Open Access
J. Glob. Innov. Agric. Sci., 2023, 11(3):341-346
ISSN (Online): 2788-4546; ISSN (Print):2788-4538
DOI: https://doi.org/10.22194/JGIAS/23.1103
http://www.jgiass.com

Response of date palm *Phoenix dactylifera* L. Hillawi cultivar to some amino acids

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This study was conducted at one of the orchards in the Abi Al-Khasib region of Basrah Governorate during the 2022 growing season to determine the extent of the response of the date palm Hillawi cultivar to spray with amino acids (Glycine, Arginine, and Tryptophan) concentrations of 1000, 1500, and 2000 mg. L^{-1} per acid, to determine the effect of these acids on some vegetative and fruitful growth characteristics. Showed results of the study showed significant superiority of s amino acid glycine at a concentration of 2000 mg. L^{-1} in leaf length, leaf width, number of new leaves, chlorophyll, carbohydrates, length and weight of fruit, weight of fleshy part of the fruit weight bunch and reducing sugars. (4.627m, 5.477cm, 17.67, 12.240 mg.100g^{-1}, 49.37 mg.g^{-1}, 3.870cm, 6.057g, 4.817g, 6.823kg, 50.76%) respectively compared with control. Arginine concentration 2000 mg. L^{-1} significantly in total protein of leaves, and total sugar and soluble solids of fruits. (4.933 mg.g^{-1}, 60.90%, 70.42%) respectively. A tryptophan concentration of 2000 mg. L^{-1} was significant to fruit size (6.590 cm^3). A tryptophan concentration of 1000 mg l was significant to sucrose on fruits (11.260%). Amino acid supplements have a significant impact on plant development and production. Combining different amino acids yields better quality and quantity of fruit.

Keywords: Amino acids, vegetative characteristics, fruit characteristics, chemical characteristics, bunch weight.

INTRODUCTION

The date palm, *Phoenix dactylifera* L., is one of the most important monocotyledonous trees in the family Arecaceae. It is one of the most important plant orders spread in the subtropical regions between latitudes 10-30 degrees north and extends to 20 degrees south of the equator (Al-Jubouri, 2002). Al-Halawi cultivar trees grow mainly in Basra and (Abu Al-Khasib) districts. The fruit is yellow in the khalal stage, light amber or amber with a tan in the wet stage, while the dates are golden brown. Al-Halawi dates have a good flavor, ripen early, and are considered one of the most popular and expensive commercial varieties (Al-Nuaimi and Jaafar, 1980).

Amino acids are the repetitive units linked together to form complex compounds with high molecular weights that are proteins and simpler compounds made of fewer amino acids that are peptides. The number 300 amino acids, but the primary building block for building all proteins, regardless of their numbers, is a group of 20 amino acids. They are called protein amino acids because they are included in protein synthesis only. It is one of the most important sources of organic nitrogen for its role in controlling the growth and detection of cells. Proteins are among the most widespread and diverse major biological molecules in the cells and tissues of living organisms, and they constitute about 50% of the dry weight of the cell, and this diversity and proliferation reflect the main role of it in all aspects of life (Cooper and Hausman, 2007). Almost every cellular activity depends on one or more specific proteins, and proteins are divided according to their function into several types: enzymes, transport proteins, storage, structural, and protective proteins (Lesk, 2010). The main units of proteins (amino acids) are compounds containing two groups, an amine, and a carboxyl, but they differ in the R side chain, which is linked to the alpha carbon atom that determines the identity of each amino acid. Amino acids (in addition to their role in the synthesis of proteins) play important roles in the plant, as they are considered as starting compounds for the synthesis of plant hormones such as tryptophan, which is the starting compound for the synthesis of auxin and methionine, the starting compound for the synthesis of ethylene, and they are also considered among the internal factors that affect the opening and closing of stomata and maintain intracellular water balance.

