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EFFECT OF HUMIC ACID AND CALCIUM IN THE GROWTH AND YIELD CONTENT OF PAPRIKA FRUITS OF CAROTINE AND ASCORBIC ACID

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Abstract

A field experiment was carried out at the Abu Ghraib site, Researches and Studies Department, Department of Horticulture in clay loam Soil texture under group of the Type Torrfluvent on Paprika Plant. The experiment included Soil treatment with three levels of Humic acid (0, 6 and 12) L Class house^{-1} (500 m^2) with symbols H0, H1 and H2 respectively, and Hch indicate Chemical Fertilization $CaCl_2$ and $CaSO_4$ Calcium spraying, two levels of (0 and 10) g Ca L^{-1} and symbol of $CaCl_2$ as Ca1 and $CaSO_4$ as Ca_2 and Control treatment as Ca_0 The study was designed to study the effect of the interaction between the Humic acid and the source of Calcium, which gives the best vegetative growth and improve the quality and quantity of the Paprika, the experiment showed the results: 1. There was a significant increase in the formation of pigments due to the Humic acid and the source of Calcium and the superiority of the treatment of the Humic acid in the third level (H_2) in the content of Chlorophyll and Carotene and recorded values (483.76 and 4.70) mg 100 g^{-1} soft substance for both Chlorophyll and Carotene respectively and record source of calcium chloride ($CaCl_2$) significantly increasing in the formation of pigments and recorded values (458.96 and 4.92) mg per 100 g^{-1} soft substance for both Chlorophyll and Carotene, respectively, and the interaction between the factors (the Humic acid and the Calcium source) was the highest value in the treatment of interference (H_2 + $CaCl_2$) which were (514.34 and 6.17) mg per 100 g^{-1} soft substance for Chlorophyll and Carotene respectively. 2. There was a significant effect of Humic acid and Calcium source in the content of fruits from Beta-Carotene and Ascorbic acid in fruits. The fertilization treatment of the Humic acid at the third level (H_2) was higher in Beta-Carotene content and values were (1.32 and 84.54) mg 100 ml^{-1} juice respectively, Calcium Chloride ($CaCl_2$) was significantly increased with values (1.29 and 66.32) mg per 100 ml^{-1} juice for both Beta-Carotene and Ascorbic acid, and the interference between the factors (Humic acid and Calcium source) was the highest value in the interference treatment (H_2 + $CaCl_2$) which were (1.43 and 87.20) mg per 100 ml^{-1} juice per from Beta-Carotene and Ascorbic acid. 3. The Humic acid fertilization was increased significantly in the Total Yield at the third level H_2 which was (12.86 ton ha^{-1}) and recorded the highest Yield in the treatment of Calcium Chloride ($CaCl_2$) which was (11.29 tons e^{-1}) and the interaction between the factors (Humic acid + Calcium Chloride) was recorded the highest yield (14.45 tons ha^{-1}).

Keywords : Humic acid, calcium, Paprika fruits, carotene, ascorbic acid

Introduction

Paprika (*Capsicum annuum* L.) is one of Solanaceae family crop, It is the third after Tomato and potato crop by the importance. South America, Southern Mexico and Guatemala are the original home of Paprika (Matlub *et al.*, 1989 and Matlub, 1984).

The importance of Paprika food is mainly due to its content of Vitamin C, as one fruit at a weight of 74 g fill the Human needs of Vitamin C for adult humans per day and contains amount of vitamin A necessary for growth, in addition to vitamins and elements of Calcium and Iron and Phosphorus (Yahi, 2000). It also contains the most important antioxidants that reduce the risk of chronic and cancerous diseases (Rao and Rao, 2007), the most important of which are Carotenoids, which are components of the enzymatic system of antioxidants (McCollum, 1980) and are essential for humans (Rao and Rao, 2007). Several recent studies have highlighted antimicrobial activity in Paprika compounds (Yahi, 2000).

