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THE EFFECT OF SPRAYING WITH AMINO ACIDS AND GROUND POTASSIUM ADDITION ON GROWTH AND PROLINE CONTENT OF POTATO LEAVES

Huda Abbas Jawad Al-Khafaji and Mohammed Sallal Oliwi*

Soil Science and Water Resources Department, College of Agriculture, Al-Qasim Green University, Babylon, Iraq.

Abstract

To find out the effect of spraying with amino acids (proline & arginine) and adding different levels of potassium and the interaction between them in the growth and yield of potatoes, a field experiment was conducted in one of the farms located in the area of Debla, South of Babylon governorate in a mixture of alluvial soil that included three levels of spraying with amino acids (Proline & Larginine). It is 0, 150, 300 ppm representing the first factor and its symbol is A_0, A_1, A_2 respectively, while the second factor represented the addition of different levels of potassium, which are 0, 120, 240 kg K h^{-1}, symbolized by the symbols K_0, K_1 and K_2 respectively and thus the number of transactions became 9 repeated transactions by 3 replications, so that the number of experimental units became 27 experimental units and the experiment was carried out within the RCBD system. 15-9-2019). The results were as follows: the spray treatment with amino acids (Proline & Arginine) at a concentration of 300ppm was superior to the treatment with A_2 in all the studied characteristics and it reached (58.04 cm, 3.33 stems $plant^{-1}$, 5.58 tons h^{-1}, 5381 cm $vegetable^{-1}$ 58.06 spad unit, 2.02 mg^{-1}) for indicators (plant height, number of main stems, vegetative dry weight, leaf area, chlorophyll index, proline leaf content). The treatment of potassium addition at the level of 240 kg h^{-1} when treatment K_2 achieved the highest growth indicators of potato yield, which did not differ significantly from the treatment of addition of potassium K_1 at the level of 120 kg K h^{-1}.

Key words: amino acids, potassium levels, potatoes.

Introduction

Amino acids are a biological stimulant that absorbs and moves quickly within the various parts of the plant because they have a direct effect on the enzymatic activity of the plant. They also enter into the formation of nucleotides, vitamins and growth hormones and then they are essential for living matter and protoplasm. And equipping energy to encourage vegetative and root growth (Abdel-Aziz and Balbaa, 2007).

Al-Hamdani and Muhammad (2014) emphasized the important role played by amino acids, such as proline and arginine, in reducing the stresses caused by salinity and dehydration through their different physiological activity by changing the osmotic stress of the plant tissue. The potassium ion is a mono-positive K^+, which is one of the main nutrients needed by the potato crop in large quantities, given the depletion that this nutrient is exposed to because it has not been added for many years to Iraqi soils. In plant tissues against the gradient of concentration with the external environment (Al-Sahhaf, 1989). Potato *Solanum tuberosum* L. is one of the most important vegetable crops and belongs to the Solanaceae family and it ranks fourth as a strategic and economic crop after wheat, maize and rice in Iraq and the world in terms of importance and cultivated area (Agricultural Statistics Directorate, 2017), so this crop is a major meal in many Countries of the World (Rana *et al.*, 2013).

***Author for correspondence :** E-mail : mohammed35@agre.uoqasim.edu.iq

Materials and Methods

A field experiment was carried out to cultivate the potato crop *Solanum tuberosum* L. in a farmer's field in the area of Debla, South of Babylon governorate, which is located at 32.3 north latitude and 44.39 east longitude during the 2019 autumn season. Then estimate the physical and chemical properties of the soil before planting.

Characteristics of vegetative growth

Plant height (cm)

Ten plants were randomly taken from the two

Table 1: Some physical and fertility characteristics of field soil before planting.

Property	Unit	The value	The reference used to assess the property
sand	250	gkg^{-1} soil	Page *et al.*, 1982
Silt	490		
Clay	260		
Texture class		Silt Loam	
Bulk density	1.35	$mg\,m^{-1}$	Hartge and Blake ,1986
Available Nitrogen	39.00	$mlg\ kg^{-1}$ soil	Page *et al.*, 1982
Available Phosphorous	14.10		
Available Potassium	188.40		

Table 2: Chemical properties of field soil before planting.

