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Effect of spraying with different concentrations of arginine and tryptophan on the growth and yield of genotypes of *Hibiscus sabdarriffa* L.

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ABSTRACT

During the summer season of 2022, a field experiment was conducted to investigate the impact of different cultivars, Arib, Black Heat, Red Heat, and Sudan 3, and spraying arginine tryptophan concentrations, control, arginine 50 mg L^{-1}, Tryptophan 50 mg L^{-1}, and arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1}, in growth and yield of some genotypes of Roselle Jamaica. The statistical analysis of the data revealed notable distinctions across all examined traits. During the analysis, the genotype demonstrated superiority over Black Heat in the majority of studied traits, encompassing various growth characteristics. The evaluated yield and its components encompassed plant height, branches no., leaf area, chlorophyll a&b, nuts no. per plant, seeds no. per nut, 1000 seeds weight, yield, and yield of dry sepals. The combination of arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1} was significantly superior in each plant height to reach 142.23 cm $plant^{-1}$, branches no. per plant (29.10 branches $plant^{-1}$), leaf area (58.21 cm2), chlorophyll a&b (32.93 mg gm^{-1}), nuts no. per plant (150.20 $nuts^{-1}$), walnut seeds no. (25.00 nut^{-1}), 1000 seeds weight (54.84 g), yield (963.91 tons H^{-1}), and the yield of dry sepal leaves (839.42 tons H^{-1}). Also, the intersections of Heet resulted in the highest values for all examined traits, including vegetative growth, chlorophyll, and yield characteristics, when combined the arginine (50 mg L^{-1}) & tryptophan (50 mg L^{-1}). However, there were no notable differences in the weight of one thousand grains among cultivars when treated with the combination of arginine (50 mg L^{-1}) & tryptophan (50 mg L^{-1}).

KEYWORDS: Kumquat plant; Genotypes; Arginine and tryptophan; Growth and yield.

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تأثير الرش بتراكيز مختلفة من الأرجينين والتربتوفان في نمو وحاصل تراكيب وراثية من نبات *Hibiscus sabdarriffa* L.

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الملخص

نفذت تجربه حقليه خلال الموسم الصيفي (2022) في حقول محطة البحوث الزراعية العائد لقسم المحاصيل الحقلية – كلية الزراعة – جامعة تكريت بهدف دراسة تأثير الاصناف(عريب ، سودان3 ، هيت احمر ، هيت اسود) والرش بتراكيز مختلفة من الارجنين التربتوفان (معاملة المقارنة والرش بالارجنين 50 ملغم لتر$^{-1}$ و الرش بالتربتوفان 50 ملغم لتر$^{-1}$ و الرش بالارجنين 50 ملغم لتر$^{-1}$ + التربتوفان 50 ملغم لتر$^{-1}$) في النمو والحاصل لتراكيب وراثية من الكجرات . أستعمل في هذه الدراسة تصميم القطاعات العشوائية الكاملة (**R.C.B.D**) ضمن نظام التجارب العاملية وبثلاثة مكررات, وأظهرت نتائج التحليل الإحصائي للبيانات وجود فروق معنوية في جميع الصفات المدروسة : تفوق التركيب الوراثي هيت أسود خلال التحليل الإحصائي للنتائج لمعظم الصفات المدروسة ومنها صفات النمو والحاصل ومكوناته ارتفاع النبات وعدد التفرعات الرئيسية و محتوى الكلوروفيل **a+b** في الاوراق وعدد الجوز في النبات وعدد البذور في الجوزة و وزن الف بذرة وحاصل البذور وحاصل الأوراق الكأسية الجافة . تفوقت توليفة الارجنين 50 ملغم لتر$^{-1}$ + التربتوفان 50 ملغم لتر$^{-1}$ معنويا في كل وارتفاع النبات (142.23 سم نبات$^{-1}$) وعدد الافرع للنبات (29.10 فرع نبات$^{-1}$) و محتوى الأوراق لكل من كلوروفيل **a+b** (**32.93** ملغم غم$^{-1}$ نسيج ورقة) وعدد الجوز في النبات(150.20 جوزة نبات$^{-1}$) و عدد بذور الجوزة (25.00 بذرة جوزة$^{-1}$) و وزن 1000 بذرة (54.84 غم) وحاصل البذور الكلي (963.91 طن هـ$^{-1}$) وحاصل الاوراق الكأسية الجافة(839.42 طن هـ$^{-1}$) ، فيما يخص التداخل الثنائي فقد أعطى التداخل بين (هيت اسود مع توليفة الارجنين 50 ملغم لتر$^{-1}$+ التربتوفان 50 ملغم لتر$^{-1}$) اعلى القيم لجميع الصفات المدروسة المتمثلة بصفات النمو الخضري والكلوروفيل وصفات الحاصل،). اما صفة وزن الف حبة لم تظهر اختلافات معنوية بين الأصناف مع توليفة الارجنين 50 ملغم لتر$^{-1}$+ التربتوفان 50 ملغم لتر$^{-1}$.

الكلمات المفتاحية: الكجرات، التراكيب الوراثية، الاحماض امينية، النمو والحاصل.