Fertilization is an important factor in determining the quantity and quality of the fruits. The importance of the fertilization process in increasing the production and improving its quality, the fertilizer has been added to include chemical and organic fertilizers such as Humic acid, which contributes to reducing the fixation of many elements in the soil because it works to reduce soil pH (Al-Hadithi, 1997, and Awad, 1986). Humic acid works to reduce the washing and loss of many elements in the water table as well as the contribution of the Humic acid to the development of the root system (Ali *et al.*, 2014 and Al-Hadithi, 1997 and AL-Fartousi, 2003). So that enhanced to increase the absorption and increasing enzyme activity of elements and cells division (Rensing and Cornelius, 1980). Calcium is an essential element in plant nutrition, which improves the characteristics of fruits and improves plant performance because it affects the osmotic pressure and transition and the enzymatic system in the plant (Mengel and Crakbi, 1987 and Yassin, 1992, and Barker *et al.*, 2007). Depend on the above, the study included the use of two sources of Calcium with three levels of Humic acid and study of the interaction which gives the best vegetative growth and improvement of the quantity and quality of the Paprika.

Materials and Methods

A field experiment was carried out in 2015 at the Abu Ghraib, Research and Studies, Horticulture Department in Clay Loam Soil under the Type Torrfluvent group, which is listed in Table (1), the seeds of Paprika were planted in the plates and after the completion of the fourth leaf, then transported to the farm the field, the farm was tilled by the disc plow and then extended the irrigation system and planted the plants at a distance of 40 cm and included treatment of the soil with three levels of Humic acid (Speedy growth) Addition of ground and concentrations (0, 6 and 12) L / House plastic (500 m 2), which symbolizes (H0 and H1 And H2) respectively and HCh to chemical fertilization which was added to the Nitrogen according to chemical fertilization recommendation (96 kg N ha^{-1}) as Urea (46% N) and Phosphorus at a rate of (184 kg P ha^{-1}) in the form of Superphosphate (P% 46) and Potassium (100 kg K ha^{-1}) in the form of Potassium Sulphate (41% K) (Allawi, 2013, and Faraj, 2006). Calcium was sprayed as $CaCl_2$ and $CaSO_4$ form at two levels (0 and 10) g Ca L^{-1} and $CaCl_2$ treatments symbol as Ca_1 and $CaSO_4$ treatments symbol as Ca2 and control symbol as Ca_0 The experiment was carried out by Randomized Complete Block Design (RCBD) (Al-Sahuki and Wahaib , 1990).

The Electrical Conductivity (EC) was estimated in the extract of Soil : Water (1: 1) by using a EC-meter device and potential Hydrogen (pH) was estimated in the extract of Soil : Water (1: 1) by using pH-meter device. (Ryan *et al.*, 2005).

Table 1 : Shows some of the Chemical and Physical Properties of the Soil used in the Experiment

Characteristics		Value	Unit
Hydrogen Potential (pH)		7.69	
Electric Conductivity (EC)		4.52	dSm^{-1}
Available Nitrogen		60.0	mg kg^{-1} Soil
Available Phosphorus		8.20	mg kg^{-1} Soil
Available Potassium		287	mg kg^{-1} Soil
Cations	Ca^{+2}	1.40	cmole L^{-1}
	Mg^{+2}	1.60	cmole L^{-1}
	K^{+1}	0.12	cmole L^{-1}
	Na^{+1}	2.70	cmole L^{-1}
Anions	SO_4^{-}	2.56	cmole L^{-1}
	Cl^{-1}	2.52	cmole L^{-1}
	HCO_3^{-1}	0.64	cmole L^{-1}
	CO_3^{-2}	Non	cmole L^{-1}
Soil		g kg^{-1}	Soil texture Class
Sand		140	Clay Loam
Silt		440	
Clay		420	

- Ca^{+2} , Mg^{+2} and Na^{+1} were estimated in Extract (1:1) Soil : Water, Ca^{+2} and Mg^{+2} were estimated by Na_2-EDTA and Na^{+1} Dissolved was estimated by Flame Photometer (Rayne *et al.*, 2005).
- Carbonates and Bicarbonates were estimated with H_2SO_4 (0.01N) (Page *et al.*, 1982)
- Cl^{-1} was estimated with Silver Nitrate (0.005N) (Ryan *et al.*, 2005)
- SO_4^{-2} was estimated by using Barium Chloride (Ryan *et al.*, 2005)
- Available Nitrogen was estimated by Microkjeldahl device and according to the method adopted by Bremner (Ryan *et al.*, 2005).
- Available Phosphorus was estimated by Olsen method (Ryan *et al.*, 2005).
- Available Potassium was estimated by Flame Photometer (Ryan *et al.*, 2005).
- Soil particles volumes were estimated (Ryan *et al.*, 2005).
- Humic acid was estimated according to (Page *et al.*, 1982) .

