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Research Article

Effect of Several Thiamine Spray Concentrations on the Growth and Yield of Genetic Structures of Sunflower *Helianthus annuus* L.

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Abstract | The experiment was carried out at one of the agricultural fields in Baghdad Governorate, Spring growing season for 2024 to study the effects of sunflower genetic structure, levels of thiamine (B_1 vitamine) foliar spray and their interaction on growth and yield components of sunflower plant (*Helianthus annuus* L.). Experimental design The experiment was conducted in RCBD with three replicates. Four tissue culture genotypes (Flower of Iraq, Pan 7392, Ishaqi and Yurflor) and a range of thiamine levels were employed. The genetic structures ranged significantly. The Ishaqi genotype had outperformed all of genotypes for earliness characters with the lowest number of days to 50% flowering and physiological maturity (65.92, 83.08) respectively. On the other hand, the Pan 7392 genotype significantly surpassed other genetic materials in yield and most characters related to plant growth such as plant height (151.58 cm), leaf area (0.6950 m^2), average head diameter (22.67 cm), number of seeds per head (1202.2), 1000-seed weight (73.83 g), seed yield (101 t/ha) and percent seed protein content was obtained by this genotypes with an average percentage of forty two point sixty three percent . The genetic materials Flower of Iraq and Yurflor proved not to excel in any evaluated characteristic. For thiamine foliar spray application, spraying with thiamine substantially exceeded control (distilled water) indicated by 50% flowering and maturity days (68.42 and 81.17 days) reduced respectively at the earliest minimum number of day to flowering and maturity in finding for its efficacy for crop protection/measures against harmful pest damage etc causing less production regarding plants production in UV-B exposed suggests this work/helps address above-mentioned goal; however it may be possible used as an addition use of other chemicals suggested here under. The value 150 ppm gave the highest values for most of the studied traits viz., plant height (154.08 cm), leaf area (0.6992 m), head diameter (23.50cm) number of seeds per head (1204.5), 1000-seed weight (72.83 g), seed yield (101.17%), and protein percent age(42.23%). The interaction between genetic structures and thiamine concentrations was significant for most traits. The combination of Pan 7392 × 150 ppm thiamine achieved the highest values for maturity duration, leaf area, head diameter, number of seeds per head, 1000-seed weight, and seed yield, reaching 102.33, 0.7733 m^2, 25.33 cm, 1219.3 seeds, 80.33 g, and 111.00, respectively.

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Introduction

Sunflower (*Helianthus annuus* L.) is the second leading in oilseed crops of global importance after soybean, due to its high seed oil content (ca 47%). Due to a high ratio of unsaturated fatty acids (oleic and linoleic acids represent 85–91% from the total fatty acid composition, saturated ones are about 9–12%) such vegetable oil as sunflower is considered one of the most healthy to be consumed (Jadaan *et al*., 1999). Additionally, sunflower oil tends to have greater oxidative stability than other vegetable oils during storage and packaging (Pande and Srivestane, 1988). In addition to its oil quality, sunflower seeds are high in protein (about 35%) with attractive amino acid patterns, which makes sunflower meal as an important source of protein for livestock and poultry feeding (Rizk and Ali, 1981). The plant is also widely used as an industrial and agricultural crop the world over including food processing, soap making butter production and the roasted seeds are primarily consumed to prepare beverage in some countries whereas its vegetative parts serve as animal feed (Chakravarty, 1976). This suite of traits has led to greater economic and agronomic importance for sunflower as a strategic field crop.

The increase in sunflower yield is a result not only of agronomic practices, but also the choice of best genotypes that respond well to growth-promoting substances, which enable better physiological efficiency. Genotypes vary in yield potential and growth pattern because of their genetic divergence as regard assimilate production, translocation efficiency and sink–source relations (Ali, 2005). Therefore, among different lines, the choice of genotypes with high output genetic structures accompanied by suitable nutritional and physiological treatments seems to be a key strategy to obtain maximum productivity. Over the last decade, the use of vitamins as organic growth enhancers in contemporary agriculture began to receive more attention as environmentally friendly alternatives because it is considered an important organic compound and a component of many metabolic pathways and enzyme activation processes (Bedour and Rawia, 2011).