INTRODUCTION

Medicinal plants mean everything of plant origin, and contain a substance or several medicinal substances capable of treating a particular disease or reducing its incidence, or which contain raw materials used in the preparation of medicinal materials. Man has always been in a constant struggle with disease since the beginning of his creation. His instinct led him and the strength of his mind, which God distinguished him with for all his creatures to use herbs and medication, which was his only refuge. One of the most important types of the genus hibiscus from an economic point of view is the type sabdariffa. This plant has several names in the Arab countries. Great importance in strengthening the heartbeat, reducing blood viscosity, and calming the nerves (Saad,1988). Numerous researches have shown that chemical fertilization has an effect on the growth of the kumquat plant and on the amount of active compounds such as dyes, acids, and others by providing the macro and micro nutrients necessary for plant growth, completing its life cycle and increasing its production. Abd-Almalic (1996), but this type of fertilization has negative effects on the environment There fore, we must seriously think about new scientific methods to obtain the highest productivity and the best quality without increasing the levels of chemical fertilizers, and the safety of the food product. One of these means is the use of amino acids, which is one of the important methods in modern agriculture, which can become one of the basic directions in scientific research and its theoretical and applied purposes alike. It also leads to an increase in crop productivity and an improvement in its quality. Also, in two field experiment throughout winter seasons, 2021 and 2022, in a Anbar Governorate, Iraq. The objective study investigated the effect of bacterial inoculation and the application of arginine and glutamic acids on the growth and physiological traits of fenugreek plants (Trigonella foenum-graecum L). The experimental factors comprised bacterial inoculation (Sinorhizobium meliloti L.) with both inoculated and inoculated groups, along with various combinations of arginine and glutamic acids. Notably, the combination of arginine at 50 mg L^{-1}+glutamic acid at 50 mg L^{-1} demonstrated significant superiority in terms of vegetative growth characteristics, as observed in the study conducted by Al-Hadithy and Al-Mohammedi in 2023. Khaled et al. (2020) studied the impact of amino acid tryptophan spraying and cutting time on some physiological, yield, oil, and some qualitative traits of lemongrass Cymbopogon citratus L. Where the use of the amino acid tryptophan at concentrations (0, 150, 250, and 350 mg L^{-1}, and the results showed that there was a significant increasing in the physiological traits and the active substance by increasing the concentrations of the amino acid tryptophan sprayed on lemongrass plants because of the vital role that this acid plays in the processes internal physiology, and environmental conditions suitable for cultivated types of plants. By increasing the concentrations of the amino acid tryptophan Gendy and Walid (2016) showed that was found the spraying plants leaves with the amino acid tryptophan at 0, 50 and 100 mg L^{-1} at the rate of three sprays of the Hibiscus Sabdaritta L. led to an effective increase in the plant

height, which reached 0 173 cm, the number of cudgel reached 16.67 plant branches, and the dry weight reached 0.173 cm. 403.6 gm plant and the chemical content of the plant from N.PK. and protein were 1.32 g, 0.17 g, 1.27 g and 7.78 g, respectively, compared to the treatment sprayed with distilled water. . It has been found in many recent scientific studies and researches that the interaction between environmental conditions, genotypes and balanced management of nutrients has a significant impact on improving production in quantity and quality. In view of the importance of the gujarat plant and the multiplicity of its dietary and therapeutic uses, studies on it are limited, so the idea of the study came with the aim of :

Understanding the genotype of galaxies to determine their optimal growth and yield comparing the optimal growth and yield-producing amounts of two amino acid combinations, tryptophan and arginine, examining the relationships between tryptophan and arginine, two amino acids, and genotypes that have been shown to enhance plant growth and productivity.

MATERIALS AND METHODS

In 2022, a field study was conducted over the summer in the Agricultural Research Station (ARS), Department of Field Crops, College of Agriculture, Tikrit University located at Salah-Din Governorate (34.27 degrees north latitude and 43.35 degrees east longitude). The study focused on sandy-textured soil mixed with the purpose of investigating the impact of spraying various concentrations of arginine and tryptophan on the growth and yield of Roselle genotypes.

Several characteristics of the experimental soil, both chemically and physically

Adjective	values
Soil reactivity pH	7.32
Electrical connection EC	2.16 (ds m^{-1})
Prepared nitrogen	20.73 mg kg^{-1}
Prepared phosphorous	4.66 ppm
Prepared potassium	101.13 ppm
Organic matter	2.22 g kg^{-1}

The experiment included two factors, the first factor was four genotypes of the Gujarat plant, including, Arib, Red Heat, Black Heat, and Sudan 3), which were obtained from the University of Anbar's Desert Studies Center (DSC). The second was spraying amino acids arginine and tryptophan, control, spraying with arginine 50 mg L^{-1}, spraying with tryptophan 50 mg L^{-1}, and spraying with arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1} . The spraying process took place when the plant reached the age of four leaves or a height of 10 cm and in the early morning. Where the field experiment was carried out according to the Randomized Complete Block Design (RCBD) and the experimental soil

prepared after it was plowed and plowed and divided into three replicates, and each replicator contains16experimental units, the area of each experimental unit is 3 x 3 m^2, with a total of 48 experimental units containing the experimental unit has four meridians The line is 3 m. The distance between lines was 75 cm, and between one plant was 40 cm. Urea fertilizer (46% N) containing 300 kg H^{-1} was applied to the experiment in two batches: one batch at planting and the other after 45 days of germination. A batch of triple calcium superphosphate fertilizer (44% P_2O_5) and potassium fertilizer (43% K_2O) were applied at different rates, with 160 kg/h and 120 kg/h, respectively. Prior to smoothing, one comes after tilling. Today, April 15, 2022, was the day of sowing. with 2-3 seeds.

