

# Growth and Visual Symptoms of Macro Deficiencies and Micronutrientes in Mallow (*Urena lobata*) Plants, Variety BR-01

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## Abstract

Within the increase of Coffee production and its export as well, a larger resourcefulness is been required to manufacture its bags. Due to these increases, a natural fiber source became valued again despite its growing had been forgotten for some years. The mallow is being observed as an excellent ecological alternative, but the knowledge of its handling and natural requirements are restricted, by the fact of lately inattention in this natural fiber. In this context with the purpose of contributing with the knowledge of this cultivation, an experiment was settled aiming to evaluate its growth, to characterize the visual of macro and micronutrients deficiency symptoms to determine the analytical levels of these nutrients. The mallow plants, variety BR-01, were cultivated in the Department of Soil's greenhouse from Universidade Federal Rural da Amazônia-UFRA, in plastic vases containing 3 kg of ground silica and submitted to the following treatments: complete, omission of N, omission of P, omission of K, omission of Ca, omission of Mg, omission of S, omission of B, omission of Cu, omission of Fe, omission of Mn and omission of Zn. After a period comprehended between 7 and 29 days, the occurrence of deficiency symptoms has started, except for the treatments with omission of S, Cu and Zn. The plants development were mostly affected by the treatments with omission of B and Ca.

**Keywords:** deficiency symptoms, mineral nutrition, natural fibers, *Urena lobata* L.

## 1. Introduction

The *Urena lobata* L. belongs to the family Malvaceae, known by being a native tropical plant from the Asian continent, with passing of the years it was introduced by the most several countries including Brazil, where its main incidence is in Pará and Maranhão States (Lorenzi, 2000; Forzza et al., 2012) and in Amazônia State which is the largest national producer (Araújo, Pereira, & Castro, 2015). The valuation of mallow cultivated was given by the fact that it produces an extremely resistant fiber, becoming an indispensable raw material to manufacture bags for products such as coffee and potato. Also, to control the humidity of these products is another advantage of using this fiber. One of the main companies that produces this package in the national market is located in Pará State (Souza, 2008), which is investing over years to stimulate the mallow production, however the main obstacle it is facing is the lack of information regarding the cultivation mainly about the soil nutrition and fertility. In Amazônia State the cultivation in meadow soils is a characteristic due to the naturally good fertility, capable to supply the plants nutritional needs (Castro, Fraxe, Santiago, Matos, & Pinto, 2009) differently from the Pará State soil. Having in mind the necessity of enlarge the nutritional information regarding the mallow cultivation in the state, this work was aimed to evaluate the growth, to characterize the macro and micronutrients deficiency, using the minus one element technique (MOET), and to determine the nutritional analytical levels in the mallow plants.

## 2. Material and Method

The experiment was installed in greenhouse of the department of soils of the Universidade Federal Rural da Amazônia-UFRA. Seeds of Mallow (*Urena lobata*) Variety BR01 were used coming from Oriental Amazonian Embrapa. The seeds were sowed in seedbed containing a mixture of black earth and sawdust in the proportion of 1:1. Seeds were germinated four days after the sowing. When the plants reached 15 days of age with their very defined leaves, the same ones were transplanted in number of two, for definitive containers. The experiment was installed following entirely delineated randomly with 12 treatments and 5 repetitions, for a total of 60 experimental portions. The used treatments were: complete, omission of N (ON), omission of P (OP), omission of K (OK), omission of Ca (OCa), omission of Mg (OMg), omission of S (OS), omission of B (OB), omission of Cu (OCu), omission of Fe (OFe), omission of Mn (OMn) and omission of Zn (OZn). The plants were irrigated daily with nutritious solution complete of Bolle-Jones (1954), diluted 1:5 with distilled water, during the first 30 days, renewing the solution to every two weeks. This solution was also successfully used in other researches with Amazonian cultivations. After that time, the leaves were rough-hewn remaining one plant by vase, passing to the diluted nutritious solution to be used 1:3 for 30 days, renewing the same one every 10 days. Soon after that period the treatments have begun using solution nutritious total load with pH 5.5.

The symptomatology evolution was followed and described since the beginning of this until they become very defined, being photographed. In this stage there was the collection of the plants, being previously taken the Biometric measurements of the same ones, separating them in superior leaves, inferior, stem and root, and this material was washed with distilled water, and put in greenhouse of forced circulation of air to 65 °C, until reaching constant weight. Soon after there was the grinding of the material in mill type Wiley for subsequent chemical analysis.

The plants height, stem diameter of two centimeter from the substratum, area was evaluated to foliate and production of dry the extracts of the matter dry from parts of the plant were obtained by digestion nitroperchloric except B, which digestion dry via. P and B determine for colorimetria, K, Ca, Mg, Cu, Fe, Mn and Zn for espectrometria of atomic absorption, and S for turbidimetria and N was determined by the method semi-micro Kjeldahl.

