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# The Effect of Amino Acids and The Date of Planting on Some Growth Characteristics of The Three Varieties of Maize

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**Abstract.** A field experiment was carried out at the Field Crops Research Station of the Agricultural Research Department - Abu Ghraib during the spring season for the years 2019 and 2020. With the aim of studying the effect of amino acids and planting dates on some growth characteristics, for three varieties of maize. A split-split plot was used according to a randomized complete block design (R.C.B.D) with three replications. The experiment included three planting dates (March 15, March 25 and April 5) that represented the main plot, while amino acids (proline and arginine) and the control treatment (distilled water) occupied the subplot. Whereas, the three varieties (Rabi', Baghdad 3, and Fajr 1) allocated to the sub-sub plot. The Rabi cultivar gave the fewest days to reach 75% male and female flowering (70.33 and 72.78 days) respectively. The Fajr 1 variety scored the highest average percentage of proline and arginine in leaves for the first season. Plants sprayed with proline at a concentration of 200 mg achieved the highest mean number of leaves, leaf area, chlorophyll content in leaves, and proline concentration in leaves for both seasons. When spraying arginine, its percentage increased in leaves. Planting dates affected most of the studied traits, planting plants on March 15 achieved a significant increase in all growth traits. The two and three way interactions had a significant effect on most growth traits, and the best interaction was for the Rabi variety when planted on March 15th and sprayed with proline.

## 1. Introduction

Maize crop (*Zea mays* L.) is one of the important crops grown on a large scale mainly for cereal production, and it ranks third after wheat and rice crops in terms of economic importance. This importance came through its use as a food, fodder and oil crop, as well as used in the biofuels industry, which contributes to reducing environmental pollution [1]. The total production of maize in Iraq for the year 2019 for the spring and autumn crops was estimated at 473.1 thousand tons, and an area amounted to 515.2 thousand dunums for both seasons [2]. Despite the application of the latest technology to predict future events of environmental changes, the world at the beginning of the third millennium is still unable to find adequate solutions to address the challenges of the heat and drought problems, which are responsible for the degradation of a third of agricultural lands and the problem of food deficit. In the coming decades, it is expected to see more changes in temperature and water levels of rivers and seas. As the problem of climate change has arisen in the arid and semi-arid regions in which Iraq is located, so attention to crop management is among the important goals to make a tangible increase in the amount of yield and improve its quality.



Currently, developing countries contribute two-thirds of the world's cereal production through the successful management of certified synthetic varieties, which are the first line of defense against agro-environmental changes. As the development of management systems for the crop, such as the appropriate planting times and important nutrients such as amino acids, must be matched by the production of high-quality grains, in quantity and quality. The change of the growing season may limit the growth of certain varieties of maize to a very large extent in the areas where they are produced, and the increase in short-term temperatures in spring planting could have effects on the yield of maize due to its synchronization with the pollination process and fertilization because the high temperature negatively affects the reproductive parts, especially the male inflorescence, due to a location at the top of the plant that is directly exposed to solar radiation. While other climatic conditions may be favorable for agriculture at the same time, as in the autumn season. The change in the growing season of any variety of maize could reduce the nutritional content of the maize crop and its adaptation to climate change due to the influence of genetic and environmental interaction [3]. To reduce its effects, it requires additives that improve the growth of synthetic varieties such as amino acids that work to withstand the conditions of different environmental stresses, as experiments have shown that amino acids play an important role in improving the qualitative and productive characteristics, especially if sprayed at times of plant exposure to stress, especially at the time of flowering, which leads to the production of healthy pollen grains capable of pollination and thus increases the fertilization process and this leads to an increase in the yield in quantity and quality as it works to stimulate plant hormones and growth materials [4]. In order to improve the agricultural reality, the efficiency of the varieties suitable for autumn cultivation in the spring season must be improved by using different genotypes and knowing the performance of each variety and its response to the added amino acids when planted at different dates. This study aims to find out the suitability of the fall varieties when planting them in the spring, to know the best planting date and used amino acid that can be recommended and to identify the most important interactions that reflect the amount of the difference between the study factors that achieve the best vegetative growth.

