva (SN).

SN**	TT	Times***	B		Cu		Mn		Zn		Fe	
μg/plant												
S	T1	0	4.475	e*	0.493	f	0.674	f	2.440	f	0.651	f
S	T2	60	49.933	e	10.289	e	24.427	e	72.292	e	210.099	e
S	T3	80	188.478	d	31.303	d	85.130	d	196.160	d	701.690	d
S	T4	100	317.109	c	55.551	c	212.702	c	350.497	c	1527.998	c
S	T5	120	538.294	b	83.810	b	365.863	b	536.115	b	2356.114	b
S	T6	140	780.760	a	112.228	a	505.635	a	642.777	a	3180.676	a
mean			313.17	B*	48.95	B	199.07	B	300.05	B	1329.54	B
C	T7	0	4.349	f	0.486	f	0.717	f	2.399	f	0.653	f
C	T8	60	83.437	e	7.781	e	49.741	e	100.762	e	290.832	e
C	T9	80	222.717	d	32.372	d	205.134	d	288.920	d	986.632	d
C	T10	100	390.024	c	67.578	c	443.993	c	491.124	c	1622.465	c
C	T11	120	869.076	b	144.961	b	839.847	b	697.141	b	2684.091	b
C	T12	140	950.565	a	169.551	a	940.347	a	781.909	a	3628.631	a
mean			420.03	A	70.45	A	413.30	A	393.71	A	1535.55	A
CV (%)			7.20		2.80		2.76		8.85		3.37	

*Means followed by the same small letter in the column and capital letter in the line not differ from one another by Tukey's test at 5% de probability. **Nutrient solution (SN), with (C) and without (S) application. ***Times, in days, of evaluation of the seedlings of *K. senegalensis*.

the most extracted in the seedlings of *K. senegalensis*, which the means among treatments without application of nutrient solution ranged among 29.82; 17.29; 19.60 and 12.00 (mg/plant) respectively and with application of nutrient solution at 47.12; 24.74; 26.70 and 23.09 (mg/plant), respectively (Table 3). Those results, at first, stood out greater requirement of *K. senegalensis* for the macronutrients.

Thereby it was found that the results of the growth parameters obtained on the seedlings were poorer in the absence of the addition of nutrient solution at T1, T2, T3, T4, T5 e T6 (Table 2) for not having had the adequate furnishing of nutrient (Tables 3 and 4). That is explained through the fact that the availability of some nutrients was not enough to meet the requirements of the newest organs.

In a similar way, under nutrient solution conditions, Wallau et al. (2008) found reduction in the growth of mogno seedlings, specially in the N omission, indicating increased demand of that nutrient in the initial developmental phase of the plant, which was also found in the present study.

The seedlings grown at 140 DAT with addition of the nutrient solution presented values of 1.22% (B); 1.51% Cu; 1.85% (Mn); 1.21% (Zn) and 1.14% (Fe) higher than T6 without the addition of nutrient solution. This greatest concentration can be arising from availability of this nutrient, for these treatments with addition of nutrient solution, containing all the available macro and micronutrients at the concentration ideal for forest species. However, it was found, in addition, alteration in the nutrient absorption dynamics by the seedlings with application or not of nutrient solution, which stands out the influence of the nutrient solution in the nutrient absorption dynamics by seedlings of *K. senegalensis*. In Table 5 is established the decreasing sequence of nutrient requirement by the seedlings at 0, 60, 80, 100, 120, 140 DAT with and without the addition of nutrient solution.

On the basis of the data presented (Table 5) in seedlings of *K. senegalensis* without and with the addition of nutrient solution

Table 5. Descending order total accumulation of macro and micronutrients obtained in seedlings of *K. senegalensis* with and without addition of nutrient solution, for different evaluation times.

Tabela 5. Ordem decrescente de acúmulo total de macro e micronutrientes obtidos em mudas de *K. senegalensis* sem e com adição de solução nutritiva, em diferentes épocas de avaliações.

Times	Macronutrients (mg/plant)	Micronutrients (μg/plant)
	Without nutrient solution	
0	N>K>Ca>Mg>P>S	B>Zn>Mn>Fe>Cu
60	N>K>Ca>P>S>Mg	Fe>Zn>B>Mn>Cu
80	N>K>Ca>P>S>Mg	Fe>Zn>B>Mn>Cu
100	N>K>Ca>P>S>Mg	Fe>Zn>B>Mn>Cu
120	N>K>Ca>P>S>Mg	Fe>B>Mn>Zn>Cu
140	N>P>K>Ca>Mg>S	Fe>B>Mn>Zn>Cu
Times	With nutrient solution	
	Macronutrients (mg/plant)	Micronutrients (μg/plant)
0	N>K>Ca>Mg>P>S	B>Zn>Mn>Fe>Cu
60	N>K>Ca>P>S>Mg	Fe>Zn>B>Mn>Cu
80	N>K>Ca>P>S>Mg	Fe>Zn>B>Mn>Cu
100	N>K>Ca>Mg>P>S	Fe>Zn>B>Mn>Cu
120	N>Ca>K>P>S>Mg	Fe>Zn>B>Mn>Cu
140	N>K>P>Ca>S>Mg	Fe>B>Mn>Zn>Cu

and in the different evaluated periods, the decreasing order of total accumulation for macro and micronutrients was established, which will be able to be utilized as a requirement referential in the production of seedlings of the species.

From that result, alteration in the nutrient absorption dynamics by the seedlings was found, which stresses the influence of the evaluation schedules in the nutrient absorption dynamics of by seedlings of *K. senegalensis*. At 140 DAT without the addition of nutrient solution, the following order: N>P>K>Ca>Mg>S>Fe>Zn>B>Mn>Cu was observed. However,

with addition of the nutrient solution at 140 DAT nutrient absorption followed this order: N>K>P>Ca>S>Mg>Fe>B>Mn>Zn>Cu. Laviola & Dias (2008) found that the order of nutrient accumulation in Barbados nut leaves at the development stage of fruits was N>K>Ca>Mg>P>Mn>Fe>B>Zn>Cu, an order which also points both N and K as the most absorbed (extracted). In the study by Laviola & Dias (2008), evaluated the accumulation of nutrients only in leaves and at production phase of the Barbados nuts, while in this work, the total accumulation in the plant at the seedling phase was evaluated.

4 Conclusions

The addition of nutrient solution supports the increase of the determined morphological characteristics of seedlings of *K. senegalensis* as well as in the total accumulation of both macro and micronutrients.

The nutrient solution modifies the nutrient absorption dynamics in *K. senegalensis* and the amount absorbed at 140 days after transplantation follows the order: N>K>P>Ca>S>Mg>Fe>B>Mn>Zn>Cu.

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