Of all these vitamins, thiamine (vitamin B1) has received more and more attention because of its essential function in plant metabolism. Thiamine is a water-soluble vitamin which serves as the cofactor for several essential enzymes in carbohydrate metabolism, energy production and cellular respiration. Similarly, it has been observed that foliar application of thiamine results in increased photosynthetic activity, antioxidant defense system, cell division and stress resistance enhancing the vegetative growth and yield attributes of oilseed crops (Hori, 2017; Pérez-Mora, 2025; Feng *et al*., 2025). In sunflower, recent experimental evidences show that thiamine treatment can signiicantly enhance growth characteristics, chlorophyll content and yield parameters under normal and stressed environments (Fatima *et al*., 2025). It should be stressed that thiamine (vitamin B1) is a completely different chemical from the nitrogenous pyrimidine base known as thymine, which is not involved in metabolism and DNA. Thymine is not directly involved in the physiology of plant nutrition and metabolic stimulation, while the function of thiamine has been confirmed to be actively involved in the regulation of plant growth and development (Taiz *et al*., 2015; Nelson and Cox, 2017).

Despite the world significance of sunflower research involving genetic variation and vitamin application, particularly thiamine foliar spraying, is still lacking under Iraqi environmental conditions. Thus, the aim of this research is to study the impact of various thiamine spray concentrations on growth and yield as affected by diverse sunflower genetic structures. Results from this investigation are anticipated to inform on how the approach of vitamin foliar application may be best optimized and combined with elite genotypes for a sustainable sunflower production while increasing yield potential under local agro-ecological scenarios.

Materials and Methods

The experiment of his workers was carried out in a field in Baghdad for the spring season, 2024. To know the effect of genetic structures and concentrations of thiamine addition by foliar spray and the interaction between them on the crop and its components of sunflower. Planting took place in the spring season on 22/2/2024. Four gene models of the sunflower crop obtained from the General Company for Industrial Crops were used in this research, and four concentrations of thiamine (vitamin B1) worked according to the complete random sector design, in three replicates, for the spring season of 2024. The first factor was four genotypes (Flower of Iraq, Pan

7392, Isaac, and Yourflor), The second factor is the addition of four concentrations of thiamine (0, 50, 100 and 150 ppm). The drill was carried out using a metal rod and the required depths were laid on it. Statistical analysis of the data was carried out and averages were compared. Coefficients according to the least significant differences test below the significance level 0.05. The experiment was fertilized with fertilizer (DAP) containing (18% N, and 46% P2O5) before planting at a rate of 240 kg. E-1 (Naeem and Narrator, 1998). Planting was done manually by placing three seeds in one jar, and then the plants were diluted to one plant when the plants reached the four-leaf stage. Urea fertilizer (46% nitrogen) at the rate of 280 kg/ha was added in two batches, the first two weeks after germination and the second at the beginning of the formation of flower buds.

The field experiment was conducted during the spring growing season of 2024 in an agricultural field located in Baghdad Province, Iraq. The experimental field was prepared following standard agronomic practices for sunflower cultivation. The experiment was arranged using a randomized complete block design (RCBD) with three replicates. Each experimental unit consisted of plots planted with sunflower genotypes, and the number of plants per plot was kept uniform to ensure reliable comparisons among treatments.

Before planting, soil samples were collected from the experimental site and analyzed to determine their physicochemical properties. The soil texture of the experimental field was classified as loamy, which is considered suitable for sunflower cultivation due to its balanced water-holding capacity and nutrient availability. Climatic conditions during the growing season were typical of the region and favorable for sunflower growth, with no extreme weather events affecting plant development.

