Effect of foliar application with Urea and CO2 enrichment on some growth characteristics and mineral content of sour orange seedlings.

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Abstract:

The influence of foliar application with urea and CO2 enrichment on growth characteristics and mineral content of 6 month old sour orange seedlings, grown under nursery condition was investigated from November 2012 to Desember 2013 .Three urea levels were used : 0(spray with distilled water), 0.5% and 1%.The transplants also exposed to three CO2 levels, near that of ambient air (0.0390%), supplied saplings with additional CO2 levels above the ambient air 0.0690% and 0.0990%.The results showed that spraying with 1% urea increased significantly all the vegetative characteristics (leaves number, leaves area, branch number, stem diameter, total vegetative and root dry weight, mineral content of leaves, chlorophyll content and branches total carbohydrate). Elevated CO2 level to 0.0990 % increased all vegetative parameters, potassium, phosphour and total carbohydrate, whereas transplants grown under ambient air (0.0390%) contained the highest chlorophyll and nitrogen leaf contents.

تأثير التغذية الورقية باليوريا والأغناء بغاز CO2 في بعض مواصفات النمو الخضري والمحتوى المعدني لشتلات النارنج.

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الخلاصة :

اجريت دراسة تأثير الرش الورقي والاغناء بغاز CO2 في نمو شتلات النارنج النامية تحت ظروف المشتل للفترة من تشرين الثاني 2012 لغاية كانون الاول 2013. انتخبت شتلات بعمر 6 أشهر ورشت ورقياً باليوريا وبثلاث مستويات هي : صفر (الرش بالماء المقطر) كمعاملة مقارنة ، 0.5 % و 1% ، بالاضافة الى اغناء البادرات بغاز CO2 بثلاث مستويات هي : تركيز CO2 في الهواء الجوي (0.0390 %) ، (0.0690 %) و (0.0990 %) . اوضحت نتائج الدراسة ان الرش الورقي باليوريا بتركيز 1 % قد ادى الى زيادة عدد الاوراق ،المساحة الورقية،عدد الافرع ، قطر الساق ، الوزن الجاف للمجموع الخضري والجذري وزيادة محتوى الاوراق من العناصر المعدنية والكلوروفيل ومحتوى الكربوهيدرات في الافرع ، كما اظهرت النتائج ان الاغناء بغازCO2 وبالاخص التركيز 0.0990 % قد زاد من معظم المواصفات الخضرية ومحتوى الاوراق من البوتاسيوم والفوسفور ومحتوى الافرع من الكربوهيدرات ، في حين ان الشتلات النامية تحت ظروف تركيز CO2 في الهواء الجوي (0.0390 %) قد احتوت على اعلى محتوى للكلوروفيل والنتروجين في الاوراق .

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Introduction:

Sour orange (*Citrus aurantium* L.) is an ornamental tree often used as a rootstocks in commercial citrus orchards. It has many good characteristics as a rootstock for citrus, including resistance to blight, adaptability to a wide varieties of soil conditions, and the favorable influence on scion is tolerance and fruit quality (Castle et al., 1993). The time required to grow citrus seedlings to a suitable size for budding may be as long as 1 to 2 years (when seedling stems are 1/4 to 3/8 inch in the diameter of a pencil (Williamson and Jackson ,1994), therefore, shorten this period would benefit by reducing various production in pots and their costs. Foliar applications of N have been suggested as an alternative to soil fertilization (Khemira et al.,1998) to decrease the potential of nitrate leaching(Council for Agriculture Science and Technology,1985).Urea is an ideal N carrier for foliar application because it contains high percentage of N (46 %) , uptake, metabolism and translocation is rapid following application. It was used by many fruit seedlings at solution in different concentration during the growing season and enhanced most of the growth parameters. (Sheo and singh ,1999) used urea at 0.5% on sour orange and Cleopatra mandarin seedlings , (Pegah sayyad and Shahsavar, 2012) used urea at 0.5 % and 0.75 % on olive transplants , (Said , 1989) on pecan and (El-Din et al.,1993) on pomegranate used urea at concentration 1% respectively.

One of the most limiting factors in the growth of terrestrial plants is the low concentration of atmospheric carbon dioxide (CO2) (Peracy and Bjorkman , 1983 ˙, Wittwer, 1983), although this atmospheric gas is the raw material for photosynthesis, only about 0.034%, (340 ppm) is currently made up of CO2 (Allen and Jr ,1997). Numerous studies conducted in CO2-enrichment greenhouses have shown a substantial increase in yield and growth rates among a wide varieties of crops, (Koch and White ,1983) on citrus rootstocks used two concentration of CO2, atmospheric CO2 (0.033%) and elevated CO2 (0.066%), (Downton et al.,1990) on mangosteen (*Garcinia mangostana* L.) which used enrichment CO2 in concentration 0.1%, (Bunce et al., 1997) on mango (*Mangifera indica*) which exposed trees to two concentration 0.035 % (ambient air) and 0.07 % (elevated CO2) ,(Keith et al., 2002) exposed sour orange trees to two concentration of CO2 , (atmospheric CO2 0.04 %) and elevated CO2 (0.07 %) ,(Kareem et al., 2006) on citrus seedlings which had been grown in two enrichment concentration (0.033 % ambient air) and (0.066% elevated CO2) . Plants grown under elevated CO2 typically have decreased tissue concentrations of some elements especially N compared with plants grown under current ambient CO2, due to growth of plants at atmospheric concentration of CO2 greater than the current ambient, can greatly affect plant tissue chemistry (Poorter et al., 1997; Cotrufo et al., 1998; Curtis and Wang, 1998 ; Loladze, 2002).

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Thus, the present investigation was planned to study the effect of foliar application with Urea and CO_2 enrichment, either solely or in combination on growth of sour orange transplants in order to produce vigorous plants to accomplish growth as early as possible.

