

THE RESPONSE OF SOME GROWTH CHARACTERS FOR TWO VARIETIES OF MAIZE TO SPRAYING WITH VITAMIN B9 AND E, AND THE AMINO ACID ARGININE

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ABSTRACT

A field experiment was conducted at the Agricultural Research Station, College of Agricultural Engineering Sciences - University of Baghdad, during the fall seasons of 2021 and 2022 to study the response of some growth traits for two varieties of maize to spraying vitamin B9 (folic acid), vitamin E (tocopherol), and arginine acid. Randomized complete block design (RCBD) within split plot arrangement with three replicates was used. The experiment included two factors, the first factor in the main plot represented two varieties of maize (Baghdad 3 and Sarah), while the second factor in the subplot represented spraying with vitamin E and B9 at concentrations of 1 and 2 g L⁻¹ and arginine acid at concentrations of 100 and 200 mg L⁻¹, in addition to the control treatment (without spraying). The results showed that Sarah variety outperformed in most studied traits for both seasons (75% male flowering, plant height, number of effective leaves, leaf area, and green leaf duration). Also spraying vitamin E, with the concentration of 2 g L⁻¹ gave highest averages in most of the traits, with the highest mean values for plant height (195.92 and 193.66 cm), number of effective leaves (14.56 and 14.56 leaves plant⁻¹), leaf area (0.7767 and 0.7950 m²), and green leaf duration (100.83 and 103.33 days) for both seasons respectively. The interaction between the two factors was significant in 75% male flowering and green leaf duration.

Keywords: Vitamin B9, Vitamin E, Arginine, Maize varieties, Growth characters

INTRODUCTION

Maize is one of the most important strategic and economic crops in the world, ranking third in importance after wheat and rice. It is widely cultivated in Iraq on an area of 45,800 hectares with a production rate of 3.184 µg ha⁻¹ in 2015 (1, 2). Maize is grown in Iraq in two seasons: the fall season, which is more suitable for climate conditions, and the spring season, which is grown in a few areas (3). Despite the wide environmental range and adaptability of this crop to different environmental conditions, maize cultivation in Iraq is facing a significant decrease in cultivated area and low production

rate compared to global production. Plants of this crop, which are cultivated in the fall season, are exposed to high temperatures during the growing season, which leads to an increase in Reactive Oxygen Species (ROS) levels. These ROS are naturally produced in plants during biological processes, and increases as plant exposure to stresses, such as high temperatures. Studies have indicated that the use of vitamins, including B9 (folic acid) and vitamin E (tocopherol), protects the plant from the risk of oxidation. Vitamin B9 plays an important role in amino acid metabolism, nucleic acid formation, and holding of free radicals that are produced in the plant when exposed to stress, in addition to

its other roles, such as cell division and elongation (4). Vitamin E plays an important role in protecting the green plastid membranes from photodamage, thus providing optimal conditions for the carbon assimilation process (5). Amino acids also play an important role in tolerating contrasting conditions such as salinity, drought, and high temperature, including arginine, in addition to its role in cell division and chlorophyll formation. Crop management significantly affects increasing production, and the use of good varieties with high potential for utilizing available growth resources is one of the management practices. Knowing the performance and response of each variety to growth factors and modern field practices is important for increasing production. The study was conducted to study the response of some growth traits for two varieties of maize to spraying with vitamin B9 (folic acid), vitamin E (tocopherol), and arginine acid.

MATERIALS AND METHODS

A field experiment was carried out in the field of the College of Agricultural Engineering Sciences / University of Baghdad / Al-Jadriyah during fall seasons of 2021 and 2022. to study the response of some growth traits for two varieties of maize to spraying with vitamins and amino acids. The research field prepared as recommended then was divided into three replicates, each consisting of 42 experimental units (3x2m). Each experimental unit included 5 rows, with 2m long, and 75cm apart, and 25cm between plants to obtain a plant density of 53,333 plant ha⁻¹. The experiment was applied according to the Randomized Complete block Design (RCBD) within split plots arrangement with three replicates. The experiment included two varieties of maize Baghdad 3 and Sarah in the main plot, and spraying vitamin E and B9 at concentrations 1 and 2 g L⁻¹, labeled as E1, E2, and spraying of arginine at concentrations of 100 and 200 mg L⁻¹ labeled as A1 and A2,

respectively, in addition to the control without spraying in sub-plot. The vitamins and amino acids were sprayed in three stages 6 fully expanded leaves (emergence of the apical meristem above the soil surface) and 8 fully expanded leaves (rapid plant growth and leaf formation), and 10 fully expanded leaves (the beginning of tassel formation and rapid growth of reproductive organs in 75% of the plants in the experimental unit (6). As a preventive measure, corn stem borer was controlled by placing a small amount of granular diazinon insecticide (10% active ingredient) in the heart of the plant at a rate of 6 kg ha⁻¹ at the stage of 6 and 8 leaves. The sowing date was 6/8/2021 for the first season and 2/8/2022 at the second season. Urea (N%46) was added at a rate of 400 kg ha⁻¹ in two doses, the first after twenty days after emergence, and the second after one month of first dose (7). Crop service operations were carried out whenever needed.