The obtained data was statistically analyzed according to Gomes (1990) and Banzato and Kronka (1992), making the variance analyses and the test of averages Tukey to 5% of probability for the comparisons of the treatments in the studied variables. The graphs were elaborated following the methodology proposed by Nunes, Ramalho and Abreu (2005), which consists of the standardization of the measured found in the test of Tukey in function of the different omissions, through the expression:

$$z_{ij} = (\bar{y}_{ij} - \bar{y}_{.j}) / s_{.j} \quad (1)$$

Where,  $Z_{ij}$  is the value of the standardized variable corresponding to the Variable biometrics  $i$  in the omission  $j$ ;  $\bar{y}_{ij}$  is the average of the Variable biometrics  $i$  in the omission  $j$ ;  $\bar{y}_{.j}$  it is the average of the variable in function of all of the omissions  $j$ ,  $s_{.j}$  is the standard deviation of the variables biometrics in function of the omissions. That standardization was accomplished for each variable biometrics using the averages of the test of Tukey.

## 3. Result and Discussion

Starting from the biometrics analyses accomplished we can observe the development of the mallow plants (Table 1), having as indicator the height, and the most affected plants were the ones with individual omission of boron, calcium and nitrogen (Graphic 01) when compared to the complete treatment. Regarding the diameter of the stem the omission of calcium, nitrogen and potassium (Graphic 02) they were that affected more compared to the complete one. The treatments with omission of calcium, nitrogen and boron were that more limited the foliar area (Graphic 03). According to Campos (2015) the nutrient calcium has the function of integrate the medium flap of the cellular walls, being also essential for the prolongation and cellular division. With that the deficiency symptoms appear mainly in the growth points in development. The boron is responsible for the synthesis of components essentials in the formation of cellular wall as the pectin, the cellulose and the lignin (Epstein & Bloom, 2006).

According to Motomiya, Molin, and Chiavegato (2009) the nitrogen is a fundamental element in the production and development of vegetative organs, such as trunk and leaves, and in plants producing of fiber it improves the length and resistance of the produced fiber. The readiness of the nitrogen and of the potassium in appropriate proportions is an important factor in the growth process and plant development. The metabolism of nitrogen in the plants, which requests appropriate amounts of potassium in the cytoplasm, is important for the production of

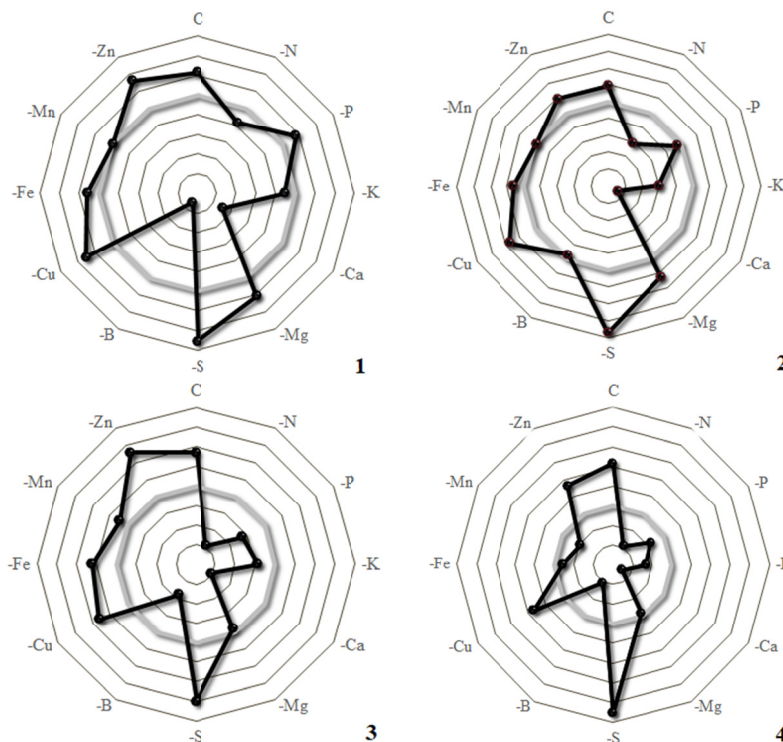
amino acids and productivity of the cultures, furthermore it is also involved in the final nitrogen metabolism phase (Viana & Kiehl, 2010).

Table 1. Biometric variables evaluated in mallow plants submitted to omission treatments

Treatments	AP (cm)	DC (mm)	AF (cm <sup>2</sup> )	MSFS(g)	MSFI(g)	MSC(g)	MSR(g)	MST(g)
Complete	97.54 abc	10.04 bc	5339.05 ab	4.38bc	11.06a	19.78b	11.6b	46.8b
ON	76.92 d	7.74 e	743.89 e	1.69d	1.97ef	5.31ef	4.7ef	13.7fg
OP	94.02 bcd	9.12 cd	2382.12 cde	2.75cd	4.42de	8.98cd	6.97cd	23.1cde
OK	79.96 cd	7.85 de	2784.00 cd	2.39d	3.65def	6.41de	6.18cde	18.6ef
OCa	49.86 e	6.09 f	599.23 e	1.35d	1.51f	2.49f	3.88f	9.23g
OMg	96.68 abcd	10.25 bc	3458.81 bc	3.21bcd	6.04cd	10.39c	8.40c	28.1c
OS	111.90 a	12.08 a	6656.05 a	7.21 a	11.04 a	31.44a	16.4a	66.1a
OB	39.50 e	9.12 cd	1412.79 de	2.70cd	1.41f	4.78ef	4.52ef	13.4fg
OCu	101.58 ab	10.59 b	5260.18 ab	4.63bc	9.43ab	17.79b	11.2b	43.0b
OFe	91.82 bcd	9.76 bc	4862.17 ab	3.12bcd	5.28d	9.69cd	7.7cd	25.8cd
OMn	85.30 bcd	9.25 bc	4066.61 bc	2.97bcd	4.18de	7.73cde	5.77def	20.7de
OZn	102.34 ab	10.03 bc	6220.98 a	4.75b	8.39bc	18.43b	11.1b	42.7b
C.V. (%)	10.95	6.74	24.26	25.95	2.28	12.85	12.67	9.61