Materials and Methods :

This trial was carried out in the experimental field of Horticulture Department, College of Agriculture, University of Baghdad during (November 2012 to Desember 2013) on six- month old sour orange seedlings (*Citrus aurantium* L.). Uniform seedlings were selected and transplanted into black polyethylene bags (25cm diameter and 40 cm height) .The potting medium was a mixture of organic matter (cattle manure) and soil at portion (1:2), seedlings were subjected to the same cultural practices during the growing season and were routinely irrigated whenever it is needed, soil and organic matter was analyzed as shown in table (1 and 2).

Eighty one seedling were selected as uniformed as possible, the experiment involved 9 treatments with 9 replicates for each treatment, each replicate represented by one seedling, as follows:

- Foliar spray with distilled water U0, U1 (0.5 %), U2 (1%). All saplings received the spraying solution with liquid soap as wetting agent ($1 ml.l^{-1}$) till run off at dates (1/3/2013), (20/3/2013), (10/4/2013), (30/4/2013), (20/5/2013).
- Three levels of CO_2 enrichment (27 sapling per tunnel) were exposed to different levels of CO_2 enrichment in 3 plastic tunnel. Each tunnel was constructed of 0.09 mm of plastic thickness and was (3 m long × 1.80 m wide × 1.5 m high). CO_2 levels was measured by using Portable Indoor Air Quality CO_2 Meter as follows:
- C0 (exposed saplings to CO_2 levels near those of ambient air 0.0390 %).
- C1 (supplied saplings with additional CO_2 levels above the ambient air 0.0690 %).
- C2 (supplied saplings with additional CO_2 levels above the ambient air 0.0990 %).

CO_2 enrichment process initiated during (March, April until May 2013, for 9 weeks (3 hours per day from 6.5 A.M till 9.5 A.M), then the plastic removed from the tunnel (Fujisawa et al.,2001). Therefore, the experiment included 3 levels of foliar sprays with urea, 3 levels of CO_2 enrichment in factorial experiment (3 × 3) with 9 replicate for each treatment, each replicate represented by one sapling using Nested Factorial Design. The results was analysied using Genstat method of analysis and the means were compared using LSD at 0.05 level of significant (Al-Rawi and khalafallah,1980).

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Table 1: physical and chemical soil analysisa-Physical analysis ($gm.kg^{-1}$ soil)

Sand	Loam	Clay	Texture
658.4	175.0	166.6	Sandy loam

b-Chemical analysis

Available($mg.kg^{-1}$soil) **Soluble Ions($Cmol.L^{-1}$)**

pH	EC(1:1)$ds.m^{-1}$	CEC($Cmol.kg^{-1}$soil)	N	P	K	Ca	Mg	Na	Cl
7.7	3.74	24.2	51.6	12.7	239.8	1.43	0.72	1.18	1.60

Table 2 : chemical analysis of organic matter

Total ($gm.kg^{-1}$)

pH	EC(1:1)$ds.m^{-1}$	organic carbon($gm.kg^{-1}$)	N	P	K	C/N
6.7	1.8	319	23	9.8	25.3	13.87

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Experimental parameters:

Number of leaves.sapling^{-1} : Recorded at the beginning (November 2012) and end (Desember 2013) of the experiment and rate of increasing were determined by calculating the difference between them.

Leaves area .sapling $^{-1}$(dm^2): Leaf area was measured by taking the maximum length multiply by the maximum width of the leaf multiplying by 2 /3, after determined the leaf area and the number of leaves per sapling ,leaves area /plant were determined by multiplying number of leaves by leaf area as mentioned in (Chou,1966).

Number and length of new branches (branch.sapling $^{-1}$) : All branches on main stem of the rootstock were numbered and measured on the end of the experiment.

Stem diameter (mm): Recorded at the beginning (November 2012) and end (Desember 2013) of the experiment and rate of increasing were determined by calculating the difference between them.

Dry weight of plant parts (gm): Dry weight of vegetative system (stem, leaves and branches) and dry weight of roots were determined at the end of investigation. **Some elements of leaf (%) :** In late October (2013), leaves (6-10 th) from the apex were selected for determining leaves mineral contents (Smith ,1966) .These samples were washed several times with distilled water and then dried at 70 C$^{\circ}$ until constant weight were reached , finally ground and digested using the method of (Piper,1950).The digested solution was used for the determination of each of Nitrogen using(Micro-kjeldahl) method , Phosphour using (Amonium molybdate) method ,Potassium using (Flame photometer) method according to methods mentioned by (Bhargava and Raghupathi ,1999).

Total chlorophyll content (mg.g $^{-1}$ fresh weight)of leaves : In October (2013) , leaves (6-10 th) from the apex (Smith ,1966) were selected for determining average leaf chlorophyll content, then wrapped in polyethylene bags ,transferred quickly to laboratory, 0.5gm from each sample was taken and transferred to 20 ml acetone (80%), after 72 hours, when chlorophyll pigment was completely extracted into acetone ,the maximum absorbance of the solution was determined spectrophotometrically at two wavelengths (663 and 645) nm .Then total chlorophyll content of leaves was calculated according to equations described in (Bajracharya ,1999).

Branch total carbohydrates (%): Total carbohydrates content of sour orange transplants were determined as percent of dry weight according to (Dubois et al.,1956)

Results and Discussion:

Results:

1-Effect of foliar urea application, CO2 enrichment and their interactions on some growth characteristics of sour orange saplings.

Leaves number.sapling $^{-1}$:

The average leaf number is presented in Table (3A & 3B) showed that, urea(U2) sprayed with (1%) and CO2

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(C2) enrichment with (0.0990 %) gave the highest means of leaves number (204.2 & 212.0 $leaf.sapling^{-1}$), respectively, while the control treatment of (U0) sprayed with water only and C0(atmospheric CO_2) gave the least average of leaves number (185.1 & 177.9 $leaf.sapling^{-1}$), respectively.Moreover, the interaction between the experimental factors involving urea×CO_2 affected leaves number significantly especially the treatment U2(1%) × C2(0.0990%) which gave (219.3$leaf.sapling^{-1}$),Table(3C).

