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EFFECT OF HUMIC ACIDS AND SPRAYING WITH AMINO ACIDS AND ALCOHOLIC SUGARS ON THE CONCENTRATION OF SOME NUTRIENTS IN POTATO TUBERS AND THEIR AVAILABILITY IN THE SOIL

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ABSTRACT

A field experiment was carried out at field of College Agricultural Engineering Sciences - University of Baghdad, during spring season 2022 to study the effect of adding humic acids to the soil and foliar applied amino acids and alcoholic sugars on the concentration of some nutrients in potato tubers and their availability in the soil. The experiment was faetorial with split-split plot arrangement within randomized complete block desigen with three replicates the experiment included three factors, The first was the addition of humic acids to the soil at three levels(0, 20, 40) Kg ha-1 Asymbol of it (H0,H1,H2), And the second factor foliar applied amino acids (0,250,500) mg L-1 A symbol of it (A1,A2,A3), the third factor foliar alcoholic sugars with concentrations (0, 20, 40) g L-1 A symbol of it(S1,S2,S3). The number of treatment was 27, The results indicated Single factors For level 40 Kg humic acid ha-1, 500 mg L-1 amino acid, 40 g L-1 alcoholic sugars gave a significant increase availability of N,P,K,Fe,Mn in soil and concentration of N,P and K in tubers. The bilateral interactions between treatments highest levels gave a significant increases in availability of N,P,K,Fe and Mn in soil and concentration of N, P and K in tubers. The triple interaction at concentrations (40 kg ha-1, 500 mg L-1, and 40 g L-1) gave the best results for all studied traies.

Key words: chelicerates, nitrogen, organic acids, phosphorus, potassium, Solanum tubersum .L.

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INTRODUCTION

Potato is one of the most important agricultural crops used for food locally and globally. It belongs to the Solanaceae family. It is one of the most important and widely used vegetable crops. It tops the list of tuber crops. Potato contained high nutritional value in the potato plant, and because it is a vegetable rich in nutrients necessary for the human body (Krylova,*et al*.,2000). The challenge facing those interested in the agricultural field is the proper diagnosis of all factors determining production and minimizing their impact through proper management and adoption of modern technologies to ensure an increase in the total yield per unit area. One of the important things in this field is the availability of the nutrient required for plants in sufficient quantities and at appropriate times so that their production is not limited. In recent years, the focus has been on adopting agricultural practices, especially fertilization with modern and environmentally harmless technologies, thus guaranteeing high quality and quantity products and reducing the negative impact on the environment (Havlin, 2022). Humic acids are part of humic substances, which play a key role in soil fertility and plant nutrition, and increase the production of plant enzymes such as Transaminase and Phosphatase and Invertase and stimulate the production of vitamins inside the cells such as vitamins A,

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D, E and K (Al Ameer and Alwan, 2018; Mahmood *et al.*,2020; Tan, 2014). These effects gave the acids a promising future in increasing crop production as a source of low-cost natural fertilizers (Ayuso *et al*,1997; Sherif and Sherif ,2007). In recent decades, the use of humic acids has spread widely to increase plant growth and production by adding them to the soil in parallel with reducing the quantities of added nutrients, including potassium, in the form of mineral fertilizers (Page *et al*,1982; Salim and Ali, 2017) . As for amino acids are biostimulants that are quickly absorbed and transported within the different parts of the plant because of their direct effect on the enzymatic activity of the plant. They are also included in the formation of nucleotides, vitamins and growth hormones. Hence, they are essential for living matter and protoplasm. They also enter into formation of enzymes and thus participate in enzymatic reactions. In cells, when amino acids are added, they are an essential nitrogenous source in the construction of proteins and enzymes and the processing of energy that encourages vegetative and root growth (Abdel-Aziz and Balbaa,2007; Al-Morjani, 2011; Al-Jumaili, 2012). Common alcoholic sugars include one of the following ingredients, mannitol, sorbitol, xylitol, erythritol, isomalt, and hydrogenated starch gluten. Alcoholic sugars are characterized by the following characteristics, their molecular weight is low, they require little or no energy to form complexes and rapid transition within the plant, they are highly stable in basic pH solutions and do not need to adjust the pH because they are soluble in all media, they have a linear structural form so they are rapidly absorbed as well It is from the plant and returns to it. It works to increase the time required for the leaves to absorb micronutrients before they dry because they are voracious (Taiz and Zeiger,2006; Zhang, 2014).

