Journal homepage
www.ajas.uoanbar.edu.iq
Anbar Journal of Agricultural Sciences
(University of Anbar – College of Agriculture)

EFFECT OF SPRAYING GLYCINE ACID ON GROWTH AND YIELD OF THREE SUNFLOWER GENOTYPES TREATED WITH YEAST SACCHAROMYCES CEREVISIAE

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Article info

Received: 2023-02-23
Accepted: 2023-04-05
Published: 2025-06-30

DOI-Crossref:
10.32649/ajas.2025.187493

Cite as:
Al-Janabi, A. S. A., Al-Rawi, A. A., and Al-Ani, M. H. (2025). Effect of spraying glycine acid on growth and yield of three sunflower genotypes treated with yeast saccharomyces cerevisiae. Anbar Journal of Agricultural Sciences, 23(1): 22-32.

Abstract

A field experiment was conducted during the spring season for 2021 and 2022 year in the Buddiab area of the Ramadi District, in soil with sandy clay loam, aim to study the effect of spraying glycine concentrations (0, 100, 200, and 300 mg L^{-1}) on the growth, yield, and quality of three sunflower genotypes (Sakha, Lulwa and Aqmar) treated with yeast *Saccharomyces cerevisiae*. The experiment was carried out in a Split-Plot arrangement according to a completely randomized block design (R.C.B.D) with three replications in 36 experimental units, where the Glycine concentrations represented the main plots, and genotypes represented sub-main plots. The main results of the experiment were summarized as follows. The genotypes had a significant effect on most of the traits included in the study, where the variety Lulwa was superior in both seasons in traits of fertility ratio per seed and yield of seeds per, while the variety Aqmar was superior in the second season only in trait of plant height and in both seasons in trait of oil percentage per seeds .The effect of spraying with different glycine concentrations on many of the traits included in the study. The concentration superior is 300 mg L^{-1} in plant height traits, fertility ratio per seed, yield of seeds per seed, and oil percentage per seed, and the concentration superior is 200 mg L^{-1} in the first season, only in the weight of 1000 seeds.

Keywords: Glycine concentrations, Yeld of seeds, Oil percentage, Yeast.

تأثير رش حامض الكلايسين في نمو وحاصل ثلاثة تراكيب وراثية من زهرة الشمس المعاملة بخميرة الخبز Saccharomyces cerevisiae

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الخلاصة

نُفذت التجربة الحقلية في الموسم الربيعي للعامين 2021 و2022 في منطقة البوذياب التابعة لقضاء الرمادي، في تربة ذات نسجة رملية طينية غرينية بهدف دراسة تأُثير رش تراكيز الكلايسين (0، 100، 200 و300 ملغم لتر$^{-1}$) في نمو وحاصل ونوعية ثلاثة اصناف من زهرة الشمس (سخا، لولوة و أٌقمار) المعاملة بمستخلص خميرة الخبز الجافة *Saccharomyces cerevisiae*. نُفذت التجربة وفق ترتيب الالواح المنشقة Split Plot بتصميم القطاعات العشوائية الكاملة R.C.B.D وبثلاث مكررات بواقع 36 وحدة تجريبية، حيث احتلت تراكيز الكلايسين الالواح الرئيسية واحتلت الاصناف الالواح الثانوية. وتلخصت أهم النتائج كالآتي. اثرت الاصناف معنوياً في اغلب الصفات الداخلة في الدراسة، فقد تفوق الصنف لولوة في كلا العامين 2021 و2022 في صفات نسبة الخصب بالبذور وحاصل البذور الكلي، وتفوق الصنف اقمار في العام الثاني فقط في صفة ارتفاع النبات وفي كلا العامين في صفة نسبة الزيت في البذور. اثر الرش بتراكيز الكلايسين المختلفة في العديد من الصفات الداخلة في الدراسة، فقد تفوق التركيز 300 ملغم لتر$^{-1}$ في صفات ارتفاع النبات ونسبة الخصب بالبذور وحاصل البذور الكلي ونسبة الزيت في البذور، وتفوق التركيز 200 ملغم لتر$^{-1}$ في العام الاول فقط في صفة وزن 1000 بذرة.