Studied traits:

- 1. Number of days from planting to 75% male flowering (days):** The number of days from the date of planting (first irrigation date) until the start of the appearance of male flowers in 75% of the plants in the experimental unit.
- 2. Plant height (cm):** The height of the plant was measured from the soil surface to the base of the flag leaf as an average of five plants (6).
- 3. Number of leaves per plant (leaf of plant⁻¹):** The number of leaves was calculated as an average of five randomly selected plants from the middle rows of the experimental unit.
- 4. Leaf area (m²):** The leaf area was estimated by measuring the length of the

leaf under the main ear of the corn and applying the following equation:

Leaf area = (length of the leaf under the main ear of the corn)² × 0.75 (8).

5. **Green leaf duration (days):** It was calculated from the date of emergence until the plants reached physiological maturity (9).

RESULTS AND DISCUSSION

Number of days from planting to 75% male flowering (days)

The results indicate a significant effect of varieties, vitamin and amino acid spraying, and the interaction between the studied factors on the average number of days from planting to 75% male flowering for both seasons (Table 1). The result shows that the variety Sarah variety took a shorter period to reach 75% male flowering with an average of 55.67 and 55.48 days for the two seasons, respectively. On the other hand, the Baghdad 3 variety required a longer period of time to reach 75% male flowering, with an average of 57.52 and 58.29 days, respectively. This can be attributed to genetic variations in the morphological traits and the response to environmental conditions, including temperature and photoperiod, which lead to differences in the number of days

required to reach the male flowering stage. These results are consistent with those of Okab and Abed (10). The data also indicate that treatment with vitamin E at a concentration of 2 g L⁻¹ resulted in the shortest period of time to reach this stage, with an average of 55.83 and 55.67 days, while the longest period of time was recorded with treatment B2 (2g L⁻¹) in the first season and A2 (200 mg L⁻¹) in the second season, with an average of 57.33 and 58.67 days, respectively. The behavior of the Sarah variety when sprayed with vitamin E, and B9, and the amino acid arginine differed from the behavior of the Baghdad 3 variety for both seasons. Spraying the amino acid and B2 and E2 at concentrations of 200 mg and 2 g of these substances reduced the number of days to reach this stage compared to concentrations of 100 mg and 1 g of each of these substances and compared to the control treatment for both seasons. However, the behavior of the Baghdad 3 variety was different, as increasing the concentrations of these substances (the amino acid and vitamin B9) from 100 to 200 mg and from 1 to 2 g increased the number of days to reach this stage, except for the increase in concentrations of vitamin E from 1 to 2 g, which reduced the number of days to reach 75% male flowering for both seasons

Table 1: Effect of varieties and vitamin B9, E, amino acid arginine, and their interaction in mean number of days to 75% male flowering (days) for the autumn seasons of 2021 and 2022.

Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2021	Sarah	55.67	56.67	55.33	56.00	55.33	55.67	55.00	55.67
	Baghdad	56.33	56.33	58.00	57.67	59.33	58.33	56.67	57.52
Means		56.00	56.50	56.67	56.83	57.33	57.00	55.83	
L.S.D _{0.05}	Varieties =		Spray treatment= 0.901			Interaction=1.385			
Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2022	Sarah	55.33	56.00	55.00	55.67	55.00	56.67	54.67	55.48
	Baghdad	57.33	57.67	62.33	57.33	58.67	58.00	56.67	58.29
Means		56.33	56.83	58.67	56.50	56.83	57.33	55.67	
L.S.D _{0.05}	Varieties = 0.820		Spray treatments =1.156			Interaction =1.557			

Plant height (cm):

The results showed a significant effect of varieties and the application of vitamins (B9 and E) and the amino acid arginine, the interaction between the two factors had non-significant differences in plant height for both seasons (Table 2). The Sarah variety outperformed with the highest mean of 195.90 cm and 193.59 cm for the two seasons, while Baghdad 3 variety recorded the lowest mean of 193.98 cm and 191.42 cm for both seasons, respectively. The reason could be due to the fact that this trait is associated with genotypes, available growth factors, and nutrients. These results are consistent with Zeboon and Mahmood (11), Ahmed et al. (12), and Kadhim and Hamza (13). The treatment of arginine spraying at a concentration of 200 mg L⁻¹ and vitamin E at a

concentration 2 g L⁻¹ recorded the highest mean at 195.92 cm for both treatments in the first season. In the second season, treatment E2 at a concentration 2 g L⁻¹ recorded the highest mean of 193.66 cm, with no significant difference between the two treatments for both seasons. The reason for this could be due to the role of vitamin E in promoting cell division and expansion (14, 15), as well as the role of the amino acid arginine in cell division and chlorophyll formation, which serves as a reserve for nitrogen and is a precursor for amino acids and nitric acid that contribute to plant growth and development (16, 17, 18). These results are consistent with Kumar et al. (19), Dawood et al. (20), and Marzauk et al. (21), who all indicated the significant effect of vitamin E and arginine on plant height

