

Effect of Some Nutrient Solutions and Foliar Nutrition on Amino Acids Content and Some Growth Parameters of Potato (*Solanum tuberosum* L.) Under Sand Culture Conditions

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Abstract

This study was carried out in the Greenhouse at Al-Tuwaittha Experimental Station (20Km Southeast of Baghdad), Agricultural Research Directorate. The experiment was laid out in Completely Randomized Design (CRD) with three replicates for each experimental unit. The results showed superiority of fertilizer in S1S2 (nutrient solution+ megafol) treatment was significantly increased tuber content of amino acids including Glutamine, Asparagine, Alanine and Arginine (1.748 ,0.689, 0.793 and 0.895 mg.100g⁻¹), respectively in comparison with the control treatment S0 which gave 0.447, 0.367, 0.320 and 0.371 mg. 100 gm⁻¹ respectively. As well as, significantly increase rates of length, diameter, fresh and dry weight reached 32.89 cm, 0.193 cm 19.54 gm and 8.57 gm) of the root system, respectively in comparison with the control treatment S0. This study shows the possibility of using nutrient solutions with megafol in sand culture to increase amino acids in tuber of potato, as well as to accelerate root growth which may increases their nutritional value.

Keywords: Foliar Nutrition, Amino Acids, Growth, Sand Culture and Potatoes

تأثير المحاليل المغذية والتغذية الورقية في محتوى الأحماض الامينية وبعض معايير النمو لنبات البطاطا *Solanum tuberosum* L. تحت ظروف الزراعة الرملية

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الخلاصة

نفذت الدراسة في البيت الزجاجي التابع الى محطة ابحاث التوتية (20 كم جنوب شرق بغداد) لدائرة البحوث الزراعية، وفق تصميم تام التعشبية (C.R.D) وبثلاثة مكررات لكل وحده تجريبية. أظهرت النتائج تفوق معاملات استعمال المحلول المغذي والاسمدة الورقية معنوياً في زيادة محتوى الدرنات من الأحماض الامينية، اذ تفوقت معاملة S1S2 (محلول مغذي + الحامض الاميني ميجافول) معنوياً وبلغت محتويات الكلوتامين، الاسباراجين، الالنين والارجنين 1.748، 0.689، 0.793 و 0.895 ملغم. 100غم⁻¹ بالتتابع مقارنة بمعاملة S0 (بدون اضافة) والتي اعطت 0.447، 0.367، 0.320 و 0.371 ملغم. 100 غم⁻¹ بالتتابع، وكذلك سجلت المعاملة S1S2 زيادة في معدلات طول وقطر والوزن الرطب والجاف للمجموع الجذري بلغ 32.89 سم و 0.193 سم و 19.54 و 8.57 غم بالتتابع قياساً بمعاملة المقارنة (بدون اضافة) اوضحت الدراسة امكانية استعمال بعض المحاليل المغذية مع المنشط الاميني (ميجافول) لزيادة معدلات الأحماض الامينية في درنات البطاطا في الزراعة الرملية والتي كان لها تأثير معنوي في تفوق بعض الصفات النمو لجذور نباتات البطاطا والتي قد تؤثر في زيادة قيمتها الغذائية.

الكلمات المفتاحية: تغذية ورقية و احماض امينية ونمو وزراعة رملية والبطاطا

Introduction

Potato (*Solanum tuberosum* L.) is the most common tuber vegetable in used food as energy source (Krylova, *et al.*, 2000). It belongs to Solanaceae family which includes more than 2000 species and 90 genus. Potato ranks as the fourth strategic crop in the world after wheat, maize and rice and it is important in food security (Hassen, 1999). Potatoes are vegetables rich in nutrients and amino acids. These amino acids are the main structural of protein and peptide of organism, giving them a high biological value. Also, they have other functions, acting as neurotransmitters and raw materials for some hormones or as a source of energy (Wlecer and Goncyarik, 1977). Besides, it also helps in the recovery, growth and development of muscle tissue, and they have a role in enhancing the flavor in food. In recent years, organic fertilizers harmless to humans, animals and plants such as nutrient solutions containing amino acids or organic compounds were used (AL-Mohammed and AL-Jubouri, 2009) which are added of low concentrations to the plant by spraying or add them with irrigation to soil (Al-Zehawi, 2007). One of these methods are soilless agriculture (Hydroponics, Sand Culture and Aerobponic). Sandculture is an effective and good scientific method in plant nutrition research through controlling the quantity and quality of nutrients that include all the elements under study (Al-Zehawi, 2012). The use of suitable nutrient solution and amino acid in soilless culture gave significant increases of the total vegetative growth in potatoes (Ahmed and Kadim, 2014). Murashev (2003) showed that the use of amino acids sprayed on leaves of potato plants led to faster maturation, increased production and improved quality. EL-Tantawy (2009) noted that addition of nutrient solution consisting of amino fert,