MATERIALS AND METHODS

A field experiment was carried out at fields of Agricultural Engineering Sciences College during the spring season 2022, according to the randomized complete block design (RCBD) using split_split_plot arrangement (36). The experiment included three factors: Addition of humic acids (0, 20 and 40 kg ha^{-1}) on week after germination It represents the main factor. The second factor is Foliar applied amino acids (0, 250 and 500 mg L^{-1}) three times after (14,28,45) days of emergence represents the secondary factor, and the third factor is Foliar applied alcoholic sugars in form of sorbitol mixed with Fe and Mn at a concentration 2.5% with concentrations (0, 20 and 40g L-1) three times. After 25,35and 45 days from emergence represents the sub-secondary factor. As the number of experimental units reached 81 experimented units. The land was prepared for cultivation by plowing, smoothing and levelling. Samples were taken from the field soil to estimate some physical and chemical properties. Table (1) shows that. experimental unit was 6m2 (3×2).

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Table 1. Some physical and chemical properties of the soil before planting

Property		Value	Unit	References
pH 1:1		7.5	-	
EC 1:1		2.36	ds m^{-1}	page et al, 1982
O.M		28.6	g kg^{-1}	
CEC		20.2	$Cmol^{+}$ kg^{-1}	Salim & ali 2017
Soluble anions	Ca^{++}	5.87	mmol L^{-1}	Richsrds, 1954
	Mg^{++}	4.34		
	Na^{+}	2.4		
	K^{+}	1.2		
	SO_4^{-2}	4.12		Salim & ali 2017
	Cl^{-}	13.9		
	HCO_3^{-}	2.5		Richsrds, 1954
	CO_3^{-2}	Nill		
Nutrients	N	28.9	mg Kg^{-1}	page et al, 1982
	P	6.00		
	K	120.6		
	Fe	1.9		Salim & ali 2017
	Mn	2.4		
Soil saparates	clay	301.0	g kg^{-1} soil	Auela &Mahai, 2017
	Silt	540.0		
	sand	159.0		
Texturc		Silty clay loam		

RESULTS AND DISCUSSION

Available nitrogen (mg kg^{-1})

It is clear from the results of the statistical analysis Table (2), that there was a significant increase in the available nitrogen in the soil, as the treatment H2 achieved the highest value 52.7 mg kg-1, with an increase of 17.37% compared to the treatment H0 (44.9) mgN kg-1. While the results of foliar applied amino acids showed a significant increases in the available nitrogen in the soil, as treatment A2 achieved the highest value of 58.5 mg N kg-1, with an increase of 43.03% compared to treatment A0 (40.9) mgN kg-1. The effect of foliar applied alcoholic sugars was significant on the available nitrogen in the soil, as the S2 level achieved the highest value of 52.63 mg N kg-1, with an increase of 18% compared to the treatment of S0(44.6)mgN kg-1. The interaction between the addition of humic acids and foliar applied amino acids had a significant effect on this characteristic, as the highest value was 63.7 mg N kg^{-1} in the H_2A_2 treatment, and the lowest value was 38.2 mgN kg^{-1} in the H_0A_0 treatment, with an increase of 66.75%. The interaction between the addition of humic acids and foliar applied with alcoholic sugars, it achieved a significant superiority in this characteristic, as the highest value reached 56.3 mg N kg^{-1} for H2A2 treatment, and the lowest value was 39.9 mgN kg^{-1} at treatment H0S0, with an increases 41.10%. foliar applied with amino acids and alcoholic sugars were also significant in this characteristic, as the highest value was 63.2 mgN kg^{-1} in A_2S_2 treatment, and the lowest value was 38.7 mgN kg^{-1} in A_0S_0 treatment, with an increase 63.31%. The triple interaction had a significant effects on this characteristic. The highest value 67.8 mg N kg^{-1} was achieved in $H_2A_2S_2$ treatment, and the lowest value was 35.6 mg N kg^{-1} at $H_0A_0S_0$, with an increase 90.45%.