كلمات مفتاحية: تراكيز الكلايسين، حاصل البذور، نسبة الزيت، نسبة الخصب، خميرة الخبز.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops, ranking third in global production after soybean and palm oil. The oil content of sunflower seeds can reach up to 55%, contributing approximately 14% of the world's total vegetable oil production (15). Sunflower oil is highly valued for its light color, high unsaturated fatty acid content, mild flavor, and high smoke point. As a result, it is widely used in human nutrition and various industries, including paint, plastics, soap, and detergents (2). Additionally, sunflower meal, a byproduct of oil extraction, is commonly used as animal feed for ruminants and poultry due to its high nutritional value, containing approximately 40% protein and 20–25% carbohydrates.

Due to the low productivity of this crop in Iraq, several methods have been followed to increase production, including the use of new and good genotypes with a high capacity to exploit the available growth resources to increase production and attention to the genetic factor of these genotypes and their suitability to the surrounding environmental conditions, in order to achieve the best growth and production for these genotypes. Many modern methods exist for preparing plants with food to increase production (5), including spraying glycine, an amino acid. Adding glycine by spraying it on the leaves is like providing a ready meal for plants, as amino acids are the main component of protein. Glycine is a powerful chelating agent for trace elements, as its molecular weight is minimal and facilitates its penetration into the plant. Glycine increases the plants' tolerance to adverse and complex conditions, such as heat, drought, salinity, and frost, by entering amino acids, especially glycine and glutamic acid, into the formation of the chlorophyll molecule. Using them thus increases the efficiency and rate of photosynthesis in plants, which helps the plant maintain its distinctive green color. In addition, amino acids, along with potassium, play a role in opening and closing the stomata of guard cells and the level of abscisic acid (ABA) (25 and 28). Yeast, especially dried baker's yeast (*Saccharomyces cerevisiae*), increases the dry matter accumulated in plant leaves by enhancing the efficiency of photosynthesis, which increases final production. Yeast also contains tryptophan, which contributes to the formation of auxins. Based on the above, the study aims to identify the best genotypes in response to the studied factors, identify the best factors affecting growth characteristics and yield, and apply the factors under study to obtain the highest production and best quality.

Materials and Methods

The field experiment was carried out during the spring season of 2021 and 2022 in the Al-Budhyab area, Ramadi district, Anbar Governorate, Iraq, using a split-plot arrangement according to Randomized Complete Block Design (R.C.B.D) with three replicates. The investigation aims to study the effect of spraying different concentrations of glycine acid on the growth, yield, and quality of three sunflower genotypes, whose seeds were soaked before planting for one hour in prepared yeast extract 2 g L^{-1}, which was prepared from distilled water with 10% sugar. The main plots included four concentrations of glycine sprayed at 0, 100, 200, and 300 mg L^{-1}, which were sprayed on the plants after the emergence of 4-5 leaves and before the first flower. The secondary plots included the three studied genotypes: Sakha, Aqmar, and Lulua. The experiment included three replicates and 36 experimental units, with the area of each experimental unit being 3x3, the distance between holes was 40 cm, and the distance between rows was 50 cm to achieve a plant density of 50,000 plants ha^{-1}. The experiment was planted on 15/3 for both years by placing three seeds in each hole, and then the experimental land was irrigated depending on the soil moisture and plant condition. Ten days after germination, the plants were thinned to one plant per hole. Weeding was done whenever necessary to eliminate weeds and their non-competition with the crop. Phosphate fertilizer was added before planting and mixed with the soil in one batch at a rate of 200 kg ha^{-1} in the form of triple superphosphate P2O5 (46%). Nitrogen fertilizer was added at a rate of 360 kg ha^{-1} in the form of urea (46% N) in three batches: the first when 4-5 leaves appeared, the second at the stage of 8-9 leaves, and the third was added at the beginning of flowering (7). Nets were placed to protect the plants and limit bird attacks. When signs of ripening appeared on the crop, such as yellowing of the back of the disc, yellowing of the end of the stem, drying of most of the leaves, the seeds taking on their natural color specific to each variety, and the hardening of their shells and contents, the harvesting process was completed.

