Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 08, Issue, 03, pp.4555-4559, March, 2017

RESEARCH ARTICLE

EARLY GROWTH OF SUNFLOWER HYBRIDS CULTIVATED IN NUTRITIVE SOLUTIONS WITH MACRONUTRIENT OMISSIONS

[1]Janderson do Carmo Lima, [2]Bruno Laecio da Silva Pereira, [3]Anacleto Ranulfo dos Santos and [4]Gilvanda Leão dos Anjos

[1]Master's degree program in Soil and Ecosystem Quality by the Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas-Brazil
[2]Doctor of Agricultural Engineering by Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas-Brazil
[3]Teacher Holder of Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas-Brazil
[3]Graduation in engineering agronomy of Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas-Brazil

ARTICLE INFO

Article History:
Received 17th December, 2016
Received in revised form
24th January, 2017
Accepted 14th February, 2017
Published online 31st March, 2017

Key words:

Mineral nutrition,
Macronutrients,
Helianthus annuus L.

ABSTRACT

Sunflower (*Helianthus annus L.*) is an oilseed that has important agronomic characteristics, such as: greater resistance to drought, cold and pests than most species normally grown in Brazil. Nitrogen and phosphorus play an important role in the metabolism and maturation of the sunflower crop; The nitrogen when omitted causes nutritional imbalance and phosphorus because it is a nutrient after being absorbed by the plant to be incorporated in organic compounds including phosphate sugars, phospholipids and nucleotides, causing a significant reduction of the development of the plants, affecting the number of leaves, the height of the plants, Stem diameter and leaf area. The experiment was carried out in a greenhouse at the Federal University of Recôncavo da Bahia located in Cruz das Almas - BA. The experimental design was completely randomized, consisting of eight treatments, two hybrids and five replications, totaling eighty vessels. The nutrient solution of Hoagland and Arnom (1950), modified by Sarruge and Haag (1974), was used. The treatments studied were: T1- Complete Solution; T2- Omission of N; T3- Omission of P; T4 - Omission K; T5- Omission of NP; T6- Omission PK, T7- Omission of NPK and T8- Omission of micronutrients. The initial growth H251 and H360 was compromised when submitted to solutions with nitrogen omission. There were positive interactions between the solution with omission of phosphorus and potassium with the two genotypes for the variables index of chlorophyll a, and H360 for the dry mass of leaves and dry mass of the aerial part. Hybrid H251 was more sensitive to macronutrient deficiency than H360.

INTRODUCTION

Sunflower (*Helianthus annus L.*) is an oleaginous one that presents important agronomic characteristics, such as: greater resistance to drought, cold and pests than the majority of the species normally cultivated in Brazil. It presents wide adaptability to the different edaphoclimatic conditions and its yield is little influenced by latitude, altitude and photoperiod (Feitosa *et al.*, 2013). According to Silva *et al.* (2011), the sunflower has several forms of use, among them the medicinal use, green fertilization, crop rotation, beekeeping, animal feeding, oil production, human consumption and biodiesel production. Oliveira *et al.* (2014) report that the growth of the sunflower from the initial stage to the appearance of the floral bud is slow, resulting in low consumption of water and nutrients; However from that period until the R9 phase (maturity of the achenes), there is an intense consumption of water and nutrients, culminating in the development of the plant. Nitrogen and phosphorus play an important role in the metabolism and maturation of the sunflower crop; The nitrogen when omitted causes nutritional imbalance and phosphorus being a nutrient after absorbed by the plant to be incorporated into organic compounds including plant development sugars, affecting the number of leaves, the height of the plants, the diameter of the stem and the leaf area and (Baiscaro *et al.*, 2008). According to Castro *et al.* (2006), because sunflower is a potassium accumulating plant and has a high potential for use as a succession crop, it is important because it plays a fundamental role in the cycling of nutrients. The amount of potassium available in the soil to meet the requirements of the plant should be higher than 0.25$cmol_c$ dm^{-3} (Blamey *et al.*, 1987).