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Table 2. Effect adding of humic acids foliar applied amino acids, and alcoholic sugars on available soil nitrogen (mg N kg^{-1})

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
H_0	A_0	35.6	38.3	40.6	38.2
	A_1	33.8	44.6	48.7	42.4
	A_2	50.3	53.9	57.9	54.0
H_1	A_0	38.1	41.5	42.6	40.7
	A_1	41.8	46.3	51.2	46.4
	A_2	53.7	55.6	63.8	57.7
H_2	A_0	42.5	43.5	45.7	43.9
	A_1	46.0	50.0	55.3	50.4
	A_2	59.8	63.6	67.8	63.7
LSD_{H*A*}		0.614		LSD_{H*A}	0.41

H * S				
Humic acids	S_0	S_1	S_2	Means Humic acids
H_0	39.9	45.6	49.1	44.9
H_1	44.5	47.8	52.5	48.3
H_2	49.4	52.4	56.3	52.7
LSD_{H*S}	0.45		LSD_H	0.41

A * S				
Amino acids	S0	S1	S2	Means Amino acids
A_0	38.7	41.1	43.0	40.9
A_1	40.5	46.9	51.7	46.4
A_2	54.6	57.7	63.2	58.5
LSD_{A*S}	0.34		LSD_A	0.15

S			
Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	44.6	48.58	52.63
LSD_S	0.22		

Available phosphorus (mg kg-1)

The results in Table (3) show a significant increases in the available phosphorus in the soil, as the treatment H2 achieved the highest value of 15.4 mg p kg-1, with an increase 65.59% and 22.22% compared to the treatment H0 (9.3) and H2 (12.6) mg p kg-1. It is also evident from the results of the same Table that Foliar applied with amino acids led to a significant increases available phosphorus in the soil, as treatment A2 achieved the highest value 13.7 mg p kg-1, with an increase 22.32% and 10.48% compared to treatment A0 (11.2) and A1 (12.4) mg p kg-1. The results also confirmed that Foliar applied alcoholic sugars had a significant effect on the available phosphorus in the soil, as the S2 level achieved the highest value 12.85 mg p kg-1, with an increase 8.43% and 2.22% compared to the treatment S0 (11.85) and S1 (12.57) mg p kg-1.

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Table 3. Effect adding of humic acids, foliar applied amino acids, and alcoholic sugars on soil available phosphorus (mg p kg^{-1})

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
H_0	A_0	6.9	8.3	8.4	7.9
	A_1	8.5	9.8	10.0	9.4
	A_2	10.3	10.5	11.0	10.6
H_1	A_0	11.3	11.4	11.7	11.5
	A_1	12.8	12.9	13.1	12.9
	A_2	13.3	13.3	13.4	13.3
H_2	A_0	14.2	14.3	14.4	14.3
	A_1	14.6	14.8	14.8	14.7
	A_2	14.9	17.9	18.8	17.2
LSD_{H*A*S}		0.153			LSD_{H*A} 0.078

H * S

Humic acids	S_0	S_1	S_2	Means Humic acids
H_0	8.6	9.5	9.8	9.3
H_1	12.5	12.6	12.7	12.6
H_2	14.5	15.7	16.0	15.4
LSD_{H*S}	0.09		LSD_H	0.07

A * S

Amino acids	S0	S1	S2	Means Amino acids
A_0	10.8	11.3	11.5	11.2
A_1	12.0	12.5	12.7	12.4
A_2	12.8	13.9	14.4	13.7
LSD_{A*S}	0.08		LSD_A	0.04

S

Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	11.85	12.57	12.85
LSD_S		0.05	