Abdullah, A.S.A., H.A. Faisal and A.Y.L. Hzaa. 2023. Response of date palm *Phoenix dactylifera* L. Hillawi cultivar to some amino acids. Journal of Global Innovations in Agricultural Sciences 11:341-346.
[Received 25 Jun 2023; Accepted 27 Sep 2023; Published 30 Sep2023]

The amino acid tryptophan plays an important role in plants, as it helps form auxins that stimulate plant
growth, such as (IAA), and plays an important role in early harvest. As for arginine, it stimulates the plant to resist harsh conditions such as heat, cold, thirst, and salinity. It also has a role in the formation of chlorophyll and encourages the formation of roots and cell division (Baqir, *et al.*, 2019). The primary role played by the amino acid Glycine inside the plant is to activate photosynthesis and raise its efficiency by stimulating chlorophyll and vegetative growth. It also has an important role in chelating some elements and protecting the plant from stress (Sakamoto and Murata, 2002). Amino acids affect the process of photosynthesis through several roles, including the participation of glycine and glutamic acid in the formation of chlorophyll pigment. Some contribute to resistance to biotic and abiotic stresses that plants are exposed to, such as proline and other important biotic and physiological roles (Wade, 2012; Lesk, 2010). Amino acids are vital stimulants because they have a direct effect on the enzymatic activity of the plant and spread quickly to all cells of the leaf and activate the plasma in the cells, thus providing the plant with great vital energy that complements its vital activity, which works to compensate for the energy lost by plants with great vital energy during the process of catabolism and respiration.

It is involved in the construction of nucleotides, vitamins, and growth hormones, and therefore it is an essential component of living matter, protoplasm, which means that it participates in enzymatic reactions in cells and is also involved in building cellular membranes (Baqir, *et al.*, 2019). According to Uba *et al.* (2015), an increase in amino acids causes the osmotic potential to drop, which in turn lowers the water potential. This increases the cell's capacity to draw water and dissolved nutrients from the growth medium, which in turn promotes plant growth (Claussen, 2005). When provided, free amino acids serve as a crucial source of nitrogen for producing proteins, enzymes, and the energy needed to support root and vegetative growth (Mohamed and Khalil, 1992; Yadav *et al.* 2005) noted that the accumulation of free amino acids under stress conditions in all stages of plant growth indicates their possible role in osmotic modification. (Darwesh 2013) showed that the addition of amino acids at a concentration of 2 ml.L^{-1} by irrigation water led to the accumulation of free amino acids in the leaves of the date palm plants, which amounted to 2.7, 2.8 mg g^{-1} dry weight for the two study seasons, respectively.

As for Aati (2016), I found that spraying date palm trees of the sweet variety with tuberculosis solution at a concentration of 4 mg. GM-1 led to a significant superiority in the fruit content of free amino acids, which amounted to 60 mg.100g-1, compared to trees that were not sprayed, as it recorded the lowest values, which amounted to 42 mg 100 g^{-1} dry weight.

This study was conducted due to a lack of research regarding the benefits of adding free amino acids to date palms and spraying them on the vegetative system in order to improve fruit quality and productivity under the changing climate conditions in the Basra Governorate environment.

MATERIALS AND METHODS

The study was conducted in one of the private orchards in the district of Abi Al-Khasib, located in the south of Basra Governorate, to know the chemical and physiological effects of spraying treatments with free amino acids (tryptophan, arginine, and glycine) on the vegetative and fruiting set of date palm trees of the Al-Halawi variety. Thirty palm trees of similar age and height, and size were selected, with three replications for each
treatment and the comparison treatment, the required agricultural service operations were carried out for all trees under study equally. I prepared solutions of each amino acid at three concentrations: 1000, 1500, and 2000 mg L^{-1}. The trees were sprayed until complete wetness by three sprays, the first on 1/9, the second on 1/2, and the third on 1/4, and the spreading material was added (Tween 20) to spray solutions to reduce surface tension, and the spraying process was carried out in the early morning. On March 20, the date palm trees under study were Pollination manually with Al-Ghanami green pollen, and after the contract (10 days), 6 stems were selected for each palm tree, and the rest were removed. Vegetative samples were taken from the third row of leaves, starting from the top of the palm tree (Al-Ani, 1998). The fruit samples were taken at the rutab stage, and the pickle weight was calculated at the date stage and after 25 weeks from the date of pollination. Laboratory analyses were carried out in the laboratories of the Palm Research Center at the University of Basra.

