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ENHANCEMENT OF VEGETATIVE GROWTH AND PRODUCTION OF VIGOROUS TRANSPLANTS IN *Khaya senegalensis* (Desr.) A. Juss. BY USING ASCORBIC ACID

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ABSTRACT

The current investigation was carried out during the two successive seasons of 2007/2008 and 2008/2009 in order to enhancement of seedling growth and produce vigorous transplants in African Mahogany by foliar application with ascorbic acid (0, 100, 200, 400 and 600 ppm).

The obtained results revealed that most of the applied concentrations of ascorbic acid (200, 400 and 600 ppm) promoted significantly the investigated morphological characters (plant height, number of leaves/plant, total leaf area/plant, fresh weight of shoot/plant and dry weight of shoot/plant) of vegetative growth of African Mahogany (10 months old) and produced vigorous transplants in both studied seasons. The maximum promotion was achieved at 600 ppm ascorbic acid which in turn being statistically indifferent with the effect obtained by 400 ppm ascorbic acid in this concern. Likewise, the maximum significant increase in concentration of photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) and of total sugars in leaves of African Mahogany plant aged 10 months was detected at 600 ppm ascorbic acid. Also, such treatment caused considerable thickness of the main stem of African Mahogany plant aged eight months by increasing thickness of both phloem and xylem tissues as well as by increasing diameter of pith. Likewise, average diameter of vessel was increased in treated plants to cope with vigorous growth induced by foliar application with 600 ppm ascorbic acid.

Keywords:*Kaya senegalensis*, African Mahogany, Ascorbic Acid, Vegetative Growth, Photosynthetic Pigments, Total Sugars, Stem Anatomy.

INTRODUCTION

Egypt and similar arid and semi-arid countries suffer from shortage in wood-raw materials which are necessary for several industrial uses. Therefore, they depend mainly on the imported woods. The current shortage and price increase created keen interest in exploring the possibility of utilizing the wood of the available windbreak and shelterbelt. Furthermore, the country has focused attention, specially during the last three decades, on establishing forest plantation to meet the acute needs for wood in Egypt (Abou-Gazia *et al.*, 1992 and El-Osta and Megahed, 1992).

Many important woody species are available and valuable for afforestation programs from which a selection should be conducted for using and covering the different sectors of Egypt. In this respect, El-Hadidi and Bolous (1979) stated that African Mahogany were found to be grow well in Upper Egypt as shade and avenue trees, where they yielded good, hard, heavy and durable wood. Thus, the Mahoganies may be planted successfully

in Egypt, specially in Upper Egypt or Toshka, to be used as wood source for useful wood works and decrease our needs imported from the foreign countries.

African Mahogany is the product of *Khaya senegalensis* A. Juss. and other related species such as *Khaya ivorensis* A. Chev. (F.A.O., 1959 and Rendle, 1967). *Khaya senegalensis*, the subject of the present investigation, belongs to the family Meliaceae which is called Mahogany family (Cronquist, 1981). *Khaya senegalensis*, African Mahogany, the Sudan or Senegal Mahogany tree produces a valuable cabinet wood, durable, resistant to impregnation and fairly easy to work. Used for most purposes; *i.e.*, furniture, fixtures, musical instruments, millwork, cars, ships and boats, caskets, airplanes, foundry patterns, veneers, and plywood (Hill, 1952 and Metcalfe and Chalk, 1979).

Recently, a great attention has been focused on the possibility of using natural and safety substances in order to improve plant growth. In this concern, antioxidants has synergistic effect on growth, yield and yield quality of many plant species. These compounds have beneficial effect on catching the free radicals or the active oxygen that producing during photosynthesis and respiration processes (Zhang and Klessing, 1997). Leaving these free radicals without chelating or catching leads to lipids oxidation and the loss of plasma membrane permeability and the death of cell within plant tissues. Antioxidants have also an auxinic action. One of the most familiar antioxidants is ascorbic acid which being synthesized in higher plants and affects plant growth and development. It is a product of D-glucose metabolism which affects some nutritional cycles activity in higher plants and play an important role in the electron transport system (Givan, 1979). Many investigators reported that ascorbic acid application resulted in enhancement of plant growth, yield and chemical constituents of some different plant species. Among of them, Barakat *et al.* (1984) and Hegab (2000) on mandarin trees, Ahmed *et al.* (1998) and Hammam *et al.* (2001) on mango trees, Ali (2000) and Ahmed and Abdel-hameed (2004) on grapevines and Ahmed *et al.* (2007) on date palms.