After completing the flowering phase, ten plants were randomly taken from the three central watermelons, and their heads were wrapped in mesh bags to protect them from attacking birds. Five plants were randomly selected from them and the following characteristics were studied:

The number of days from planting to 50% flowering.

1. The number of days from planting to maturity.
2. Plant height: measured from the surface of the soil to the base of the disk.
3. Leaf area: The leaf area of the plant was calculated by measuring the maximum width of any leaf and using the following equation: $LA = 0.65 \sum W2$ as LA = leaf space and W 2 = square width of the sheet (El-Sahookie *et al*., 1982)
4. Disc diameter rate (cm): Calculated by measuring the part that includes disc flowers (Sahuke *et al*., 1999).
5. The number of seeds/head: According to the number of seeds per head after neglecting them by hand and then extracting the rate of the ten heads.
6. Weight of 1000 seeds/g: I took 1000 seeds randomly from the yield of the ten heads seeds three times and then weighed.
7. Seed oil percentage %: The percentage of oil in seeds was calculated based on the dry weight of the seeds using the Soxhlet device according to the method mentioned by the American Society of Chemical Analysts and as follows:

$$\text{Oil percentage} = \frac{\text{Weight of oil extracted from sample seeds}}{\text{Seed weight of the sample}} \times 100$$

(AOAC, 1980)

8. Seed yield g/plant: According to the average yield of the seeds of the ten harvested plants.

Results and Discussion

The number of days from planting until is 50% flowering A

In Table 1, it is determined that the genetic structures of sunflower cultivars have a significant influence on the days to reach at 50% flowering between seeding and flowering for spring season 2024. The Ishaqi genotype showed the minimum number of days to flowering (65.92 days) which indicates its genetic propensity for earliness and quick shift from vegetative to reproductive phase. In contrast, genotype Pan 7392 had the maximum number of days to 50% flowering (76.17), showing longer vegetative phase growth duration. This variation of genotypes may result from genetic factors controlling physiological processes related to flowering, such as photoperiod sensitivity, assimilate accumulation, and hormonal balance. These results confirm findings of Luezkiewicz (2004) and Ul-Haq *et al*. (2006) who noted that variability in days to 50 per cent flowering between genotypes in sunflower was as a result of genetic differences.

In respect to the impact of thiamine spraying levels on the days to 50% flowering, as indicated in Table

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1, a substantial effect was demonstrated. The lowest mean value was obtained in the control treatment (distillled water spraying) which averaged 68.42 days, and the highest one, from seed treatment with thiamine at 150 ppm that recorded a mean of 75.83 days. This delayed flowering under higher thiamine concentrations might be due to the role of thiamine (vitamin B_1) in carbohydrate metabolism and energy production via serving as a cofactor of numerous essential enzyme catalytic transformations. Enhanced metabolism can lead to vegetative growth, leaf accumulation and higher photosynthetic rate that extends the vegetative period with delay in flowering. Moreover, an increase in antioxidant capacity and cellular stability have been observed with thiamine as well, possibly due to stabilized vegetative growth prior to flowering initiation.

Table 1: *Effect of several concentrations of Thiamine spraying on the Growth and yield of genetic structures of sunflower and their interactions in the number of days of planting to 50% of flowering plant.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	69.33	71.67	73.33	75.00	72.33
Pan7392	73.33	75.00	76.00	80.33	76.17
Isaac	59.67	64.67	68.00	71.33	65.92
Yourflor	71.33	73.00	73.67	76.67	73.67
Average effect concentrations	68.42	71.08	72.75	75.83	
L. S.D 0.05	Concentrations 1.460		Genetic structures 1.460		Concentrations x compositions N.S

As for the interaction of sunflower genetic structures with thiamine concentrations, non-significant interaction effect was found for number of days from planting to 50% flowering (Table 1). These results indicate that the effect of thiamine on flowering time was similar among genetic structures examined, and that whatever effects were differentially induced they were largely due to genetic additive variation and a main effect of thiamine application rather than their interaction.