Measured Characteristics:

ten plants were randomly chosen from the crop, specifically from the protected central rows within each experimental unit. The analyzed traits included:

Plant height (cm): Determined by measuring the distance from the plant's base at the soil level to the base of the capitulum.

1000-seed weight: A randomly selected sample of 1000 seeds was obtained from the total harvested yield of each experimental unit and weighed using a precision electronic balance.

Seed fertility percentage (%): A 50 g seed sample was randomly taken from each experimental unit. The number of full and empty seeds was recorded to compute the fertility percentage based on the following equation:

Seed Fertility Percentage (%): The fertility percentage was determined using the following equation:

Total Seed Yield (tons ha^{-1})

The total seed yield was calculated using the formula (8):

$$\text{Fertility Percentage} = \left(\frac{\text{Number of filled seeds}}{\text{Number of filled seeds} + \text{Number of empty seeds}}\right) \times 100$$

Total seed yield = Average seed yield per plant for each treatment × Plant density

Total seed yield = Average seed yield per plant for each treatment × Plant density

The result was then converted into tons per hectare (tons ha^{-1}) (1)

Seed Oil Percentage (%)

The oil content in seeds was measured based on dry weight using a Soxhlet apparatus, following the method outlined by the American Association of Official Analytical Chemists (AOAC) (13). The oil percentage was determined as follows:

$$Oil\ percentage = \left(\frac{Weight\ of\ extracted\ oil\ from\ the\ sample}{Weight\ of\ the\ sample\ seed}\right) \times 100$$

Statistical Analysis: After data collection and organization, the experiment results for each year were analyzed separately using the GenStat computer software. The Least Significant Difference (L.S.D) test was applied to distinguish between statistically different means at a significance level of 0.05 (10).

Results and Discussion

Plant Height: Table 1 indicated significant differences in plant height as influenced by genotype and glycine application. The results showed that the Sakha genotype achieved the maximum plant height in 2021, with a value of 183.51 cm, which did not significantly differ from the Aqmar genotype, which had an average plant height of 183.48 cm. Both genotypes significantly outperformed the Lulwa genotype, which had an average plant height of 181.19 cm. In 2022, the Aqmar genotype recorded the highest average plant height of 207.99 cm, significantly differing from the Sakha and Lulwa genotypes, with average heights of 202.93 cm and 202.64 cm, respectively. These findings are consistent with the results of other researchers, including (6, 22, 24 and 27).

The results in Table 1 showed that plants sprayed with glycine at a concentration of 300 mg L^{-1} achieved the highest average plant height in 2021, reaching 197.44 cm, compared to the concentrations of 0, 100, and 200 mg L^{-1}, which produced average plant heights of 168.12 cm, 174.56 cm, and 190.78 cm, respectively. In 2022, the same glycine concentration (300 mg L^{-1}) resulted in the highest average plant height of 218.28 cm. The reason for the increased plant height is that the spraying was done in two stages: the sixth true leaf and the onset of floral bud formation. The first stage corresponds to the beginning of vegetative growth (stem and leaves), and the second stage occurs while the stem is still in the growth phase. The timing of the spray concerning these growth stages likely promoted elongation, enhanced the plant's vital activity, particularly cell division and expansion, and increased enzymatic activity, which facilitates the release of nutrients, making them more available to the plant, thereby boosting its growth rate (12 and 23). These results are consistent with the findings of (16, 18 and 19), who also reported a significant effect of increasing glycine concentrations on this trait.

Table 1: Effect of genotypes and glycine concentrations on sunflowers' plant height (cm) treated with yeast for 2021 and 2022.

	Spring 2021					Spring 2022				
Genotypes	Concentration				Average	Concentration				Average
	0	100	200	300		0	100	200	300	
Sakha	164.17	180.33	189.33	200.20	183.51	193.53	205.50	200.93	211.73	202.93
Lulwa	178.00	167.93	190.57	188.27	181.19	190.07	198.33	202.33	219.83	202.64
Aqmar	162.20	175.40	192.43	203.87	183.48	186.57	206.50	215.57	223.27	207.98
Average	168.12	174.56	190.78	197.44		190.06	203.44	206.28	218.28	
L.S.D	Concentration	Genotypes				L.S.D	Concentration	Genotypes		
	1.15	2.00					3.25	2.37		

Table 1: The effect of genotypes and glycine concentrations on the plant height (cm) trait of sunflowers treated with yeast for the years 2021 and 2022 shows that plants sprayed with glycine at a concentration of 300 mg L^{-1} were superior, giving them the highest average plant height for the year 2021, reaching 197.44 cm. In 2022, the same concentration of glycine, 300 mg L^{-1}, gave the highest average, reaching 218.28 cm.)