Thus, the present investigation is an attempt to through to light more information about the effect of ascorbic acid on seedling growth of *Khaya senegalensis* (Desr.) A. Juss. The effect on photosynthetic pigments, sugar content and stem anatomy was also investigated.

MATERIALS AND METHODS

The research work presented in this paper was carried out at the Wire-House of Agricultural Botany Department, Faculty of Agriculture, Cairo University, Giza, Egypt during the two successive seasons of 2007/ 2008 and 2008/2009 in order to enhancement of seedling growth and produce vigorous transplants in African Mahogany by foliar application with ascorbic acid.

Source of seeds:

Seeds of *Khaya senegalensis* (Desr.) A. Juss. were collected from fully ripe fruits during June 2007 and June 2008 from marked mother plus trees, about 79 years old, grown in Zoological Garden at Giza, Egypt.

Procedure of the experiment:

Seeds of African Mahogany were soaked in tap water for 24 hours and then sown in plastic trays, 40 × 60 cm, filled with peatmoss and clean sand at the ratio of 1:1 by volume. Seeds were sown on fourth July, 2007 in the first season and replicated on first July, 2008 in the second one to provid the experimental plant materials. At the age of two months, the emerged uniform seedlings were transplanted to plastic pots, one seedling per pot, (30 cm diameter) filled with clay and sand at the ratio of 1 : 1 by weight. Each pot was received NPK at the recommended rates. At the age of three months (one month from transplanting), seedlings were subjected to foliar application with ascorbic acid at concentrations of 100, 200, 400 and 600 ppm. The plants assigned for control treatment were sprayed with tap water.

The experiment was made in a complete randomized block design with three replicates. The replicate contained 40 pots, each 8 pots were assigned for one treatment.

Recording of data:

At the age of ten months from sowing date, plants were lifted from pots for recording the characters of vegetative growth and for physiological studies. The determined characters of vegetative growth includes:

1- Plant height (cm).
2- Number of leaves per plant.
3- Total leaf area $(cm)^2$ per plant.
4- Fresh weight of shoot (g) per plant.
5- Dry weight of shoot (g) per plant.

For physiological studies, photosynthetic pigments and total sugars were determined quantitatively in leaves of treated and untreated plants in the first season of 2007/2008 at the age of ten months from sowing date. Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were extracted by using dimethyl formamide and determined according to Nornai (1982) as mg/g fresh weight of Mahogany leaves. Total sugars was determined by using phenolsulphoric method according to Dubois *et al.* (1956) as mg/g fresh weight of Mahogany leaves.

Anatomical studies:

It was intended to carry out a comparative microscopical examination on plant material which showed the most prominent response of plant growth to investigated treatments. Specimens were taken from the median internode of the main stem throughout the second season of 2008/2009 at the age of eight months from sowing date. Specimens were killed and fixed for one week in F.A.A. solution, washed in 50% ethyl alcohol, dehydrated in normal butyl alcohol series and embedded in paraffin wax of melting point 56°C, sectioned to a thick of 20 microns, double stained with crystal violet-erythrosine, cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Slides were examined microscopically and photomicrographed.

Statistical analysis:

Data on morphological characters of vegetative growth as well as on photosynthetic pigments and total sugars were subjected to conventional methods of analysis of variance according to Snedecor and Cochran (1982).

The least significant difference (L.S.D.) at 0.05 level was calculated for each investigated character under different assigned treatments.