## 2. Materials and methods

A field experiment was carried out at the Abu Ghraib Research Station of the Agricultural Research Department for the year 2019 and 2020 according to R.C.B.D design and with three replications, following the system of split-split plots. The study included three factors. The first was the planting dates (15 March, 25 March and 5 April) allocated to the main plot. Second factor was and amino acids (proline, arginine) at a concentration of 200 mg. L<sup>-1</sup> as well as the control treatment without spraying which allocated to the (Sub-plot), where the nutrient solutions sprayed with two sprays, the first in the 7-leaf stage of vegetative growth and the second at the beginning of the male flowering in the early morning. While the varieties (Rabi, Fajr 1 and Baghdad 3) occupied the sub-sub-plot. The experiment land was plowed, smoothed and leveled, some of its characteristics are shown in Table (1). After that, the field was divided into three replicates, the distance between them is (2 m), each replicate contained 27 experimental units, and the dimension of the experimental unit was (3 x 4) m, and the distance between furrows was 75 cm and between hills 25 cm, with a plant density of 53,333 plants ha<sup>-1</sup>. The seeds were planted by hand. The experiment was fertilized with nitrogen fertilizer at a rate of 320 kg N ha<sup>-1</sup> in the form of urea (46% N), and it was added in three batches, the first at planting, the second when the plant reached a height of 30 cm, and the third at the beginning of male flowering. Triple superphosphate fertilizer (P<sub>2</sub>O<sub>5</sub> 46%) was also added at a rate of 200 kg per hectare at one time at planting [5]. The stem borer insect was controlled with the granulated diazinon insecticide 15% active ingredient at a rate of 6 kg ha<sup>-1</sup> in two batches, the first after 20 days of emergence and the second 15 days after the first batch.

Ten plants were taken from the midlines and their growth characteristics were measured: The number of days from planting up to 75% male and female flowering, and leaf area (cm<sup>2</sup>), which were measured according to the following equation:

$$\text{Leaf area} = \text{Square length of the leaf under the ear} / 0.75 \quad [6]. \quad (1)$$

Determination of the chlorophyll content in the SPAD using a handheld digital SPAD - 502 meter and reading the result directly in the field [7]. The proline was also estimated in the leaves ( $\text{mg gm}^{-1}$ ) using the Bates method [8], as proline is then estimated using the following equation:

$$\text{Proline } (\mu\text{moles per gram tissue}) = \frac{\text{Reading} \times 20}{\text{Sample weight (gm)}} \times 1.47 \quad (2)$$

The amino acid arginine was also determined on the basis of total nitrogen by using the Kjeldal method and according to the following method [9]:

$$\text{Arginine amino acid percentage} = \text{Total nitrogen percentage} \times 3.2 \quad (3)$$

Table 1. the chemical and physical characteristics of the soils of the studied seasonal field

Parameter	Spring season1	Spring season 2	Unit
EC	3.33	3.51	$\text{dc m}^{-1}$
pH	7.14	7.27	-
Silt	585	538	$\text{gm kg}^{-1}$ soil
Sand	255	267	$\text{gm kg}^{-1}$ soil
Clay	160	195	$\text{gm kg}^{-1}$ soil
Texture	Silty Clay Loam		
N (available)	24.3	29.6	$\text{mg kg}^{-1}$ soil
P (available)	13.25	12.6	$\text{mg kg}^{-1}$ soil
K (available)	163	154	$\text{mg kg}^{-1}$ soil
$\text{CaCO}_3$	2.5	2.4	$\text{mmol/L}$

### 3. Results and Discussion

*3.1. The number of days from planting to 75 male flowering.* The variety Rabi 'needed fewer days to reach 75% male flowering (70.33 days), while the Fajr1 variety recorded the highest number of days to reach that stage (71.30 days), which did not differ significantly from the variety Baghdad 3, which took 71.15 days to reach this stage of flowering for the second season only (Table 2). The reason may be attributed to the different genetic makeup of the cultivated varieties, which by nature, some of them may be late in flowering and the other may be early in flowering because this trait is greatly affected by the genetic factor. This finding was consistent with Taha et al. [10] Sharif and AL-Rawi [11]. The results also showed that the two dates (April 5 and March 25) recorded the lowest number of days to reach the stage of 75% male flowering (68.81 and 68.89 days) for both seasons respectively. Whereas, the plants planted on March 15 took the longest time to reach this stage (77.78 and 72.93) days for both seasons, respectively.

The difference between planting dates in the number of days to reach the stage of 75% male flowering. The reason may be due to the difference in the length of the light period, temperature and humidity, and the interaction between them from time to time and from year to year, which is reflected in the length and shortness of the vegetative growth stage and then the beginning of the reproductive growth and the emergence of sexual organs. This result is in agreement with Mahmoud *et al.* [12]. The results also showed that there is a significant interaction between planting dates and varieties, and this interaction fluctuated and differed in presentation and delay in the date of planting. As the plants of the Rabi variety planted on March 25 gave the least number of days to reach this stage (68.67 days), which did not differ significantly from the rest of the varieties planted at the same date, while the interaction between the early date (March 15) and plants of variety Baghdad 3 gave the longest time to reach the stage of 75% male flowering, which reached 73.78 days for the second season only. The results also showed that the planting date had the largest and main role in influencing this characteristic. The three-way interaction had a significant effect on the time to reach 75 male blooms in the second season only. As the plants of the variety Baghdad 3 gave the least time to reach this

stage (67 days) when planted on March 25 under the influence of arginine, and the longest period to reach 75 male blooms when planted on March 15 and sprayed with distilled water (74.03 days).

Table 2. The effect of cultivar, amino acids, and planting dates on number of days from planting up to 75% of the male flowering for the spring season for the years 2019 and 2020.