Studied traits

Characteristics of Vegetative:

1. Plant height (cm^{-1})

Plant height was measured from the soil surface level to the highest apex of the marked plants using a meter tape for ten plants from each experimental unit and from the two middle lines.

2. Number of main branches per plant (Branch $Plant^{-1}$)

The number of main branches of plants whose height was measured was calculated, and then the average number of branches per plant was taken

3. Leaf area (cm^2 $sheet^{-1}$)

The leaf area was calculated for ten random plants and for fifty leaves from each plant and from separate places of the plant using the disc method of known diameter and following the following steps:

A- The weight of the fresh leaves

B- Taking a tablet of known diameter from these papers, and then weighing it with a sensitive scale

$$\frac{Paper\ disk\ space2\ p}{Paper\ disc\ weight} = \frac{the\ leaf\ area\ of\ plant}{Fresh\ leaf\ weight}$$ (Bin Salman, 1996)

4- Total chlorophyll a&b (µg gm^{-1})

Chlorophyll a&b was measured by extraction method using an electronically device, spectrophotometer, model LKB-Biochrom Cambridge. England) (Makinney, 1941). The samples were taken from the top third leaf from dom plants. Then, one gram sample was taken. After, the samples were crushed with a mortar with of 20 ml of acetone (80%), after that the leachate was separated from the precipitate by using a centrifuge with 500 rpm speed for 15 min.. finally, one ml. was taken by filtering after adding 9 ml of acetone (80%).The optical density of the leachate was

measured by using the spectrophotometer at two wavelengths (A_{645} and A_{663} nm), and the chlorophyll was calculated by using the following equation (Zhang and Kirkham, 1996):

$Chl_a = 12.25 \times A663.2 — 2.79 \times A646.8$

$Chl_b = 21.50 \times A646.8 — 5.10 \times A663.2$

Chl_{total}=Chla+Chlb Since:

Chl_a = chlorophyll a.

Chl_b = Chlorophyll b.

Chl_{total} = Total chlorophyll.

The numbers 12.25, 2.79, 21.5, and 5.10 = Constants

The lower numbers 646.8 and 663.2 = represent the wavelengths used by the spectrometer for measurement.

Characteristics of the product and its components

1. The nut no. per plant (no. plant^{-1})

The number of nuts set in five plants of the experimental units for each replicator was calculated, then the average number of nuts per plant was taken after 75% of the flowers had opened.

2. Seeds no. per nut (seed nut^{-1})

The number of seeds contained in the nut belonging to the previous paragraph was calculated, then the average number of seeds per nut was taken

3. Weight of 1000 (gm)

One thousand seeds from the plants mentioned in the previous paragraph were counted and then weighed using a sensitive balance

4. Seed Yield (kg H^{-1}).

The weight of the seed yield per experimental unit was calculated using a sensitive balance and the following equation was applied to extract the seed yield per hectare

5. Yield of dried sepals leaves (kg h^{-1})

The weight of the yield of dry sepals for one experimental unit was calculated using the sensitive scale, and the following equation was applied by extracting the yield of dry sepals.

Duncan's multiple range test was used to compare the means at the probability level of 5% after the experiment was factorially analyzed using the R.C.B.D.

RESULTS AND DISCUSSION

1. Plant height (plant cm^{-1})

The results of the analysis of variance in Appendix (1) indicate that there are significant differences between the averages of this trait because the influence of genotypes, amino acids (arginine and tryptophan) and their concentrations, and the binary interaction between amino acids (arginine and tryptophan) and genotypes. The results of Table (1) showed that the genotype Black Hit was significantly superior, with the highest average of the trait reaching 138.84 cm ($Plant^{-1}$), compared to plants of genotype Arabe, which gave the lowest average plant height in (131.05) cm $Plant^{-1}$. The variation in plant height among different genotypes may arise from disparities in their genetic makeup and their distinct responses to environmental conditions, influencing their ability to harness environmental benefits. This variability is evident in the diverse characteristics of vegetative growth, notably in plant height. These findings align with the research of Basazinew and Bizuayehu (2016) and Wachamo and Gessese (2022).