RESULTS AND DISCUSSION

I- Morphological characters of vegetative growth:

Data on morphological characters of vegetative growth of African Mahogany as affected by foliar application with different concentrations of ascorbic acid in two successive seasons are presented in Table (1).

1- Plant height:

It is realized from Table (1) that the control plants recorded a plant height of 38.5 cm in the first season and 41.2 cm in the second one which proved significant difference with most of the studied treatments. The relatively low sprayed concentration of 100 ppm ascorbic acid showed no significant effect on plant height of African Mahogany plants, 10 months old, in both studied seasons.

Table (1).The effect of foliar application with ascorbic acid on morphological characters of vegetative growth of African Mahogany plants, 10 months old, in two successive seasons

Treatments	Conc. ppm	Morphological characters of vegetative growth				
		Plant height (cm)	No. of leaves / plant	Total leaf area (cm^2)/plant	Shoot fresh weight (g) / plant	Shoot dry weight (g) / plant
First season of 2007 / 2008						
Control	0	38.5	11.3	1102.5	14.97	5.16
Ascorbic acid	100	39.7	11.2	1119.8	15.16	5.15
	200	45.4	12.1	1261.3	17.04	5.83
	400	52.2	12.9	1395.7	18.82	6.46
	600	53.8	13.1	1412.3	18.92	6.52
L.S.D. (0.05)		5.32	0.64	122.8	1.75	0.59
Second season of 2008 / 2009						
Control	0	41.2	11.5	1196.3	16.08	5.91
Ascorbic acid	100	40.4	11.7	1208.5	16.29	5.88
	200	48.5	12.8	1361.7	18.33	6.67
	400	54.9	13.7	1554.2	20.27	7.42
	600	56.1	14.0	1586.8	20.44	7.49
L.S.D. (0.05)		5.97	0.72	141.5	1.83	0.62

By contrast, any of the other three sprayed concentrations of ascorbic acid (200, 400 and 600 ppm) induced significant promotion effect in this respect. The maximum increase in plant height was recorded at 600 ppm ascorbic acid, being 39.7 and 36.2% more than that of the control in the first and second season; respectively. Worthy to mention that the difference between 400 and 600 ppm ascorbic acid was not significant.

2- Number of leaves / plant:

Data presented in Table (1) clearly show that all tested concentrations of ascorbic acid, except that of 100 ppm, increased significantly number of leaves developed per African Mahogany plant, 10 months old, in both studied seasons. The maximum increase in number of leaves was detected when plants of African Mahogany were sprayed with 600 ppm ascorbic acid, being 15.9% more than leaves of the control plants in the first season and 21.7% more than leaves of the control plants in the second one. Worthy to note that

number of leaves developed per plant received 600 ppm ascorbic acid did not statistically differed than number of leaves developed per plant received 400 ppm ascorbic acid.

3- Total leaf area / plant:

It is noted from Table (1) that the effect of foliar application with the assigned concentrations of ascorbic acid on total leaf area per African Mahogany plant showed the same trend that previously mentioned about the effect of ascorbic acid on number of leaves developed per the same plant. The relatively low sprayed concentration of 100 ppm had no significant effect on total leaf area per plant in both studied seasons. By the contrary, any of the other three sprayed concentrations induced significant promotion effect in this concern, and the difference between the last two used concentrations (400 and 600 ppm ascorbic acid) was not significant. The maximum increase in total leaf area per plant was recorded at 600 ppm ascorbic acid, being 28.1 and 32.6 % more than total leaf area per untreated plant in the first and second season; respectively.

4- Fresh weight of shoot/plant:

Data given in Table (1) indicate that all sprayed concentrations of ascorbic acid, except that of 100 ppm, had significant promotive effect on fresh weight of shoot per African Mahogany plant in both studied seasons. The maximum increase in fresh weight was detected at 600 ppm ascorbic acid, being 26.4 and 27.1% more than fresh weight of shoot per untreated plant in the first and second season; respectively. Worthy to mention that the difference between the two high used concentrations (400 and 600 ppm ascorbic acid) was not significant in this respect.