****Corresponding author: Janderson do Carmo Lima,***
Master's degree program in Soil and Ecosystem Quality by the Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas-Brazil.

Table 1. Volume (ml) of stock solutions to form 1 L of modified nutrient solution, using omission of N, P and K, according to the respective treatments

Stock solution (1M)	Complete	- N	- P	-K	-NP	-PK	-NPK	-MICRO
	---(mL) --							
KH_2PO_4	1	1	-	-	-	-	-	1
NH_4NO_3	-	-	-	2	-	2,5	-	-
KCl	-	5	1	-	6	-	-	-
$CaCl_2$	-	5	-	-	5	-	5	-
$MgSO_4$	2	2	2	2	2	2	2	2
KNO_3	5	-	5	-	-	-	-	5
$Ca(NO_3)_2$	5	-	2	5	-	5	-	5
$(NH_4)_3PO_4$	-	-	-	1	-	-	-	-
Micronutrients **	1	1	1	1	1	1	1	-
Iron – EDTA*	1	1	1	1	1	1	1	-

** Micronutrient solution (g/l): H_3B0_3 = 2,86; $MnCl_2$ $4H_20$ = 1,81; $ZnCl_2$ = 0,10; $CuCl_2$ = 0,04; H_2Mo0_4 H_20 = 0,02. * Iron-EDTA Solution: 26.1 g of disodium EDTA dissolved in 286 ml of 1N NaOH + 24.9 g of $FeSO_4 .7H_2O$ and aerated overnight.

Due to the interaction between genotype and environment present in most plant species, a frequent study is necessary, which will make it possible to select and recommend those most adapted to the producing regions, obtaining higher yields and economic returns to producers (Ivanoff *et al.* 2010 and Porto *et al.*, 2008). In this context, the objective was to evaluate the initial growth of two sunflower genotypes when grown in nutrient solutions with omissions of macronutrients in the Recôncavo Baiano.

MATERIALS AND METHODS

The work was carried out from May to July 2016, in a greenhouse at the Federal University of Recôncavo da Bahia, in the Center of Agrarian, Environmental and Biological Sciences, in the municipality of Cruz das Almas, Bahia. Seedlings of cultivars H251 and H360 were obtained in polyethylene trays containing washed sand as substrate. Eight days after sowing, transplanting was carried out for vessels with 6 dcm^{-3} capacity, with washed sand and vermiculite as the substrate in 2: 1 ratio. The experimental design was completely randomized, consisting of eight treatments and five replicates, being 40 pots per cultivar, totaling 80 experimental units. The treatments were applied in nutritional solutions suggested by Hoagland and Arnon (1950), modified by Sarruge and Haag (1974). The treatments studied were: T1- Complete Solution; T2- Omission of N; T3- Omission of P; T4 - Omission K; T5- Omission of NP; T6- Omission PK; T7 - Omission of NPK and T8 - Omission of micronutrients (Table 1). The application of the treatments started 15 days after the emergency.

The pH 5.7 (± 1) of the solutions was corrected weekly and maintained using 0.01N NaOH or 0.01N HCl as required. At 45 days after transplanting, the measurements were made using a graduated ruler at the height of the main stem, stem diameter with a digital caliper, chlorophyll index of the leaves, readings were performed using portable Falker chlorophyll meter, CFL1030. For determination of dry mass the plants were partitioned into leaves, stems and roots, placed in a forced air circulation oven at 65ºC, until reaching constant weight, after which they were weighed in a precision scale. Data were submitted to analysis of variance using the SISVAR statistical program (Ferreira, 2008) and the means were compared by the Tukey test, at 5% probability.