Table (1) results demonstrate a notable impact on plant height when Gujarat plants are sprayed with varying concentrations of amino acids, namely arginine and tryptophan. Moral superiority exhibited the highest averages in this regard, reaching 142.23 $cmplant^{-1}$. In contrast, the lowest averages were observed when the comparative treatment involved spraying with distilled water only, resulting in a height of 123.29 $cmplant^{-1}$. The elevation in plant height is attributed to the application of arginine and tryptophan amino acids on kumquat plant shoots. This application activated vital processes within the plant, including cell division, elongation, and enhanced enzyme activity crucial for decomposing organic compounds. Furthermore, the nitrogen released from these acids played a fundamental role in protein synthesis, energy processing, improved water and nutrient absorption, chlorophyll molecule formation, and the stimulation of plant hormones like auxins and gibberellins. These hormones are pivotal for increased cell division and elongation, contributing positively to average plant height.

Ramadan et al. (2019) and al-Namrawi (2021). It is also noted by the table that there was a significant effect of the interaction between the concentrations of amino acids (arginine and tryptophan) and the genotypes in this trait, as the genotype plants recorded black heat with the fourth spraying treatment (arginine 50 mg ltr^{-1} + tryptophan 50 mg ltr^{-1}) higher Average for the trait reached (150.26) cm, $plant^{-1}$. While the genotype Sudan3

Table 1.the Effect of genotypes & spraying different arginine and tryptophan concentrations on plant height (cm)

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Control	125.73 h	120.26 i	126.63 gh	120.53 i	123.29 d
Arginine (50 mg $^{L-1}$)	132.60 ef	135.60 de	141.80 bc	141.40 bc	137.85 b
Tryptophan (50 mg L^{-1})	130.00 fg	131.26 f	136.66 d	138.33 cd	134.06 c
Arginine + Tryptophan (50 mg L^{-1})	135.86 de	137.86 cd	150.26 a	144.93 b	142.23 a
Average genotypes	131.05 c	131.25 c	138.84 a	136.30 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

2. Branch Number per plant (branch no. plant^{-1})

This characteristic is considered one of the most prominent physiological activities of the plant during the vegetative growth stage, as the branches differ in their representative efficiency due to physiological and morphological reasons, including the height of the branch, the position of the connection with the stem, the number and distribution of the leaves it bears, the results shown in Table (2) indicate the presence of significant effects of the study factors And its binary combinations increased the average number of branches, as it was noted that there were significant differences between the genotypes, as the Black Heat variety excelled, and the highest average of the trait was (28.88) branches. Plant^{-1}, while the genotype gave Arabi the lowest mean for the trait, which reached (26.35) branches. Plant^{-1}, and the reason for this may be due to the specific genetic basis of the plant's ability to branch. Or the reason for the increase in the number of branches may be attributed to the lack of competition between plants for nutrients, which in turn leads to an increase in the concentration of hormones that work to break the apical dominance and encourage the growth of lateral buds and thus increase the number of branches in general (Al-Younes et al., 1987) and this results are in line with what was found mechanism Alfayyadh and Abd-kreem (2020). As for the effect of the concentrations of amino acids (arginine and tryptophan) on a trait, it was significant when the concentration (arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1}) gave the highest average number of branches, which reached (29.10) a branch of plant^{-1}, while a treatment was given Not adding less The mean for the class was (24.00) branches. Plant^{-1}, and the reason for this may be due to the role of arginine and tryptophan in reducing the activity of growth inhibitors, providing free nitrogen for the plant, and increasing the vegetative growth rate of the plant, such as the height of the plant, Table (2), and thus increasing the number of branches in the plant, or the reason for this may be due to the increase in the number of branches of the variety due to the great role of spraying amino acids Which lead to the stimulation of a number of physiological processes and increase the rates of photosynthesis

by increasing the build-up of chlorophyll and improving plant growth through it (El-Ghamry et al. 2009). It is also noted from the table that there is a significant effect of the overlap between the concentrations of amino acids (arginine and tryptophan) and the genotypes in this trait, as the genotype recorded Black Heat with the fourth spraying treatment (arginine 50% + tryptophan 50%) the highest mean for the trait reached 30.53 plant branches^{-1}, while the genotypes were recorded as Arab The sprayed (with distilled water) had the lowest average of the plant height trait, which was 22.46, branch plant^{-1}.

Table 2. Effect of genotypes & spraying different arginine and tryptophan concentrations on branch number per plant (branch no. plant^{-1})

Treatment	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Control	22.46 g	23.35 fg	25.43 e	24.60 ef	24.00 c
Arginine (50 mg L^{-1})	27.73 cd	27.13 d	30.13 ab	28.26 bcd	28.31 b
Tryptophan (50 mg L^{-1})	27.33 d	27.33 d	29.43 ab	27.93 cd	28.00 b
Arginine (50 mg L^{-1} + Tryptophan 50 mg L^{-1})	27.90 dc	29.33 ab	30.53 a	28.66 bc	29.10 a
Average genotypes	26.35 c	26.83 bc	28.88 a	27.36 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