The interaction between humic acids and amino acids achieved a significant effect on this characteristic, as the highest value was 17.2 mg p kg^{-1} at treatment with H_2A_2, and the lowest value was 7.9 mg p kg^{-1} when treated with H_0A_0, with an increase 117.72%. As well as for the effect of the overlap between humic acids and alcoholic sugars, it achieved a significant superiority in this property, as the highest value was 16 mg p kg^{-1} for H_2S_2 treatment, and the lowest value was 8.6 mg p kg^{-1} at treatment H_0S_0, with an increase 86.05%. The interaction between amino acids and alcoholic sugars resulted in significant differences also in this characteristic, as the highest value was 14.4 mg p kg^{-1} in A_2S_2 treatment, and the lowest value was 10.8 mg p kg^{-1} in A_0S_0 treatment, with an increase 33.33%. The triple interaction had a significant effect on this property, as the highest value 18.8 mg p kg^{-1} was achieved in $H_2A_2S_2$ treatment, and the lowest value was 6.9 mg p kg^{-1} at $H_0A_0S_0$, with an increase 172.46%.

Available potassium (mg kg^{-1}) : The results of the statistical analysis, Table (4) shows a significant increase in the available potassium in the soil, as the treatment H_2 achieved the highest value 183.0 mg K kg^{-1}, with an increase of 29.88% and 17.53% compared to the treatment H_0 (140.9) and H_2 (155.7) mg K kg^{-1}. The results of the same table indicated that Foliar applied amino acids led to a significant increase in the available potassium in the soil, as treatment A_2 achieved the highest value 184.7 mg K kg^{-1}, with an increase 31.83% and 19.32% compared to treatment A_0 (140.1) and A_1 (154.8) mg. kg^{-1}. The results also showed that Foliar applied alcoholic sugars was significant in the available potassium in the soil, as the S_2 level achieved the highest value of 169.02 mg K kg^{-1}, with an increases 12% and 5.84% compared to the treatment S_0 (150.91) and S_1 (159.69) mg K kg^{-1}.

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Table 4. Effect adding of humic acids, Foliar applied amino acids, and alcoholic sugars on soil available potassium (mg K kg^{-1})

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
	A_0	125.4	127.5	128.7	127.2
H_0	A_1	130.5	131.9	137.9	133.4
	A_2	142.8	169.5	174.5	162.3
	A_0	136.4	140.8	144.3	140.5
H_1	A_1	147.7	151.6	154.8	151.4
	A_2	162.7	177.6	185.3	175.2
	A_0	147.7	154.1	156.3	152.7
H_2	A_1	171.5	179.6	187.8	179.6
	A_2	193.5	204.7	251.8	216.7
LSD_{H*A*S}		1.338			LSD_{H*A} 0.692

H * S

Humic	S_0	S_1	S_2	Means Humic acids
H_0	132.9	142.9	147.0	140.9
H_1	148.9	156.7	161.5	155.7
H_2	170.9	179.5	198.6	183.0
LSD_{H*S}		0.84		LSD_H 0.69

A * S

Amino	S0	S1	S2	Means Amino acids
A_0	136.5	140.8	143.1	140.1
A_1	149.9	154.3	160.2	154.8
A_2	166.4	183.9	203.9	184.7
LSD_{A*S}		0.69		LSD_A 0.27

S

Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	150.91	159.60	169.02
LSD_S		0.46	

The results indicated a significant effect of the bilateral interaction between humic acids and amino acids on this trait, as the highest value was 216.7 mg K kg^{-1} in the H_2A_2 treatment, and the lowest value was 127.2 mg K kg^{-1} in the H_0A_0 treatment, with an increase 70.36%. The results showed a significant effects of the bilateral interaction between the addition of humic acids and Foliar applied alcoholic sugars in this property, as the highest value was 198.6 mg K kg^{-1} for H_2S_2 treatment, and the lowest value was 132.9 mg K kg^{-1} at H_0S_0 treatment, with an increases 49.44%. The interaction between amino acids and alcoholic sugars also led to significant differences in this characteristic, as the highest value was 203.9 mg K kg^{-1} in A_2S_2 treatment, and the lowest value was 136.5 mg K kg^{-1} in A_0S_0 treatment, with an increases 49.38%. The triple interaction it was significant in this property, as the highest value of 251.8 mg K kg^{-1} was achieved in $H_2A_2S_2$ treatment, and the lowest value was 125.4 mg K kg^{-1} at $H_0A_0S_0$, with an increases 100.80%.