Weight of 1000 seeds: The results of data analysis in Table 2 showed significant differences between the genotypes used under study and the concentrations of glycine in this trait, as the Lulua variety outperformed by having the heaviest seeds per 1000 seeds with an average of 75.73g and significant differences from the rest of the genotypes that recorded an average weight of 1000 seeds of 74.72 and 74.81g for the Sakha and Aqmar genotypes, respectively. In the second year, 2022, the Sakha variety recorded the highest weight per 1000 seeds, reaching 71.70g, with a significant difference from the Lulua and Aqmar genotypes, which did not have a significant difference in the weight of 1000 seeds and recorded an average for the trait of 70.82 and 71.04g, respectively. This result is consistent with what was reached by (11, 14 and 17).

The data shown in Table 2 showed a significant effect of spraying with different glycine concentrations on the weight of 1000 seeds for both years. In 2021, plants sprayed with a concentration of 200 mg L^{-1} outperformed and gave the heaviest weight of 1000 seeds with an average of 79.55 g, an increase of 13.67% over the comparison treatment without spraying and a significant difference from the concentration of 100 and 300 mg L^{-1}, which gave an average weight of 1000 seeds of 72.23 and 78.59 g, respectively. The reason for the superiority of the 200 mg L^{-1} concentration in this trait may be attributed to the lack of competition between the storage parts (seeds) as it had fewer seeds than the plants sprayed with a concentration of 300 mg L^{-1} and according to the compensation principle which led to an increase in the weight of the plants sprayed with this concentration (200 mg L^{-1}). As for the year 2022, the 300 mg L^{-1} glycine spray treatment outperformed and gave the highest average for the trait, reaching 79.68 g, with an increase of 24.71% over the comparison treatment without spraying and a significant difference from the 100 and 200 mg L^{-1} glycine concentrations. This result is consistent with thxe findings of (4, 16, 18 and 19), who indicated the significance of the effect of increasing the spraying of glycine concentrations on sunflower plants in the 1000-seed weight trait.

Table 2: Effect of genotypes and glycine concentrations on the weight of 1000 sunflowers treated with yeast seeds for 2021 and 2022.

Genotypes	Spring 2021					Spring 2022				
	Concentration				Average	Concentration				Average
	0	100	200	300		0	100	200	300	
Sakha	67.30	69.21	86.33	76.05	74.72	63.39	69.52	72.34	81.55	71.70
Lulwa	71.63	76.31	76.66	78.32	75.73	59.67	67.52	78.29	77.81	70.82
Aqmar	71.01	71.17	75.66	81.39	74.81	68.61	66.46	69.39	79.69	71.04
Average	69.98	72.23	79.55	78.59		63.89	67.83	73.34	79.68	
L.S.D	Concentration	Genotypes				L.S.D	Concentration	Genotypes		
	0.68	0.53					0.47	0.59		

Table 2 Effect of genotypes and glycine concentrations on the 1000 seed weight trait of sunflowers treated with yeast for 2021 and 2022. The data showed a significant effect of spraying with different glycine concentrations on the 1000 seed weight trait for both years. In 2021, plants sprayed with a concentration of 200 mg L^{-1} outperformed those sprayed with a concentration of 200 mg L^{-1}.

Seed fertility %: Table 3 showed significant differences between the genotypes and glycine concentrations for the two years in the fertility percentage trait. The results of Table 3 showed a significant effect of the genotypes on the seed fertility percentage, as the Sakha genotype gave the highest average fertility percentage of 83.90%, significantly outperforming the Lulu and Aqmar genotypes, which reached 81.83 and 81.53%, respectively, for the first year. In the second year, the Sakha genotype also significantly outperformed Lulu by giving the highest fertility percentage of 87.90%, but it did not differ significantly from the Aqmar genotype, while it differed significantly from the Lulu genotype. This result is consistent with the results of (3, 22 and 26).