Property	Unit	The Value	The reference used to assess the property
Soil reaction pH		7.72	Richards ,1954
Electrical conductivity ECe	dSm^{-1}	3.81	
Cation Exchangable CEC	Cmol. $+kg^{-1}$	26.30	Bashour and Al-Sayegh, 2007
Soil organic matter SOM	gkg^{-1}	23.10	Page *et al.*, 1982
Gypsum	soil	0.95	
Lime		215.30	
Ions dissolved			
Calcium Ca^{+}		9.50	
Magnesium Mg^{+}	ml	6.25	Bashour and
Sodium Na^{+}	mol	4.80	Al-Sayegh,
Potassium K^{+}	L^{-1}	1.95	2007
Sulfates $So4^{-1}$		10.30	
Chloride Cl^{-1}		12.40	
Bicarbonate $HCO3^{-1}$		4.80	
Carbonates CO3+		Nil	

mean cells for each experimental unit. Plant height was measured using a tape measure and the medium extracted.

Number of stems (stem $plant^{-1}$)

The number of aerial stems of five plants was randomly counted from the two mean mers for each experimental unit and the average was extracted.

The percentage of dry weight of the shoots

The percentage of dry weight of foliage was calculated as follows (Sahhaf, 1989)

Dry weight percentage of shoots = (dry weight/soft weight) × 100.

The leaf area of the plant (cm^2 $plant^{-1}$)

Three plants were taken randomly from the two mean cells for each experimental unit and the leaf area was calculated by the following equation (Watson and Watson, 1953).

Paper space (cm^2) =

$$\frac{paper\ area\,(45\,tablets) * weight\ of\ papers\,(9\ papers)}{Dry\ weight\ for\ tablets\,(45\,tablets)}$$

The percentage of chlorophyll in the leaves (SPAD unit)

Measured with a $SPAD^{-502}$ Chlorophyll meter.

Determination of the amino acid proline in vegetable leaves

Using the method of Bates *et al.*, (1973).

Results and Discussion

Influencing some characteristics of vegetative growth.

Plant height (cm)

It is noted through the results of the statistical analysis, table 3, the significant effect of spraying with amino acids, potassium levels and the overlap between them in plant height (cm). As the amino acid spray had a significant effect in this characteristic by giving the highest value for plant height at treatment A_2 for the spray level of 300 ppm, with a value of 58.04 cm compared to the comparison treatment for treatment A_0 without spraying, which amounted to 45.17 cm and an increase of 28.49%, as it is noted from the same table that The addition of potassium levels had a significant effect in increasing the plant height characteristic of the potato yield and its highest value was at 240 kg H^{-1} represented by the treatment k_2 with a value of 58.57 cm, compared to the two parameters A_0 and A_1, which each had a value of 52.51 and 41.63 cm each, respectively, with an increase

Table 3: The effect of spraying with amino acids and potassium levels and the interaction between them on plant height (cm).

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	40.13	41.16	43.62	41.63
k_2	45.16	52.18	60.19	52.51
	50.22	55.16	70.33	58.57
average	45.17	49.50	58.04	
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	4.21	4.21	14.60	

of 11.54, 40.69%. Also, the double interference sprayed with amino acids and the ground addition of potassium levels led to a significant increase in plant height for potato yield and the highest value of it was when the interaction treatment A_2K_2, which amounted to 70.33 and the lowest value was when the interaction treatment (comparison) A_0K_0, which amounted to 40.13 cm, with an increase of 75.25%.

Number of main stems (stem plant^{-1})

Table 4 shows that the effect of spraying with amino acids and potassium levels and the interaction between them had a significant effect on the number of stems of the potato plant (stem plant^{-1}). It is noticed from the table that spraying with amino acids had a significant effect by giving the highest value in the number of main stems of the potato plant, represented by the treatment. A_2, with an average of 3.33 legs. plant^{-1}, as measured by the two treatments A_0 and A_1, which each valued 2.01 and 2.73 stems vegetable^{-1}, with an increase of 65.67 and 21.97% each, respectively, the effect of adding potassium levels had a significant effect on the characteristic of the number of stems of the potato plant (stem vegetable^{-1}) and the highest value for this characteristic was when treatment K_2, which amounted to 3.45 stems plant^{-1}, as measured by the two treatments K_0 and K_1, which amounted to 2.83 and 1.80 stems. plant^{-1}, with an increase of 91.66 and 21.90% for each, respectively. As for the effect of the interaction between spraying with amino acids and the addition of potassium levels, it also had a significant effect on the characteristic of the number of main stems of the potato crop and the highest value was when the interaction treatment A_2K_2, which amounted to 4.50 stems plant^{-1} and the lowest value when compared to A0K0, which was 1.50 stems plant^{-1}.