3. Leaf area (cm^2)

The results indicated in the analysis of variance that showed in the Appendix 1 reported that there was a significant difference between the averages of this trait due to the influence of genotypes and both tryptophan and arginine are amino acids. Table 3's findings demonstrated that there were notable variations between them, with the genotype outperforming black heat and carrying the highest average of (21301.58) cm^2 leaf^{-1}, while the Arab genotype gave the lowest average amounting to (21105.33 cm2 leaf^{-1}). The reason for the variation in genotypes in this trait It may be attributed to the genetic differences between these genotypes And to their ability to absorb more amounts of nitrogen, which leads to an increase in the number of leaves in the plant and thus an increase in the leaf area, and this is what Ottman and others indicated (2000), or the difference between the genotypes of the giraffes in this trait may be due to their variation in the number of leaves in addition to their variation in the speed of grow up to Reaching the maximum leaf area, and this result agrees with (Yaqoob et al., 2015). The combination of Arginine (50 mg BTR^{-1}) and Tryptophan (50 mg Baltr^{-1}) exhibited the highest leaf area value, averaging 22,172.33 cm² per leaf. This outperformed all other treatments, with the comparison treatment yielding the lowest average leaf area of 20,228.17 cm² per leaf. Nitrogen, being a vital nutrient essential for plant growth at all stages, plays a crucial role in leaf

development. Amino acids also contribute positively to various physiological processes, such as cell division, expansion, differentiation, growth, and the enhancement of photosynthetic efficiency. These processes collectively influence nutrient absorption, leading to an increase in leaf area (Kakkar et al., 2000). These results were in line with each of (Al-Mohammadi, 2018 and Baqer, 2018). Regarding the bilateral overlap between the amino acid coefficients (arginine and tryptophan) and the genotypes in this trait, the overlap between the combination of arginine 50 mg ptr^{-1} + tryptophan 50 mg ptr^{-1} 1 with all genotypes giving the highest averages For the trait, it was (22115.67, 22179.33, 22205.67, and 22188.67) cm^2 $leaf^{-1}$, while the genotype Arib and Al-Marshoosh (with distilled water) recorded the lowest mean for the trait amounted to (20076.00) (cm^2 $leaf^{-1}$).

Table 3. Effect of genotypes and spraying with different concentrations of arginine and tryptophan on leaf area (cm^2 $leaf^{-1}$)

Treatment	Genotypes				
	Arab	Sudan 3	Black heat	Red heat	Average of Treatments
Without addition	20076.00 f	20104.0 ef	20533.67 d	20199.00 e	20228.17 d
Spraying with arginine 50 mg per liter	21122.00 c	21137.3 c	21331.33 b	21206.33 c	21199.25 b
Spraying with tryptophan 50 mg L	21107.67 c	21107.6 c	21135.67 c	21120.67 c	21117.92 c
Spraying with arginine 50 mg I with tryptophan 50 mg L	22115.67 a	22179.3 a	22205.67 a	22188.67 a	22172.33 a
Average genotypes	21105.33 c	21132.0 b	21301.58 a	21178.67 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

4.Chlorophyll content (b + a) in Total

The results of Table (4) showed that there were significant differences between the genotypes in the characteristic of total chlorophyll, as the genotype was superior to Black Heat by giving it the highest average of (29.17), while the Arab genotype gave the lowest average of (26.66). to genetic differences between genotypes Where the genotype of black heat was superior in most of the growth characteristics of the plant, as in Tables 1, 2, and 4. All these factors combined eventually led to an increase in the chlorophyll content of the leaves. The results of the same table showed that there were significant differences in the characteristic of total chlorophyll at the concentration (Arginine 50 mg per $litre^{-1}$ + Tryptophan 50 mg in L^{-1}) where it excelled significantly on the rest of the concentrations and gave the highest rate for the trait reached (32.93).While it gave comparison treatment) the lowest rate for the trait was (22.69). Arginine and tryptophan have a role in providing ready-made nutrients and in increasing the efficiency of their absorption by the plant, which stimulates the metabolic

processes of the plant and results in an improvement in growth. Nitrogen liberated from amino acids in the formation of chlorophyll, as well as the formation of amino acids that enter into the formation of chloroplasts, in addition to the fact that amino acids are the building blocks of proteins that work in multiple functions in the plant as regulators of metabolic processes, transport and storage of nitrogen and protein, and increase Plant resistance in most difficult conditions such as high and low temperatures, thirst, salinity and poor aeration of the soil Abdel-Hafez (2007) in addition to the superiority of this combination in growth characteristics Table (1, 2 and 3) which was reflected in the increase in chlorophyll content in the leaves. As for the interaction coefficients between genotype and acids Amino (Arginine and Tryptophan) We find that there are significant differences in the characteristic of total chlorophyll between the treatments, and the treatment of overlap between the genotype gave black heat with concentration (arginine 50 mg pL^{-1} + tryptophan 50 mg pL^{-1}) the highest value for the trait amounted to 35.33, while it gave Treatment of interaction between genotype Sudan3 with Not adding or treating the comparison, the lowest value of the trait amounted to (21.74).

Table (4) Effect of genotypes and spraying with different concentrations of arginine and tryptophan on chlorophyll content (a + b) in leaves.