		First season 2019				Second season 2019			
Planting date	Amino acid	Verities			Date x Amino	Verities			Date x Amino
		Rabi	Baghdad 3	Fajr 1		Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	77.33	79.67	78.00	78.33	71.33	74.03	72.33	72.59
	Prolin	77.33	78.00	77.67	77.67	73.67	73.33	72.67	73.22
	Arginin	77.67	77.67	76.67	77.33	72.33	74.00	72.67	73.00
3/25	Dist. Water	76.00	74.00	75.67	75.22	67.67	70.00	67.67	68.44
	Prolin	75.00	75.33	74.00	74.78	67.67	70.00	70.00	69.22
	Arginin	73.67	74.00	75.67	74.44	70.67	67.00	69.33	69.00
4/5	Dist. Water	69.33	68.67	69.33	69.11	69.67	70.67	72.33	70.89
	Prolin	68.67	68.33	68.67	68.56	68.67	69.00	71.33	69.67
	Arginin	68.00	68.33	70.00	68.78	71.33	72.33	73.33	72.33
L.S.D 5%		n.s			n.s		2.62		n.s
		Dates				Dates			
Dates* variety	3/15	77.44	78.44	77.44	77.78	72.44	73.78	72.56	72.93
	3/25	74.89	74.44	75.11	74.81	68.67	69.00	69.00	68.89
	4/5	68.67	68.44	69.33	68.81	69.89	70.67	72.33	70.96
L.S.D 5%		n.s			2.14		1.73		1.60
		Amino Acid				Amino Acid			
Amino × Variety	Dist. Water	74.22	74.11	74.33	74.22	69.56	71.56	70.78	70.63
	Prolin	73.67	73.89	73.44	73.67	70.00	70.78	71.33	70.70
	Arginin	73.11	73.33	74.11	73.52	71.44	71.11	71.78	71.44
L.S.D 5%		n.s			n.s		n.s		n.s
Variety		73.67	73.78	73.52		70.33	71.15	71.30	
L.S.D 5%		n.s			0.82				

3.2. Number of days from planting to 75% of female flowering. The results of Table (3) indicate that there are significant differences between the varieties in the number of days from planting and up to 75% female flowering, as the plants of the variety Rabi recorded the lowest average for this trait (72.78 days), while the plants of the var. Fajr 1 gave the longest period to reach the stage (73.81 days). This is consistent with the findings of Hussein [13] and Taha *et al.* [10] who indicated that the varieties differed among themselves in the time required to reach the stage of female flowering. The results also showed that there were significant differences in the different planting dates for the studied trait. The plants planted on April 5 and March 25 gave the lowest number of days to reach the stage of 75% female flowering (71.93 and 71.19 days), while planting data of March 15 recorded the longest period (80.67 and 75.63 Day) for both seasons respectively. The reason may be due to the high temperatures, the lack of humidity and the long period of solar brightness, which accelerated the stages of crop growth and thus directly affects the stage of female flowering in addition to that early in

the two dates (April 5 and March 25) in the time period required to reach the stage of male flowering, which led to behavior similar to the female flowering of these dates. This confirms what Al-Kaisy [14] found. The results also showed a significant interaction between planting dates and varieties, as the plants of the Rabi variety when planted on March 25 recorded a significant decrease in the number of days to reach this stage (70.89 days), while the period increased to reach 75 female flowering (75.22 days) for plants of the variety Baghdad 3. When planting on March 15 for the second season only. The results indicated that there was a significant interaction between planting dates and amino acid spraying for the second season only. As the amino acid proline added on the cultivated plants on March 25 recorded the shortest period (71.00 days), while the control treatment sprayed with distilled water on March 15 gave the longest period to reach this stage (76.44 days).

Table 3. The effect of cultivar, amino acids, and planting dates on number of days from planting up to 75% of the female flowering for the spring season for the years 2019 and 2020.