Humic acid was digested by H_2SO_4 and $HClO_4$ (Ryan *et al.*, 2005) and the following elements were estimated :-

- Nitrogen by Microkjeldahl device. (Ryan *et al.*, 2005).
- Potassium by Flame Photometer device (Ryan *et al.*, 2005).
- Phosphorus by Spectrophotometer (Ryan *et al.*, 2005). the result were in Table (2):-

Table 2 : Some chemical characteristics of Humic acid

Characteristics	Humic acid	Nitrogen	Potassium	Phosphorus	pH
units	Mg kg^{-1} dry matter	%	%	%	
values	128000	3.20	6.00	0.90	6.20

Yield was harvested in the end of experiment and the fourth leaf from the top was taken and estimate the following characteristics

- **Total Chlorophyll** was estimated by extract the leaf by acetone (80%) and using Spectrophotometer to read in the waves length (663 and 645) nanometer the total Chlorophyll was measured by using the following equation :-

  Total Chlorophyll (mg L^{-1}) = 20.2 D (645 nm) + 8.02 D (663 nm) and then adapted to mg 100 g^{-1} wet weight according to (Dalaly and Al-Hakem, 1987).

- Leaves and Fruits content from **Total Carotene** (mg 100 g^{-1} wet weight) according to (Dalali and Al-Hakem, 1987). Carotene was estimated by extract Carotene pigment from leaves and fruits by using acetone (85%) and reading in Spectrophotometer at length wave 480 nm , the Carotene was measured by using the following equation:-

Carotene quantity (mg L^{-1}) =(Photo absorption 480 * extract solution volume)/ 250

Then adapted to (mg 100 g^{-1} wet weight)

- **Ascorbic acid** (mg 100ml^{-1} juice)

Ten fruits were taken (same maturity) at the fourth harvesting from every experimental unites washed by water and dried by blotter and cut to many pieces and put in Blender to making Juice and then spate the Juice by piece of fabric, Ascorbic acid was estimated according to (A.O.A.C., 1975), added 20 ml from acidic solution (Oxalic acid and Acetic acid) to 5 ml from the Juice, take 10ml from the mixing solution with pigment of 6.2-Dichlorophenol indophenol.

Results and Discussion

1. Total Chlorophyll and Carotene Content in Leaves

Results were showed the significant effect of Humic acid and the source of Calcium on pigment formation, Humic acid treatment (H_2) was the highest values of Chlorophyll and Carotene (483.76 and 4.70) mg 100 g^{-1} fresh weight compared with control treatment (H_0) (349.23 and 3.27) mg 100 g^{-1} fresh weight respectively .

Tables (3 and 4) were showed the statistical results of increasing significant of source of Calcium on pigment building, $CaCl_2$ (Ca_1) treatment was increased of pigment building significantly (458.96 and 4.92) mg 100 g^{-1} fresh weight for Chlorophyll and Carotene respectively compared with control treatment Ca_0 (417.80 and 3.47) mg 100 g^{-1} fresh weight respectively , The interference between Humic acid and source of Calcium was recorded the highest value in (H_2 + Ca_1) were (514.34 and 6.17) mg 100 g^{-1} fresh weight for Chlorophyll and Carotene respectively .

Chlorophyll A and B and Carotenoids like Carotene depended on three factors were Genetic factor, light and nutrition availability like Mg, Ca, S and N, existing of humic acid in the soil increases from availability and content of Mg, Ca and the other nutrients and that will increase the activity of pigments building of Chlorophyll and Carotene (Berkowitz, 1998), Humic acid appeared the important of Chloroplast as a center of photosynthesis process in the plant which Chlorophyll and another pigment work together in the photosynthesis process.

Humic acid increases from Chlorophyll and Carotene in the leaves content because they consider as a necessary nutrient source for pigment building for building, protect and provide the energy for photosynthesis process (Abu- Dhahi and Al-Unis, 1988).as well as it is role in less of aging of leaves because it contains organic compound or it enhances to build a useful compounds for plant like amino acids especially proline (El-Hammady *et al.*, 1999).