5- Dry weight of shoot/plant:

It is clear from Table (1) that the effect of foliar application with the adopted concentrations of ascorbic acid on dry weight of shoot per African Mahogany plant showed the same trend that previously mentioned about the effect of ascorbic acid on fresh weight of shoot per the same plant. The relatively low used concentration of 100 ppm had no significant effect on dry weight of shoot per African Mahogany plant in both studied seasons. Whereas, any of the other three sprayed concentrations (200, 400 and 600 ppm ascorbic acid) induced significant increase in this concern and the difference between the two high used concentrations (400 and 600 ppm) was not significant. The maximum increase in shoot dry weight was recorded at 600 ppm, being 26.2 and 26.7% more than shoot dry weight of untreated plant in the first and second season; respectively.

From the above menthioned results about the effect of foliar application with different concentrations of ascorbic acid on morphological characters of vegetative growth of African Mahogany, it could be stated that most of the applied concentrations promoted significantly morphological characters under investigation (plant height, number of leaves / plant, total leaf area / plant, fresh weight of shoot / plant and dry weight of shoot / plant). The maximum promotion was achieved at 600 ppm ascorbic acid which in turn being statistically indifferent with that of 400 ppm ascorbic acid in this concern.

As far as the authors are aware previous information on the effect of ascorbic acid on morphological characters of vegetative growth of *Khaya*

senegalensis seedlings or other related tree species are not available in the literature. However, many investigators reported that ascorbic acid application resulted in enhancement of plant growth, yield and chemical constituents of some different fruit trees. Among of them, Barakat *et al.* (1984) and Hegab (2000) on mandarin trees, Ahmed *et al.* (1996) and Hammam *et al.* (2001) on mango trees, Ali (2000) and Ahmed and Abdel-Hameed (2004) on grapevines and Ahmed *et al.* (2007) on date palms, being generally in harmony with the present findings.

II- Physiological studies:

Photosynthetic pigments and total sugars were determined quantitatively in leaves of *Khaya senegalensis* (Desr.) A. Juss. plants, 10 months old, as affected by foliar application with different concentrations of ascorbic acid in the first season of 2007/2008. Data on these constituents are given in Table (2).

1- Photosynthetic pigments:

It is obvious from Table (2) that the relatively low sprayed concentration of 100 ppm ascorbic acid had no significant effect on concentration of chlorophyll a, chlorophyll b and carotenoids in leaves of African Mahogany plant aged 10 months. By contrast, any of the other three used concentrations of ascorbic acid (200, 400 and 600 ppm) showed significant promotive effect on photosynthetic pigments. The maximum significant increase in concentration of photosynthetic pigments in leaves of African Mahogany was detected at 600 ppm ascorbic acid, being 24.8% more than the concentration of chlorophyll a in leaves of untreated plant, 28.5% more than the concentration of chlorophyll b in leaves of untreated plant and 30% more than the concentration of carotenoids in leaves of untreated plant.

2- Total sugars:

It is realized from Table (2) that the first two tested concentrations (100 and 200 ppm) ascorbic acid had no significant effect on the concentration of total sugars in leaves of African Mahogany plant aged 10 months. On the other hand, the high used concentration of 400 or 600 ppm ascorbic acid increased significantly the concentration of total sugars in leaves of African Mahogany plant aged 10 months and the difference between these two concentrations was not significant. The maximum increase in concentration of total sugars was recorded at 600 ppm ascorbic acid, being 18.1% more than the control. The present findings are generally in agreement with those reported by Ahmed *et al.* (2007).