RESULTS AND DISCUSSION

It was verified that there were significant differences ($p \leq 5\%$ and 1%) between the evaluated treatments and cultivars together with their interactions (table 2), being able to observe the respective average squares to evaluate the effect of the omission of N, P, K and Combinations on the variables: chlorophyll a index, chlorophyll b index, total chlorophyll, Cla / Clb ratio and height. The H251 and H360 genotypes have been shown to be influenced by the omission N, P and K, since these nutrients make up part of the structure of amino acids, proteins, nitrogen bases, nucleic acids, enzymes, coenzymes, vitamins, pigments and byproducts. Of processes such as ionic absorption, photosynthesis, respiration, cell multiplication and differentiation, which interfere directly or indirectly in the development of the plant as observed by Marschner (1995) and Malavolta *et al.* (1997). When growth is retarded by nutritional deficiency, plants are uniformly chlorotic (Raij, 1991), especially when macronutrient deficiency is combined. This similarity occurs due to the reduction of chlorophyll concentration, since nitrogen and phosphorus are essential for the formation of the pigment. It was observed that the cultivar H360 the isolated omissions of N, P, K, NP, PK, NPK and micro (table 3) showed not to influence the evaluated variables when compared to the complete solution. The cultivar H251 showed sensitivity regarding the omission of N for the analyzed variables. Among the evaluated treatments, the omission of N influenced negatively the index of chlorophyll a, chlorophyll b index and total chlorophyll index promoting a considerable reduction in both genotypes. The importance of nitrogen as an essential constituent of amino acids, the main constituents of proteins, as well as its role in cell division and in the production of chlorophyll is well known. According to Malavolta (2006), N is the most required nutrient, being constituent of the molecule of chlorophyll and a series of compounds with numerous functions in the plant. The omission of NPK was the limiting factor in the initial height of the plants in relation to the treatment with complete solution. The same observations were described by Batista *et al.* (2003) when studying nutritional deficiency symptoms in soursop and pumpkin. It was noticed that there was a positive interaction between the potassium omission solution and the H360 hybrid and the phosphorus and potassium omission solution with the H251 hybrid for the variable chlorophyll index, which indicates that this nutrient did not compromise the performance of the For this variable.

Table 2. Summary of variance analysis with respective average squares for the following variables: Chlorophyll a, Chlorophyll a, Chlorophyll b, Total chlorophyll index, Cla / Clb ratio (Cla: Chlorophyll a and Clb: chlorophyll b) And Height of plants, for sunflower cultivars grown under nutrient solutions. Cruz das Almas-BA, 2016

Sources of Variation	Index of chlorophyll a	Index of chlorophyll b	Total Chlorophyll Index	Relationship Cla/Clb	Height (cm)
Solutions	79,93**	23,9**	190,18**	0,52**	644,67**
Genotypes	11,08^{NS}	3,32 ^{NS}	26,61^{NS}	0,19*	419,15**
Solutions * Genotypes	10,92**	2,81*	24,22**	0,07 ^{NS}	172,85**
Error	2,92	1,26	7,8	0,04	32,8
C.V (%)	7,12	13,34	8,60	6,58	13,48

* Significant at 5% probability by F test.; ** Significant at 1% probability by test F.; ^{NS} Not significant at 5% probability by F test.

Table 3. Unfolding of interactions for the variables: Chlorophyll a, Chlorophyll b index, Total chlorophyll index and plant height, for sunflower cultivars grown under nutrient solutions. Cruz das Almas-BA, 2016

Cultivars	Solutions							
	Index of chlorophyll a							
	Completa	-N	-P	-K	-NP	-PK	-NPK	-Micro
H251	24,56bcA	15,93dB	26,19abA	26,96abA	24,1bcA	29,08aA	20,99cA	24,75bcA
H360	25,62abA	20,67cA	24,56abA	26,69aA	23,16abcA	26,39abA	22,93bcA	25,91abA
	Index of Chlorophyll b							
H251	8,88abcA	4,56dB	9,37abA	10,22abA	8,17bcA	11,35aA	6,51cdA	8,75bcA
H360	9,51abA	6,67cA	8,53abcA	9,67abA	7,77abcA	10,04aA	7,45bcA	10,19aA
	Total Chlorophyll Index							
H251	33,45bcA	20,5dB	35,49abA	37,18abA	32,27bcA	40,43aA	27,51cA	33,5bcA
H360	35,13abA	27,34cA	33,09abcA	36,37abA	30,93abcA	36,43aA	30,4bcA	36,1abA
	Height (cm)							
H251	47,35abA	48,5abB	40,6bcA	59,6aB	36,37cdA	48,5abA	26,4dA	55,6aB
H360	43,2abcA	37,6bcA	41,33abcA	44,8abA	32,1cA	52,2aA	31,8cA	37,0bcA

* Lowercase letter for comparison between rows and uppercase in columns.