Planting date	Amino acid	First season 2019				Second season 2019				
		Varieties			Date x Amino	Varieties			Date x Amino	
		Rabi	Baghdad 3	Fajr 1		Rabi	Baghdad 3	Fajr 1		
3/15	Dist. Water	80.33	82.33	80.67	81.11	76.67	76.67	76.00	76.44	
	Prolin	80.33	81.33	80.33	80.67	74.33	76.00	74.67	75.00	
	Arginin	80.00	80.67	80.00	80.22	74.67	76.67	75.00	75.44	
3/25	Dist. Water	78.33	77.00	79.33	78.22	70.43	72.33	70.33	71.03	
	Prolin	77.33	77.67	76.67	77.22	69.67	71.67	71.67	71.00	
	Arginin	77.00	76.33	78.00	77.11	72.67	70.00	72.00	71.56	
4/5	Dist. Water	72.33	72.00	72.00	72.11	71.33	72.67	75.00	73.00	
	Prolin	71.67	71.33	72.00	71.67	71.67	72.33	74.00	72.67	
	Arginin	71.33	71.33	73.33	72.00	73.67	75.00	75.67	74.78	
L.S.D 5%		n.s			n.s		n.s		n.s	
Dates* variety			Dates				Dates			
	3/15	80.22	81.44	80.33	80.67	75.22	76.44	75.22	75.63	
	3/25	77.56	77.00	78.00	77.52	70.89	71.33	71.33	71.19	
	4/5	71.78	71.56	72.44	71.93	72.22	73.33	74.89	73.48	
L.S.D 5%		n.s			3.23		1.27		0.96	
Amino × Variety			Amino Acid				Amino Acid			
	Dist. Water	77.00	77.11	77.33	77.15	72.81	73.67	73.33	73.27	
	Prolin	76.44	76.78	76.33	76.52	72.67	73.56	73.89	73.37	
	Arginin	76.11	76.11	77.11	76.44	73.67	73.89	74.22	73.93	
L.S.D 5%		n.s			n.s		n.s		n.s	
Variety		76.52	76.67	76.93		72.78	73.70	73.81		
L.S.D 5%		n.s			0.73					

3.3. *Number of leaves per plant (leaf plant<sup>-1</sup>)*. The results showed in Table (4) that spraying with amino acids on the vegetative part had a significant effect on the leaves number, as it gave the treatment of spraying with proline at a concentration of 200 mg. Liter<sup>-1</sup> the higher number of leaves (13.58 and 14.65 leaf plant<sup>-1</sup>). While the number of leaves in plants decreased to 12.93 and 13.47 leaf plant<sup>-1</sup> when sprayed with distilled water and arginine for both seasons respectively. The reason for the superiority of proline may be due to its main role in regulating the osmotic effort and the expansion of the ability of cells to absorb water and nutrients, which leads to an increase in the cells division responsible for the formation of special tissues for each organ in the plant. This result was similar to

what a number of researchers had indicated that spraying proline on the shoots increased the number of leaves [15]. The difference in planting dates in the first season led to significant differences in the number of leaves (Table 4). the plants planted on March 15 gave the highest number of leaves (13.89 leaves. Plant<sup>-1</sup>), outperforming the rest of the other dates, while the late date (April 5) recorded the lowest average number of leaves (12.96 leaves. Plant<sup>-1</sup>). This is in line with what Kazem [16] found, who evaluated the performance of introduced varieties of maize according to the effect of planting dates and at different locations. Also, there was a significant response to varieties, amino acids, and planting dates in the first season only. Plants of the variety Fajr 1 when sprayed with proline and planted on March 15 gave the highest average number of leaves (14.91 leaves. Plant<sup>-1</sup>), The lowest response was (12.50 leaves. Plant<sup>-1</sup>) when planting cultivar plants Baghdad 3 on April 5 and spraying them with distilled water for the first season

Table 4. The effect of cultivar, amino acids, and planting dates on number of leaves of maize.

Planting date	Amino acid	First season 2019				Second season 2019			
		Verities			Date x Amino	Verities			Date x Amino
		Rabi	Baghdad 3	Fajr 1		Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	12.917	13.667	13.500	13.36	13.33	14.17	13.51	13.67
	Prolin	13.750	13.583	14.917	14.08	14.68	15.10	15.95	15.24
	Arginin	14.583	13.917	14.250	14.25	14.32	9.05	14.89	12.75
3/25	Dist. Water	12.917	12.750	12.917	12.86	13.40	13.66	13.66	13.57
	Prolin	13.667	13.667	13.000	13.44	14.85	14.99	15.15	15.00
	Arginin	12.757	12.750	13.083	12.86	13.62	13.89	14.42	13.98
4/5	Dist. Water	12.667	12.500	12.590	12.58	13.65	13.41	14.00	13.69
	Prolin	13.083	13.500	13.083	13.22	13.44	14.31	13.42	13.72
	Arginin	13.083	13.333	12.833	13.08	13.81	13.76	13.43	13.67
L.S.D 5%		0.84		n.s		n.s		n.s	
Dates									
Dates* variety	3/15	13.750	13.722	14.222	13.89	14.11	12.77	14.78	13.89
	3/25	13.113	13.056	13.000	13.05	13.95	14.18	14.41	14.18
	4/5	12.944	13.111	12.836	12.96	13.63	13.83	13.61	13.69
L.S.D 5%		n.s		0.35		n.s		n.s	
Amino Acid									
Amino × Variety	Dist. Water	12.833	12.972	13.002	12.93	13.46	13.74	13.72	13.64
	Prolin	13.500	13.583	13.667	13.58	14.32	14.80	14.84	14.65
	Arginin	13.474	13.333	13.389	13.39	13.91	12.24	14.25	13.47
L.S.D 5%		n.s		0.35		n.s		0.90	
Variety		13.26	13.29	13.35	13.90		13.59	14.27	
L.S.D 5%		n.s		n.s		n.s		n.s	