The results in Table 3 indicated a significant effect of glycine concentrations on seed fertility percentage. The fertility rate varied, with the 300 mg L^{-1} concentration achieving the highest fertility percentages of 88.04% and 92.99% for the two years, respectively, compared to the control treatment, which had fertility percentages of 74.81% and 79.75% for the same years, showing significant differences from all other concentrations. Meanwhile, the 100 mg L^{-1} and 200 mg L^{-1} concentrations showed significant differences from the control treatment, reaching 83.83% and 82.99%, respectively, with no significant difference in the first year. The higher glycine concentration's superior performance could be attributed to its direct effect on improving the plant's reproductive and vegetative traits, its ease of absorption by the plant, as well as stimulating the vitality of reproductive organs and activating other hormones, particularly auxins, which enhance pollen vitality and lead to increased fertility.

Table 3: Effect of genotypes and glycine concentrations on the percentage of seed fertility (%) of sunflowers treated with yeast for 2021 and 2022.

	Spring 2021					Spring 2022				
Genotypes	Concentration				Average	Concentration				Average
	0	100	200	300		0	100	200	300	
Sakha	75.57	86.48	83.82	89.72	83.90	81.83	88.84	86.83	94.12	87.90
Lulwa	70.39	84.01	83.79	89.12	81.83	77.17	83.91	91.89	92.29	86.32
Aqmar	78.48	81.00	81.36	85.28	81.53	80.24	88.40	89.91	92.57	87.78
Average	74.81	83.83	82.99	88.04		79.75	87.05	89.54	92.99	
L.S.D	Concentration	Genotypes				L.S.D	Concentration	Genotypes		
	2.29	1.77					2.34	1.35		

Table 3: The effect of genotypes and glycine concentrations on the trait of seed fertility percentage % for sunflowers treated with yeast for the years 2021 and 2022, and the significance of the effect of glycine concentrations on this trait. The fertility percentage varied as the concentration exceeded 300 mg L^{-1}.

Total seed yield (tons ha^{-1}): The analysis results indicated the significance of the effect of genotypes and glycine concentrations during the two years of the study. Table 4 shows that the Sakha genotype was significantly superior in both years of the study, recording the highest average seed yield per unit area of 3.813 and 3.741 tons.ha^{-1}, respectively, compared to the Lulu genotype in the first year and the Aqmar genotype in the second year, which gave the lowest average for the trait of 3.662 and 3.610 tons.ha^{-1}, respectively. These results are consistent with the results of other researchers who found a significant difference between the studied genotypes in the trait of seed yield per unit area, each of (6, 11, 14 and 17).

The results of Table 4 showed that spraying plants with a high concentration of glycine 300 mg L^{-1} achieved the highest average seed yield in the two years, amounting to 4.136 and 4.294 tons.ha^{-1}, with a significant increase of 0.946 and 1.312 tons ha^{-1} over the control plants (without spraying), which gave the lowest average for the trait, amounting to 3.190 and 2.982 tons ha^{-1}, respectively. It did not differ significantly from the concentration treatments of 200 mg L^{-1} in the first year only, while it differed significantly from all treatments in the second year. This result agreed with the results of researchers (16, 18, 19, 20 and 21), who found a positive effect of glycine in increasing the seed yield per unit area.

Table 4: Effect of genotypes and glycine concentrations on the total seed yield (tons ha^{-1}) of sunflowers treated with yeast for 2021 and 2022.

Genotypes	Spring 2021 Concentration 0	100	200	300	Average	Spring 2022 Concentration 0	100	200	300	Average
Sakha	3.185	3.645	4.280	4.142	3.813	3.285	3.495	3.827	4.359	3.741
Lulwa	3.204	3.520	3.935	3.988	3.662	2.709	3.656	4.011	4.248	3.656
Aqmar	3.182	3.368	3.891	4.278	3.680	2.952	3.521	3.690	4.276	3.610
Average	3.190	3.511	4.036	4.136		2.982	3.557	3.843	4.294	
L.S.D	Concentration	Genotypes				L.S.D	Concentration	Genotypes		
	0.21	0.10					0.04	0.08		

Table 4 Effect of genotypes and glycine concentrations on the total seed yield (tons h^{-1}) of sunflowers treated with yeast for 2021 and 2022. The results of Table 4 showed that spraying plants with a high concentration of glycine 300 mg L^{-1} achieved the highest average seed yield in.