The results of tables (Abu Dhahi and Al-Younes, 1988; Al-Bahrani, 2015) showed the significant effect of adding humic acids in increasing the availabiliy of macro and micro

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nutrients. This can be due formation of natural chelates with posatine changed ions. Humic acid itself have some nutrients on well slowly released to plant root. (Tan, 2014; Al-Bahrani, 2015; Garcia, *et al*.,2016; Mohsen and Alwan,2019). The addition of humic acids to the soil has a significant effect on increasing the availability of phosphorus, and this is due to humic acid affect on decreasing pH whic improves the availability P thrush decreasing P sorption (Pukalchik, *et al*.,2019; Mohsen and Alwan,2019). Amino acids play a role in increasing the availability of macro and micro nutrients, as amino acids are considered as a direct source of organic nitrogen. They also have a great available to chelate the micronutrients in the soil and make them availabile for absorption and maintain them from fixation. The amino acid glycine and the glutamic are among the most effective acids as materials for chelation (Wendell, 2002; Sekhon, 2003). Also, adding them to the vegetative part has an indirect effect by increasing the root and vegetative system, which increases the availability of the various nutrients by increasing the root secretions of organic acids. The free amino acids, when added, are an essential nitrogenous source in the construction of proteins and enzymes and the processing of energy that encourage vegetative and root growth and thus increase the amounts of available nutrients in the soil (Abdel-Aziz and Balbaa, 2007). sorbitol led to a significant increase in the biochemical characteristics of the plant because it is an alcoholic sugar that belongs to carbohydrates. Therefore, it will lead to an increase in the primary metabolites of carbohydrates, proteins, peptides, lipids, lactic substances and organic acids. The influential role in the vital processes of plants, respiration, energy liberation and ATP production, which has a positive effect in plant growth leafy area chlorophyll, photosynthesis, increasing metabolism, and root secretions, which makes the medium acidic and encourages the growth and reproduction of microorganisms, thus increasing the availability of macro- and micronutrients in the soil (Brown and Shelp,1997; Taiz and Zeiger, 2006).

Nitrogen concentration in the tubers

It is clear from the results of the statistical analysis Table (5), that there was a significant increases in the concentration of nitrogen in tubers Treatment H_2 achieved the highest value 1.370%, with an increases 50.55% and 38.38% compared to treatment H_0 0.910 and H_1 0.990. While the results of Foliar applied amino acids showed a significant increases in the concentration of nitrogen in the tubers, as treatment A_2 achieved the highest value 1.200%, with an increases 18.81% and 13.21% compared to treatment A_0 1.010 and A_1 1.060. The effect of Foliar applied alcoholic sugars was significant on the nitrogen concentration in the tubers, as the level S_2 achieved the highest value 1.140%, with an increases 11.76% and 3.63% compared to the treatment S_0 1.020 and S_1 1.100. The interaction between humic acids and amino acids was significant in this property, as the highest value was 1.550% at treatment H_2A_2 and H_1A_2, and the lowest value was 0.800% at treatment H_0A_0, with an increase 93.75%. The interaction between humic acids and alcoholic sugars and between amino acids and alcoholic sugars was not significant in this respect. The triple interaction had a significant effects on this characteristic, as the highest value 1.680% was achieved in $H_2A_2S_2$ treatment, and the lowest value of 0.670% was achieved in $H_0A_0S_0$, with an increase of 150.74%.