Table (2).The effect of foliar application with ascorbic acid on photosynthetic pigments and total sugars in leaves of African Mahogany plants, 10 months old, in the first growing season of 2007/2008

Treatments	Conc. (ppm)	Photosynthetic pigments (mg/g F.W.)			Total sugars (mg/g F.W.)
		Chlorophyll a	Chlorophyll b	Carotenoids	
Control	0	2.496	0.832	1.055	8.316
Ascorbic acid	100	2.502	0.829	1.062	8.327
	200	2.759	0.944	1.218	8.643
	400	3.048	1.057	1.364	9.792
	600	3.116	1.068	1.372	9.818
L.S.D. (0.05)		0.238	0.095	0.137	1.024

III- Anatomical studies:

It was aimed in this investigation to follow up the internal structure of the main stem of plants which exhibited the most noticeable response to tested treatments. The aforementioned findings concerning the morphological characters of vegetative growth of African Mahogany proved that foliar application with 600 ppm ascorbic acid achieved the most remarkable effects among various tested concentrations of ascorbic acid. Such treatment caused maximum significant promotive effect on vegetative growth characters and induced vigorous transplants in African Mahogany. This may justify a further study on the spraying effect with 600 ppm ascorbic acid on the internal structure of the main stem of African Mahogany plants.

Microscopical measurements of certain histological characters in transverse sections through the median internode of the main stem of African Mahogany, eight months old, as affected by foliar application with 600 ppm ascorbic acid in the second season of 2008/2009 and those of untreated plants are given in Table (3). Likewise, microphotographs illustrating such treatment as well as the control are shown in Figure (1).

It is clear from Table (3) and Figure (1) that ascorbic acid treatment caused considerable thickness of the main stem by increasing the internode diameter by 16.2% more than that of the control. Although a negligible decrease of 4.6% in thickness of cortex below the control was observed, the increase in stem diameter due to ascorbic acid treatment could be attributed to the considerable increases in thickness of phloem and xylem tissues as well as in diameter of pith by 22.5, 20.4 and 27.5% more than those of the control; respectively. Likewise, average diameter of vessel was increased in treated plants by 33.3% over the control.

As far as the authors are aware, information concerning anatomical structure of the main stem of African Mahogany plant as affected by foliar application with ascorbic acid are not available in the literature.

Table (3). Measurements in micron of some histological characters in transverse sections through the median internode of the main stem, eight months old, of normal African Mahogany plants and of those sprayed with 600 ppm ascorbic acid (Means of three sections from three specimens)

Histological characters	Treatments		
	Control plants	Plants sprayed with 600 ppm ascorbic acid	± % to control
Stem diameter	4458	5179	+ 16.2
Cortex thickness	584	557	- 4.6
Phloem tissue thickness	377	462	+ 22.5
Xylem tissue thickness	514	619	+ 20.4
Vessel diameter	39	52	+ 33.3
Pith diameter	1487	1817	+ 25.8