Leaves area.$sapling^{-1}$ (dm^2):

Average leaves area is presented in Table (3A & 3B) showed that , foliar application of urea (U2) and CO_2 enrichement (C2) gave the highest leaves area(65.09 &65.16 dm^2) respectively ,compared with control treatments U0 and C0 which gave (52.01& 52.31 dm^2) respectively .The interaction between studied treatments observed that U1(0.5%)×C2(0.0990%) gave the highest leaves area (70.18 dm^2),Table(3C) .

Branches number.$sapling^{-1}$:

Data tabulated in Table (3A&3B) showed that, urea application and CO_2 enrichment increased branches number, whereas the higher significant values belonged to U2 and C2 which gave (3.89& 4.22) respectively, compared with control treatments U0 and C0 which gave the lowest value (3.22 & 2.67) respectively. The interaction between the experimental factors including, urea× CO_2 affected branches number significantly especially the treatment U2×C2 which gave (5.00),Table(3C).

Length of branches.$sapling^{-1}$(cm):

Data in Table(3A&3B) indicated that , foliar application of urea (U1) and CO_2 enrichment (C2) increased the length of branches (59.92&59.71 cm) respectively, while the control treatment (U0 &C0) gave the lowest value (43.99 & 41.93 cm) respectively.Moreover, the interaction between the experimental factors indicated, that U2(1%)× C1(0.0690%) treatment had achieved the highest value(70.13 cm), Table(3C).

Stem diameter(mm):

Data presented in Table (3A&3B) showed that, there is a significant effect of foliar application of urea and CO_2 enrichment, whereas the highest value belonged to U2 and C2 which gave (8.97 & 9.65 mm) respectively, compared with control treatment U0 and C0 which gave the lowest value (8.35&7.45 mm) respectively. The interaction between the studied treatments indicated, that U2×C2 treatment gave the highest value(9.76 mm). Table(3C).

Total vegetative dry weight (gm):

Data in Table(3A& 3B) indicated, that foliar application of urea (U2) and CO_2 enrichment (C2)caused higher significant foliages dry weight (129.1& 133.2 gm)respectively ,compared with control treatment which gave(112.0&103.4 gm) respectively.The interaction between the studied factors revealed, that U2×C2 gave the highest value(138.4 gm) ,Table(3C).

2-Effect of foliar urea application, CO_2 enrichment and their interaction

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on some growth characteristics and some elements of sour orange saplings.

Total root dry weight (gm):

Table (4A & 4B) shows that there was a significant effect of foliar application of urea and CO2 enrichment on root dry weight , U2 and C2 treatments produced high dry weight (33.42 & 34.31 gm) respectively , whereas roots from untreated transplants (control) produced the lowest dry weight (31.97 & 31.87 gm) respectively , urea × CO2 interaction significantly influenced root dry weight , roots of transplants treated with U1×C2 produced the highest dry weight (34.95 gm),Table (4C).

Nitrogen content (%):

Data presented in Table (4A&4B) showed that, foliar application of urea increased nitrogen content in leaves ,especially concentration (U2) which gave the highest value(1.96%)compared to untreated transplants (control) which gave the lowest value(1.73 %), whereas CO2 enrichment decreased nitrogen content in leaves especially concentration (C1) which gave (1.81%) compared to unenrichment saplings (atmospheric CO2) which gave the highest value(1.90%).Moreover , the interaction between the studied factors including ,urea × CO2 affected leaves nitrogen content significantly especially the treatment U2×C1 which gave (1.99%) compared to the treatment U0×C1 which gave the lowest value(1.67%),Table(4C).

Phosphour content (%):

The concentration of phosphour in leaf tissues of sour orange transplants in response to urea application and CO2 enrichment were presented in Table(4A&4B).It was cleared that , phosphour content of leaves was increased by increasing urea and CO2 concentration , treatment U2 and C2 had achieved the highest values (0.34&0.32%) respectively, while sour orange transplants under control treatment gave the lowest values(0.21&0.23%) respectively .The interaction between the studied treatments indicated , that U2×C2 gave the highest value(0.36 %),Table(4C).

Potassium content (%):

Data presented in Table (4A&4B) showed that, foliar application of urea and CO2 enrichment, increased potassium content in leaves, especially concentration (U2) and (C2) which gave the highest value(1.50&1.43%) respectively, compared to untreated transplants (control) which gave the lowest value(1.23 &1.30%) respectively.The interaction between the experimental factors indicated, that U2×C1 treatment had achieved the highest value (1.56%),Table(4C).

Chlorophyll content ($mg.gm^{-1}$ fresh weight):

The results were given in Table (4A&4B) showed that, the foliar application of urea increased leaf chlorophyll content ,especially concentration (U2) which gave the highest value (11.93 $mg.gm^{-1}$fresh weight) compared to untreated transplants (control) which gave the lowest value (9.22 $mg.gm^{-1}$fresh weight) , whereas CO2 enrichment decreased chlorophyll content in leaves especially concentration (C2) which gave(9.65 $mg.gm^{-1}$ fresh weight)compared to unenrichment transplants (atmospheric CO2) which gave the highest value(11.93 $mg.gm^{-1}$fresh

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weight).The interaction between the studied factors involving urea× CO_2 affected chlorophyll content significantly especially the treatment U2×C1 which gave (11.81mg.gm^{-1}fresh weight) compared to the treatment U0×C2 which gave the lowest value (7.31 mg.gm $^{-1}$fresh weight),Table(4C).

Total carbohydrate (%):

The results were given in Table (4A&4B)showed that foliar application of urea and CO_2 enrichment increased total carbohydrate in branches,U2and C2 treatment recorded the highest values (8.00&8.21%) respectively, compared to the untreated transplants(control)which gave the lowest value(7.65&6.98%)respectively, The interaction between the studied factors revealed, that U2×C2 scored the highest value(8.24%) ,Table(4C).