Table 4. Summary of analysis of variance with respective average squares for the following variables: stem diameter, leaf number, dry leaf mass (MSF), total dry mass (MST) and aerial part of plants, for sunflower cultivars cultivated under Solutions. Cruz das Almas-BA, 2016

Sources of Variation	Stem of diameter (mm)	Number of sheets	MSF	MST	Aerial part dry mass
			----------------(g)-----------------		
Solutions	13,86**	17,59**	3,43**	30,82**	14,57**
Cultivars	1,16 ^{NS}	19,51**	1,03**	6,19**	1,43*
Solutions * Cultivar	0,88**	3,29 ^{NS}	0,15*	1,6 ^{NS}	0,74*
Error	0,32	1,78	0,05	0,83	0,31
C.V (%)	11,8	13,65	23,62	29,01	26,08

* Significativo a 5% de probabilidade pelo teste F.; **Significativo a 1% de probabilidade pelo teste F.; ^{NS} Não significativo a 5% de probabilidade pelo teste F.

Table 5. Deployment of the interactions for the variables: stem diameter, number of leaves, dry leaf mass (MSF), total dry mass (MST) and aerial part of plants for sunflower cultivars grown under nutrient solutions. Cruz das Almas-BA, 2016

Cultivars	Solutions							
	Rod Diameter (mm)							
	Completa	-N	-P	-K	-NP	-PK	-NPK	-Micro
H251	5,49abA	4,31bcA	4,23bcA	5,78aA	3,4cdA	6,17aA	2,27dB	6,59aA
H360	5,78abA	4,01cA	4,70bcA	5,42abA	3,92cA	6,26aA	3,69cA	6,05aA
	leaf dry weight (g)							
H251	1,03abB	0,52dA	0,62cdA	1,41abB	0,37dA	1,06abB	0,20dA	1,66aA
H360	1,37bA	0,41cA	0,84cA	1,70abA	0,35cA	2,03aA	0,38cA	1,85abA
	Aerial part dry mass (g)							
H251	2,32bcA	1,59cdA	1,45cdA	3,35abA	0,85dA	2,46abcB	0,42dA	3,7aA
H360	2,79bcA	1,05dA	1,82cdA	3,38abA	0,84dA	4,29aA	0,83dA	3,67abA

* Lowercase letter for comparison between rows and uppercase in columns.