***Field soil analysis*:** A soil sample was collected from the planting site at a depth of 0-30cm randomly to represent soil of the agricultural field to know some of its physical and chemical properties, as shown in Table (1).

Table 1. Some physical and chemical properties of the experimental field soil.

Property	Unit	value
PH	1:1	7.82
Ec	ds/m	14.46
$CaCo_3$	g/kg	48.32
Organic matter	g/kg	24.18
Ready nitrogen	g/kg	6.12
Ready Phosphorus	g/kg	0.82
Soil articulations		
Sand	48.20	
Silt	467.12	
Clay	484.68	
soil texture	silty loamy	

***Characteristics studied in the experiment*:**

1- Characteristics of vegetative growth

New leaves number (fronds): The number of new leaves formed for the shoot was calculated according to the following equation:

Number of new leaves formed = Number of leaves after the treatment - Number of leaves before the treatment

Leaf length (m)

Leaflet length and width (cm): Leaf length and leaflet length and width were measured using a tape measure.

Estimation of total protein: Determining total nitrogen in the fruits using the steam distillation apparatus is based on the method of (Page *et al*., 1982). Then the total protein was estimated through the following equation:

Percentage of proteins = the percentage of nitrogen in the leaves x 6,25

Estimation of carbohydrates: The concentration of total soluble carbohydrates in leaves was estimated according to the phenol-sulfuric acid method based on (Dobois *et al*., 1956).

Estimation of total chlorophyll: Total chlorophyll in the leaves was estimated according to Zaehringer's method (Zaehringer *et al*., 1974).

Estimation of free amino acids: It was estimated using the extraction method according to what was stated by (Moore and Stein, 1954).

2- Characteristics of the fruiting growth:-

Fruit length: Fruits were randomly taken from all the stems of the palm tree, and their lengths were measured using a Vernier's foot, and the average fruit length was calculated by dividing the total fruit lengths by the number of fruits.

Fruit volume: 16 fruits were taken randomly from each treatment, and their volume was measured by calculating the amount of displaced water resulting from placing it inside a graduated cylinder, where the displaced water represents the average volume of the fruits, and then extracted the average fruit/tan ness of the fruit volume (cm^3/ fruit).

Fruit weight: The weight was calculated by taking 16 fruits, and the weight was recorded using a sensitive electric scale, and then the average weight of the fruit was extracted.

Fruit pulp weight: The seeds were removed from the fruits and weighed on the same scale. The weight of the fleshy part was extracted by subtracting the seed's weight from the fruit's total weight.

Weight of the fruit pulp = Weight of the fruit - Weight of the seed.

Bunch Weight: After harvesting the fruits for each palm tree separately, the total yield of the palm tree was weighed by means of a field scale, and then the average weight of the bunch was extracted for each treatment in (kg) by dividing the total yield of the palm tree by the number of bunches of the palm tree.

Total sugars: The Eynon Lane method mentioned in Abbas and Abbas (1992) estimated total fruit sugars.

Total soluble solids: The percentage of total dissolved solids was estimated using the (Refractometer Hand) device, and then the reading was adjusted at a temperature of (20^0 C) based on Shirokov (1968).

Study coefficients and statistical analysis:

(C) Spraying with distilled water (comparison treatment).
(T1) Spraying with Tryptophan at a conc. of 1000m $mg.L^{-1}$
(T2) Spraying with tryptophan at a conc. of 1500 $mg.L^{-1}$.
(T3) Spraying with Tryptophan at a conc. of 2000 $mg.L^{-1}$.
(A1) Spraying with arginine at 1000 $mg.L^{-1}$.
(A2) Spraying with arginine at a conc. of 1500 $mg.L^{-1}$.
(A3) Spraying with arginine at a conc. of 2000 $mg.L^{-1}$.
(G1) Spraying with glycine at a conc. of 1000 $mg.L^{-1}$.
(G2) Spraying with glycine at a conc. of 1500 $mg.L^{-1}$.
(G3) Spraying with glycine at a conc. of 2000 $mg.L^{-1}$.