Dry weight of shoots (tons h^{-1})

The results of the statistical analysis indicated in table 5 that the effect of spraying with amino acids and potassium levels and the interaction between them had a significant effect on the increase in the dry weight of the potato crop. The effect of spraying with amino acids (proline & arginine) had a significant effect by giving the highest value for this characteristic, which reached 5.58 tons h^{-1} when treatment A_2, compared to two treatments A_0 and A_1, which amounted to 3.85 and 2.56 tons h^{-1} and an increase of 117, 44.93% for each of them, respectively and it is also noticed from the same table that the effect of adding potassium levels had a significant effect on increasing the dry weight of the shrimp in tons h^{-1} for the potato yield and that its highest value was at treatment K_2, which amounted to 5.40 tons h^{-1} compared to the two treatments K_0 and K_1 which amounted to 2.33 and 4.27 tons h^{-1}, with an increase of 131.8, 26.46% for each, respectively and the results of the same table indicated that the interaction between spraying with amino acids and adding potassium levels had a significant effect on increasing the dry weight of the shoots in tons h^{-1} and that its highest value was when the A_2K_2 interference treatment, which was 7.25 tons h^{-1} and the lowest value was when the comparison treatment A_0K_0, which is not spraying with amino acids and not adding potassium, which amounted to 1.95 tons h^{-1}.

Paper area (cm^2)

The results of the statistical analysis in table 6 indicated that the effect of spraying with amino acids and potassium levels and the interaction between them was significant in the characteristic of the leaf area of the potato plant, as the A_2 treatment, which is spraying with amino acids (proline & arginine), surpassed the spraying level of 300 ppm in giving the highest average of the leaf area and reached 5381. In comparison to the A_1 treatment, which gave a value of 5010 cm^2 and the

Table 4: The effect of spraying with amino acids and potassium levels and the interaction between them on the number of main stems (stems plant^{-1}).

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	1.50	1.80	2.10	1.80
k_2	2.00	3.10	3.40	2.83
	2.55	3.30	4.50	3.45
average	2.01	2.37	3.33	
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	0.55	0.55	0.89	

Table 5: The effect of spraying with amino acids and potassium levels and the interaction between them on the dry weight of the shoots (tons h^{-1}).

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	1.90	2.00	3.10	2.33
k_2	2.15	4.25	6.41	4.27
	3.65	5.30	7.25	5.40
average	2.56	3.85	5.58	----
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	0.75	0.75	2.59	

Table 6: The effect of spraying with amino acids and potassium levels and the interaction between them on the leaf area (cm^2 $plant^{-1}$).

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	2995	3120	3139	3084
k_2	3150	5612	5885	4882
	4336	6300	7120	5918
average	3493	5010	5381	----
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	225.3	225.3	528.9	

comparison treatment, which amounted to 3493 cm^2, with rates of increase of 7.40 and 54.0% for each, respectively, it is also noted from the same table that the addition of potassium levels had a significant effect in increasing the characteristic of the leaf area of the potato yield and that the highest value It was at an additional level of 240 kg h^{-1} for treatment K_2 whose value was 5918 cm^2 and the lowest value was when the comparison treatment K_0 which was not adding potassium, which amounted to 3084 cm^2, compared to treatment K_1 for the level of 120 kg h^{-1}, which gave a value of 4882 cm^2 and an increase of 91.89, 21.22% for each of them respectively and the results of the statistical analysis of the same table indicated that the interactions between spraying with amino acids and adding potassium levels had a significant effect on increasing the characteristic of the leaf area (cm^2) of the potato crop. And that its highest value was when the interference treatment A_2K_2, which amounted to 7120 cm^2 and the lowest value for this characteristic was when the interference treatment A_0K_0, which amounted to 2995 cm^2, with an increase of 37.72%.

Manual chlorophyll spad unit

The results of the statistical analysis in table 7 indicated that the effect of spraying with amino acids and potassium levels and the interaction between them had a significant effect on the increase in the percentage of chlorophyll in the leaves. Its value was when the comparison treatment A_0, which was not spraying with amino acids, which amounted to 50.51 spad units, with an increase of 14.95% and the effect of adding potassium levels to a significant increase in the percentage of chlorophyll in the leaves of the potato plant and that the highest value of it was when treatment K_2, whose value was 62.06 spad unit, compared to the two treatments K_0, K_1, which amounted to 47.91, 52.35 spad units, with rates of increase of 29.53 and 18.48% for each, respectively

Table 7: The effect of spraying with amino acids and potassium levels and the interaction between them in the spad unit chlorophyll index.

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	45.62	48.13	50.00	47.91
k_2	50.10	53.00	53.95	52.35
	55.81	60.12	70.25	62.06
average	50.51	53.75	58.06	----
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	1.33	1.33	3.45	

and the results of the same table indicated that the interaction treatments between spraying with amino acids (proline & arginine) and potassium addition levels had a significant effect. In increasing the chlorophyll index of potato yield, its highest value was when the interaction between spraying with amino acids (proline & arginine) was treated at the spray level of 300 ppm. The level of potassium addition is 240 kg h^{-1} when the interference treatment A_2K_2 whose value was 70.25 spad units and the lowest value was when the interference treatment A_0K_0, which amounted to 45.62 spad units, with an increase of 53.98%.