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Table 5. Effect adding of humic acids, Foliar applied amino acids, and alcoholic sugars on the nitrogen concentration in tubers (%)

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
	A_0	0.670	0.860	0.880	0.800
H_0	A_1	0.900	0.930	0.960	0.930
	A_2	0.970	0.990	1.040	1.000
	A_0	1.010	1.010	1.020	1.010
H_1	A_1	0.680	1.020	1.030	0.910
	A_2	1.040	1.040	1.050	1.050
	A_0	1.140	1.230	1.240	1.210
H_2	A_1	1.310	1.340	1.380	1.350
	A_2	1.460	1.510	1.680	1.550
LSD_{H*A*S}			0.180		LSD_{H*A} 0.110

H * S

Humic acids	S_0	S_1	S_2	Means Humic
H_0	0.850	0.930	0.960	0.910
H_1	0.910	1.030	1.030	0.990
H_2	1.300	1.360	1.440	1.370
LSD_{H*S}		N.S		LSD_H 0.082

A * S

Amino acids	S0	S1	S2	Means Amino
A_0	0.940	1.030	1.050	1.010
A_1	0.970	1.100	1.130	1.060
A_2	1.160	1.180	1.260	1.200
LSD_{A*S}		N.S		LSD_A 0.066

S

Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	1.020	1.100	1.140
LSD_S	0.062		

N.S: Non Significeant

Phosphorus concentration in tubers

The results in Table (6), indicat a significant increases in concentration of phosphorus in tubers, as treatment H_2 achieved the highest value 0.420%, with an increase of 61.54% and 27.27% compared to treatment H_0 0.260 and H_2 0.330. Foliar applied amino acids led to a significant increases in the concentration of phosphorus in tubers, as treatment A_2 achieved the highest value 0.360%, with an increases of 16.13% and 5.88% compared to treatments A_0 0.310 and A_1 0.340. The results confirmed that Foliar applied alcoholic sugars was significant in the concentration of phosphorus in the tubers, as the level S_2 and S_1 achieved the highest value 0.340%, with an increases of 3.03% compared to the treatment S_0 (0.330).

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Table 6. Effect adding of humic acids, Foliar applied amino acids, and alcoholic sugars on the phosphorus concentration in tubers(%)

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
	A_0	0.220	0.270	0.250	0.240
H_0	A_1	0.260	0.270	0.270	0.260
	A_2	0.270	0.280	0.290	0.280
	A_0	0.290	0.300	0.250	0.280
H_1	A_1	0.330	0.340	0.350	0.340
	A_2	0.350	0.370	0.370	0.360
	A_0	0.390	0.390	0.400	0.390
H_2	A_1	0.410	0.420	0.430	0.420
	A_2	0.430	0.450	0.450	0.450
LSD_{H*A*S}			0.037		LSD_{H*A} N.S

H * S

Humic acids	S_0	S_1	S_2	Means Humic
H_0	0.250	0.270	0.270	0.260
H_1	0.320	0.330	0.320	0.330
H_2	0.410	0.420	0.430	0.420
LSD_{H*S}		N.S		LSD_H 0.020

A * S

Amino acids	S0	S1	S2	Means Amino
A_0	0.300	0.320	0.300	0.310
A_1	0.330	0.340	0.350	0.340
A_2	0.350	0.360	0.370	0.360
LSD_{A*S}		N.S		LSD_A 0.014

S

Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	0.330	0.340	0.340
LSD_S		0.012	

N.S: Non significant

While the interaction between humic acids and amino acids, between humic acids and alcoholic sugars, and between amino acids and alcoholic sugars did not have a significant effect on this trait. The triple interaction had a significant effect on this characteristic, as the highest value 0.450% was achieved at treatment $H_2A_2S_2$, and the lowest value was 0.220% at treatment $H_0A_0S_0$, with an increase 104.55%.

Potassium concentration in tubers

Data in Table (7) shows a significant increases in potassium concentration in tubers, as treatment H_2 achieved the highest value of 2.50%, with an increases of 13.12% and 3.73% compared to treatment H_0 2.21 and H_2 2.41. The results of the same Table indicat that Foliar applied amino acids led to a significant increases in potassium concentration in the tubers, as treatment A_2 achieved the highest value 2.48%, with an increases 8.29% and 5.53% compared to treatment A_0 2.29 and A_1 2.35. The results also showed that Foliar applied alcoholic sugars had a significant effects on the potassium concentration in the tubers, while Foliar applied with alcoholic sugars and the interaction between humic and amino acids and between amino acids and alcoholic sugars did not have a significant effect on this trait. The results also showed a significant effect of the binary interaction between humic acids and alcoholic sugars on this characteristic, as the highest value reached

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2.58% for the H_2S_2 treatment, and the lowest value reached 2.18% in the H_0S_0 treatment, with an increase rate of 18.34%. As for the triple interaction it was significant in this regard, as the highest value 2.84% was achieved in H2A2S2 treatment, and the lowest value 2.09% was achieved in H0A0S0, with an increase 35.88%.