Note. \* Following averages for the same letters in the columns, don't present significant difference at the level of 5% of probability, for the test of Tukey.

Plant height (AP), stem diameter (DC), leaf area (AF), dry matter of the superior leaves (MSFS), dry matter of the inferior (MSFI) leaves, dry matter of the stem (MSC), roots dry matter (MSR) and total matter (MST) dried mallow plants.



Graphs 1, 2, 3 and 4. Representation considering the average of height variation, diameter of the stem, leaf area and total dry matter respectively for all of the omissions and complete

To evaluate which treatment that favored less the production of dry matter of the plants, the different parts of the plants were considered. The leaves dry matter (Table 01) it was less responsive the omission of calcium, nitrogen and potassium, these presented significant difference, when compared to the complete treatment and the omission of sulfur was superior, however in the mass it dries of the superior leaves didn't happen significant difference. Similar result was observed by Rosolem and Bastos (1997) in the culture of the cotton plant, where the omission of sulfur didn't obtain parameters significantly different from the complete treatment.

Regarding the stem dry matter, of the roots and total (Graphic 04) except for the complete treatment, omission of sulfur, copper and zinc, the others limited the growth (Table 1). In the total dry matter the treatment more limiting was the omission of calcium, following by boron and nitrogen. The decreasing order of the nutrients in function of the reduction of total matter was: Ca > B > N > K > Mn > P > Fe > Mg > Zn > Cu > S.

Table 2. Macronutrientes tenors ( $\text{g kg}^{-1}$ ) and of micronutrientes ( $\text{mg kg}^{-1}$ ) in the superior and inferior leaves in function of the treatments

Treat	N	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn
<i>Upper leaves</i>											
Comp	33.5 ab	2.5cde	16.5de	6.3 efg	4.4 ab	3.6abc	13.0efg	144.45 <sup>a</sup>	682.65a	62.45d	151.20b
ON	16.5 d	4.7ab	23.7bc	8.0 def	3.4 ab	3.0bcd	17.82 a	67.35b	416.85a	127.75bc	106.65cd
OP	27.8 bc	1.1e	26.0b	5.7 fg	4.4 ab	2.5cd	13.76cdef	56.50b	444.50a	65.25d	77.25 e
OK	32.3abc	5.1 a	3.7 f	11.1abc	5.0 ab	4.6 ab	15.14bc	53.60b	418.35a	108.10bc	90.75cde
OCa	32.8 ab	3.3abcde	15.7de	4.9 q	5.4 ab	4.4ab	14.84cd	55.55b	477.65a	57.20d	114.65 c
OMg	34.0 ab	3.3abcd	31.8 a	9.7 bcd	1.7 b	3.0bcd	14.10cde	63.75b	433.35a	106.20c	84.70 de
OS	25.6 c	2.2 de	12.0e	11.4 ab	4.5 ab	1.8d	10.66 i	51.90b	386.15a	138.80ab	115.20c
OB	33.5 ab	3.0 bcde	20.4cd	13.0 a	4.2 ab	4.9 a	11.16hi	49.80b	595.60a	162.90a	194.80 a
OCu	28.3 bc	2.3cde	17.3d	5.3 fg	4.5 ab	3.9abc	12.34fgh	55.05b	451.20a	54.15d	75.90 e
OFe	28.6 bc	2.5cde	19.5cd	8.5 cde	5.4 ab	3.5abcd	13.28def	71.05b	411.35a	112.25bc	112.90 c
OMn	36.0 a	4.3abc	23.2bc	7.9 def	5.6 a	4.1abc	16.74ab	64.45b	528.40a	7.75e	144.10 b
OZn	33.1 ab	2.2cde	16.5de	5.6 fg	4.9 ab	3.9abc	11.64ghi	50.75b	397.60a	60.55d	74.55 e
CV %	10.83	32.32	12.88	16.15	39.62	22.28	5.40	16.39	34.22	16.76	10.43
<i>Bottom leaves</i>											
Comp	21.2 bc	1.8 c	14.7 bc	9.8 de	5.4 bc	3.5 e	13.37 defg	141.20b	712.00b	100.00efg	157.45cd
-N	14.5 d	3.7 a	17.6 b	10.7 de	4.2 bc	3.5 e	18.40 a	49.60d	592.70b	157.75cd	217.65b
-P	20.8 bcd	0.6 d	25.1 a	10.7 de	5.2 bc	4.3 de	15.60 bcd	45.95d	601.65b	123.15def	246.95 a
-K	20.2 bcd	3.8 a	2.4 e	14.9 b	13.1 a	5.0 bcd	15.95 abc	141.55b	702.45b	156.25cd	181.90c
-Ca	19.4 bcd	1.7 c	9.9 cd	9.5 e	6.7 b	5.4 abcd	15.55 bcde	137.60b	735.55b	154.15cde	158.90c
-Mg	23.9 ab	3.3 ab	15.8 b	13.9 bc	1.7 c	4.5 cde	15.31bcdef	164.25q	1395.6 a	214.95ab	130.75de
-S	16.7 cd	2.7 abc	7.4 d	21.4 a	4.9 bc	1.8 f	13.10 efg	147.70ab	988.45ab	244.35 <sup>a</sup>	159.20c
-B	29.5 a	3.5 a	16.1 b	14.3 bc	7.3 b	5.9 ab	12.68 g	60.95cd	575.90b	177.50bc	60.15g
-Cu	22.4 bc	1.7 c	13.6 bc	10.4 de	5.8 b	5.5 abc	13.04 fg	53.95cd	753.70b	99.50fg	107.75ef
-Fe	22.3 bc	2.3 bc	14.6 bc	10.2 de	5.5 bc	6.2 a	14.68cdefg	68.35c	605.20b	152.25cdef	93.20f
-Mn	30.1 a	3.0 ab	16.6 b	12.2 cd	6.3 b	5.4 abcd	17.56 ab	59.10cd	676.60b	46.75g	65.05g
-Zn	22.7 bc	1.8 c	14.4 bc	10.5 de	5.5 bc	5.7 abc	13.64cdefg	133.00b	1034ab	99.05fg	45.15g
CV%	13.83	20.56	15.80	9.00	31.41	11.70	7.62	7.62	30.45	17.37	9.30