The increasing of Chlorophyll and Carotene in Paprika leaves content which sprayed by $CaCl_2$(Ca_1) and $CaSO_4$ (Ca_2) comparing with Ca_0 treatment may be return to the rule of the Calcium in stimulation the enzymes and homeostasis which get from stimulate the Calcium to (Calcium–dependent ATPase) enzyme which associate with membranes and it works to push the Calcium from cytoplasm to gaps, endoplasm net , endoplasm bridges and mitochondria (site of energy) which depend of it build all metabolic compounds like building and protect pigments, the mechanism of Calcium working prevents Calcium from competes magnesium and sediments the Phosphate and that will increase of building activity of metabolic compounds like pigments (Bush, 1995). $CaCl_2$ spraying considers better than $CaSO_4$ spraying because the last consider as source of sulfur more than using as source of Calcium (Barker and David, 2007).

Table 3 : Effect of Humic acid and source of Calcium in Paprika leaves content of Chlorophyll (mg 100 g^{-1} fresh weight)

Calcium Ca	**Humic acid fertilization**				**Calcium**
	H_0	**H_1**	**H_2**	**HCh**	
Ca_0	345.34	404.80	469.07	450.75	417.80
Ca_1	357.36	485.75	514.34	478.33	458.96
Ca_2	345.30	445.34	467.73	416.86	418.64
H Fert. Type	349.23	445.90	483.76	448.10	H*Ca
LSD 0.05	Ca		H		
	8.98		10.37		17.96

Table 4 : Effect of Humic acid and source of Calcium in Paprika leaves content of Carotene (mg 100 g^{-1} fresh weight)

Calcium Ca	**Humic acid fertilization**				**Calcium**
	H_0	**H_1**	**H_2**	**HCh**	
Ca_0	2.77	3.30	4.27	3.53	3.47
Ca_1	4.03	4.67	6.17	4.83	4.92
Ca_2	3.00	3.20	3.67	3.34	3.29
H Fert. Type	3.27	3.72	4.70	3.89	H*Ca
LSD 0.05	Ca		H		
	0.58		0.65		1.13

The interaction effect between Humic acid and Calcium especially $CaCl_2$ was increased of Chlorophyll and Carotene in leaves content, that return to role of carboxyl and hydroxyl groups which are react with Ca^{+2} and contain (organic - metallic complex) which have very important role in nutrient availability (Tan, 1986), increasing roots, improvement plant growth and increasing means of building of metabolic compounds like Carotenes and Chlorophylls.

2. Ascorbic Acid and Beta-Carotenes in Fruits Content

Table(5): was showed the significant effect of Humic acid and Calcium source in Beta - Carotene content in the fruit , the results showed that the maximum Beta-Carotene (1.32 mg 100 ml^{-1} Juice from Beta – Carotene was in H_2. The statistical results in table (5) showed that the source of Calcium affected in Beta- Carotene building, Ca_1 ($CaCl_2$) was increased in Beta-Carotene significantly (1.29 mg 100 ml^{-1} juice comparing with control treatment Ca_0 (1.08 mg ml^{-1} juice, the interaction between Humic acid and source of Calcium was recorded the highest value in Beta-Carotene content (1.43 mg ml^{-1} juice in (H_{2*} Ca_1) treatment.

Table 5 : Effect of Humic acid and source of Calcium in Paprika fruit content of Beta-Carotene (mg 100 ml^{-1} juice)

Calcium Ca	Humic acid fertilization				Calcium
	H_0	H_1	H_2	HCh	
Ca_0	0.80	1.10	1.23	1.17	1.08
Ca_1	1.17	1.32	1.43	1.27	1.29
Ca_2	1.10	1.20	1.33	1.18	1.19
H Fert. Type	1.02	1.20	1.32	1.20	H*Ca
LSD 0.05	Ca		H		
	0.13		0.15		0.25

Table (6) was showed the significant increasing in Ascorbic acid in the fruit with increasing of Humic acid levels and changing of Calcium source, H_2 treatment was showed the maximum value of Ascorbic acid (84.54 mg 100 ml^{-1} juice of Ascorbic acid) comparing with control (H_0) (57.93 mg 100 ml^{-1} juice of Ascorbic acid). Table (6) was showed the statistical results for source of Calcium and its effect of Ascorbic acid , Ca_2 ($CaSO_4$) treatment showed the significant increasing in Ascorbic acid (75.08 mg 100 ml^{-1} juice) comparing with control treatment (Ca_0) (66.32 mg 100 ml^{-1} juice) , the interaction between Humic acid and source of Calcium was recorded the highest value of Ascorbic acid (87.20 mg 100 ml^{-1} juice) at($H_{2*}Ca_2$) treatment.