3.4. Leaf Area (cm<sup>2</sup>). The results of Table (5) showed that the cultivars had a significant effect on this trait for both seasons, as the variety Rabi'a gave the highest average of the leaf area of 5441 and 4933 cm<sup>2</sup> for both seasons respectively, while the two varieties Fajr 1 and Baghdad 3 gave the lowest average for this characteristic, which amounted to 5171 and 4802 cm<sup>2</sup> for the two seasons, respectively. The difference between varieties may be due to the genetic variation between them, which was reflected in their ability to respond to the surrounding environmental factors, and then their difference in the characteristic of the leaf area. This result was consistent with those of Khan *et al.*

[17]. It is also noticed from Table (5) that spraying with amino acids on the shoots increased the average leaf area significantly compared to the control treatment for both seasons. The highest mean for leaf area achieved when plants sprayed with proline at a concentration of 200 mg. Liter<sup>-1</sup> (6038 and 5247 cm<sup>2</sup>) for the two seasons respectively. While the control treatment, spraying with distilled water, recorded the lowest leaf area in both seasons (4644 and 4477 cm<sup>2</sup>) respectively. The reason may be due to the role of proline, which works to preserve osmosis, control the opening and closing of stomata, and maintain a balance between taking carbon dioxide entering the plant and losing water during the transpiration process. It is also considered a store of carbon and nitrogen and works to sweep free radicals and thus protect enzymes and membranes from side effects in addition to proline containing the main group of amines in building and maintaining chlorophyll, thus the proportion of chlorophyll increases and thus the photosynthesis process on which plants depend mainly in the formation of the vegetative parts, including the leaf area. This finding is consistent with Saddon and Zuraini [15]. The results also show that there are significant differences between planting dates for the first season only, as the plants planted on March 15 surpassed by giving their plants the highest leaf area of 5657 cm<sup>2</sup> compared to the late April 5, which gave the least leaf area (5034 cm<sup>2</sup>). The reason may be due to the exposure of plants at an early date to a suitable temperature and light period that led to the continuation of the process of expansion and division of cells and increasing the leaf area, and these results are in agreement with the results of Kazem [16]. The results indicated the significant interaction between varieties and amino acids in the first season only. There was a direct increase in the leaf area when the variety Rabie was sprayed with the amino acid proline at a concentration of 200 mg. L-1 with an average (6298 cm<sup>2</sup>), this area decreased when treating the cultivar Fajr 1 with distilled water 4382 cm<sup>2</sup> in the first season only. From this interaction, it is noticed the important role that proline plays in increasing the photosynthesis process and transferring the products of this process to the areas needed by the Rabie variety, taking advantage of its genetic potential and its physiological characteristics with high efficiency, thus achieving the largest leaf area. The three-way interaction had a significant effect on this characteristic for the first season only. The plants of the Rabi 'variety when sprayed with proline at the early date (March 15) recorded the highest leaf area of 6698 cm<sup>2</sup>, while the plants of the Fajr 1 variety, with the comparison treatment at the first planting date, gave the lowest average of the leaf area (3963 cm<sup>2</sup>).

Table 5. The effect of cultivar, amino acids, and planting dates on leaf area of maize.

Planting date	Amino acid	First season 2019				Second season 2019			
		Varieties			Date x Amino	Varieties			Date x Amino
		Rabi	Baghdad 3	Fajr 1		Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	4824	5275	5037	5045	4701	4589	4293	4528
	Prolin	6698	6207	5788	6231	5146	5314	5340	5267
	Arginin	5553	5272	6256	5694	5012	4984	5301	5099
3/25	Dist. Water	4642	5203	3963	4603	4512	4038	4291	4280
	Prolin	6075	6354	6033	6154	5268	5205	5525	5333
	Arginin	5638	5002	4962	5201	5069	4942	4941	4984
4/5	Dist. Water	4410	4294	4147	4284	4626	4226	4415	4422
	Prolin	6121	5808	5260	5730	5289	5045	5090	5141
	Arginin	5003	5171	5093	5089	4775	4879	4867	4840
L.S.D 5%			599.5		n.s		n.s		n.s
Dates									
Dates* variety	3/15	5692	5585	5694	5657	4953	4962	4978	4965
	3/25	5452	5520	4986	5319	4950	4728	4919	4866
	4/5	5178	5091	4833	5034	4897	4717	4790	4801
L.S.D 5%			n.s		198.1		n.s		n.s
Amino Acid									
Amino x Variety	Dist. Water	4626	4924	4382	4644	4613	4285	4333	4411
	Prolin	6298	6123	5694	6038	5234	5188	5318	5247
	Arginin	5398	5148	5437	5328	4952	4935	5036	4974
L.S.D 5%			348.9		173.9		n.s		117.2
Variety		5441	5399	5171		4933	4802	4896	
L.S.D 5%			220.9				112		