Table 7. Effect adding of humic acids, Foliar applied amino acids, and alcoholic sugars on potassium concentration in tubers (%)

Humic acids	Amino acids	Sugar alcohols S_0	S_1	S_2	H * A
	A_0	2.09	2.19	2.20	2.16
H_0	A_1	2.21	2.22	2.22	2.22
	A_2	2.24	2.24	2.25	2.24
	A_0	2.26	2.33	2.33	2.31
H_1	A_1	2.36	2.36	2.37	2.36
	A_2	2.71	2.59	2.40	2.57
	A_0	2.40	2.41	2.43	2.42
H_2	A_1	2.45	2.45	2.46	2.45
	A_2	2.52	2.56	2.84	2.64
LSD_{H*A*S}			0.20		LSD_{H*A} N.S

H * S

Humic acids	S_0	S_1	S_2	Means Humic
H_0	2.18	2.22	2.22	2.21
H_1	2.44	2.43	2.37	2.41
H_2	2.46	2.47	2.58	2.50
LSD_{H*S}		0.14		LSD_H 0.13

A * S

Amino acids	S0	S1	S2	Means Amino
A_0	2.25	2.31	2.32	2.29
A_1	2.34	2.35	2.35	2.35
A_2	2.49	2.46	2.50	2.48
LSD_{A*S}		N.S		LSD_A 0.10

S

Sugar alcohols	S_0	S_1	S_2
Means Sugar alcohols	2.36	2.37	2.39
LSD_S	N.S		

The results of tables (Al-Jumaili, 2012; Al-Bahrani, 2015) show the significant effect of adding humic acids to the soil in increasing the concentration of macro nutrients in tubers. As mentioned, the reason for this is due to the fact that humic acids are a rich source of nitrogen and phosphorus (Verkaik, 2006). It directly affects the permeability of the cell membranes of the root and leaves, which facilitates the absorption of nutrients (Osten,*et al.*, 2017), and the humic acids are characterized by their high ability to hold nutrients in the soil solution and then increase their absorption, as well as increase the respiration of roots and formation of root hairs, chlorophyll, sugars and amino acids in the plant and then contribute to raising the efficiency of the photosynthesis process, which affects the increase in the concentration of nutrients inside the plant (Pettit, 2004; Zandonadi,*et al*,2016; Mahmood,et al,2019;). Humic acids also increase water and nutrients, especially In the upper parts of the plant, it improves the availability of phosphorus, increases the absorption of both potassium and phosphorus, improves soil aggregations in ccraase P availability it availability for plants (Katka,*et a*l.,2009). As well as what was previously explained, humic acids play an important role in increasing the ability of the plant to absorb water and the necessary nutrients (nitrogen, phosphorus and sulfur) to build the necessary