Using a Randomized Complete Block Design (RCBD), the experiment was carried out. The experiment consists of three replications and ten treatments. The results were analyzed using GenStat version 7. According to Al-Raw and Khalafallah (2000), the Least Significant Difference Test (L.S.D.) was used to compare means at the probability threshold of 0.05.

RESULTS AND DISCUSSION

The results of Table 2 shows that the treatment of the amino acid glycine (G3) a concentration of 2000 mg. L^{-1} excelled in leaf length, leaf width, and the number of new leaves, as it recorded the highest values, which amounted to 4.627 m, 5.477 cm, and 17.62, respectively, with a considerable deviation from the course of treatment. The comparison, while the treatment of the amino acid arginine (A3) a concentration of 2000 mg. L^{-1} recorded the highest values in the leaf length of 49.60 cm, with a substantial variation from the control treatment, which had the lowest measurements of 45.20 cm. This may be attributed to adding amino acids increasing the period and number of cell divisions and their expansion (Idris, 2009).

According to Table 3, when glycine (G3) was applied at a concentration of 2000 mg. L^{-1}, it resulted in higher mean levels of chlorophyll (12.240 $mg.100gm^{-1}$) and carbohydrates (49.37 37 mg. gm^{-1}) in leaves compared to other treatments. On the other hand, the treatment of arginine (A3) with the same concentration yielded the highest values of total protein content (4.933 $mg.gm^{-1}$) in leaves, which was significantly higher than the control treatment (2.867 $mg.gm^{-1}$). This may be attributed to the important role of arginine in protein synthesis because it contains the highest ratio of N: C, which is among the 21 amino acids and is the most important in storing and transporting organic nitrogen in plants (Winter *et al*., 2015). While the comparison treatment was significantly superior to all treatments with the content of leaves of free amino acids, as it recorded the highest values, which amounted to (69.14) mg100 g^{-1}, while treatment of arginine (A3) with a concentration of 2000 mg. L^{-1} recorded the lowest values, which amounted to (46.14) mg100 g^{-1}. The cause of

this might be linked to the trees in the comparison treatment being subjected to more stress, which made them adopt a natural behavior in this case by breaking down the protein and liberating the free amino acids from it, and thus increasing the plant content of the free amino acids. The high demand for nitrogen during initial stress may lead to increased production of non-protein amino acids or other nitrogen-containing metabolites.(Batista-Silva.*et al*.,2019)

Table 2. Effect of concentrations of some amino acids on some Characteristics of leaves of the date palm cultivar Hillawi

Treatment	Number of new leaves	Leaf length	Leaflet length	Leaflet width
C	7.33	2.997	45.20	4.047
T1	12.33	3.993	47.20	5.137
T2	13.33	4.153	47.87	5.253
T3	14.67	4.330	49.23	5.263
A1	11.33	4.023	48.20	5.230
A2	12.33	4.187	48.70	5.260
A3	14.33	4.237	49.60	5.303
G1	13.67	4.140	48.03	5.243
G2	14.67	4.237	48.93	5.320
G3	17.67	4.627	49.56	5.477
LSD	1.24	0.128	1.45	0.134

(C) Spraying with distilled water (comparison treatment). (T1) Spraying with Tryptophan at a concentration of 1000m mg.L^{-1} (T2) Spraying with tryptophan at a concentration of 1500 mg.L^{-1}. (T3) Spraying with Tryptophan at a concentration of 2000 mg.L^{-1}. (A1) Spraying with arginine at 1000 mg.L^{-1}. (A2) Spraying with arginine at a concentration of 1500 mg.L^{-1}. (A3) Spraying with arginine at a concentration of 2000 mg.L^{-1}. (G1) Spraying with glycine at a concentration of 1000 mg.L^{-1}. (G2) Spraying with glycine at a concentration of 1500 mg.L^{-1}. (G3) Spraying with glycine at a concentration of 2000 mg.L^{-1}.