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	22.38 j	21.74 k	24.13 i	22.52 j	22.69 d
Spraying with arginine 50 mg per liter	27.88 f	30.10 cd	29.45 e	30.35 c	29.44 b
Spraying with tryptophan 50 mg L	26.52 g	26.11 h	27.77 f	26.26 gh	26.67 c
Spraying with arginine 50 mg I with tryptophan 50 mg L	29.89 d	33.15 b	35.33 a	33.38 b	32.93 a
Average genotypes	26.66 d	27.77 c	29.17 a	28.13 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

5. Number of nuts per plant (Nut $Plant^{-1}$)

The results of Table (5) showed that the genotype Black Hit was significantly superior, with the highest average of the trait amounting to (148.55) Nut^{-1}, compared to the plants of the genotype Arabe, which gave the lowest mean for the trait, amounting to (136.60) Nut^{-1}, due to the reason for the superiority of the genotype Heat black to its superiority in growth characteristics, leaf area and number of branches implant and the content of chlorophyll a and b as shown in Table (2, 3 and 4), which led to an increase The efficiency of the process of photosynthesis, and this was reflected in the processing of emerging flowers with their requirements of processed food, and thus increasing the percentage of fertility in them, and then increasing the number of nuts in the plant.

The findings presented in Table (5) demonstrate a significant impact on the trait when Gujarat plants are subjected to the spray of amino acids, specifically arginine and tryptophan. Notably, the application of a dual-acid spray (arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1}) resulted in the most significant effect, with the trait's highest averages observed at (20.150) nuts per plant. In contrast, the lowest averages were noted when the control treatment involved spraying with distilled water only, amounting to (50.123) nuts per plant. The notable increase in nut production per plant is attributed to the role of amino acids (arginine and tryptophan) in enhancing nutrient availability and chlorophyll formation (see Table 3). This enhancement contributes to heightened photosynthetic efficiency and increased respiration, leading to the production of energy compounds (ATP) that benefit the plant during its growth phase.

Table (5) The effect of genotypes and spraying with different concentrations of arginine and tryptophan on the number of nuts per plant (nut^{-1})

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	115.46 h	124.26 g	131.63 f	122.66 g	123.50 c
Spraying with arginine 50 mg per liter	143.80 cde	143.60 cde	150.96 b	141.76 e	145.03 b
Spraying with tryptophan 50 mg L	140.66 e	143.13 de	150.06 bc	141.40 e	143.81 b
Spraying with arginine 50 mg I with tryptophan 50 mg L	144.33 b-e	149.30 bcd	161.63 a	145.56 b-e	150.20 a
Average genotypes	136.60 c	140.07 b	148.57 a	137.85bc	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

Moreover, the amino acids stimulate processes associated with protein synthesis and trigger the production of plant hormones such as auxins, gibberellins, and cytokinins. This stimulation results in amplified vegetative growth, manifested through increased plant height, number of branches, and leafy area (refer to Tables 1, 2, and 3). These positive effects are reflected in the observed increase in the number of nuts per plant. In Table (4), it is noteworthy that the Black Hit genotype, subjected to the fourth spraying treatment (Arginine 50 mg L^{-1} + Tryptophan 50 mg L^{-1}), recorded the highest mean for the trait, reaching (161.63) nuts per plant. In contrast, the Arib Al-Marushoosh genotype (treated with distilled water) exhibited the lowest mean for the trait at 115.46 nuts per plant.

6. Number of seeds in one nut (nut^{-1} seed)

The results of table (6) showed the genotype was superior to black heat and recorded the highest average for the characteristic, indicating that there were notable differences across the genotypes. (85.23 Number of seed per boll (seed. boll $^{-1}$), while the Sudan 3 genotype gave the lowest

average for the trait amounted to (89.22) nut^{-1} seeds, and the reason is due to The ability of the black heet genotype to convert photosynthetic products into More nutrients and their transfer from the leaves to the seeds formed in the acorn prevent Its decrease, as well as the superiority of the genotype of black heat in traits, plant height, number of branches, and leafy area, as shown in Tables (1, 2, and 3), and thus led to an increase in the number of seeds in the nut. Table 6 results demonstrate a significant impact when spraying Gujarat plants with varying concentrations of amino acids, specifically arginine and tryptophan. Notably, the combined application of arginine (50 mg ltr^{-1}) and tryptophan (50 mg ltr^{-1}) resulted in a significantly superior mean value of 0.25 nuts per seed. In contrast, the control treatment, sprayed solely with distilled water, exhibited the lowest average of 91.21 nuts per seed. This discrepancy could be attributed to the pivotal role of arginine and tryptophan in chloroplast formation, contributing significantly to enhanced carbon metabolism efficiency in leaves. Consequently, this process increases carbohydrate production, aids in the synthesis of proteins, processes food materials, and facilitates the transport of essential elements and dry substances from leaves (the source) to storage locations in acorn reproductive parts and formed seeds.