**3.5. Chlorophyll content in leaves (Spad).** The results of Table (6) indicated that spraying with proline amino acid at a concentration of 200 mg. L<sup>-1</sup> recorded the highest average for this trait, which reached 53.23 and 52.43 Spad for both seasons respectively, and the chlorophyll content of the plant decreased when spraying with distilled water, recording the lowest average for the trait (47.78 and 46.12 Spad) for the two seasons respectively. Exposing the plant to any stress (heat, salt, or dehydration) causes a decrease in the pigments of photosynthesis, the most important of which is chlorophyll. It is also known that chlorophyll is esters of amino acids, and the addition of proline, which is a store of carbon and nitrogen, works to protect enzymes and membranes from side effects. Consequently, it increases the activity of enzymes that delay aging in the leaves and reduce the production of free radicals, as they act as a scavenger material for these compounds (ROS), which is positively reflected in the activity of the photosynthesis process and increasing the chlorophyll content [18]. This finding is in agreement with Al-Hamdani and Muhammad [19]. The planting dates also had a significant effect in the chlorophyll index, as the date of March 25 achieved the highest average for the chlorophyll index, which reached 50.73 spad, and there were no significant differences between it and the late date, while the first date recorded the lowest index of chlorophyll (48.65 spad). The results also indicate the significant interaction between the planting dates and the amino acids for both seasons, as the proline amino acid spraying at early date of March 15 and the late date of April 5 achieved the highest average for this characteristic (54.27 and 53.06 spad) for both seasons respectively, while spraying with distilled water was given on March 15 Also, on April 5, the lowest average for the trait was 45.68 and 44.39 Spad for the two seasons, respectively.

Table 6. The effect of cultivar, amino acids, and planting dates on chlorophyll content (SPAD) of maize.

Planting date	Amino acid	First season 2019				Date x Amino	Second season 2019			
		Verities			Date x Amino		Verities			Date x Amino
		Rabi	Baghdad 3	Fajr 1			Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	46.72	46.35	43.98	45.68	44.17	45.67	46.33	45.39	
	Prolin	54.80	55.27	52.73	54.27	50.00	51.33	52.33	51.22	
	Arginin	54.50	52.14	53.45	53.36	48.67	49.33	50.00	49.33	
3/25	Dist. Water	45.44	48.97	50.08	48.16	47.77	48.33	49.67	48.59	
	Prolin	52.53	52.75	54.57	53.28	53.33	53.00	52.67	53.00	
	Arginin	50.23	54.36	52.71	52.43	49.83	49.67	52.33	50.61	
4/5	Dist. Water	49.41	49.69	49.42	49.51	44.61	43.17	45.40	44.39	
	Prolin	52.62	52.02	51.75	52.13	51.27	54.07	53.83	53.06	
	Arginin	50.15	51.33	52.78	51.42	50.77	52.93	52.13	51.94	
L.S.D 5%		n.s			2.52	n.s			1.716	
Dates* variety	3/15	52.01	51.26	50.05	51.10	47.61	48.78	49.56	48.65	
	3/25	49.40	52.03	52.45	51.29	50.31	50.33	51.56	50.73	
	4/5	50.73	51.02	51.31	51.02	48.88	50.66	50.46	49.80	
L.S.D 5%		n.s			n.s	n.s			1.425	
Amino × Variety	Dist. Water	47.19	48.34	47.83	47.78	45.51	45.72	47.13	46.12	
	Prolin	53.32	53.35	53.01	53.23	51.53	52.80	52.94	52.43	
	Arginin	51.63	52.61	52.98	52.41	49.76	50.64	51.49	50.63	
L.S.D 5%		n.s			1.53	n.s			0.946	
Variety		50.71	51.43	51.27		48.93	49.72	50.52		
L.S.D 5%		n.s				n.s				

**3.6. Proline acid concentration ( $\text{mg gm}^{-1}$ ) in leaves.** The results referred to in Table (7) show that the Fajr-1 cultivar significantly outperformed the rest of the other varieties by giving it the highest average concentration of proline acid in the leaves ( $2.26 \text{ mg gm}^{-1}$ ), while the lowest average for this characteristic belongs to the cultivar Rabi ( $2.09 \text{ mg gm}^{-1}$ ), which did not differ significantly from the variety Baghdad 3, for the first season only. The reason may be due to the difference between these varieties among themselves in the leaves absorbing acid when sprayed, filling their tissues and increasing the concentration in them. The results of the study also showed that the difference in amino acids had a significant effect on the content of proline in the leaves, as the plants sprayed with proline at a concentration of  $200 \text{ mg L}^{-1}$  recorded the highest average of  $2.70$  and  $2.64 \text{ mg gm}^{-1}$  for the two seasons respectively, compared to the control treatment which recorded the lowest mean of ( $1.70$  and  $1.78 \text{ mg gm}^{-1}$ ) for both seasons respectively (Table 7). The reason for the increase in its concentration may be due to the increased absorption of this acid by the leaves and its increased concentration in them, as well as the role of this acid in influencing the opening and closing of the stomata, which facilitated the passage of proline into the leaves and thus increased its accumulation inside the tissues. This result is consistent with the findings of Al-Zuhri [20]. The planting dates also had a significant effect on the concentration of proline acid in the leaves, as the cultivation on March 25 gave the highest average of  $2.39 \text{ mg gm}^{-1}$  without significantly different from the early date of March 15, this percentage decreased when planting late on April 5, which recorded the lowest proline content in leaves ( $1.90 \text{ mg gm}^{-1}$ ). The two-way interaction between the cultivars and the amino acids had a significant effect on the average of this trait for the first season only. Plants of the Fajr 1 cultivar, Table 7. Effect of cultivar, amino acids and planting dates on the characteristic of proline concentration in leaves ( $\text{mg gm}^{-1}$ ) for the spring season for the years 2019 and 2020.