Table 3. Macronutrient tenors ( $\text{g kg}^{-1}$ ) and of micronutrient ( $\text{mg kg}^{-1}$ ) in the stem in function of the treatments

<i>Stem</i>											
Comp	7.1 ef	3.1 a	6.7 de	5.7 def	2.4 d	2.6 abc	11.69 ab	58.45 bcd	151.35 abc	61.85 d	50.25 cd
-N	4.7 f	3.7 a	8.6 cd	6.8 cde	2.0 d	2.9 abc	11.73 ab	61.85 d	109.45 abc	10.92 abc	65.89 bcd
-P	19.6 b	0.5 b	6.3 de	5.0 fg	2.1 d	2.7 abc	10.92 abc	57.50bcd	137.55 abc	2.5 abcd	61.05 bcd
-K	15.7 c	3.2 a	1.6 f	5.5 ef	3.9 b	3.8 a	9.80 cd	61.65 bcd	126.75 abc	1.6 f	111.55 a
-Ca	20.0b	3.1 a	4.8 ef	3.7 g	2.3d	3.6 ab	10.03 cd	144.95 a	131.75 abc	15.7 c	60.70 bcd
-Mg	11.8 d	3.6 a	11.5 abc	7.9 abc	0.9 e	2.5 abcd	9.32 d	134.75 a	93.45 c	7.3 ef	127.75 a
-S	5.4 ef	3.0 a	6.1 de	8.6 a	2.5 cd	0.9 d	10.45 bcd	131.75 a	103.65 bc	11.2 bc	135.30 a
-B	29.0 a	3.4 a	12.1 abc	8.4 ab	5.4 a	2.3 abcd	10.18 cd	65.95 bc	185.95 <sup>a</sup>	1.8 cd	76.80 b
-Cu	7.1 ef	2.7 a	7.2 de	6.0 def	2.1 d	2.9 abc	10.37 bcd	53.80 cd	116.50 abc	11.23 abc	43.20 d
-Fe	7.3 ef	2.9 a	11.2 bc	7.5 abc	3.4 bc	1.8 cd	11.67 ab	68.45 b	140.00 abc	57.50bcd	68.80 bc
-Mn	13.5 cd	3.2 a	14.9 a	7.0 bcd	3.6 b	2.2 bcd	11.23 abc	60.65 bcd	172.05 ab	6.8 cde	67.40 bcd
-Zn	8.3 e	3.1 a	12.9 ab	7.6 abc	3.3 bc	2.1 bcd	12.18 a	60.15 bcd	136.70 abc	20.0b	33.00bcd
CV%	12.29	16.76	18.51	9.90	15.36	11.70	6.16	7.99	2.69	17.37	7.67