Number of days from planting to maturity

The results presented in Table 2 demonstrated a significant effect of sunflower genetic structures on the number of days from planting to physiological maturity during the spring growing season of 2024. The Ishaqi genotype recorded the shortest maturity period, with a mean of 83.08 days, reflecting its genetic tendency toward earliness and rapid completion of its life cycle. In contrast, the Pan 7392 genotype exhibited the longest maturity duration, reaching 94.58 days, which indicates a prolonged vegetative and reproductive growth period. Such variation among genotypes can be attributed to inherent genetic differences in growth rate, assimilate partitioning, and the regulation of developmental processes, including senescence and grain filling. These findings are consistent with the results reported by Muppidothi *et al.* (1996), who observed significant differences among sunflower varieties in the number of days from planting to full maturity.

Table 2: *Effect of several concentrations of thiamine spraying on the growth and yield of genetic structures of sunflower and their interactions in the number of days from planting to maturity.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	78.67	84.33	88.00	89.67	85.17
Pan7392	86.33	92.00	97.67	102.33	94.58
Isaac	77.67	82.67	85.33	86.67	83.08
Yourflor	82.00	87.67	91.00	97.33	89.50
Average effect concentrations	81.17	86.67	90.50	94.00	
Sl.S.D 0.05	Concentrations 1.541		Genetic structures 1.541		Concentrations x Compositions 3.082

Regarding the effect of thiamine foliar spray concentrations, the results in Table 2 showed a significant influence on maturity duration. The control treatment (spraying with distilled water) resulted in the earliest maturity, recording 81.17 days, whereas the application of 150 ppm thiamine significantly delayed maturity, reaching 94.00 days. This delay in maturity may be explained by the role of thiamine (vitamin B_1) in enhancing metabolic efficiency, energy production, and photosynthetic activity, which promotes prolonged vegetative growth and delays senescence. Moreover, thiamine has been reported to improve antioxidant defense mechanisms and cellular integrity, thereby extending the functional lifespan of leaves and supporting a longer grain-filling period before physiological maturity.

The interaction between sunflower genetic structures and thiamine concentrations showed significant differences for this trait, as indicated in Table 2. The combination of the Ishaqi genotype × distilled water resulted in the shortest maturity period (77.67 days), reflecting the inherent earliness of this genotype under minimal external stimulation. Conversely, the interaction between Pan 7392 × 150 ppm thiamine produced the longest maturity duration, reaching 102.33 days. This pronounced interaction suggests that late-maturing genotypes respond more strongly to higher thiamine concentrations by extending their growth cycle, likely due to enhanced assimilate accumulation and delayed senescence, which ultimately contributes to improved yield potential.

Plant height (cm)

The effect of sunflower Genetic structures was highly significant for plant height during the season 2024 (Table 3). Plant height The highest plant height value (151.58 cm) was recorded by the Pan 7392 genotype, while the lowest one was recoded for Ishaqi genotype with a mean of 144.08 cm. These variations in plant height between genetic patterns are likely due to natural variation that exists for genes controlling cell elongation, internode length, and overall vegetative vigour. Similar findings have been reported by Goksay *et al.* (1997), who found out that plant height differ significantly among genotypes of sunflower.

Table 3: *Effect of several concentrations of Thiamine spraying on the Growth and yield of genetic structures of sunflower and their interactions in plant height (cm).*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	140.00	144.33	148.67	152.00	146.25
Pan7392	145.33	149.33	153.67	158.00	151.58
Isaac	139.00	142.33	145.67	149.33	144.08
Yourflor	142.33	146.00	153.00	157.00	149.58
Average effect concentrations	141.67	145.50	150.25	154.08	
Sl.S.D 0.05	Concentrations 1.233		Genetic structures 1.233		Concentrations x compositions N.S