Table 6 : Effect of Humic acid and source of Calcium in Paprika fruit content of Ascorbic acid (mg 100 g^{-1} juice)

Calcium Ca	Humic acid fertilization				Calcium
	H_0	H_1	H_2	HCh	
Ca_0	53.55	61.07	81.33	69.33	66.32
Ca_1	60.13	70.19	86.30	83.53	75.03
Ca_2	60.00	71.00	87.20	82.00	75.08
H Fert. Type	57.93	67.41	84.54	78.29	H*Ca
LSD 0.05	Ca		H		
	4.50		5.20		9.01

The increasing of Ascorbic acid and Beta-Carotene at fruit content at addition of Humic acid may be return to it by provide nutrient in the soil and improve soil physical characteristics by increasing aggregate stability (Al-Shikli and Hameed, 2002), decreasing the stress of minerals lack in plant especially Calcium which causes encouraging of photosynthesis process doing (Khalil *et al.*, 2007, Dalali and Hakim, 1987), carbohydrate and amino acids increasing and improving of vegetative growth and that led to increase carbohydrate which forms Ascorbic acid and Beta-Carotene (Barooah and Ahmed, 1964), increasing of Ascorbic acid and Beta-Carotene in Calcium treatments in fruit content may be return to role of Calcium in Chlorophyll and Carotene content increasing tables (3 and 4) so that led increasing of photosynthesis products especially carbohydrates which transport to the fruit so that led to increasing the total solid materials which solve in fruit like sugars, organic acids, Ascorbic acid, Salt and Beta-Carotene. etc. (Sahi, 1998).

From results, there are significant increasing in Ascorbic acid and Beta-Carotene in fruit content at the interaction of treatments that return to role of Humic acid in provide the plant of necessary nutrients because Humic acid works to free the nutrients in Soil and it contains auxins and cytokines which work to enhance the physiological activities and necessary elements nutrients, that led to accumulate of carbohydrates and nutrients and the increasing of pigment content in leaves. (Mohammed, 2009 Nour *et al.*, 2010; Abdel-Mawgoud *et al.*, 2011), Calcium helps to length and divisions of cells and connect with auxins as well as it has role in osmotic activity in plant and it forms carbohydrate and metabolic materials in plant (Ali *et al.*, 2014, Burstrom, 1968)

3. Total Yield

From the results above and table (7) , there was significant increasing in Total Yield, Humic acid was increased in total yield significantly , the maximum yield (12.86 Mg ha^{-1}) at H_2 treatment comparing with control treatment H_0 (6.37 Mg ha^{-1}) this result deals with (Al-Fartosi, 2003), Calcium Chloride as a source of Calcium (Ca_1) was recorded the highest value of Total Yield (11.29 Mg ha^{-1}) comparing with control (Ca_0) (8.34 Mg ha^{-1}) this result deals with (Khalil *et al.*, 2007). The interference between Humic acid and source of Calcium was recorded highest value (14.45 Mg ha^{-1}) at (H_2 * Ca_1) treatment.

Table 7 : Effect of Humic acid and source of Calcium in Total Yield of Paprika (Mg ha^{-1})

Calcium Ca	Humic acid fertilization				Calcium
	H_0	H_1	H_2	HCh	
Ca_0	5.67	8.20	11.50	8.00	8.34
Ca_1	6.95	10.62	14.45	13.15	11.29
Ca_2	6.50	9.91	12.63	12.42	10.37
H Fert. Type	6.37	9.98	12.86	11.19	H*Ca
LSD 0.05	Ca		H		
	0.36		0.42		0.768

The increasing in Yield when Humic acid application return to its contain from element like Nitrogen, Potassium and Phosphorus table (2), Humic acid contains active groups contribute in Amino acid reactions with Cations to form organic-metallic complexes which have very important role in elements availability, all these groups behave as electrons donor so it can connect with Cations like Potassium, Calcium, Magnesium and micronutrient which behave as electrons acceptor (Barker *et al.*, 2007, Tan, 1986). Humic acid contributes in decreasing (pH) of soil solution and that increase elements availability in the soil solution and its absorption by plant roots (Tate and Theng, 1980, Lutfi, 1986, Mohammed and Al-Unis, 1991).