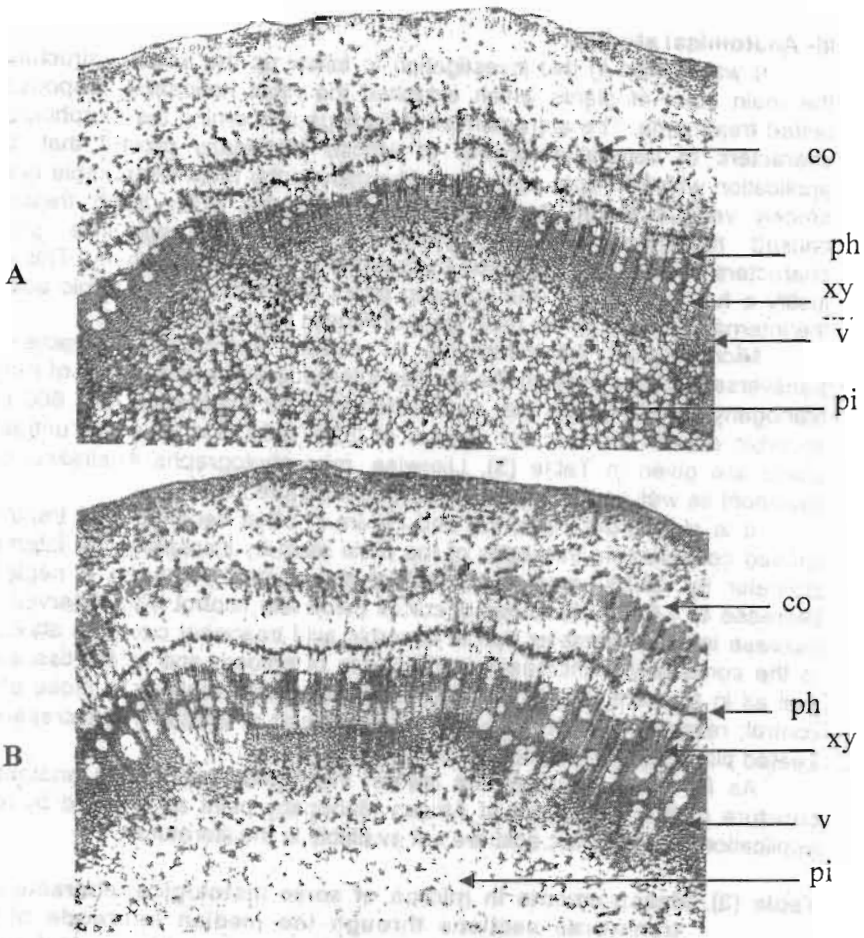

Figure (1): Transverse sections through the median portion of the main stem of *Khaya senegalensis* (Desr.) A. Juss., eight months old, as affected by foliar application with ascorbic acid. (x 58)

A- From main stem of untreated plant.

B- From main stem of plant treated with 600 ppm ascorbic acid.

Details: co, cortex; ph, phloem; pi, pith; v, vessel and xy, xylem.

REFERENCES

Abou-Gazia, H.A.; A.M.El-Baha and M.M.Megahed (1992). Evaluation of some casuarinas species and provenances trials in North-Western zone of Egypt. Egypt. Jour. of Appl. Sci., Zagazig Univ., 7 (6): 405-428.

Ahmed, F.F.and H.M. Abdel-Hamed (2004). Influence of some antioxidants on growth, vine nutritional status, yield and quality of berries in banaty grapevines. Assuit Jour. of Agric. Sci., 35 (4): 131-140.

Ahmed, F.F.; M.A.Ragab and A.E.M.Mansour (1998). Effect of ascorbic acid and citrine on some mango cultivars. Egypt. J. Hort., 25 (1): 15-25.

Ahmed, F.F.; Y. Mohamed and B.M. Abd Alla (2007). The relation between using some antioxidants and productivity of Sewy date palms. Minia J. of Agric. Res. and Develop., 27 (4): 753-770.

Ali, A.H. (2000). Response of Flame seedless grapevines to spraying with ascorbic acid and boron. Minia J. of Agric. Res. and Devolp., 20 (1): 159-174.

Barakat, M.R.; A.M. Sweidan and M.M. El-Said (1984). Growth, flowering and fruiting efficiency of mandarin trees as affected by foliar application of boron, molybdenum or ascorbic acid. Bull. Fac. of Agric., Univ. of Cairo, 35 (2) : 1103-1106.

Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, p. 813-815.

Dubois, M.; F. Smith; K.A. Gilles; J.K. Hamilton and P. A. Rebers (1956). Colorimetric method for determination of sugars and related substances. Anal. Chem., 28 (3): 350-356.

El-Hadidi, M.N. and L. Bolous (1979). The Street Trees in Egypt. Dar Memphis for Printing, Cairo, Egypt.

El-Osta, M.L. and M.M. Megahed (1992). Characterization of biomass of some species introduced to Egypt. Alex. Jour. of Agric. Res., 37 (3): 85-105.

FAO (1959). Tree Planting Practices in Tropical Africa. FAO Forestry Development Paper, (8): 213-215.

Givan, G. V. (1979). Metabolic detoxification of ammonia in tissues of higher plants. Phytochemistry, 18:375-382.