chitosam sprayed on tomato leaves led to a significant increase in the fresh weight of the plant and the dry weight of the vegetative and root total. whereas Faraj and Shaker, (2011) found when studying the effect of amino acids (Tyrosine, Proline, and Arginine) on tomato plant that the addition of 200 gm / L gave the highest values with significant differences in fresh and dry weight of the root total comparison with the control treatment. Jezek, *et al.*, (2011) found that spraying the potato plant with selenium at 200 gm. ha⁻¹ effected in increasing of amino acids content in tubers (Phenylpine, Aspirin, Glotamine and Tyrosine). Moreover, using nutrient solution with three sand cultures (Al-ukhayder Sand, Karbala Sand and Bottom River Sand) showed that the bottom river sand gave the highest increasing in leaf area and dry weight of vegetative growth (Eesa, *et al.*, 2009). Spraying potatoes after ten days of germination with the commercial nutrient solutions and amino acids gave significant increase in the number of stems / plant at hydroponic system (Ahmed and Kadim, 2014).

The aim of this study was to assessment the effect of interaction between nutrient solution and foliar spray on amino acids content and some growth parameter of potatoes under sand culture system.

Materials and Methods

This study was carried out in the greenhouse at Al-Tuwaita Experimental Station/Baghdad during period from 10th Dec. 2016 to 20th Feb. 2017 using *Solanum tuberosum* riviera cv

Preparation and Construction of the Sand Culture Trough

Sand culture trough was constructed in the greenhouse, the tubers were planted in the trough a height of 0.6 m, width

1.25m and a length 5 m filled with sandy - rivers (Picture 1). The sand was washed several times with tap water to get rid of salts, the physical and chemical characteristics of the sand were described in Table (1).



Picture (1) Planting of Tubers

The nutrient solution was adapted from Al-Zehawi, 2012 (Table 2). Nutrient solution was pumped by an electric pump from a tank with capacity of 1 m³ through drip irrigation system. Tap water was used for the control treatment. During the experiments carried out, an automatic operating system was used to pump nutrient solution starting at 7:00 am and maintaining an intermittent nutrient flow, 20 min on and 10 min off, until 4:00 pm. At night, the system was activated twice, at 4:00 pm. until 7:00 am (Turn off for 120 min and Turn for 10 min). The electrical conductivity (EC) of the nutrient solution was kept at 1.5-2.00 dc/cm⁻¹ and the pH 5.5 - 6.5. The nutrient solution was totally replaced every 14 - 21 days.

Treatments

S0: Without addition fertilizer as control (Only Water)

S1: Standard nutrient solution

S2: Foliar spray with megafol (Activated Amino Acid) contains a set of amino acids and 28% nitrogen, 4.5% total organic matter and carbon 15%. Using spray at a rate of 3 ml/ liter. Production and packaging Italian Valagro company

S3: Foliar spray with Magnum Phosphate urea 44% Phosphorus and 18% Nitrogen a fertilizer using spray at a rate of 3 ml / liter, Production company Kemir – Growhow.

S4: Foliar spray with Agro-leaf Element compound mixture fertilizer consist of N, P, and K (20, 20, and 20) with trace elements (B, Ca, Zn, Mn, and Fe) using spray at a rate of 2 gm /L. Production and Packaging Scott Company.

S1S2: Nutrient Solution + Megafol (Foliar Spray)

S1S3: - Nutrient Solution + Magnum (Foliar Spray)

S1S4: - Nutrient Solution + Agro-leaf (Foliar spray)

Foliar fertilizer was added by spraying on the plants at the early time of morning to avoid the high temperatures applicate (While the Nutrient Solution Added Through the Irrigation System). Spraying treatments were carried out 4 times, the first one 15 days from the emergence and after that in 15 day's interval. Tuber potatoes were planted 0.25 m between each of them and 0.75 m from one line to another (Picture 2) (2 m Long for the Lines and Two Lines for Each Treatment) and left 1m between each treatment to prevent nutrient transfer. Completely Randomized Design (CRD) was used (El-Sahookie and Wahib,1990).