Table (6) Effect of genotypes and spraying with different concentrations of arginine and tryptophan on the number of seeds in one nut (nut^{-1} seed)

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	22.40 b	21.93 b	21.80 b	21.53 b	21.91 b
Spraying with arginine 50 mg per liter	23.53 ab	22.66 b	24.93 ab	22.86 b	23.50 ab
Spraying with tryptophan 50 mg L	23.26 b	23.30 b	23.53 ab	22.60 b	23.17 b
Spraying with arginine 50 mg I with tryptophan 50 mg L	24.13 ab	23.66 ab	27.13 a	25.10 ab	25.00 a
Average genotypes	23.33 b	22.89 c	23.85 a	23.52 ab	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

Moreover, the amino acids play a crucial role in stimulating physiological processes during the flowering stage, thereby increasing pollen quantity and decreasing the impact of growth inhibitors. This reduction in growth inhibitors helps mitigate the inhibition of cell growth and division in the plant, ultimately leading to an increased number of grains in the nut. Examining the same table, it is evident that the Black Heat genotype, subjected to the fourth treatment of spraying (Arginine 50 mg L^{-1} + Tryptophan 50 mg L^{-1}), exhibited the highest mean for the trait, recording 27.13 nuts per seed. Conversely, the Heat Red genotypes, sprayed with distilled water, recorded the lowest mean of 21.53 nuts per seed.

7. Weight of 1000 seeds (g)

The results of Table (7) showed no significant differences between genotypes in this trait. The treatment of spraying with When two amino acids were added, the average weight of 1000 seeds grew at the fastest rate (arginine 50 mg L^{-1} + tryptophan 50 mg L^{-1}). amounted to (54.84) gm^{-1} seed, which was considerably less than the result of the comparison treatment, which was (42.80). $Seed^{-1}$ gm, and the explanation for this could be linked to the role that amino acids play in maintaining the proper balance of nutrients and their favorable impact on plant growth by enhancing the initial cell infrastructure, particularly the chloroplasts, which in turn increases the effectiveness of photosynthesis. (Kandil et al., 2016), which is reflected in the increase in the rate of net photosynthesis, or the variation in the response of genotypes to the influence of amino acids at this stage Which led to an increase in the vegetative total and thus an increase in the rate of net photosynthesis that leads to an increase in the weight of 1000 seeds and thus contributes to an increase in the average weight of 1000 seeds (Elsayed, 2018), also, increasing the concentrations of amino acids has improved the characteristics of vegetative growth such as plant height and leafy area (Tables 1 and 3) this has led ton increase in the outputs of the photosynthesis process as a result of the increase in the interception of the light that was reflected in the yield on the increase in the weight of 1000 seeds, which is one of the outlets in which the products of photosynthesis accumulate in a concentrated manner. When adding (arginine 50 mg Ltr^{-1} + tryptophan 50 mg Ltr^{-1}), the genotype outperformed Arabib and recorded the highest rate, resulting in (46.46) gm $seed^{-1}$ for the binary overlap between genotypes and amino acids. In contrast, the comparison treatment with the genotype produced Heat Black, which had the lowest average of the trait (41.96) (gm $seed^{-1}$).

Table (7) Effect of genotypes and spraying with different concentrations of arginine and tryptophan on the weight of 1000 seeds ($seed^{-1}$ g)

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	43.06 efg	42.67 fg	41.96 g	43.50 d-g	42.80 c
Spraying with arginine 50 mg per liter	45.43 abc	45.26abc	44.76bcd	45.40 abc	45.21 ab
Spraying with tryptophan 50 mg L	44.57 b-e	45.16abc	45.33abc	44.06 c-f	44.78 b
Spraying with arginine 50 mg I with tryptophan 50 mg L	46.46 a	45.60abc	45.40 abc	45.90 ab	54.84 a
Average genotypes	44.88 a	44.67 a	44.36 a	44.71 a	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

8. Seed yield (kg h^{-1})

Table (8) indicates a significant impact of genotypes as per the Duncan multi-range test. The Black Heat genotype demonstrated a noteworthy superiority in the trait, registering (840.00) kg H^{-1}, while the Arab genotype exhibited the lowest mean for the trait at (815.25) kg H^{-1}. The variation in susceptibility and the efficiency of genotypes in harnessing photosynthetic products contributed to the observed differences in this trait. This variation extended to various characteristics, including seed yield. The superior performance of the Black Heat genotype in grain yield may be attributed to its advantages in vegetative growth aspects such as plant height and leaf area (Tables 1 and 3), as well as yield-related factors like the number of nuts per plant and the number of seeds in the nut (Table 6).

The addition of amino acids proved to be significant. Specifically, the addition of (arginine 50 mg/L + tryptophan 50 mg/L) resulted in the highest mean for the trait, reaching (91.963) kg H^{-1}, compared to the treatment without amino acid addition, which recorded the lowest mean at (06.688) kg H^{-1}. Foliar spraying of amino acids facilitates nutrient absorption during the vegetative growth and branching stages, enhancing chlorophyll concentration and photosynthesis. This, in turn, increases dry matter production, stimulates enzymes responsible for protein synthesis, and positively impacts carbohydrate levels. These effects collectively contribute to an increase in grain yield. Moreover, the combination of (genotype Black Heat with arginine 50 mg/L + tryptophan 50 mg/L) outperformed other combinations, yielding the highest mean for the trait at (31.985) kg H^{-1}, while the combination of (genotype Arab + treatment comparison) yielded the lowest mean at (81.681) kg H^{-1}.