Proline content in leaves of potato plants (mg gm^{-1})

Table 8 showed that the effect of spraying with amino acids (proline & arginine) and potassium levels and the interaction between them had a significant effect on increasing the content of potato leaves from proline, as it was noticed that spraying with amino acids had led to an increase in the leaves' content of proline and that the highest value for it was upon treatment. A_2, which amounted to 2.02 mg gm^{-1} and the lowest value for this

Table 8: Effect of spraying with amino acids and potassium levels and the interaction between them on proline content in potato leaves (mg^{-1}).

Potassium levels	Amino acids (proline + arginine)			average
k_0	A0	A_1	A_2	
k_1	1.37	1.55	1.60	1.51
k_2	1.65	1.97	1.85	1.76
	1.98	2.10	2.63	2.24
average	1.66	1.80	2.02	----
L.S.D (0.05)	Potassium levels	Amino acids	overlap	
	K	A	K*A	
	0.10	0.10	0.66	

characteristic was when the two treatments A0 and A1, which had a value of 1.66 and 1.80 mg g^{-1}, with an increase of 21.69, 12.22% for each, respectively and the results of the same table indicated that adding potassium levels had a significant effect in increasing the content of potato leaves of proline and that the highest value of it was with treatment K_2, which was 2.24 mg g^{-1}, as measured by the two treatments K_0 and K_1, which measured 1.51 and 1.76 mg gm^{-1} with an increase of 48.34, 27.27% each, respectively and it is also noticed from the same table that the interaction between spraying with amino acids and potassium levels significantly increased the content of potato leaves from proline and that the highest value of it was when the interaction treatment A_2K_2, which amounted to 2.63 mg gm^{-1} and its lowest value was with the interference treatment A_0K_0, which was 1.37 mg gm^{-1}, with an increase of 92%.

It is noted from tables 4, 5, 6, 7, 8 and 3 that the effect of spraying with amino acids (proline & arginine) on the leaves of the potato crop, as well as the addition of potassium levels to the soil, led to the improvement of the vegetative growth characteristics of the potato crop represented (plant height and number of main stems And the leaf area, the index of chlorophyll, the dry weight of the shoot and the content of the leaves from proline) or the amino acids act by their direct effect in providing the necessary energy to increase the division, sizes and numbers of cells, which leads to an increase in the formation of nucleic acids and proteins, which leads to an increase in plant height, leaf area, dry weight of the plant and its chlorophyll content And proline and these results are in agreement with (Mohamed, 2012 and Elshafey 2016) who found that the characteristic of plant height, chlorophyll content, leaf area and dry weight of the plant were significantly affected by the levels of spraying, as the increase in amino acids leads to a decrease in the osmotic effort of the cell and thus the ability of the cell to gain water. The nutrients dissolved in it from the growth medium and then increase the vegetative growth of plants (Abu Dahi and Al-Younes, 1988) as they share These acids in building carbohydrates and building proteins by building chlorophyll, which stimulate photosynthesis (Shafeek *et al.*, 2012).

The added potassium levels also led to the improvement of the vegetative growth characteristics by increasing the levels of addition, which is attributed to the positive role of potassium in stimulating cells to divide and elongation, especially meristematic cells and the increase in the transfer of photosynthesis products from the places of their manufacture to the places of their need in the plant and what is reflected in the increase in growth Including the height of the plant, the number of stems and the leaf area as a result of the division and elongation of the leaf cells, which led to an increase in the chlorophyll content and the dry weight of the shoots and the lack of potassium leads to the reduction of both the number of stems and the leaf area and then reduced the capacity of the source, which leads to a decrease in the average carbon representation and the final product and works On reducing the amount of carbon-assimilating material available for growth (Hussain *et al.*, 2011). Also, the addition of potassium led to an increase in the content of potato leaves of proline in comparison with the comparison treatment, as this nutrient leads to an increase in the percentage of protein formed in the plant and its shortened role to produce the cytokitin growth regulator that delays aging and then delays the destruction of proteins in the plant, which leads to Increasing proline. These results followed the same trend with findings by (Mujtaba, 2007 and Fanaei *et al.*, 2011) who indicated an increase in leaf proline content with increasing levels of potassium supplementation.

Conclusions

It is concluded from this study that spraying with amino acids (proline & arginine) and at a concentration of 300pmm, this treatment excelled in increasing all growth indicators and that the treatment K_2 achieved the highest growth indicators of potato yield.

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