According to Table 4, the fruit properties were significantly impacted by treating them with glycine (G3) at a concentration of 2000 mg. L^{-1}. The fruit length, weight, fleshy part weight, and bark weight all showed higher values of (3.870 cm, 6.057 g, 4.817 g, and 6.823 kg) respectively, compared to the reference treatment. On the other hand, treating the fruit with tryptophan (T3) at a concentration of 2000 mg.L^{-1} resulted in the highest fruit volume of 6.590 cm3, which was significantly different from the reference treatment's lowest value of 4.267 cm3. The osmotic potential is reduced by an increase in amino acids, which in turn lowers the water potential of the cell. This increases the cell's capacity to draw water and nutrients that are dispersed in it from the growth medium, which in turn increases the plant's ability to grow vegetatively (Taiz, *et al*., 2015; Amini and Ehsanpour, 2005).

Table 3. Effect of concentrations of some amino acids on some Chemical properties of Date palm leaves cultivar Hillawi.

Treat.	Total protein (mg.g^{-1})	Total carbohydrates (mg.g^{-1})	Total chlorophyll (mg.100g^{-1})	Free amino acids (mg.100g^{-1})
C	2.867	31.84	8.473	69.14
T1	3.243	37.81	9.497	47.03
T2	3.743	41.39	10.280	47.14
T3	4.917	47.54	10.790	46.16
A1	3.160	37.73	9.857	46.98
A2	3.730	43.13	10.817	46.99
A3	4.933	49.10	11.900	46.14
G1	3.243	37.96	10.233	47.14
G2	4.110	45.13	11.750	48.03
G3	4.657	49.37	12.240	49.42
LSD	0.687	1.87	0.488	1.18

(C) Spraying with distilled water (comparison treatment). (T1) Spraying with Tryptophan at a concentration of 1000m mg.L^{-1} (T2) Spraying with tryptophan at a concentration of 1500 mg.L^{-1}. (T3) Spraying with Tryptophan at a concentration of 2000 mg.L^{-1}. (A1) Spraying with arginine at 1000 mg.L^{-1}. (A2) Spraying with arginine at a concentration of 1500 mg.L^{-1}. (A3) Spraying with arginine at a concentration of 2000 mg.L^{-1}. (G1) Spraying with glycine at a concentration of 1000 mg.L^{-1}. (G2) Spraying with glycine at a concentration of 1500 mg.L^{-1}. (G3) Spraying with glycine at a concentration of 2000 mg.L^{-1}.

Table 4. Effect of concentrations of some amino acids on the Weight of the bunch and some characteristics of date palm fruits Cultivar Hillawi

Treat.	Fruit length (cm)	Fruit volume (cm^3)	Fruit weight (g)	Fruit pulp weight (g)	Bunch Weight (kg)
C	2.747	4.267	4.907	3.630	4.140
T1	3.753	5.407	5.260	3.970	5.930
T2	3.753	5.550	5.307	4.080	6.757
T3	3.787	6.590	5.297	4.103	6.820
A1	3.717	5.120	5.727	4.470	5.917
A2	3.813	5.277	5.733	4.503	6.283
A3	3.830	5.430	6.010	4.763	6.733
G1	3.753	5.247	5.493	4.353	5.920
G2	3.813	5.290	5.567	4.380	6.390
G3	3.870	5.567	6.057	4.817	6.823
LSD	0.046	0.242	0.415	0.440	0.319

(C) Spraying with distilled water (comparison treatment). (T1) Spraying with Tryptophan at a concentration of 1000m mg.L^{-1} (T2) Spraying with tryptophan at a concentration of 1500 mg.L^{-1}. (T3) Spraying with Tryptophan at a concentration of 2000 mg.L^{-1}. (A1) Spraying with arginine at 1000 mg.L^{-1}. (A2) Spraying with arginine at a concentration of 1500 mg.L^{-1}. (A3) Spraying with arginine at a concentration of 2000 mg.L^{-1}. (G1) Spraying with glycine at a concentration of 1000 mg.L^{-1}. (G2) Spraying with glycine at a concentration of 1500 mg.L^{-1}. (G3) Spraying with glycine at a concentration of 2000 mg.L^{-1}.

Amino acids play an important role in the synthesis of hormones and proteins, and they also promote the formation of DNA and RNA nucleic acids. This, in turn, leads to increased cell division, which is necessary for fruit growth. Amino acids also support the movement and transportation of nutrients from the leaves to the fruits, which is critical for

growth and size. Ultimately, this results in increased fruit weight and the accumulation of dry matter. (Hounsome *et.al*., 2008).