Increasing Calcium Chloride and Sulphate ($CaCl_2$ and $CaSO_4$) comparing with control (Ca_0) treatment in Yield may be return to role of Calcium in the cell membrane by its work to connect Phosphate group with groups of Phospholipids and Proteins carboxyl at the membranes Surfaces for helping to keep membrane building and it considers as key in primary cell wall building, it has role in enzymes and phyto-hormones stimulation (Rensing and Cornelius, 1980). Calcium Chloride ($CaCl_2$) spraying considers better than ($CaSO_4$) spraying because of the difference between the nature of molecule, $CaCl_2$ has Ca more than $CaSO_4$ and $CaSO_4$ used as a source of (SO_4) more than (Ca). (Barker and David, 2007).

The interference effect between Humic acid and source of Calcium especially Chloride ($CaCl_2$) in yield increasing maybe return to active group of Humic which react with (Ca^{+2}) to contain organic metallic complexes which have very important role in nutrients availability (Thang, 2007; Tan, 1986), increasing roots, improve plant growth and increase yield.

References

Abdel-Mawgoud, A.M.R.; El-Bassiouny, A.M.; Ghoname, A. and Abou-Hussein, S.D. (2011). Foliar application of amino acids and micronutrients enhance performance of green bean crop under newly reclaimed land conditions. Australian Journal of Basic and Applied Sciences, 5(6): 51 – 55.

Abu-Dhahi, Y.M. and Al-Unis, M.A. (1988). Plant Nutrition guide. Ministry of higher education and scientific research. University of Mosul.

Allawi, M.M. (2013). Effect biological, Organic and Chemical Fertilization in Architectural Construction of Roots, growth and yield of Paprika (*Capsicum annuum* L.). Ph. D. thesis. College of Agriculture. University of Baghdad.

Al-Fartousi, B.A.J. (2003). Effect of water extract for some organic waste on wheat growth (*Triticum aestvuim).* Master thesis. College of Agriculture. University of Baghdad.

Al-Hadithi, A.A. (1997). Role of Humic acids applied of nutrient concentrate and freeing of some nutrient in calcareous soils. Master thesis. College of Agriculture – University of Baghdad.

Ali, A.H.; Mohammed, B.; Arif, S. and Az-Alden, Z. (2014). Effect of marine plant extract spraying in some properties of quantity and quality of yield for two cultivars of potato. Agricultural Iraqi magazine, 19(5): 78 – 86.

Ali, N.S.; Rahi, H.S. and Shakir, A.A. (2014). Soil Fertility. College of Agriculture. University of Baghdad. Dar-Al-kutub for scientific books publishing and distribution.

Al-Sahuki, M. and Wahaib, K.M. (1990). Applications of experiment design and analysis. . Ministry of higher education and scientific research. University of Baghdad. Iraq.

Al-shikhli, A.H. and Hameed, S.K. (2002). Effect of humic acids and multiple sugars for different organic substances in soil building. Iraqi Agricultural Sciences Magazine. 33(1): 41–48.

Association of Official Analytical Chemistry (1975). Official methods of analysis. 12th Ed. A.O.A.C. Washington.

Awad, K.M. (1986). Soil chemical principles. Ministry of higher education and scientific research. University of Basra printing house.

Barker, A.V. and David, J.P. (2007). Handbook of plant nutrition. Reproduced in by NCIS group. Division of informal pic.

Barooah, S. and Ahmed, A.Z. (1964). N.P.K. Trial on tomato response to NPK fertilizers at different level on growth, yield and ascorbic acid content of tomato. Indian Journal Agron. 9(4): 268–272.

Berkowitz, G.A. (1998). Water and salt stress. In : photosynthesis, A comprehensive treatise (Raghavendra, A. S., Ed.). Cambridge university. Press, 226 – 237.

Burstrom, H.G. (1968). Calcium and plant growth. Boil. Rev., 43: 287–318.

Bush, D.S. (1995). Calcium regulation in plant cells and its role in signaling. Annu. Rev. plant physiol. plant. Mol. Biol., 46: 95 – 122.