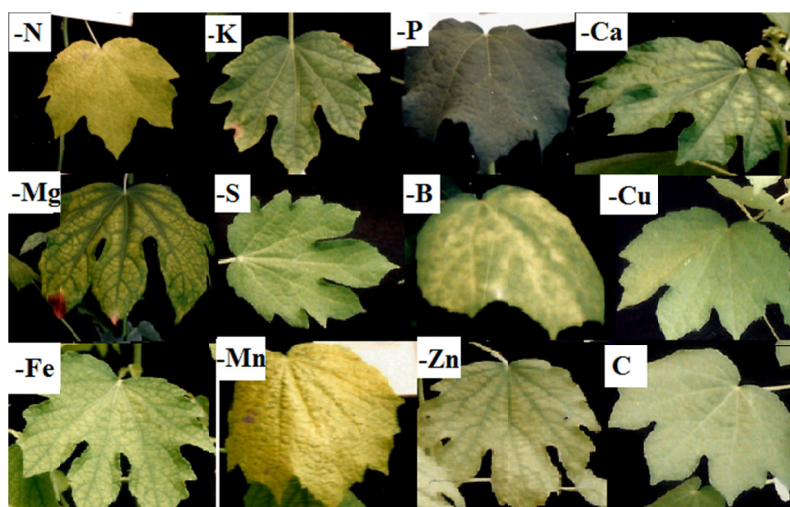


Figure 1. Mallow leaves under-effect of the different nutrients nutrients omission

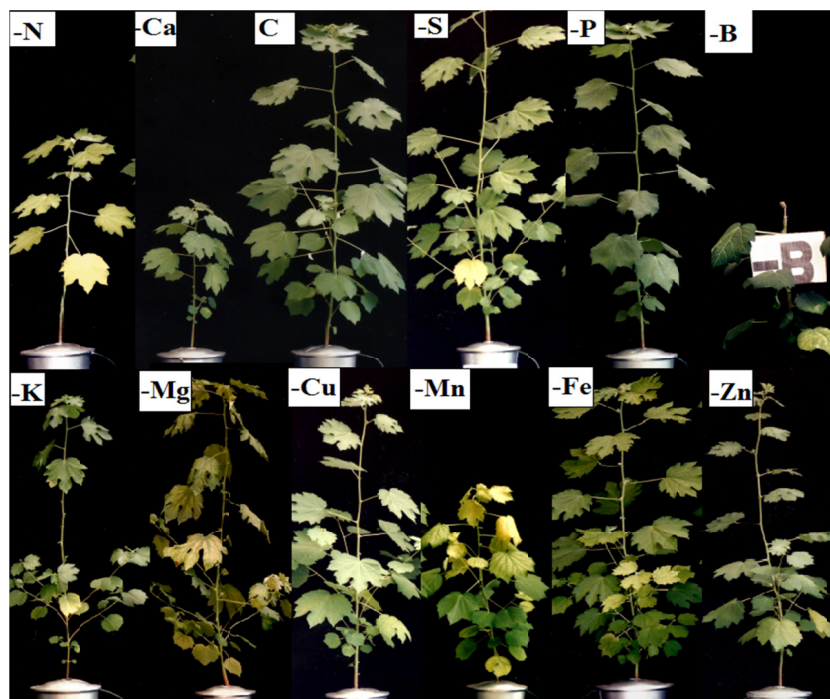


Figure 2. Developments of the mallow under-effect of the different omissions of nutritious

### 3.1 Omission of Nitrogen

The nitrogen leaves tenors on the superior leaves of the complete treatment were of  $33.5 \text{ g kg}^{-1}$  and in the inferior of  $21.2 \text{ g kg}^{-1}$ . The lowest tenors of nitrogen in the superior and inferior leaves were observed in its omission, when compared with the complete treatment (Table 2).

Mallow plants cultivated in nutritious solution with omission of nitrogen, manifested symptoms of deficiencies in that macronutrient 7 days after the beginning of the treatments. The mallow plants exhibited the pale green coloration initially in the old leaves, being distributed even in the limbo, in the pecíolo and in the ribs, with the intensity of the deficiency and of the age of the plants, those leaves presented green-yellowish shade (Image 1) and finally they became totally yellowish with subsequent necrosis.

The nitrogen composes several molecules of the vegetable cells, including amino acids, proteins and acids nucleicos, chlorophyll, coenzymes and secondary metabólitos, being considered one of the most important elements for the increase of the production. The deficiency of nitrogen takes to a coordinate repression of genes involved in the chlorophyll synthesis, photosynthesis and synthesis of proteins (Marschner, 2011). It was also observed, plants of reduced height with 76.92 cm, restricted foliage with area to foliate small of  $743.89 \text{ cm}^2$ , plants with fine stem of 7.74 diameter mm, when compared with the complete treatment (Image 02), haul of that the lowest tenors of nitrogen were obtained in the omission of the same nutrient and in the one, however they don't present significant differences (Table 3), when compared with the one. Viégas, Haag, Silva and Monteiro (1992) observed similar characteristics of deficiency of nitrogen in jute plants, also producing fibers. In agreement with Mattioni, Menezes, Baldi and Segalin (2011) the nitrogen is an essential macronutrient to the vegetative development, because this is the nutrient requested in larger amounts. They compose structures of the main structural and enzymatic proteins, amino acids and nucleic acid (DNA and RNA) and without its presence the plant doesn't grow, which is a extreme important fact, due to the mallow cultivates, the economical value is found in its stems.