Regarding the various OFT foliar spray concentrations, Table 3 showed that plant height varied significantly. Plant height highest plant height (154.08 cm) was achieved with 150 ppm thiamine applied, and the lowest by the untreated control (141.67 cm). The higher plant height at greater thiamine concentration could be due to the role of thiamine in promoting metabolism and use of nitrogen leading to cell division and elongation. There are also reports grandvialndin is potential in the induction of gibberellin biosynthesis and its activities, which can be expressed as elongation of stem and internode length. Furthermore, the increase in photosynthetic rate and energy source by exogenous thiamine leads to strong vegetative growth and consequently increased plant height (Fadel, 2025; Hamad and Fadhil, 2024).

Concerning the response of sunflower genetic structures to thiamine concentrations, data in Table 3 indicated that, the interaction effect was not significant for plant height indicating that all genetic structures were similar in their response on mean height of sunflower plants from 77 DAS across all thiamine concentrations.

Leaf area (cm^2)

Table 4 shows There is importance differences in the genetic structures, as the genetic structure of Pan7392 exceeded and gave the highest rate of 0.6950 cm2 and gave genetic makeup Isaac's the lowest rate of 0.5783 cm^2.

Table 4: *Effect of several concentrations of Thiamine spraying on the growth and yield of genetic structures of sunflower and their interactions in the leaf area (cm^2).*

Concentrations compositions genetic	Spring Season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	0.5500	0.5967	0.6433	0.6733	0.6158
Pan7392	0.6133	0.6667	0.7267	0.7733	0.6950
Isaac	0.5233	0.5567	0.5967	0.6367	0.5783
Yourflor	0.5767	0.6200	0.6733	0.7133	0.6458
Average effect concentrations	0.5658	0.6100	0.6600	0.6992	
Sl.S.D 0.05	Concentrations 0.00779		Genetic structures 0.00779		Concentrations x compositions 0.01559

We note from Table 4 that the superior concentration of 150 by increasing the leaf area, which gave a significant difference of 0.6992 compared to spraying with distilled water, as it gave the lowest rate of the trait of 0.5658 cm^2. This substance plays an effective role in the processes of carbon metabolism, increasing cell division and multiplication and increasing the root system, which increases the absorption of nutrients, especially nitrogen, which contributes to increasing the leaf area (Abu Dahi and Younis, 1988).

As for the overlap between the genetic structures and concentrations, it was shown from Table 4 that there are significant differences for the same trait, as the overlap between the genetic structure Pan7392 and concentration 150 gave the highest rate of 0.7733.

Disc diameter rate (cm)

It is noted from the results of Table 5. There is importance differences in this trait for the genetic structures, as the genetic structure exceeded Pan7392 and gave the highest rate of 22.67 cm and gave the genetic makeup of Ishaqi the lowest rate of 16.58 cm. This result is consistent with Al-Haidary (2018) who indicated that there are differences in the diameters of the sun and kitten heads according to their genetic makeups.

Table 5: *Effect of several thiamine spraying concentrations on the growth and yield of genetic structures of sunflower and their interactions in disk diameter.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	15.33	18.67	20.67	23.33	19.50
Pan7392	19.00	22.67	23.67	25.33	22.67
Isaac	12.67	14.67	18.33	20.67	16.58
Yourflor	17.67	21.33	23.00	24.67	21.67
Average effect concentrations	16.17	19.33	21.42	23.50	
Sl.S.D 0.05	Concentrations 0.855		Genetic structures 0.855		Concentrations x compositions 1.710

It is noted from Table 5 that there are significant differences for the characteristic of the diameter of the disc, as the concentration of 150 gave the highest rate of 23.50 and the spraying with distilled water gave the lowest rate of 16.17.

The results of Table 5 confirmed the existence of significant differences in the intervention between the genetic structures and concentrations, as the overlap between the genetic structure Pan7392 and the concentration 150 gave the highest rate of 25.33.