Hammam, M.S.; B.M. Abd Alla and S.G. Mohamed (2001). The beneficial effects of using ascorbic acid with some micronutrients on yield and fruit quality of Hindy Bisinnara mango trees. Assuit J. of Agric. Sci., 32 (5): 181-193.

Hegab, M.Y. (2000). Response of Balady mandarin trees to application of citric and ascorbic acids in combined with iron and zinc. Egypt. J. App. Sci., 15 (1): 50-70.

Hill, A.F. (1952). Economic Botany (2nd Edit.). Mc Graw-Hill Book Co. Inc. New York, p. 111-112.

Metcalfe, C.R. and L. Chalk (1979). Anatomy of the Dicotyledons, (Vol. I). The Clarendon Press, Oxford, p. 349-358.

Nassar, M.A. and K.F. El-Sahhar (1998). Botanical Preparations and Microscopy (Microtechnique). Academic Bookshop, Dokki, Giza Egypt, 219 pp. (In Arabic).

Nornai, R. (1982). Formulae for determination of chlorophyllous pigments extracted with N. N. Dimethyl formamide. Plant Physiol. 69:1371-1381.
Rendle, A.B. (1967). Classification of Flowering Plants (Vol. II). Published by the Syndics of the Cambridge University Press. p. 290-291
Snedecor, G.W. and W.G. Cochran (1982). Statistical Methods. The Iowa State University Press 7th Edit., 2nd Printing, 507 pp.
Zhang, S. and D.F. Klessing (1997). Salicylic acid activities a 48-K0 MAP Kinase in tobacco. Plant Cell, 9: 409-424.

تحسين النمو الخضرى وإنتاج شتلات قوية من الكايا السنغالى باستخدام حامض الاسكوربيك

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أجرى هذا البحث خلال موسمين متتاليين هما ٢٠٠٧/٢٠٠٨ و ٢٠٠٨/٢٠٠٩ بهدف تحسين النمو الخضرى وإنتاج شتلات قوية من الكايا السنغالى (الماهوجنى الافريقى) باستخدام حامض الاسكوربيك رشا بتركيزات صفر، ١٠٠، ٢٠٠، ٤٠٠ و ٦٠٠ جزء فى المليون.

أوضحت النتائج المتحصل عليها أن معظم التركيزات المستخدمة من حامض الاسكوربيك (٢٠٠، ٤٠٠، ٦٠٠ جزء فى المليون) نشطت معنويا جميع الصفات المورفولوجية للنمو الخضرى (ارتفاع النبات، عدد الأوراق للنبات، المساحة الكلية للأوراق على النبات، الوزن الرطب والجاف للمجموع الخضرى للنبات) لنبات الكايا السنغالى عند عمر ١٠ شهور فى كلا موسمى الدراسة. وكان أقصى تنشيط للنمو الخضرى عند رش حامض الاسكوربيك بتركيز ٦٠٠ جزء فى المليون والذى لم يختلف معنويا فى تأثيره عن الرش بتركيز ٤٠٠ جزء فى المليون. وكانت أقصى زيادة فى تركيز صبغات البناء الضوئى والسكريات الكلية فى أوراق الكايا السنغالى تم الحصول عليها عند الرش أيضا بتركيز ٦٠٠ جزء فى المليون حامض الاسكوربيك ، وكان لهذا التركيز أيضا تأثيرا مرغوبا على التركيب التشريحى للساق الرئيسية حيث أدى الرش إلى زيادة فى سمك الساق الرئيسية نتيجة الزيادة الحادثة فى سمك كل من نسيجى الخشب واللحاء بالإضافة إلى زيادة فى قطر النخاع البارنشيمى مقارنة بالنباتات الغير معاملة، كما أدى الرش أيضا بهذا التركيز إلى حدوث زيادة فى قطر أوعية الخشب لتتناسب مع قوة النمو الحادثة فى المجموع الخضرى للنباتات المعاملة.

قام بتحكيم البحث

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