### 3.2 Omission Phosphorus

The lowest tenor of observed phosphorus was of  $0.6 \text{ g kg}^{-1}$  in the inferior leaves and of  $1.1 \text{ g kg}^{-1}$  in the superior leaves in the treatment that omitted this nutritious one, while in the treatment I complete the tenor to foliate of the nutrient in superior leaves was of  $2.5 \text{ g kg}^{-1}$ , and in the inferior leaves of  $1.8 \text{ g kg}^{-1}$  (Table 02). In both cases the concentration of the nutrient was larger in superior leaves demonstrating like this the mobility of the nutrient in the plant. The symptoms of phosphorus deficiency appeared 26 days after the application of the treatment in the oldest leaves with a green-dark coloration, being more evident in the margins of the limbo (Illustration 1) and

with rough aspect to the touch, very similar to the result obtained by Salgado, Azzini, Feitosa, and Hiroce (1982) in other cultivars of fibers, the sisal. With the intensification of the deficiency there was premature fall of the leaves, very characteristic symptoms of the deficiency of this nutritious one, because it affects the chloroplast directly according to Cobra Netto, Accorsi, and Malavolta (1971). In the stem, the phosphorus tenors (Table 3) didn't differ among all of the treatments, except for the phosphorus omission that was inferior significantly (Illustration 2). In the study accomplished by Silva, Kondo and Sabino in 1994, the relationship between the phosphorus and the quality of agricultural products verified that the nutrient influences directly in the culture of the cotton plant in the opening of the bud and in the length of the fiber, characteristic that very wanted for in the cultivation of the mallow, because the fiber is extracted of the stem of this plant.

### 3.3 Omission Potassium

The tenor to foliate of potassium in the complete treatment in the superior leaves it was of  $16.5 \text{ g kg}^{-1}$  and in the inferior of  $14.7 \text{ g kg}^{-1}$  what reflects the mobility of the nutrient. With the potassium omission the tenor was of  $3.7$  and  $2.4 \text{ g kg}^{-1}$  in the superior and inferior leaves respectively, being, inferior to the complete treatment (Table 2). There was an increase in the potassium tenor in the treatments with omission of magnesium, phosphorus, nitrogen and manganese, in the superior leaves, while in the inferior leaves the increase happened in the phosphorus omission, as well as in the stem the omissions of manganese, zinc, boron, magnesium and iron, they increased the potassium tenor, when compared with the complete treatment.

The potassium deficiency began showing to the 29 days after the beginning of the application of the treatments and it was characterized, initially, for the marginal chlorosis in the inferior leaves, so much close to the base as for the apex. Later, necroses appeared, being of brown-dark color in the affected areas (Figure 1), following for premature fall of the leaves. The potassium deficiency also affected the height of the plant with  $79.6 \text{ cm}$  and of the diameter of the stem with  $7.8 \text{ mm}$  (Figure 2) in relation to the tenors it was noticed that the absence of the micronutrients Zn, Mn and B and of the macronutrient Mg. They showed more where the potassium increased its tenors in the stem (Table 3). Similar symptoms were described by Viégas et al. (1992) in jute plants and curauá plants (Viégas et al., 2014). Silva (1999) reported that, the nutrient potassium influences in the quality of the fiber, improving the index micrometric (thinness and maturity) and reducing the percentage of short fibers in the culture of the cotton. Studies accomplished by the Foundation-MT (2001), Ferrari et al. (2005), and Freitas, Leandro, and Carvalho (2007) showed that the increment of doses of the potassium in the manuring influenced the cotton production positively.

### 3.4 Omission of Calcium

The tenor to foliate of calcium in the complete treatment in the superior leaves was of  $6.3 \text{ g kg}^{-1}$  and in the inferior of  $9.8 \text{ g kg}^{-1}$ , while with the omission of that nutritious of  $4.9 \text{ g kg}^{-1}$  and of  $9.5 \text{ g kg}^{-1}$  respectively, in the stem, the omission of that nutritious one caused decrease of the tenor of the same, but not in a significant way (Table 2). With the omission of calcium the tenors of potassium and magnesium they increased what can be explained by the competitive inhibition among those cations.

The deficiency of calcium was verified after 15 days after the application of the treatments. With the progress of the deficiency, stains chlorotic following by necrosis appeared in the boards and limbo of the new leaves following by the abscission (Figure 1). It was also observed drastic reduction of the growth (Figure 2), affecting the aerial part with  $49.86 \text{ cm}$  of height, fine stem with  $6.09 \text{ mm}$ , small production of leaves and consequently reduced foliar area of  $559.25 \text{ cm}^2$ . In the stem it happened an increment in the tenor of calcium in the omission of the element boron, the smallest obtained tenor was in the omission of the magnesium (Table 3). The calcium is one of the main representatives of the cell wall and of the medium lamella, because both are constituted of pectate of calcium. Another relevant fact is to be this nutrient to be extremely necessary for the appropriate operation of the meristem, besides being indispensable to the mitosis, process of cell reproduction (Reis, 2011). The observed results were very similar to the obtained by Salgado et al. (1982) in sisal and Viégas et al. (2014) in curauá.