Picture (2) Preparation of Troughs

The average number of stems and plant height were measured after 55 days for 5 plants from each treatment (Picture 3).



Picture (3) Plants of Sand Culture

Leaf area was measured with the portable leaf area meter (USACI-202) (Tekalign and Hammes, 2005).

Furthermore, the dry weight of the plants was recorded after air drying for three days and then in an electric oven at 70°C until constant weight. The lengths and diameters of the roots were estimated

after drawing the root images by the scanner (Sadik, *et al.*, 2011). The fresh and dry weight of roots were measured by taking known weights from the roots and placed in an electric oven at 70 °C for 48 hours until the weight constant (Pictures 4, 5, and 6). Amino acids were estimated by HPLC (High Performance Liquid Chromatography) of potato tubers According to (Itakura, *et al.*, 2001).



Picture (4) Roots of S1S4 Treatment

Table (1) Some Physical and Chemical Properties of the Sand Used in Experiments

Parameters	Standard Unit	Value	
pH		7.9	
Electrical Conductivity	dc/cm ⁻¹	3.4	
Ca ⁺²	mg.L ⁻¹	118	Ions Soluble
Na ⁺²	mg.L ⁻¹	95	
Mg ⁺²	mg.L ⁻¹	74	
Cl ⁻	mg.L ⁻¹	120	
HCO ₃	mg.L ⁻¹	68	
Available K	mg.Kg ⁻¹	105	
Available P	mg.Kg ⁻¹	22.3	
Available N	mg.Kg ⁻¹	26	
Silt	gm.Kg ⁻¹	172.0	
Clay	gm.Kg ⁻¹	46.0	
Sand	gm.Kg ⁻¹	782.0	
Soil Texture	Sandy		

Table (2) The Standard Combination Used in the Preparation of the Nutrient Solution (gm / L³)

Elements	N	P	K	Ca	Mg	Fe	Zn	Cu	Mo	Mn	B
Concentration	250	70	350	223	40	5	0.1	0.3	0.03	1.5	0.7

(Al-Zehawi, 2012)

The analyzed of sand used in the expelimed was carried out in the laboratories of the Ministry of Science and Technology / Pollutant Treatment Technology Center

The tubers were harvested after 60 days. Data were analyzed using Statistical Analysis System (SAS, 2001). The significant differences among means were compared by L.S.D at ($P \geq 0.05$).



Picture (5) Roots of S0 Treatment



Picture (6) Roots of S1S2 Treatment

Results and Discussion

Tuber Content of Amino Acid

The results presented in Table (3) showed that the combination of nutrient solutions and foliar spraying had positive effect on tuber content of amino acid. The treatment (S1S2) gave the highest significant differences ($P < 0.05$) in the tuber content of amino acids (Glutamine, Asparagine, Alanine and Arginine)

1.748, 0.689, 0.793 and 0.895 mg. 100 gm⁻¹ respectively. Besides, there was no significant differences between S1S3 and S1S4 treatments which gave 1.688, 0.585, 0.733 and 0.805 mg. 100gm⁻¹) and (1.720, 0.667, 0.774 and 0.889 mg. 100 gm⁻¹) respectively compared with control treatment 0.447, 0.367, 0.320 and 0.371 mg. 100g⁻¹ respectively.

The results showed that nutrient solutions and foliar application caused increasing in content of amino acid in tuber of potato. The increase in (Glutamine, Asparagine, Alanine and Arginine) at S1S2, S1S3 and S1S4 treatments may be due to their nutrient elements content. Specially the nitrogen, which increase the amino acids by increasing the proteins synthesis (Hamman, *et al.*, 1996) and (Leegood, *et al.*, 2000). Also, the increasing in potassium helps to convert nitrogen to amino acids and proteins by activation the enzyme nitrate reductase in the process of nitrate reduction and conversion to ammonia in the plant, which is associated with ketonic acid to the amino acids, (Al-dakhula, 2001).