For the chlorophyll b index, it was observed that (Table 3) there was interaction between the solution without PK and both genotypes, the same occurred for the total chlorophyll index and for the height of the plants but with significant interaction only for the H360, Evidencing the tolerance of the plants in the absence of these macronutrients. The variables: diameter, number of leaves, leaf dry mass, total dry mass and aerial part showed significant effect ($p \leq 5\%$ and 1%) as a function of the evaluated solutions and hybrids (Table 4). This effect is justified by the performance of each nutrient, where they are macromolecules and are indispensable in plant metabolism, although in their absence growth is significantly compromised. The cultivars H251 and H360 presented significant differences in the growth variables evaluated in function with omission of macronutrients, and these had a negative influence on the development of the sunflower cultivars. Table 5 shows that the cultivars H251 and H360 show a considerable limitation on the variables evaluated in the respective treatments compared to the complete solution, but the results obtained by cultivar H360 in the variables were superior to the cultivar H251 showing a greater resistance with respect to the omission this nutrients. The omission of N significantly reduced the growth of the plants, affecting the number of leaves and the diameter of the stem in relation to the complete treatment. With this, there was a significant decrease in shoot dry matter production in relation to the complete treatment. Nitrogen favors vegetative growth, mass accumulation, increase of leaf area and, consequently, the expression of the productive potential of the crop. This fact occurs due to the effect of the nutrient on the ionic absorption, photosynthesis, respiration, multiplication and cellular differentiation (Malavolta *et al.,* 1997). In an experiment with sunflower in nutrient solution, Carelli *et al.* (1996) observed that N deficiency caused a decrease of 31% in the photosynthesis rate, which, in turn, is related to the decrease in the amount of the rubisco enzyme, since part of the total nitrogen of the leaf is allocated in this enzyme. It was also observed in table 5 that the treatments with omission of P in the nutrient solution showed a decrease in stem diameter (mm), leaf dry mass (g) and aerial part (g), thus evidencing the function of phosphorus in plant, because it is linked to the structure of the same in the process of energy transfer and storage, affecting several metabolic processes such as protein synthesis and nucleic acid (Malavolta, 2006). It was observed that almost all the plants submitted to the solution with omission of potassium were the ones that presented the highest values in relation to the other omissions, because the period under study was not enough for the hybrids to show deficiency by this element. Potassium (K) acts as an activator of numerous enzymes, its deficiency causes disturbances in metabolic events, such as accumulation of free or soluble nitrogen compounds. These compounds may be amino acids, amides and ammonia, in addition to amines, decarboxylation products of amino acids, such as putrescine, N carbamylputrescin and agmatine (Epstein *et al.,* 2005).

In relation to the unfolding of the interaction, a positive interaction is observed, that is, the best performance when compared to the other treatments, between the solution with omission of PK in both genotypes for the variable stem diameter, the same effect is verified for the Dry mass of leaves for H360 and between the omission of micronutrients and H251 for that same variable. Already evaluating the interaction in relation to the aerial part, it was observed a significant effect between the solution -Micro and H251, and the solution -PK and H360. Nitrogen and potassium were the most required nutrients in the early growth stage of most crops. The importance of nitrogen as an essential constituent of amino acids, the main constituents of proteins, as well as its role in cell division and in the production of chlorophyll is well known. Potassium acts on osmotic processes, on protein synthesis, on membrane stability and permeability, and on pH control (Malavolta *et al.,* 1997; Marschner, 1995). These functions of both nutrients may explain the requirement of the plant, which is in intense metabolic activity at this early stage of development. The absence of macronutrients significantly affected all variables evaluated in both cultivars in a study by Silva *et al.* (2009), with Ca, Mg and K being the most limiting. The nutrients phosphorus, nitrogen, potassium, magnesium and calcium were limiting in the production of dry mass of the aerial part of the açaizeiro (Euterpe Oleracea) in 48,94, 49,33, 33,15, 37,14 and 27,21% respectively (Viègas *et al.,* 2004).

Conclusions

The initial growth of the H251 and H360 genotype was compromised when submitted to solutions with nitrogen omission. There were positive interactions between the solution with omission of phosphorus and potassium with the two genotypes for the variables index of chlorophyll a and H360 for the dry mass of leaves and dry mass of the aerial part. The Hybrid H251 was more sensitive to macronutrient deficiency than H360.

REFERENCES

Aguiar Neto, P., Oliveira, F.A., Marques, L.F., Rodrigues, A.F., Santos, F.G.B2. 010. Efeitos da aplicação do fósforo no crescimento da cultura do girassol. Revista Verde, v. 5, n. 4, p. 148-155.

Batista, M. M. F., Viégas, I. J. M., Frazão, D. A. C., Thomaz, M. A. A., Silva, R. C. L. 2003. Efeito da omissão de macronutrientes no crescimento, nos sintomas de deficiências nutricionais e na composição mineral em gravioleiras (Annona muricata. Revista Brasileira de Fruticultura, Jaboticabal, v. 25, n. 2, p. 315-318.