Planting date	Amino acid	First season 2019				Second season 2019			
		Verities			Date x Amino	Verities			Date x Amino
		Rabi	Baghdad 3	Fajr 1		Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	1.65	1.94	1.80	1.79	1.797	1.667	1.653	1.70
	Prolin	2.52	2.99	2.78	2.76	2.547	2.677	2.897	2.70
	Arginin	2.13	1.92	2.06	2.04	2.313	2.667	2.337	2.43
3/25	Dist. Water	1.86	1.94	2.00	1.93	2.060	1.903	1.777	1.91
	Prolin	2.42	2.57	3.38	2.79	2.647	2.647	2.703	2.66
	Arginin	2.61	2.21	2.53	2.45	2.523	2.420	2.643	2.52
4/5	Dist. Water	1.43	1.31	1.41	1.38	1.867	1.537	1.767	1.72
	Prolin	2.49	2.64	2.47	2.54	2.747	2.650	2.327	2.57
	Arginin	1.68	1.83	1.88	1.79	1.990	1.567	1.967	1.84
L.S.D 5%		0.314			n.s	n.s			0.44
Dates* variety	3/15	2.10	2.28	2.21	2.20	2.219	2.337	2.296	2.28
	3/25	2.30	2.24	2.63	2.39	2.410	2.323	2.374	2.36
	4/5	1.87	1.92	1.92	1.90	2.201	1.918	2.020	2.04
L.S.D 5%		0.18			0.25	n.s			n.s
Amino × Variety	Dist. Water	1.65	1.73	1.74	1.70	1.908	1.702	1.732	1.78
	Prolin	2.48	2.73	2.88	2.70	2.647	2.658	2.642	2.64
	Arginin	2.14	1.98	2.16	2.09	2.276	2.218	2.316	2.27
L.S.D 5%		0.18			0.19	n.s			0.18
Variety		2.09	2.15	2.26		2.27	2.19	2.23	
L.S.D 5%		0.10				n.s			

when sprayed with proline, achieved the highest average of  $2.88 \text{ mg. gm}^{-1}$ , significantly different from the rest of the other interactions except for the plants of variety Baghdad 3 sprayed with the amino acid proline. While the interaction between the cultivar Rabie and the control treatment, the lowest average proline concentration in leaves was  $1.65 \text{ mg. gm}^{-1}$  for the first season. The results also showed a significant interaction between varieties and planting dates in their effect on this trait. When planting on March 25, the cultivar Fajr 1 gave the highest average proline of  $2.63 \text{ mg. gm}^{-1}$ , compared to the cultivar Rabi when cultivated late April 5, the lowest mean for this trait was  $1.87 \text{ mg. gm}^{-1}$  for the first season only. The two-way interaction between planting dates and amino acids showed a significant effect on the mean of this trait for the second season only. As proline at the early date recorded the highest average of ( $2.70 \text{ mg. gm}^{-1}$ ), which did not differ significantly with proline and arginine, which was sprayed on plants on other dates, with the exception of arginine at the last date, At the same time, spraying with distilled water on the plants in early planting date gave the lowest average percentage of proline in the leaves of  $1.70 \text{ mg.gm}^{-1}$  for second season. The effect of the three-way interaction was significant between study factors on the averages of the proline trait, as the plants of the Fajr 1 cultivar grown on March 25 and sprayed with proline gave the highest mean of ( $3.38 \text{ mg. gm}^{-1}$ ), while the mean of the trait decreased significantly ( $1.31 \text{ mg. gm}^{-1}$ ) for cultivar Baghdad 3 when Plant it late on April 5 and spray it with distilled water for the first season only.