### 3.5 Omission of Magnesium

In the superior leaves in the treatment complete the tenor of magnesium was of  $4.4 \text{ g kg}^{-1}$  and in the inferior of  $5.4 \text{ g kg}^{-1}$ . On the other hand, the tenors foliate with omission of magnesium in the superiors and inferior were of  $1.7 \text{ g kg}^{-1}$ . There was not significant difference among the tenors in the leaves of the complete treatment and the omission of magnesium, in spite of the values in the complete have been superiors to the omissions (Table 2). The tenor to foliate of magnesium in the inferior leaves increased with the potassium omission, what can be explained by the interaction among those nutritious ones. In the stem it also happened increase in the tenors of nitrogen, boron and zinc with the omission of magnesium (Table 3), they put the only treatments statistically different was the omission of magnesium, when compared with the complete treatment (Figure 2).

The first symptoms of deficiencies of magnesium were observed 28 days after the beginning of the treatments. Initially the oldest leaves presented yellowing and chlorosis internervial (Figure 1), and a narrow strip of green fabric stayed along the ribs. With the intensity of the deficiency the parts of the margins appeared injured and it happened the shedding its leaves, very similar to the that was observed in curauá plants by Viégas et al. (2014). In agreement with Lange (2007) the symptoms of deficiency of magnesium are justified for the fact of the nutrient to play fundamental part for the survival of the plant. This nutrient is one of the components of the chlorophyll molecule where participates in the processes of transfer of energy for the activation of enzymes, it interferes in the absorption of nutrients as phosphorus and potassium besides acting in the water balancing of the plant.

### 3.6 Omission of Sulfur

The tenors foliate of sulfur varied a little, being  $3.5 \text{ g kg}^{-1}$  in the superior leaves to  $3.6 \text{ g kg}^{-1}$  in the inferior. With the omission of sulfur of  $1.8 \text{ g kg}^{-1}$  in both leaves (Table 2). The omission of sulfur reduced the tenors of this nutritious one in the stem of the plants, when compared with the complete treatment (Table 3).

Visible symptoms of deficiency of sulfur were not observed (Figures 1 and 2). It is attributed to the fact that the plants have accumulated enough amounts of this nutritious one for his originating from development the diluted nutritious solutions used before the beginning of the treatments. Although the symptoms of deficiency of sulfur haven't been manifested, it is not an indicative to stop being important in his nutrition of the mallow. Santos et al. (2008) presented similar results in the cultivates of the cotton, where the cultivation was not responsive to the increment of sulfur.

### 3.7 Omission of Boron

The tenors foliate of boron in the little complete treatment varied between the superior and inferior leaves, being of  $13 \text{ g kg}^{-1}$  to  $13.37 \text{ g kg}^{-1}$ , respectively. In the superior leaves with boron omission happened reduction of the tenor to foliate, being of  $11.16 \text{ g kg}^{-1}$  and in the inferior of  $12.68 \text{ g kg}^{-1}$  (Table 2). It was verified in the superior leaves increase in the tenors foliate of boron with the omissions of nitrogen, manganese, potassium and calcium and in the inferior leaves of nitrogen, manganese and potassium in relation to the complete. The highest boron tenor in the stem (Table 3) was observed in the omission of zinc and of manganese, while the smallest tenor happened in the absence of magnesium besides inferior to the tenor of the treatment of the boron omission.

The visual symptoms of boron deficiency happened 13 days after the beginning of the treatments, the second showing, soon after the one of nitrogen, being the sensitive mallow the boron deficiency. This result can be associated to the fact that the boron possesses the function of facilitating the transport of sugars through the membranes. Also, it is believed that it is involved in the synthesis of the base uracil (Faquin, 2005). According to Marschner (1995) the boron is related to a series of physiologic processes of the plants as, for instance: transport of sugar; synthesis of the cellular wall, lignification, structures of the cellular wall, breathing, carbohydrates metabolisms, RNA metabolisms, acid indolacetic metabolisms, phenolic acids, ascorbate metabolism, fixation of nitrogen and decrease of the toxidez of aluminum.

The main characteristic of the deficiency of this nutritious one was the death of the growth apical, followed by the premature fall of the recently-formed leaves and close of the budding, which presented chlorotic areas, rough to the touch, lightly curved down, little number of leaves and, reduced foliar area. According to the study driven by Carvalho, Ferreira, and Staut (2011) the boron deficiency in cotton plants causes the fall of fruits, it reduces the productivity and the quality of fibers. The boron deficiency in cotton, even if temporary, takes to the bad formation of the vases of the xilema, what can reduce the translocation of nutrients and of carboidratos for new woven (Oliveira, Milaneze, Moraes-Dallaqua, & Rosolem, 2006).

### 3.8 Omission of Copper

The tenor to foliate of copper in the complete treatment in the superior leaves they were of  $144.45 \text{ mg kg}^{-1}$  and in the inferior of  $141.2 \text{ g kg}^{-1}$  not differing amongst themselves. With the copper omission the tenor was of  $55.05$  and  $53.95 \text{ mg kg}^{-1}$  in the superior and inferior leaves respectively, being, inferior to the complete treatment.