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Table3: Effect of foliar urea application, CO_2 enrichment and their interaction on some growth characteristics of sour orange saplings.

concentration (%)		leaves number. sapling $^{-1}$	leaves area. sapling $^{-1}$ (dm^{2})	Branches number. sapling $^{-1}$	Branches length. sapling $^{-1}$ (cm)	Stem dimeter (mm)	Total vegetative dry weight (gm)
Urea concentration)A(							
U0		185.1	52.01	3.22	43.99	8.35	112.0
U1		188.9	61.35	3.33	59.92	8.58	120.7
U2		204.2	65.09	3.89	57.31	8.97	129.1
L.S.D 0.05		7.20	2.18	0.55	4.27	0.37	2.97
(B)CO2 enrichment Levels							
C0		177.9	52.31	2.67	41.93	7.45	103.4
C1		188.3	60.98	3.56	59.58	8.81	125.2
C2		212.0	65.16	4.22	59.71	9.65	133.2
L.S.D 0.05		7.36	1.87	0.49	6.90	0.71	7.72
(C) A×B							
U0	C0	168.3	46.09	2.33	39.83	7.00	92.60
	C1	188.0	53.52	3.67	42.03	8.56	117.3
	C2	199.0	56.42	3.67	50.10	9.50	126.3
U1	C0	173.0	54.00	2.33	45.03	7.30	103.4
	C1	176.0	59.87	3.67	66.57	8.76	123.7
	C2	217.0	70.18	4.00	68.17	9.70	135.0
U2	C0	192.3	56.85	3.33	40.93	8.06	114.3
	C1	201.0	69.55	3.33	70.13	9.10	134.7
	C2	219.3	68.88	5.00	60.87	9.76	138.4
L.S.D 0.05		11.69	3.39	0.87	8.39	0.81	8.17

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Table4: Effect of foliar urea application, CO2 enrichment and their interaction on some growth characteristics and mineral content of sour orange saplings.

Urea concentration)A(							
Concentration (%)		**Total root dry weight (gm)**	**Nitrogen (%)**	**Phosphour (%)**	**Potassium (%)**	**Chl (mg.g -1) fresh weight**	**Carbohydrate (%)**
U0		**31.97**	**1.73**	**0.21**	**1.23**	**9.22**	**7.65**
U1		**32.91**	**1.85**	**0.28**	**1.42**	**10.92**	**7.74**
U2		**33.42**	**1.96**	**0.34**	**1.50**	**11.93**	**8.00**
L.S.D 0.05		**0.90**	**0.03**	**0.03**	**0.05**	**0.49**	**0.32**
(B)CO2 enrichment Levels							
C0		**31.87**	**1.90**	**0.23**	**1.30**	**11.93**	**6.98**
C1		**32.13**	**1.81**	**0.28**	**1.42**	**10.48**	**8.21**
C2		**34.31**	**1.83**	**0.32**	**1.43**	**9.65**	**8.21**
L.S.D 0.05		**0.94**	**0.07**	**0.06**	**0.07**	**0.61**	**0.82**
(C) A×B							
U0	**C0**	**30.93**	**1.84**	**0.17**	**1.20**	**11.57**	**6.58**
	C1	**31.61**	**1.67**	**0.21**	**1.23**	**8.78**	**8.21**
	C2	**33.37**	**1.70**	**0.26**	**1.26**	**7.31**	**8.18**
U1	**C0**	**32.10**	**1.91**	**0.22**	**1.28**	**11.72**	**6.78**
	C1	**31.69**	**1.76**	**0.29**	**1.45**	**10.86**	**8.21**
	C2	**34.95**	**1.87**	**0.33**	**1.52**	**10.17**	**8.23**
U2	**C0**	**32.57**	**1.97**	**0.32**	**1.43**	**12.51**	**7.58**
	C1	**33.09**	**1.99**	**0.34**	**1.56**	**11.81**	**8.20**
	C2	**34.61**	**1.93**	**0.36**	**1.50**	**11.48**	**8.24**
L.S.D 0.05		**1.47**	**0.08**	**0.07**	**0.09**	**0.85**	**0.87**

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Discussion

It is observed from the above mentioned results in Tables(3A&3B) that a significant increase occurred in leaves number, leaves area ,branches number , branches length ,stem diameter ,vegetative dry weight .Increasing these characteristics by foliar application of urea may be attributed to the role of nitrogen which occupied (46%) of urea composition, that serves as a constituent of many plant cell components,including amino acids ,amides, proteins ,nucleic acids, nucleotides ,coenzymes,etc.(Taiz and zeiger,2006) ,moreover ,there is a strong positive correlation between photosynthesis and leaf nitrogen content for many C3 species (Field and Mooney,1986 ; Evans,1989), through increased amounts of stromal and thylakoid proteins in leaves (Bungard et al., 1997),besides that, up to 75 % of leaf nitrogen is found in the chloroplasts, most of it invested in ribulose bisphosphate carboxylase alone (Brown,1978). These findings are in agreement with (Lawlor,1995) who indicated that nitrogen supply stimulates plant growth and productivity, as well as photosynthetic capacity of leaves , Therefore,we can expect under condition of nitrogen a vailability there is a high rates of photosynthesis,consequently increasing total leaf number , individual leaf area , total leaf area ,branches number ,branches length ,stem diameter which reflected eventually in increasing vegetative dry weight .

The obtained results are in harmony with the findings obtained by (Mustafa et al.,2011), who indicated that , there were a remarkable effect of spraying different N sources (urea ,ammonium nitrate ,calcium nitrate and crystalon) with concentration (0.5 %) on vegetative growth of picual olive seedlings, estimated as percentage of seedling height , increment leaves number per plant , lateral shoots number per plant , stem diameter , leaf dry weight , and (Shaheen and Aly,2011) , who indicated that , there were a significant effect on foliar application of urea with concentration (1%) weekely on vegetative characteristics of rooted olive cuttings , estimated as number of leaves , stem diameter , shoot number and dry weight of vegetative parts.

Increasing vegetative characteristics of transplants exposed to elevated CO2 may be attributed ,Growth under elevated CO2 changes plant structure through its effects on primary and secondary meristems of shoots and roots that include ,cell division , cell expansion and differentiation , which may be altered by increased substrate availability and possible by differential expression of genes involved in cell cycling and cell expansion (Taylor,1997 ; Pritchard et al.,1999) ,moreover (Rayle et al.,1982 ; D'Aostino and Kieber,1992) , indicated that plant hormones including cytokinins, auxins, and gibberellins are involved in controlling developmental events within apical meristems such as cell division, cell elongation and protein

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synthesis , furthermore , that the evidence to date supports that , the pivotal role of cytokinins in regulating plant cell division , differentiation , cyclin genes and cell elongation.