Table 2: Effect of varieties and vitamin B9, E, amino acid arginine, and their interaction in mean plant height for the autumn seasons of 2021 and 2022.

Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2021	Sarah	194.67	195.00	197.17	195.33	196.00	196.17	197.00	195.90
	Baghdad	192.67	193.00	194.67	194.00	195.00	193.67	194.83	193.98
Means		56.00	193.67	194.00	195.92	194.67	195.50	194.92	195.92
L.S.D	Varieties = 1.164		Spray treatments = 1.553			Interaction = N.S			
Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2022	Sarah	191.83	192.83	194.6	193.16	194.16	193.83	194.66	193.59
	Baghdad	189.83	190.66	192.16	191.16	191.83	191.66	192.66	191.42
Means		190.83	191.75	193.41	192.16	193.00	192.75	193.66	
L.S.D	Varieties = 0.542		Spray treatments = 0.628			Interaction = N.S			

The number of leaves (plant leaf⁻¹)

The results indicate a significant effect of varieties and the application of vitamins and amino acid arginine on the number of leaves, while the interaction did not have a significant effect on this trait for both seasons (Table 3). Sarah variety gave highest mean (14.67 and 14.56 leaf plant⁻¹) while Baghdad 3 variety

recorded the lowest mean (13.99 and 13.76 leaf plant⁻¹) for both seasons, respectively, and this may be due to their genetic nature, which are influenced by environmental conditions, and their difference in the height of the plant (Table 2). These results agree with Jassem and Katib (22) and Zeboon and Mahmood (11), who pointed out the difference in the number of leaves between varieties.

Plants sprayed with a concentration of 2 g L⁻¹ of vitamin B9 and E2 had the highest mean (14.56 leaf plant⁻¹) for both treatments in the first season, while treatment E2 with a concentration of 2 g L⁻¹ had the highest mean 14.56 leaf plant⁻¹ in the second season. The control treatment recorded the lowest mean (14.00 and 13.46 leaf plant⁻¹) for both seasons, respectively, this may be attributed to the role of vitamin B9 and E in plant growth, as vitamin B9 (folic acid) is an antioxidant that protects cells from free radical harm, which improves the cell's condition to perform its functions and hence reflects on plant growth (increased number of leaves). Spraying at the 6-leaf stage, which is characterized by the appearance of the

apical meristem and rapid cell division, and the 8-leaf stage, which is characterized by the plant's rapid growth and the formation of leaves, may have also contributed to this result, as it lengthens the duration of leaf effectiveness. These results agree with Elewi and Zeboon (23) and Youssif (24). In addition, the important role of vitamin E in protecting cell membranes and preventing fat oxidation, and it plays an important role in growth and development as well as regulating electron transport in the second photosynthetic system in the process of photosynthesis (15, 25, 26), this may have led to a delay in the aging of the leaves and then an increase in their number.

Table 3: Effect of varieties and vitamin B9, E, amino acid arginine, and their interaction in the effective leaf number (leaf plant⁻¹) for the autumn seasons of 2021 and 2022.

Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹)								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2021	Sarah	14.20	14.66	14.86	14.26	14.93	14.66	15.13	14.67
	Baghdad	13.80	13.93	14.20	13.93	14.20	13.86	14.00	13.99
Means		14.00	14.30	14.53	14.10	14.56	14.26	14.56	
L.S.D _{0.05}	Varieties =		Spray treatments= 0.401			Interaction=N.S			
Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹)								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2022	Sarah	13.60	14.20	14.73	14.53	15.06	14.56	15.26	14.56
	Baghdad	13.33	13.86	14.06	13.76	13.80	13.66	13.86	13.76
Means		13.46	14.03	14.40	14.15	14.43	14.11	14.56	
L.S.D _{0.05}	Varieties = 0.674		Spray treatments =0.437			Interaction= N.S			

4. Leaf area (m²).

The results in Table 4 showed a significant effect of varieties and spraying vitamins and amino acids on the leaf area, with no significant differences between the studied factors for the two seasons. Sarah variety was superior with the highest mean reach 0.7767 and 0.7729 m², respectively, while Baghdad 3 variety gave the lowest mean of 0.6667 and 0.7729 m² for both seasons, respectively, this may be attributed to the genetic variation among varieties in this trait and its association with the number of active

leaves. These results are consistent with Al-Tamimi (27) and Ahmed et al. (12).