Oil content in seeds %: The results of the variance analysis in Table 5 indicated a significant effect of both genotype and glycine concentrations on the oil percentage in sunflower seeds. The Aqmar genotype significantly outperformed the others, recording the highest oil percentage of 42.82% and 45.48% in both years, respectively, compared to the lowest percentage observed in the Lulwa genotype, which recorded 34.80% and 35.41% for the two years, respectively. The Aqmar genotype significantly differed from the Sakha genotype in both years, with the Sakha genotype showing oil percentages of 41.62% and 43.64%, respectively. Additionally, the Sakha genotype significantly outperformed the Lulwa genotype in both years. These results are in agreement with the findings of researchers (6, 8 and 9)

The results also indicated that the glycine concentration of 300 mg L^{-1} significantly outperformed the other concentrations in both years, achieving the highest oil percentage of 40.57% and 42.13% for the two years, respectively, compared to the control treatment, which recorded lower percentages of 39.08% and 40.63% for the respective years. In the first year, there were no significant differences between the 300 mg L^{-1} concentration and the 100 mg L^{-1} and 200 mg L^{-1} concentrations, which recorded oil percentages of 39.38% and 39.95%, respectively. However, in the second year, the 300 mg L^{-1} concentration significantly differed from the 100 mg L^{-1} concentration, which recorded 41.45%, but showed no significant difference from the 200 mg L^{-1} concentration, which recorded 41.84%. These results are consistent with the findings of researchers (4, 16 and 19), who highlighted the high effect of glycine concentrations on the oil content in seeds.

Table 5: Effect of genotypes and glycine concentrations on the percentage of oil in seeds (%) of sunflowers treated with yeast for 2021 and 2022.

Genotypes	Spring 2021 Concentration 0	100	200	300	Average	Spring 2022 Concentration 0	100	200	300	Average
Sakha	40.71	41.09	41.95	42.73	41.62	43.02	43.46	43.98	44.11	43.64
Lulwa	34.36	34.87	34.92	35.05	34.80	34.65	35.48	35.57	35.93	35.41
Aqmar	42.19	42.19	42.98	43.94	42.82	44.22	45.40	45.97	46.34	45.48
Average	39.08	39.38	39.95	40.57		40.63	41.45	41.84	42.13	
L.S.D	Concentration	Genotypes				L.S.D	Concentration	Genotypes		
	0.89	0.31					0.68	0.54		

Table 5: Effect of Genotypes and Glycine Concentrations on the Oil Percentage (%) in Sunflower Seeds Treated with Yeast for 2021 and 2022. The results of the variance analysis presented in the table indicate a significant effect of both genotypes and glycine concentrations on the oil percentage in sunflower seeds during both seasons.

Conclusions

It can be concluded that there is a variation in the performance of the genetic materials under study in response to the experimental conditions and across two seasons. The Lulwa genotype excelled in both seasons for specific traits. Additionally, the plants were affected by glycine spraying at different concentrations. The results showed that the 300 mg L^{-1} glycine concentration was the most effective in improving plant height and fertility percentage.

Supplementary Materials:

No Supplementary Materials.

Author Contributions:

The first author contributed to the writing and preparation of the original draft. The second author contributed to the review, editing, and methodology. The third author contributed to the review, editing, and methodology.

Funding:

This research received no external funding.

Institutional Review Board Statement:

The study was conducted following the approved protocol of the Ministry of Higher Education and Scientific Research.

Informed Consent Statement:

No Informed Consent Statement.

Data Availability Statement:

No Data Availability Statement.

Conflicts of Interest:

The authors declare no conflict of interest.

Acknowledgments:

The authors thank the College of Agriculture, University of Anbar, Iraq, for their assistance.

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