Hence, it is possible that plant hormones production and supply through roots and shoots may be altered in elevated CO_2 conditions, and thereby may modify above ground growth (e.g meristems size , leaf area) and developmental profile (e.g apical dominance, leaves number, stem diameter and branching) which reflected eventually in increasing vegetative dry weight .

These results agree with (Idso and Kimball,1991; Idso and Kimball, 1992a) , who indicated that , there were a significant effect of exposing sour orange transplants from seedling stage to CO_2 enrichment with concentration (0.03%) above the atmospheric CO_2, the results showed remarkable changes in leaves number , trunk diameter, shoots number per plant compared to atmospheric CO_2 (ambient air), and (Fujisawa,2001), who indicated that CO_2 enrichment of sweet orange(cv.shiranuhi) with concentration (0.125 %) for three hours daily from 4-7 A.M for three month increasing leaf number , leaf area, elongation of shoots and stem diameter compared to atmospheric CO_2 (ambient air).

As it results from Tables (4A&4B), it was noticed that, foliar application of urea increased significantly total root dry weight, the reason of this might be interpreted that ,foliar feeding of urea increase N reserves and therefore improve leaf chlorophyll content ,shoot growth, total leaf area ,consequently increasing photosynthetic activity and may have produced more carbohydrate than control plants ,which could supply more energy to the root system and eventually increasing total root dry weight.Our results also agree with those of (Fuchigami ,2001 ; Shufu et al.,2002), who found out that, foliar urea application increased root biomass in young apple potted trees and altered root architecture (e.g primary and secondary roots), because the absorbed urea N was converted into amino acids in leaves and then translocated into stems, branch and roots for storage).

One of the benefits of foliar fertilization is the increased uptake of nutrients from the soil, it was noticed from the obtained results that foliar urea application increased N,P,K contents in leaves ,this notion is based on the belief that, the foliar fertilization causes the plants to release more sugars and other exudates from its roots into the rhizosphere .Beneficial microbial populations in the root zone are stimulated by the increased availability of these exudates.In turn ,this enhanced biological activity increases the availability of nutrients , disease-suppressive biochemicals ,vitamins and other factors beneficial to the plant (Marschner,2003).(Fritz,1978) ,pointed out that a repeated application of small units of foliar fertilizers stimulates plant metabolism and an increased nutrients uptake via the roots can be observed., the obtained results are in harmony with the findings obtained by(El-Din et al.,1993 ;

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Sheo and singh ,1999 ; Pegah sayyad and Shahsavar, 2012).

Increasing chlorophyll content and percentage of total carbohydrate in transplants treated with urea application was most likely due to, the effects of high N levels on urea ,many researchers like (Field and Moony,1986; Amaliotis et al.,2004) indicated ,that there is very close link between chlorophyll and nitrogen content .It is understandable, because nitrogen is a structural element of chlorophyll and protein molecules, and thereby affects formation of chloroplasts and accumulation of chlorophyll in them (Daughtry,2000 ; Tucker,2004), on the other hand , Nitrogen supply has large effect on leaf growth because it increases the leaf area of plants and , on that way , it influences on photosynthesis , moreover ,there is a strong positive correlation between photosynthesis and leaf nitrogen content for many C3 species (Field and Mooney,1986 ; Evans,1989), through increased amounts of stromal and thylakoid proteins in leaves (Bungard et al., 1997),besides that, up to 75 % of leaf nitrogen is found in the chloroplasts, most of it invested in ribulose bisphosphate carboxylase alone (Brown,1978),consequently ,we can expect high rates of photosynthesis products especially carbohydrates.The results is in a good agreement with the results of (Fahl et al.,1994) in young coffee plants , (Cheng et al., 1999) in young apple trees ,(Cheng et al.,2001) in pear plants and with (Singh et al., 2005) in mango trees.They proved that chlorophyll content in leaves correlated with tissue total nitrogen concentration and , the urea-treated leaves have had higher photosynthetic activity and produced more carbohydrate than the control leaves.

Increasing total root dry weight of transplants exposed to elevated CO2 may be attributed to, increasing foliage growth and thereby, increasing photosynthetic products and using it in construction of different plant organs particularly with regard to root proliferation (number,length and branch) which lead eventually to increase total root dry weight.These findings are in agreement with those reported by (Norby,1986) in *Quercus alba* trees and (Idso and Kimball,1991) in sour orange trees who stated that ,there was a significant increase in root dry weight of transplants exposed to elevated CO2 compared with transplantes grown under condition of ambient air (atmospheric CO2).

Leaf nitrogen concentration in plant leaves typically decrease under elevated CO2 (Ainsworth and Long ,2005) ,this decrease in tissue nitrogen is likely due to dilution of nitrogen from increased carbohydrate concentrations or may be due to that reabsorbing nitrogen from fully expand leaves during the process of accelerated senescence ,this nitrogen was stored in the storage proteins of the first year leaves ,from which it was removed in the spring to sustain the enormous burst of new branch growth in the enriched transplants because the new branch growth following bud burst of the enriched transplants was enormous compared with that of the ambient

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transplants (atmospheric CO_2) (Kimball et al.,2007).The obtained results are in harmony with the findings obtained by (Gries et al.,1993 ; Cotrufo et al.,1998 ; Francisco and Syvertsen,2006) .