The results also indicate that vitamins and amino acids. Treatment E2, with a concentration of 2 g L⁻¹, recorded the highest mean of 0.7767 m² and 0.7950 m², while the control treatment recorded the lowest mean of 0.6867 m² and 0.6850 m² for both seasons, respectively. This may be attributed to the role of vitamin E, which is an antioxidant that plays an important role in maintaining membrane stability (28), delaying plant aging and regulating electron transfer in the photosystem II (25).

Table 4: Effect of varieties and vitamin B9, E, amino acid arginine, and their interaction in mean the leaf area (m²) for the autumn seasons of 2021 and 2022.

Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means	
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂		
Autumn 2021	Sarah	0.7067	0.7933	0.8200	0.7000	0.8133	0.7800	0.8233	0.7767	
	Baghdad	0.6667	0.6833	0.6900	0.6933	0.7200	0.7233	0.7300	0.6667	
Means		0.6867	0.7383	0.7550	0.6967	0.7667	0.7517	0.7767		
L.S.D	Varieties= 0.0436	Spray treatments= 0.0496				Interaction=N.S				
Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹),								Means	
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂		
Autumn 2022	Sarah	0.7067	0.7733	0.8200	0.7000	0.8133	0.7800	0.8167	0.7729	
	Baghdad	0.6633	0.6900	0.7000	0.7067	0.7633	0.7633	0.7733	0.7229	
Means		0.6850	0.7317	0.7600	0.7033	0.7883	0.7717	0.7950		
L.S.D	Varieties= 0.0477	Spray treatments =0.0492				Interaction=N.S				

5. Green leaf duration (days)

The result indicates a significant effect of varieties in first season, spraying with vitamins and amino acids, and the interaction between factors on the green leaf duration in both seasons. Sarah variety had the highest mean of 101.81 days in the first season, The results also shows that treatment B2 with a concentration of 2 g L⁻¹ of vitamin B9 had the highest mean of 102.50 days in the first season, while treatment E2 at 2 g L⁻¹ of vitamin E had the highest mean of 103.83 days in the second season, with no significant difference from treatment B2. On the other hand, the control treatment had the lowest mean (98.00 and 101.00 days) for both seasons, respectively. These results can be attributed to the important roles of vitamins in the plant cells' longevity and delaying their senescence. Vitamin B9 inhibits the biosynthesis of glycine, which contributes to the formation of proteins and chlorophyll in the green plastid membranes, as well as its role in DNA synthesis and regulation of cell division (29, 30). Moreover,

vitamin E has a role in regulating the growth and development of plants, preventing fat oxidation, maintaining the stability of membranes, and its role in the carbon metabolism process. Through its presence in the green plastids, it performs these functions and delays leaf senescence.

Regarding the interaction we notice from the results (Table 6) that the two varieties (Sarah and Baghdad 3) showed a similar behavior when the concentration of the amino acid arginine increased from 100 to 200 mg L⁻¹ and vitamin B9 increased from 1 to 2 g L⁻¹. The duration of leaf retention increased with the increase in the spraying concentrations of these materials. Despite this similar behavior, they differed when increased concentrations of vitamin E spraying from 1 to 2 g liter⁻¹, as this characteristic increased Sarah variety, while this trait was fixed at Baghdad 3 variety, and that spraying all these materials increased the green leaf duration for both varieties compared to control treatment for the both respectively.

Table 5: Effect of varieties and vitamin B9, E, amino acid arginine, and their interaction in mean duration of green leaf retention (days) for the autumn seasons of 2021 and 2022.

Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹ , mg)								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2021	Sarah	99.33	102.33	102.67	102.00	102.67	101.33	102.33	101.81
	Baghdad	96.67	101.33	102.00	101.33	102.33	99.33	99.33	100.33
Means		98.00	101.83	102.33	101.67	102.50	100.33	100.83	
L.S.D	Varieties =	Spray treatments= 0.750				Interaction=0.986			
Growing season	Vitamin B9 and E concentrations and the amino acid arginine (g L ⁻¹ , mg)								Means
	Varieties	C0	A ₁₀₀	A ₂₀₀	B ₁	B ₂	E ₁	E ₂	
Autumn 2022	Sarah	102.33	103.33	103.67	102.33	103.67	104.33	105.33	103.57
	Baghdad	99.67	102.33	103.33	102.33	103.33	102.33	102.33	102.24
Means		101.00	102.83	103.50	102.33	103.50	103.33	103.33	
L.S.D	Varieties = N.S	Spray treatments =0.941				Interaction =1.788			

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