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amino acids, which leads to an increase in the protein content of the leaves, as it is the most important component of the cell protoplasm, and this was confirmed by (Al-Jumaili, 2012; Blackett,*et al*.,2015; Mohsen and Alwan, 2019.). Research has shown that humic acids not only affect the growth of the vegetative and root syste666.m of the plant, but also stimulate the absorption of nutrients from vegetable crops (Dursun,*et al*.,2002;Katka,*et al*.,2009) Amino acids play an important and significant role in increasing the concentration of nutrients in the leaves. The increase that occurred as a result of amino acid Foliar applied is due to the fact that these acids play an important role in many vital processes, whether they are present in free form or as a component of proteins, in addition to that these acids encourage vital activities, especially the processes of division And the expansion of plant cells, as well as the increase in the activity of enzymes that work to decompose organic compounds and work to liberate elements from them, which increases their availability and in turn increases plant growth rates. Free amino acids are also a major nitrogenous source in building proteins and enzymes and processing them (Abdel-Aziz and Balbaa, 2007). Amino acids also have a positive role in improving nutritional status. The reason is due to the role of amino acids in changing the osmotic potential of the plant cell, as an increase in amino acids leads to a decrease in the osmotic potential of the cell, and thus the ability of the cell to withdraw water and nutrients dissolved in it from the growth medium increases, thus increasing Its concentration in plants (Abu Dhahi and Al-Younes, 1988). The energy that encourages vegetative and root growth and thus the transfer of nutrients from the leaves to the tubers and increases the concentrations of N,P and K in the tubers. sorbitol is an effective delivery system that has the ability to deliver micronutrients and macro nutrients through the transport vessels inside the plant, thus reaching the appropriate amount of them equally to all different parts of the plant and ensuring that it performs its required role, and this was confirmed by (Bowen, 2003,;Al-Shammari, 2018), as well. It has a role in regulating the osmotic pressure when it accumulates inside the plant, and thus will lead to improving the plant's absorption of water and nutrients from the soil, increasing their concentrations within the plant parts, and contributing to raising the efficiency of the roots in absorbing the largest amount, and this was confirmed by (Salim, and Ali, 2017).

CONCLUSIONS

It can be concluded from above results that Humic acid application and Amino acids and alcohol sugar foliar application and their interactions can have very important and have positive effect on soil available nutrients which improving or at least maintaining soil fertility especially for next crop. The improvement of tuber nutrient concentration can have an effect on tubers bio fortification in some nutrients such as iron and on tuber mineral contents and nutritional.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.- Author/s signature on Ethical Approval Statement

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تأثير الأحماض الدبالية والرش بالأحماض الأمينية والسكريات الكحولية في تركيز بعض المغذيات في درنات البطاطا وفي جاهزية بعض المغذية في التربة

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المستخلص

نفذت تجربة حقلية في أحد حقول كلية العلوم الهندسية الزراعية – جامعة بغداد / الجادرية خلال الموسم الربيعي 2022 لدراسة تأثير إضافة الأحماض الدبالية إلى التربة ورش الأحماض الأمينية والسكريات الكحولية في تركيز بعض العناصر المغذية في درنات البطاطا وتوافرها في التربة. صممت التجربة وفق ترتيب الألواح المنشقة–المنشقة ضمن تصميم القطاعات الشاملة المعشاة وبثلاث مكررات وتضمنت ثلاثة عوامل، الأول إضافة الأحماض الدبالية إلى التربة بثلاثة مستويات (0، 20،40) كغم هـ$^{-1}$ ورمز لها(H0،H1،H2)، والعامل الثاني رش الأحماض الأمينية (0، 250، 500) ملغم لتر$^{-1}$ رمز لها (A1،A2،A3)، والعامل الثالث رش السكريات الكحولية بتراكيز (0،20،40) غرام لتر$^{-1}$ ورمز لها (S1،S2،S3). بلغ عدد المعاملات 27 معاملة، أشارت النتائج إلى أن العوامل الفردية للمستوى 40 كغم هكتار$^{-1}$ احماض دبالية ، 500 ملغم لتر$^{-1}$ احماض امينية ، 40 غرام لتر$^{-1}$ سكريات كحولية أعطت زيادة معنوية في تراكيز النيتروجين، الفسفور، البوتاسيوم، الحديد، المنغنيز في التربة وتركيز N وP وK في الدرنات. أعطت التداخلات الثنائية بأعلى المستويات بين المعاملات زيادة معنوية في تركيز النيتروجين والفوسفور والبوتاسيوم والحديد والمنغنيز في التربة وتركيز النيتروجين والفوسفور والبوتاسيوم في الدرنات. أعطى التداخل الثلاثي بالتراكيز (40 كغم هكتار$^{-1}$، 500 ملغم لتر$^{-1}$، 40 غم لتر$^{-1}$) أفضل النتائج لجميع الصفات المقاسة.

الكلمات المفتاحية: المخلبيات، النيتروجين، الأحماض العضوية، الفسفور، البوتاسيوم، البطاطا.