Biscaro, G.A., Machado, J.R., Tosta, M.S., Mendonça, V., Soratto, R.P., Carvalho, L.A. 2008. Adubação nitrogenada em cobertura no girassol irrigado nas condições de Cassilândia – MS. Ciência e Agrotecnologia, v. 32, n. 5, p. 1366-1373.

Blamey, F. P. C., Edwards, D. G., Asher, C. J. 1987. Nutritional disorders of sunflower. Brisbane: University of Queensland. 72 p.

Carelli, M. L. C., Ungaro, M. R. G., FAHL, I., NOVO, M. do C. de S. S. 1996. Níveis de nitrogênio, metabolismo, crescimento e produção de girassol. Revista Brasileira de Fisiologia Vegetal, Campinas, v.8, n.2, p.123-130.

Castro, C., Oliveira, F.A., Moreira, A., Salinet, L.S., Veronesi, C.O. 2006. Rochas brasileiras como fonte alternativa de potássio para a cultura do girassol. Espaço & Geografia, v. 9, n. 2, p. 179-193.

Epstein, E., Bloom, A. J. 2005. Mineral nutrition of plants: principles and perspectives. 2. ed. Sunderland: Sinauer Associates, 400 p.

Feitosa, H.O., Farias, G.C., Silva Júnior, R.J.C., Ferreira, F.J., Andrade Filho, F.L., Lacerda, C.F. 2013. Influência da adubação borácica e potássica no desempenho do girassol. Comunicata Scientiae, v. 4, n. 3, p. 302-307.

Ferreira, D. F. 2008. Sisvar: um programa para análises e ensino de estatística. Revista Symposium, Lavras, v. 6, p. 36-41.

Hoagland, D. R. and Arnon, D. I. 1950. The water-culture method for growing plants without soil. Berkeley, University of California. 32p. Circular, 347).

Ivanoff, M.E.A., Uchôa, S.C.P., Alves, J.M.A., Smiderle, O.J., Sediyama, T. 2010. Formas de aplicação de nitrogênio em três cultivares de girassol na savana de Roraima. Revista Ciência Agronômica, v. 41, n.3, p. 319-325.

Malavolta, E. 2006. Manual de nutrição mineral de plantas. São Paulo: Agronômica Ceres, 638 p.

Malavolta, E., Vitti G.C., Oliveira S. A. 1997. Avaliação do estado nutricional das plantas :princípios e aplicações. Piracicaba: POTAFOS. 319p.

Marschner, H. Mineral nutrition of higher plants. New York: Academic Press. 889p. 1995.

Oliveira, C.R., Oliveira, J.L., Barbosa, F.R., Dario, A.S., Moura, S.G., Barros, H.B. 2014. Efeito do nitrogênio em cobertura na produtividade de girassol, no Estado do Tocantins. Cientifica, v. 42, n. 3, p. 233-241.

Porto, W. S. *et al.* 2008. Evaluation of sunflower cultivars for central Brazil. Scientia Agricola, v. 65, n. 02, p. 139-144.

Raij, B. V. 1991. Fertilidade do solo e adubação. São Paulo; Piracicaba: Ceres, Potafos, 343 p.

Silva, A.R.A., Bezerra, F.M.L., Sousa, C.C.M., Pereira Filho, J.V., Freitas, C.A.S. 2011. Desempenho de cultivares de girassol sob diferentes laminas de irrigação no Vale do Curu, CE. Revista Ciência Agronômica, v. 42, n. 1, p. 57-64.

Silva, E. B. *et al.* 2009. Sintomas visuais de deficiências nutricionais em pinhão-manso. Pesquisa Agropecuária Brasileira , Brasília, v. 44, n. 4, p. 392- 397.

Surrage, J.R., Haag, H.P. 1974. Analises químicas em plantas. Piracicaba: ESALQ, 56p.

ViégaS, I. J. M. *et al.* 2004. Limitações nutricionais para o cultivo de açaizeiro em latossolo amarelo textura média, estado do Pará. Revista Brasileira de Fruticultura, Jaboticabal, v. 26, n. 2, p. 382-384.

****