Increased transplants leaves content of phosphour and potassium at elevated CO_2 may be attributed to root system architectures that are more efficient at taking up nutrients , including phosphour and potassium , (Pritchard and Rogers,2000) presented evidence that under elevated CO_2 ,root system often exhibit increased growth of lateral and primary roots ,leading to deep rooted , and suggested that , this would lead to increased efficiency of nutrient uptake , (Berntson,1994), found that changes in root system architecture under elevated CO_2 led to increased efficiency of soil exploitation .The results is in a good agreement with (Norby et al.,1986), who observed, absorbed phosphour and potassium was increased under elevated CO_2 condition and (Penuelas et al.,1997) , who did not identified from their studies decreasing in potassium content as a result of CO_2 enrichment , on the other hand , the results disagreement with findings of (Labanauskas ,1971 ; Gries et al.,1993 ; Syvertsen et al.,2000) , who found decreasing in leaves mineral content under CO_2 enrichment conditions .The difference between our results and those of (Labanauskas ,1971 ; Gries et al.,1993 ; Syvertsen et al.,2000) , may be due to different sampling times , we took samples about 5 months after CO_2 enrichment in October , whereas they took samples within CO_2 enrichment treatments , and this may affect in the determination of leaves mineral content , because one of the most consistent effects of growth at elevated CO_2 is a decrease in stomatal conductance (Ainsworth and Rogers,2007 ; Wullschlegar et al.,2002) , leading to decreased transpiration which consider one of the main factors for absorbing mineral from soil solution (Devlin ,1975), consequently leading to decreasing leaves mineral content .

Decreasing leaf chlorophyll content under elevated CO_2 may be attributed to dilution effect of nitrogen from increased carbohydrate concentration, because nitrogen is an essential part of the chlorophyll molecule (Tam and Magistad,1935) ,moreover increasing leaves number under elevated CO_2 comparing with ambient air (atmospheric CO_2) led to reabsorbing nitrogen from fully expand leaves during the process of accelerated senescence to sustain the enormous burst of new branch growth in the enriched transplants because the new branch growth following bud burst of the enriched transplants was enormous compared with that of the ambient transplants (atmospheric CO_2) (Kimball et al.,2007).The obtained results are in harmony with the findings obtained by (Idso et al.,1996 ;Francisco and Syvertsen ,2006) ,who indicated that ,chlorotic appearance of leaves from high CO_2 grown sour orange transplants is due to a decrease in chlorophyll content possibly resulting from large starch grains and starch accumulations altering

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normal chloroplast structure and function.

Increasing branchs total carbohydrate of transplants exposed to elevated CO_2 may be attributed to, inhibition of several mitochondrial respiratory enzymes like succinate dehydrogenase, cytochrome oxidase, thereby, decreasing oxidizing carbohydrate organic compounds (Gonzalez-Meler et al.,1996 ; Gonzalez – Meler and Siedow,1999).The results are in a good agreement with the results of (Norby et al.,1986 ; Hafiz ,2008) , who proved that, levels of elevated CO_2 generally stimulates the net photosynthetic fixation of CO_2 in plants , because the present atmospheric concentration of CO_2 is insufficient to saturate the primary carboxylation by rubisco in photosynthesis , and CO_2 supresses the competing process of photorespiration.

Finally, it can be concluded from the present study that, under the same conditions of our study foliar application with urea and CO_2 enrichment could be benefit on vegetative growth (number of leaves, leaves area, stem diameter, branches number /sapling), plant organs dry weight and total carbohydrate of sour orange transplants to reach a suitable size for budding in an earlier age than normal.

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Reference:

Ainsworth, E.A and A.Rogers.2007.The response of photosynthesis and stomatal conductance to rising CO2: mechanisms and environmental interactions.*Plant Cell Environment* .30, 258-270.

Ainsworth, E.A. and S.P.Long. 2005. What have we learned from 15 years of free-air CO2 enrichment (FACE)? Ameta-analysis review of the responses of photosynthesis, canopy properties and plant production to rising CO2. *New Phytologist*. 165, 351-372.

Allen, L.H., Jr.1997. Potentials for carbon dioxide enrichment.*In*: B.J.Barfield and J.F.Gerber (eds.).Modification of the Aerial Environment of Crops.Amer.Soc.Agr.Eng.,p.500-519.

Al-Rawi, K.M and A.M.Khalafalla. (1980)**.** Design and Analysis of Agricultural Experiments. Dar Al-Kutub for Printing and Publishing. Mosul Univ. (In Arabic).

Amaliotis, D.,I.Therios.,M.Karatissiou.2004.Effect of nitrogen fertilization on growth, leaf nutrient concentration and photosynthesis in three peach cultivars.ISHS, *Acta Horti* ,449:36-42.

Bahargava, B.S.and H.B.Raghupathi. 1999. Analysis of plant material for macro and micronutrients .pp: 49-82. In Tandon, H.L.S. (eds). Methods of analysis of soils, plants, water and fertilizers. Binng Printers. L-14, Lajpat Nagar New Delhi .

Bajracharya, D. 1999.Experiments in Plant Physiology. Narosa Publishing House New Delhi Madras Bombay Calcutta. pp. 51-53.

Berntson, G.M .1994. Modelling root architecture: Are there tradeoffs between efficiency and potential of resource acquisition ? *New Phytologist* .127, 483-493.

Brown, R.H.1978.Adifference in nitrogen use efficiency in C3 and C4 plants and its implications in adaptation and evolution, Crop Sci 18: 93-98.

Bunce,S.,W.W.Anthony.,S.Christopher and J.N.Robert.1997.Leaf gas exchange,drymatter partitioning and mineral element concentration in mango as influenced by elevated atmospheric carbon dioxide and root restriction.*J.Amer.Soc.Hort.Sci*.122(6):849 – 855.(Abs.)

Bungard, R.A, D.Mcneil and J.D. Morton. 1997. Effects of nitrogen on the photosynthetic apparatus of *Clematis vitalba* grown at several irradiance.*Australian Journal of Plant Physiology* .24:205-214.

Castle, W.S., D.P.H.Tucke, A.H.Krezdorn, and C.O.Youtsey.1993.Rootstocks for Florida Citrus.Univ of Florida publication SP 42.

Cheng, L., S.Dong and L.H.Fuchigami.2001.Effects of nitrogen fertigation on reserve

ISSN 2072-3875

nitrogen and carbohydrate status and regrowth performance of pear nurcery plants.*Acta Hortic*. 564 :51-62.