In the superior leaves, the treatment that presented superior copper tenor was significantly the complete when compared with the remaining of the treatments (Figure 1). In the inferior leaves the highest tenors of copper (Table 2) were observed in the omission of magnesium, meantime in the stem (Table 3) there were not larger variations in the tenors.

Visible symptoms of copper deficiencies were not observed in mallow plants (Figure 2) can be associated with the solution diluted supplied the plants before the beginning of the treatments to provide the appropriate development of the plants.



### 3.9 Omission of Iron

The tenors foliate of iron in the little complete treatment varied between the superior and inferior leaves, being of 13 mg kg<sup>-1</sup> to 13.37 mg kg<sup>-1</sup>, respectively. In the superior leaves with boron omission happened reduction of the tenor to foliate, being of 11.16 mg kg<sup>-1</sup> and in the inferior of 12.68 mg kg<sup>-1</sup> (Table 2).

In the treatment where the iron was omitted it happened a reduction of this micronutriente in the superior leaves, but it didn't represent significant difference, when compared with the complete treatment. The treatment where happened omission of magnesium contributed so that there was larger absorption of iron in the inferior leaves. In the stem (Table 3), there were not larger statistical variations in none of the treatments.

The deficiency of iron began days after the omission of that nutritious one. Initially, the widespread chlorose was observed in the new leaves, similar to the deficiency of manganese, just staying the ribs of green color during some time standing out as a fine reticulated (Figure 1). With the aggravation of the deficiency, the symptom appeared the other leaves, reaching in few weeks the superior half of the plants. However, according to Marcus-Wyner and Rains (1982), there is need of very severe deficiency of iron so that the productivity is affected, what happened in the present experiment with the mass total drought. In the study of Mendes (1959) the omission of iron was the micronutriente less limitante in the culture of the cotton.

### 3.10 Omission of Manganese

The omission of manganese of the nutritious solution just provoked reduction in the tenors of this element in the superior leaves of 7.75 mg kg<sup>-1</sup> in relation to the complete with 62.45 mg kg<sup>-1</sup> (Table 2). In the superior leaves, the highest tenors of manganese were obtained in the treatments with boron omissions, sulfur, nitrogen and iron and in the inferior leaves, with omissions of sulfur, magnesium, boron, nitrogen and potassium. The highest tenors of manganese in the stem were obtained in the omission of the nutritious boron, magnesium, iron and zinc (Table 3).

The first symptoms of deficiency of manganese were observed 17 days the beginning of the treatments with yellowing of the new leaves with strips of green fabric surrounding the ribs, with some similarity presented by the deficiency of iron. As the deficiency developed also reached the oldest leaves, appearing in both cases small red points with subsequent necrosis distributed in the limbo to foliate (Figures 1 and 2). Later, it happened premature fall of the affected leaves, beginning of the apical part down. Similar results were observed by Rosolem and Bastos (1997), however without fall of the leaves in cotton plant, on the other hand, Ohki (1973) described the fall of leaves in the absence of the nutrient in the culture of the cotton.

### 3.11 Omission of Zinc

The tenor to foliate of zinc in the complete treatment in the superior leaves was of 151.2 mg kg<sup>-1</sup> and in the inferior of 157.4 mg kg<sup>-1</sup>. With the omission of zinc the tenor to foliate was of 74.5 and 45.1 mg kg<sup>-1</sup> in the superior and inferior leaves respectively, being, inferior to the complete treatment (Table 2).

In agreement with the results, the highest tenors of zinc in the superior leaves, happened when the boron of the solution was omitted, in the inferior leaves, with the phosphorus omission and nitrogen, while in the stem the tenor of zinc increased with the omission of the sulfur, magnesium and potassium (Table 3).

Visible symptoms of deficiencies of zinc were not observed in mallow plants (Figures 1 and 2), could be associated with the supply of the micronutriente before the beginning of the treatments so that there was the full development of the plant. The deficiency of zinc shows for the lack of development of the young organs. For real field conditions, the zinc is not very common, except in soils that received excessive liming, showing like this in newer leaves, turn chlorotic excessively (Albuquerque, Silva, & Dantas Neto, 2014).

## 4. Conclusion

The individual omissions of N, P, K, Ca, Mg, B, Fe and Mn in the nutritious solution promote the occurrence of visual symptoms of nutritional deficiency, which were shown in a general way easily characterized.

The mallow is sensitive to the deficiency of nitrogen, because it is the first nutrient to manifest the visual symptoms of deficiency.

For being the stem of the mallow the part used for the fiber extraction, the accentuated reduction of the height with the shortening of the stem, death and stoppage of the apex buds, the deficiencies caused by the omissions of B and Ca deserve special attention.

The production of total matter is more affected for the omissions of Ca, N and B.

The individual omissions of N, K, Ca, S, B, Cu, Mn and Zn result in reduction in the tenor of the superior leaf and the omissions of N, P, K, S, Cu and Zn in the inferior leaf of its respective nutritious.

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