According to Table 5, when arginine (A3) was administered at a concentration of 2000 mg. L^{-1}, the fruit content of total sugars and soluble solids reached the highest values of 60.90% and 70.42%, respectively. This was significantly different from the comparison therapy which had the lowest values of 49.87% and 68.90%, respectively. As for the treatment of the amino acid glycine (G3) at a concentration of 2000 mg. L^{-1}, it excelled in the fruit content of reducing sugars, as it recorded the highest values, which amounted to 50.76%, with a substantial change when compared to the comparative therapy, which recorded the lowest values, amounting to 38.86%. While treating the amino acid tryptophan (T3) at a concentration of 1000 mg.L^{-1} excelled in the sucrose content of fruits, reaching 11.260%, with a considerable difference from the comparative therapy, which recorded a value of 11.013%.

Table 5. Effect of concentrations of some amino acids on some Chemical properties of date palm fruits cultivar Hillawi.

Treat.	Total sugars (%)	Reducing sugars (%)	Sucrose (%)	TSS (%)
C	49.87	38.86	11.01	68.90
T1	53.37	42.11	11.26	63.98
T2	54.50	43.74	10.73	66.49
T3	58.33	47.93	10.40	66.92
A1	54.35	43.67	10.78	68.48
A2	58.13	47.52	10.61	67.68
A3	60.90	50.62	10.24	70.42
G1	54.84	43.72	11.11	67.16
G2	56.39	48.00	10.72	70.09
G3	60.88	50.76	10.06	69.81
LSD	2.235	1.166	0.506	2.429

(C) Spraying with distilled water (comparison treatment).(T1) Spraying with Tryptophan at a concentration of 1000m mg.L^{-1} (T2) Spraying with tryptophan at a concentration of 1500 mg.L^{-1}. (T3) Spraying with Tryptophan at a concentration of 2000 mg.L^{-1}. (A1) Spraying with arginine at 1000 mg.L^{-1}. (A2) Spraying with arginine at a concentration of 1500 mg.L^{-1}. (A3) Spraying with arginine at a concentration of 2000 mg.L^{-1}. (G1) Spraying with glycine at a concentration of 1000 mg.L^{-1}. (G2) Spraying with glycine at a concentration of 1500 mg.L^{-1}. (G3) Spraying with glycine at a concentration of 2000 mg.L^{-1}.

Based on our findings, applying amino acids as a foliar spray has been shown to increase the levels of total carbohydrates and polysaccharides in both stressed and non-stressed plants. This aligns with similar studies on various plant species, as noted by (Abdel Aziz *et al.*, 2010). It's worth noting that there's a clear connection between photosynthesis rates and nitrogen contents in leaves. When leaves have a high nitrogen supply, photosynthesis rates increase, leading to greater biomass production, which was observed in the study by (Neuberg *et al.*, 2010).

***Conclusions*:** Adding amino acid supplements to plants can improve both the quantity and quality of their fruit, while also having a significant impact on overall plant growth and output. It is recommended to use a group of free amino acids, instead of just one, for the best results. Experimenting with different concentrations of amino acids can help achieve the optimal levels for maximum benefits.

***Authors' contributions*:** Authors' contributions: Abdul Samad A. Abdullah and Hassan A. Faisal: conceived and designed the experiments, Abdul Samad A. Abdullah: performed the experiments, and analyzed the data. Ahmed Y. L. Hzaa. wrote the paper, and reviewed the manuscript.
All authors read and approved the final manuscript.

Funding: by Authors

Ethical statement: This article does not contain any studies with human participants or animals performed by any of the authors .

Availability of data and material: We declare that the submitted manuscript is our work, which has not been published before and is not currently being considered for publication elsewhere

Code Availability: Not applicable
Consent to participate: All authors are participating in this research study .
Consent for publication: All authors are giving their consent to publish this research article in JGIAS

Acknowledgements: The authors thank the Date Palm Research Center, Basrah, Iraq, and the Department of Horticulture and Landscape, Agriculture faculty, University of Basrah, Iraq for helping with this work.

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