Dalali, B.K. and Hakim, S.H. (1987). Foods analysis. Ministry of higher education and scientific research. University of Mosul.

El-Hammady, A.E.; Wanas, W.H.; El-Saidi, M.T. and Shahin, M.F.M. (1999). Impact of proline application on the growth of grape plantlets under salt in vitro, Arab university J. Agric. Sci., 7: 191 – 202.

Faraj, A.H. (2006). Effect of chemical and organic fertilizers on yield and component of tomato (*Lycopersicon esculentum* mill) in desert areas under drip irrigation system by using water saline. Iraqi magazine for soil sciences. 6(1): 125 - 134.

Khalil, A.S. Dawood, Z.A. and Talal, M. (2007). Effect of hydraulic stress, calcium chloride and naphthalene of acetic acid on growth, yield and quantity of potato. Iraqi agriculture magazine, 12(3): 51-62.

Lutfi, A.A.F.L. (1986). Effect of Nitrogen categories and different levels of calcium in nutrient solutions on growth and yield of tomato. Master thesis. College of agriculture. university of Baghdad.

Matlub, A.N. (1984). Vegetable production in conditioner environment. Dar-Al-kutub for publishing and distribution. university of Mosul.

Matlub, A.N.; Mohammed, A.S. and Abdul, K.S. (1989). Vegetable production. second part. Higher education printing. university of Mosul. Ministry of higher education and scientific research. Iraq.

McCollum, J.P. (1980). Producing vegetable crop . 3rd Ed. The interstate printer and publisher. USA.

Mengle, K. and Crakbi, E.A. (1987). Plant nutrition principles. Translation of Saad-allah Najem Abdullah

Al-Naemi. Ministry of higher education and scientific research. University of Mosul.

Mohammed, A.K. and Al-Unis, M.A. (1991). Plant physiology bases . Dar-Al-kutub for publishing and distribution. Ministry of higher education and scientific research. University of Mosul. Iraq. P.1028.

Mohammed, A.S. (2009). Effect of nitrogen fertilization and sea weed extract spraying on growth of cucumber. Diyala magazine for agricultural sciences, 1(2): 134 – 145.

Nour, K.A.M.; Mansour, N.T.S. and Abdul-Hakim. (2010). Influence of foliar spray with seaweed extract on growth, setting and yield of tomato during summer season. Journal plant production Mansoura University, 1(7): 961- 970.

Page, A.L.; Miller, R.H. and (Eds) Keency, D.R. (1982). Chemical and microbiological properties. 2nd edition. Am. Soc. Agron. Wisconsin. USA.

Rao, A.V. and Rao, L.G. (2007). Carotenoids and human health. Pharma. Res., 55: 207 -216.

Rensing, L. and Cornelius, G. (1980). Biological membrances a composition of oscillating systems. BIOL Rundschau 18: 197-206.

Ryan, G.G. and Abdul-Rashid, A. (2005). Soil and plant analysis laboratory guide. International center of agricultural research in the dry areas (ICARDA).

Sahi, B.G. (1998). Effect of spraying time number of nutrient solution (Al-Nahrin) in growth and yield of paprika Cordoba cultivar. Iraqi agricultural sciences magazine. Ed. 29(2): 144–173.

Tan, K.H. (1986). Degradation of soil minerals by organic acid 1-25. In p.M. Hung and M.S. Chnitzar (eds) Interaction of soil minerals with natural organic and microbes soil Sci. Soc. Am. Madison. Wisconsin. USA.

Tate, K.R. and Theng, B.K.G. (1980). Organic matter and its interaction with inorganic soil constituents. P225- 249. Newzaland and Soc. Soil Sci.

Thang, P.T.N. (2007). Ripening behavior of capsicum (*Capsicum annuum* L.) Fruit. Thesis for the degree of doctor of philosophy. University of Adelaide, South Australia. 149.

Yahi, E.M. (2000). The contribution of fruit and vegetable consumption to human health. In fruit and vegetable phytochemicals: chemistry, nutritional value, and stability. (Ed. Laura A. de la Rosa, Emilio Alvarez-parrilla, Gustavo A. Gonzalez-Aguilar) Black Well Pub. Lowa, USA.

Yaseen, B.T. (1992). Water stress physiology in plant. Dar-Al-kutub for publishing and distribution. university of Mosul.