Plant Vegetative Growth

Data represented in Table (4) showed the higher increasing in S1S4 treatment in the number of stems, plant height, leaf area and dry weight of vegetative growth by 5.33 stems.plant⁻¹, 65.33 cm, 73.70 dm² and 26.98 g, respectively, compared to the control treatment. The significant difference in vegetative traits may be due to the availability of major and minor nutrients around the root zone and its availability and transfer to the vegetative parts as well as the nutrients which

Table (3) Effect of Combination of Nutrient Solutions and Foliar Spraying on Tuber Content of Amino Acid (mg.100⁻¹) of Potatoes Under the Sand Culture Conditions

Treatments	Glutamine Mg.100g ⁻¹	Asparagine Mg.100g ⁻¹	Alanine Mg.100g ⁻¹	Arginine Mg.100g ⁻¹
S0	0.447	0.367	0.320	0.371
S1	1.520	0.557	0.705	0.703
S2	1.525	0.533	0.655	0.708
S3	1.488	0.500	0.652	0.689
S4	1.500	0.509	0.659	0.681
S1S2	1.748	0.689	0.793	0.895
S1S3	1.688	0.585	0.773	0.805
S1S4	1.720	0.667	0.774	0.889
L.S.D 5%	0.080	0.104	0.054	0.090

Table (4) Effect of Combination of Nutrient Solutions and Foliar Spraying on Number of Stems, Plant Height, Leaf Area and Dry Weight of Vegetation Potatoes Under the Sand Culture Conditions

Treatments	Number of Stems	Plant Height (cm)	Leaf Area dm ²	Dry Weight of Vegetation(gm)
S0	2.00	31.25	39.30	17.62
S1	3.67	50.80	60.55	23.23
S2	3.33	44.30	58.80	21.99
S3	3.33	41.33	57.10	21.75
S4	3.67	44.55	57.63	22.40
S1S2	5.23	65.00	73.53	26.97
S1S3	5.00	61.34	70.33	25.77
S1S4	5.33	65.33	73.70	26.98
L.S.D 5%	1.58	4.061	13.10	1.27

sprayed on plant, especially amino acids (Megafol) and balanced compound fertilizers (Agroleaf + Magnum), which positively effects to the traits of vegetative growth. the result of our study was agreed with Kang and Han (2005), Imma *et al.* (2006) and Novella *et al.* (2008).

Roots Parameters Growth

The lengths, diameters, and the fresh and dry weight of roots were significantly affected by nutrient solutions and foliar application. The results in Table (5) showed significant differences between combination of nutrient solution by foliar spraying treatments on roots traits. S1S2 treatment

was significantly superior in root parameters which gave (32.89 cm, 0.193 cm, 19.54 gm and 8.57 gm) respectively, compared with control treatment which gave 22.96 cm, 0.113 cm, 10.96 gm and 5.89 gm, respectively.

To discuss the growth of potato roots (Table 5) and (Pictures 4, 5, and 6), high rates of these traits were observed when using nutrient solution by foliar application. This is due to the effect of nutrients in these qualities due mainly to the availability of nitrogen and potassium. In addition, fertilization of these elements leads to increase of growth, especially root growth, which affects the increased availability and take

Table (5) Effect of Combination of Nutrient Solutions and Foliar Spraying on Lengths, Diameters, and the Fresh and Dry Weight of Roots of Potatoes Under the Sand Culture Conditions

Treatments	Length of Root(cm)	Diameter of Root (cm)	Fresh Weight of Root (gm)	Dry Weight of Root (gm)
S0	22.96	0.113	10.96	5.89
S1	28.16	0.163	15.62	7.85
S2	26.78	0.153	14.23	7.30
S3	26.27	0.140	14.01	7.20
S4	26.31	0.146	14.96	7.30
S1S2	32.89	0.193	19.54	8.57
S1S3	30.85	0.180	18.30	8.15
S1S4	32.52	0.190	19.33	8.54
L.S.D 5%	1.44	0.012	1.75	0.59

up by the plant (Ahmed and Kadhim, 2014).

Also, the availability of the nitrogen causes improved nutritional status in the plant including increase vegetative growth, which leads to increasing of Photosynthesis process and increasing production of carbohydrates, which transports to the roots and contribute to increase of their weight.

The availability of phosphorus in the nutrient solution may give increasing growth, the branching and strengthen roots (Abu Dahi, *et al*, 2007). When amino acids added or sprayed on the plant are consider important nitrogenous source of formation proteins and enzymes that promote vegetative and roots growth (Abd EL-Aziz and Balbaa, 2007). Possibility of using.

Conclusions

From the present study it can be concluded the possibility of using nutrient solutions in sand culture to increase amino acids in tuber of potato, as well as to accelerate growth and improve production that increases their economic and nutritional value.

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