Cheng ,L.,S.Guack,S.Dong and L.H.Fuchigami.1999.Effects of foliar urea on reserve nitrogen and carbohydrate in young apple trees with different nitrogen background.*Horti Sci*.34: 492-498.

Chou, G.J .1966. Anew method of measuring the leaf area of Citrus. .Acta Hort. 5, 7-20.

Cotrufo, M.F.,P.Ineson and A.Scott.1998.Elevated CO2 reduces the nitrogen concentration of plant tissues.*Global Change Biology*.4,43-54.

Council for Agriculture Science and Technology. 1985 .Agriculture and ground water quality. Council Agr.Sci.Technol.Ret.103.

Curtis, P.S. and X.Wang.1998.Ameta-analysis of elevated CO2 effects on woody plant mass, form and physiology. *Oecologia*,113 , 299-313.

D'Agostino.I.B. and J.J.Kieber. 1999. Molecular mechanisms of cytokinin action.*Plant Biol*.2:359-364.

Daughtry, C.S.T., C.I.Walthall., S.M.Kim., E.J.MCmurtrey .2000. Estimating leaf chlorophyll concentration from leaf and canopy reflectance.*Rem.Sens.of Environment*,74:229-239.

Devlin, R.M .1975 .Plant Physiology. 3rd. ed. East-west Press .New Delhi, Madras, INDIA.

Downton, W.J.S., W.J.R. Grant and E. K. Chacko .1990.Effect of elevated carbon dioxide on the photosynthesis and early growth of Mangosteen (*Garcinia mangostana* L.) Scientia Horticulturae . Volume 44 . Issues 3-4 , pages 215 – 255.

Dubois, M., K.A.Gilles., J.K.Hamilton., P.A.Rebers. and F.smith . 1956. Colorimetric Method for Determination of Sugars and Related Substance .Anal Chem. 28 (3): 350-356.

El-Din, I.S.,Nouman ,V.F.and Youssef ,N.f. 1993. Influence of spraying Urea and Gibberellic acid on Pomegranate seedlings growth .*Egypt.J.Appl .Sci*.,8 (7): 571 – 582

Evans, J.R.1989.Photosynthesis and nitrogen relationship in leaves of C3 plants, *Oecologia*, 78 (9-19).

Fahl, J.I.,M.L.C.Carelli.,J.Vga.,A.C.Magalhães.1994.Nitrogen and irradiance levels affecting net photosynthesis and growth of young coffee plants,*J.Horti.Sci*.69:161-169.

Field.C,.H.A.Mooney.1986.The photosynthesis-nitrogen relationship in wild plants, in: T.J.Givnish(Eds.)., on the economy of plant form and function ,Cambridge University Press, pp.25-55.

Francisco, G. S and J.P. Syvertsen .2006. Salinity tolerance of cleopatra mandarin and carrizo citrange citrus rootstocks seedling is affected by CO2 enrichment during growth. J.

ISSN 2072-3875

Amer. Soc. Hort- science. 131(1): 77- 82.

Fritz ,A.1978.Foliar fertilization- a technique for improved crop production.V.Africa Symp.Hort.Crops.*Acta Hort*.,84: 150-161.

Fuchigami,L.H.2001.The relationship of foliar and soil application to nitrogen use efficiency growth and productivity of young Gala/M9 apple trees.*Acta Horticulture*.(In Press).

Fujisawa, H.S.O.T. Takahara and T.Ogata. 2001. Effects of carbon dioxide enrichment on tree vigor of citrus cv. shiranuhi under greenhous culture *.J. Japan. Soc. Hort sci.* 70(5): 593- 595.

Gonzalez-Meler, M.A and J.N. Siedow. 1999. Direct inhibition of mitochondrial respiratory enzymes by elevated CO2: does it matter at the tissue or whole plant level ? Tree Physiology 19, 253 - 259.

Gonzalez-Meler, M.A.Ribas-Carbo., JN, Siedow., B.G Drake.1996. Direct inhibition of plant mitochondrial respiration by elevated CO2. Plant Physiology. 112, 1349 - 1355.

Gries, C., B.A.Kimball., S.B.Idso.1993.Nutrient uptake during the course of a year by sour orange trees growing in ambient and elevated atmospheric CO2 concentration *.Journal of Plant Nutrition*. 16 (1): 129- 147. (Abstract)

Hafiz, I.M. 2008. Carbon dioxide enrichment effects on growth and physiological attributes of oil palm seedlings. Master Thesis, Putra University, Malaysia .

Idso, S.B. and B.A.Kimball . 1991. Effect of two and a half years of atmospheric CO2 enrichment on the root density distribution of three old sour orange tree. *Agricultural and Forest Meterology*, 55(3-4):345-349(Abstract).

Idso, S.B and B.A.Kimball.1992a.Above ground inventory of sour orange trees expo-sed to different atmospheric CO2 concentration for 3 fully years.*Agricultura and Forest Meterology*.60(1-2): 145-151.

Idso, S.B., B. A. Kimball., D.L.Hendrix .1996. Effects of atmospheric CO2 enrichment on chlorophyll and nitrogen concentration of sour orange tree leaves.Environmental and Experimental Botany. 36(3): 323 -331.

Kareem, E.K.,P.H.Jones., W.T.Avigen and L.H.A.Jr.2006.Growth,dry matter partitioning, and diurnal activities of RuBP carboxylase in citrus seedlings maintained at two levels of CO2. *Physiologia Plantarum* , V.67 , Issue3 , P.477 – 484.

Keith, E.I.,J.K.Hoober., S.B.Idso., G.W.Wall and B.A.Kimball.2002.Atmospheric CO2 enrichment influences the synthesis and mobilization of putative vacuole storage proteins in sour orange tree leaves. Environmental and

ISSN 2072-3875

Experimental Botany.V.48, Issue3,P.199- 211.

Khemira, H., T.L.Righetti, and A.N.Azarenko.1998.Nitogen Partitioning in Apple as affected by timing and tree growth habit. *J. Hort.Sci.Biotech*.73:217 – 223.