*3.7. Arginine acid concentration in leaves (%)*. The results in Table (8) showed that the Fajr-1 variety achieved the highest average leaf content of this acid (3.84 and 2.18%), while Rabie cultivar gave the lowest average for this characteristic (3.58 and 2.01%) for both seasons respectively. The spraying of amino acids on the shoot increases the percentage of essential amino acids, of which the arginine is among them, and this percentage varies according to the ability of the genotype to absorb these acids and thus the accumulation of this acid increases inside the leaves of the variety that received the largest amount of the added acid. Also, there was a significant increase in the leaves content of arginine acid when spraying arginine on the shoots of the plants of the experimental unit, which recorded the highest average for this trait, reaching 4.77 and 2.63%. compared to the control treatment, which gave the lowest average (3.61 and 1.4%) for the two seasons respectively. This increase can be explained by the treatment of the leaves with arginine as a spray and the ease of its passage from the stomata because this acid is of the free type L that is not bound, which leads to its accumulation in the tissues and thus increase its content in the leaves. This result was consistent with those of Al-Zuhri [20]. The planting dates had a significant effect on this characteristic (Table 8), as the plants cultivated on March 25 recorded the highest average percentage of arginine in the leaves, reaching 3.93 and 2.30% for both seasons respectively, while the plants cultivated in the early and late dates gave the lowest average for the studied characteristic of 3.61 and 1.95% for both seasons respectively. The effect of the interaction between varieties and amino acids significantly affected the mean of this trait for the first season only. As the Rabie cultivar scored higher and lower average for this characteristic (4.83 and 2.37%) when treated with arginine and sprayed with distilled water for the first season for both treatments respectively. We also notice that the plants of the variety Fajr 1 when planted on March 25 recorded a significant increase in the mean of this trait (4.25 and 2.59%) for both seasons respectively. Whereas, the percentage of arginine in the leaves decreased when the variety Rabi planted at the early date of March 15, and the lowest average was recorded for the aforementioned trait (3.39 and 1.89%) for the two study seasons, respectively. The interaction between amino acids and planting dates was significant for this trait for the 2020 season only. When planting on March 25, the interaction was towards increasing the average of this acid when spraying with the amino acid arginine at a concentration of 200 mg. Liter (2.83%), while the concentration of this acid decreased in the leaves for the first planting date when spraying with distilled water, with an average of  $1.29 \text{ mg.gm}^{-1}$ . The three-way interaction between the study factors was significant, as the plants of the Rabie cultivar at early planting (March 15th) under the influence of arginine outperformed the highest average for the studied trait (5.07%), while the average of this trait decreased significantly (2.18%) for the plants of the Rabi` variety at early planting and spraying with distilled water for the first season only.

Table 8. Effect of cultivar, amino acids and planting dates on the characteristic of Arginine concentration in leaves (mg gm<sup>-1</sup>) for the spring season for the years 2019 and 2020.

Planting date	Amino acid	First season 2019				Date x Amino	Second season 2019			
		Verities			Date x Amino		Verities			Date x Amino
		Rabi	Baghdad 3	Fajr 1			Rabi	Baghdad 3	Fajr 1	
3/15	Dist. Water	2.18	2.387	2.303	2.29	1.187	1.387	1.303	1.29	
	Prolin	2.91	4.110	3.927	3.65	1.913	2.110	1.927	1.98	
	Arginin	5.07	4.857	4.763	4.89	2.570	2.857	2.763	2.73	
3/25	Dist. Water	2.56	2.683	3.210	2.82	1.567	1.683	2.343	1.86	
	Prolin	4.053	3.983	4.623	4.22	2.033	1.983	2.623	2.21	
	Arginin	4.917	4.453	4.940	4.77	2.917	2.787	2.807	2.83	
4/5	Dist. Water	2.370	2.270	2.360	2.33	1.370	1.270	1.360	1.33	
	Prolin	3.670	4.100	4.150	3.97	2.337	2.100	2.150	2.19	
	Arginin	4.527	5.087	4.353	4.65	2.193	2.420	2.353	2.32	
L.S.D 5%		0.47			n.s	n.s			0.29	
		Dates				Dates				
Dates* variety	3/15	3.390	3.784	3.664	3.61	1.890	2.118	1.998	2.00	
	3/25	3.846	3.707	4.258	3.93	2.172	2.151	2.591	2.30	
	4/5	3.522	3.819	3.621	3.65	1.967	1.930	1.954	1.95	
L.S.D 5%		0.27			0.22	0.28			0.21	
Amino × Variety	Dist. Water	2.374	2.447	2.624	2.48	1.374	1.447	1.669	1.49	
	Prolin	3.546	4.064	4.233	3.94	2.094	2.064	2.233	2.13	
	Arginin	4.838	4.799	4.686	4.77	2.560	2.688	2.641	2.63	
L.S.D 5%		0.27			0.26	n.s			0.17	
Variety		3.58	3.77	3.84		2.01	2.06	2.18		
L.S.D 5%		0.15				0.16				

#### 4. Conclusions

The addition of amino acids improved most of the characteristics of vegetative growth (such as plant height, leaf area and chlorophyll content in the leaves). The early spring planting with the addition of amino acids (proline and arginine) also improved most of the vegetative growth characteristics of the maize varieties used in the study.

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