Table (8) Effect of genotypes and spraying with different concentrations of arginine and tryptophan on seed yield (kg H^{-1})

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	681.18h	685.60gh	699.71 g	685.74 gh	688.06 d
Spraying with arginine 50 mg per liter	862.35 d	860.82 d	883.57c	865.06 d	867.95 b
Spraying with tryptophan 50 mg L	768.12 f	765.59 f	791.39 e	773.83 f	774.73 c
Spraying with arginine 50 mg I with tryptophan 50 mg L	949.38 b	949.54 b	985.31 a	971.40 ab	963.91 a
Average genotypes	815.25 c	815.39 c	840.00 a	824.01 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

9. Yield of dry sepal leaves (kg h^{-1})

The results displayed in Table (9) demonstrate the significant effects of the study factors and

the bilateral overlap in raising the mean of the trait. It was also observed that the genotypes differed significantly from one another, with the genotype resulting in a higher trait average (60.709) kg H^{-1}, which was superior to Black Heat, and the genotype resulting in an Arab with the lowest trait mean being (53.690) kgE^{-1} The reason for the superiority of the genotype of Black Heat in this trait is due to nature The genetics of this structure were superior in the characteristics of vegetative growth, the height of the plant, the number of branches, and the leaf area as in Tables (1, 2, and 3), and in the characteristics of the yield, the number of nuts and the number of seeds per nut, as in Tables (5 and 6), This was seen in both the yield increase and these traits. Just like when you spray amino acids, dry cup leavesThe non-addition treatment produced the lowest mean for the characteristic, equivalent to (52.579) kg H^{-1}, whereas the addition (arginine 50 mg LTR^{-1} + tryptophan 50 mg LTR^{-1}) was superior, with an average score of (42.839) kg H^{-1}. The spraying of amino acids was restricted. The study led to facilitating the process of nutrient absorption from the soil and its transfer to the plant, as well as an increase The vital activities, especially the process of photosynthesis and the synthesis of enzymes, which contributed to the transfer of the products of this process from the places of export to the places of estuaries, especially the sepals' leaves. The genotype shows superiority over red heat with the addition of (arginine 50 mg ptr^{-1} + tryptophan 50 mg ptr^{-1}) as the genotype recorded the highest value for the trait amounted to (24.845) kg H^{-1} in the bilateral overlap between genotypes and amino acids, while the genotype gave Arabic with comparison treatment (without addition) the lowest value of the trait amounted to (72.569) (E^{-1} kg).

Table (9) Effect of genotypes and spraying with different concentrations of arginine and tryptophan on the yield of dry sepal leaves (kg h^{-1})

Treatments	Genotypes				Average of Treatments
	Arab	Sudan 3	Black heat	Red heat	
Without addition	569.72 j	580.14 i	586.58 h	581.65 hi	579.52 d
Spraying with arginine 50 mg per liter	722.47 e	720.71 e	730.95 d	724.90 e	724.58 b
Spraying with tryptophan 50 mg L	640.10 g	638.30 g	669.51 f	642.51 g	647.65 c
Spraying with arginine 50 mg I with tryptophan 50 mg L	829.90 c	831.36 c	815.18 a	845.24 b	839.42 a
Average genotypes	690.53 c	692.47 c	709.60 a	698.57 b	

Significant differences ($p<0.05$) are indicated by different letters at between the treatment.

Appendix 1. Analysis of variance table represented by mean squares for the studied traits

source of contrast	duplicates	Varieties effect	The effect of amino acids	Interaction between varieties and acids	experimental error
d. f	2	3	3	9	30
Plant height	62.333	177.90**	787.05**	32.52**	4.957
Number of main branches	0.103	40.14**	62.50**	0.768	0.471
leaf area	5058.90	90616.1**	7579742.7**	24868.3**	3831.01
Chlorophyll content (b+a)	0.034	12.805**	225.60**	3.66**	0.032
Number of nuts per plant	2.985	367.93**	1657.75**	731.18	12.912
Number of seeds in one nut	140.3	923.1	19.390**	3.020	3.641
Weight of 1000 seeds	651.1	0.562	20.701**	0.882	0.744
Seed yield	295.251	1624.17**	169652.4**	770.80	91.091
Yield of dry sepal leaves	6.416	884.62**	149113.7**	105.67**	9.262

Significant at the level of 0.05 ** Significant at the level of 0.01 ns Not significant

CONCLUSION

Most of the examined traits were significantly influenced by the performance of the genotypes, The combination of spraying with 50 mg L^{-1} arginine and 50 mg L^{-1} tryptophan demonstrated superior performance across all studied traits. Heat Black exhibited significant superiority in the majority of growth, yield, and component characteristics, reflecting a notable increase and suggesting its suitability to the experimental conditions compared to other genotypes. The interactive effect between genotypes and the combination of spraying with 50 mg L^{-1} arginine and 50 mg L^{-1} tryptophan was significant for all the traits under study.

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