Kimball, B.A., S. B. Idso., S. Johnson and M.C.Rillice. 2007. Seventeen years of carbon dioxide enrichment of sour orange trees: Final results .Global Change Biology .13, 2171 - 2183 .

Koch, K.E and D.W.White . 1983. CO2 enrichment of carrizo citrange and swingle citrumelo rootstocks . *Proc. Fla. State .Hort. Soc*..96 : 37 -40 .

Labanauskas, C.K., L.H.Stolzy., L.J.Klotz and T.A.De Wolf . 1971. Soil carbon dioxide and mineral accumulation in ctrus seedling (*Citrus sinensis* var. Bessie) Plant and Soil. 35(1-3): 337-346. (Abstract).

Lawlor, D.W.1995.Photosynthesis, productivity and environment. *Journal of Experimental Botany* .46:1449-1461.

Loladze, I.2002.Rising atmospheric CO2 and human nutrition: toward globally imbalanced plant stoichiometry? *Trends in Ecology and Evolution*,17 , 457 -461.

Marschner, H. 2003. Mineral Nutrition of Higher Plants.2nd edition. 6th. Printing Academic Press 525 B Street, Suite 1900, San Diego, California 92101- 4495 ,USAhttp:// www.academicpress.com .

Mustafa, N.S, L.f.Hagag, M.F.M. Shaheen, and E.S.El-Hady.2011.Effect of spraying different N sources on growth performance of picual olive seedlings. American- Eurasian : *J.Agric.& Environ.Sci*., 11(6): 911-916.

Norby, R.J., G.O. Elizabeth and R.J. Luxmoore .1986. Effects of atmospheric CO2 enrichment on the growth and mineral nutrition of *Quercus alba* seedlings in nutrient poor soil. Plant Physiol . 82(3): 13 - 22.

Pegah Sayyad , A. and A. R.Shahsavar .2012 .The influence of urea , Boric Acid and Zinc Sulphate on vegetative traits of olive .*Jour.Biol.Environ.Sci*., 6 (16), 109 – 113 .

Penuelas, J., S.B.Idso., A.Ribas and B.A.Kimball .1997. Effects of long term atmospheric CO2 enrichment on the mineral concentration of *Citrus aurantium* leaves. *New Phytologist* . 135(3): 439 - 444.

Peracy, R.W. and O.Bjorkman .1983.CO2 and plants: Physiological effects *In*: E.R.Lemon (ed.).CO2 and plants. p.65 – 107.

Pipper, C.S.1950.Soil and Plant Analysis .Interscience Publications, Inc.New York. 279-284.

Poorter, H.,B.Y.Van., R.Baxter, J.Denhertog ,P.Dijkstra and R.M.Gifford.1997.The effect of elevated CO2 on the chemical composition and construction costs

ISSN 2072-3875

of leaves of 27 C3 species. *Plant Cell and Environment*, 20,472-482.

Pritchard, S.G and H.H. Rogers.2000.Spatial and temporal deployment of crop roots in CO2 – enriched environments.*New Phytolgist*.147, 55-71.

Pritchard, S.G., H.H.Rogers., S.A.Prior.,C.M.Peterson.1999.Elevated CO2 and plant structure : a review.*Global Changes* Biol.5:807-837.

Rayle, D.L., C.W.Ross., N.Robinson .1982. Estimation of osmotic parameters accompanying zeatin-induced growth of detached cucumber cotyledons.*Plant Physiol*.70:1634-1636. [PMC free article].

Said, W.T.(1989).Study of Some Factors Affecting Growth of Pecan Seedlings.M.Sc.Thesis, Fac. of Agric. Moshtohor, Zagazig University.

Shaheen, S.A and A.A.Aly. 2011. Responce of rooted olive cuttings to mineral fertilization and foliar spray with urea and gibberelline .*Nature and science*: 9(9):76-86.

Sheo, G., I.P.Singh.1999.Effect of Foliar application of urea, GA3 and ZnSO4 on seedling growth of two citrus species. *Jour. Appl . Hort*., 1(1) : 51-53 .

Shufu, D.,L.Cheng., C.F.Scagel and L.H.Fuchigami.2002.Nitrogen absorption, transl- ocation and distribution from autumn foliar applied urea in young potted apple (*Malus domestica*) trees.*Tree Physiology*.22:1305 -1310.

Singh ,N.P.,C.S.Malhia and R.C.Sharma. 2005.Effect of foliar feeding of N,P and K on vegetative and fruiting characters of mango cv.dusheri .Mango and Date Palm : Culture and Export.3(5):35-49.

Smith, P.F .1966. Leaf Analysis of Citrus. chapt 8 in fruit nutrition.2nd edition, Edited by N.F. Childers Horticultural Publications. Rutgers University , New Brunswick, New Jersey .

Syvertsen, J.P., L.S.Lee and J.W.Grosser. 2000. Limitation on growth and net gas exchange of diploid and tetraploid citrus rootstock cultivars grown at elevated CO2 .J. Amer.Soc. Hort. Sci. 125(2): 228 - 234.

Taiz, L. and E. Zeiger.2006. Plant physiology . Fourth Edition .Sinauer Associates ,In C., publishers.www .sinauer.com .

Tam, R.K and O.C.Magistad .1935.Relationship between nitrogen fertilization and chlorophyll content in Pineapple plants.Plant Physiology .vol 10 (1): 159-166.

Taylor, C.B. 1997.Plant vegetative development: from seed and embryo to shoot and root .*Plant Cell*. 9:981-988 [PMC free article].

Tucker, M.2004.Primary nutrients and plant growth-In: Essential plant nutrients (Scribed, Ed.).North Carolina Department of Agriculture.

ISSN 2072-3875

Williamson .J.G and L.K.Jackson .1994.Citrus Propagation[1] .Fact sheet HS–86.

Wittwer, S.H.1983.Rising atmospheric CO2 and Crop productivity. Hort.Sci.18:667 – 673.

Wullschleger, S.D., T.J.Tschaplinski., R.J.Norby.2002.Plant water relations at elevated CO2 –implications for water-limited environment .25,319-331.

ISSN 2072-3875