The number of seeds/ head

The data of Table 6 indicate There is importance differences in the number of seeds/head of genetic structures that exceed the genetic makeup Pan7392, the highest rate over the rest of the genetic structures, gave 1202.2, while the Ishaqi genetic makeup gave the lowest rate in this trait amounted to 1168.3. This result is consistent with Rahim *et al.* (2006), Rahim and Hamid (2025) when evaluating 20 hybrids of sunflower significantly affected the genetic makeup of this trait. This result is consistent with Shamma and Bakr (2009) and that the difference in the number of seeds in the disc is due to the increase in the size of the disc.

Table 6: *Effect of several concentrations of Thiamine spraying on the growth and yield of genetic structures of sunflower and their interactions in the number of seeds/ head.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	1159.0	1175.0	1189.0	1199.0	1180.5
Pan7392	1172.0	1204.7	1212.7	1219.3	1202.2
Isaac	1135.3	1163.3	1182.0	1192.7	1168.3
Yourflor	1164.7	1181.0	1198.7	1207.0	1187.8
Average effect concentrations	1157.8	1181.0	1195.6	1204.5	
Sl.S.D 0.05	Concentrations 5.95		Genetic structures 5.95		Concentrations x compositions 11.90

It is noted from Table 6 that there are significant differences for the characteristic of the number of seeds for concentrations, as the concentration of 150 gave the highest rate of 1204.5 and spraying with distilled water gave the lowest rate of 1157.8.

Table 6 showed significant differences in the overlap between the genetic structures and the concentrations of this trait, as the overlap between the genetic structure Pan7392 and the concentration 150 gave the highest rate from the rest of the other interactions and gave 1219.3.

Weight of 1000 seeds (g)

Table 7 shows There is importance differences between the genetic structures in this trait that exceed the genetic structure of Pan7392 and gave the highest rate of 73.83 and gave the lowest genetic makeup rate of 59.25. These differences between genetic structures are due to genetic factors controlling plant morphological traits and the increase is due to the transport of nutrients from source to downstream Luezkiewicz *et al.* (2004).

Table 7 shows the existence of significant differences for the weight characteristic of 1000 seeds / g, as the concentration of 150 gave the highest rate of 72.83 seeds/g and spraying with distilled water gave the lowest rate of 59.00 seeds/g.

As for the overlap between the genetic structures and concentrations, between Table 7, there are significant differences for the same trait, as the overlap between the genetic structure Pan7392 and the concentration 150 gave the highest rate of 80.33 seeds/g.

Table 7: *Effect of several thiamine spraying concentrations on the growth and yield of genetic structures of sunflower and their interactions in the weight of 1000 Seeds/g.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	57.33	62.00	65.00	69.00	63.33
Pan7392	65.67	72.67	76.67	80.33	73.83
Isaac	53.33	57.33	61.67	64.67	59.25
Yourflor	59.67	68.33	71.67	77.33	69.25
Average effect concentrations	59.00	65.08	68.75	72.83	
Sl.S.D 0.05	Concentrations 0.835		Genetic structures 0.835		Concentrations x compositions 1.671

Seed yield g/plant

Table 8 indicates There is importance differences in the seed yield trait of the genetic structures that exceed the genetic structure Pan7392 and gave the highest rate of 101.00 and the genetic makeup of Ishaqi gave the lowest rate of 86.75. This result is consistent with Karim (2010) when using genetic structures from sunflower that outweigh the Flamy genetic makeup over the rest of the structures in this trait. This result is consistent with Aliwi and Customer (2021) and the reason for this is due to the increase in the weight of 1000 seeds, which led to an increase in the yield of This genetic makeup is Table 7.

Oil ratio %

Table 9 indicates there is importance differences in the seed yield trait of the genetic structures that exceed the genetic structure of Pan7392 and gave the highest rate of 42.633% and the genetic makeup of Ishaqi gave the lowest rate of 40.275%. The reason for the superiority of this genetic structure is due to the quality of sunflower seeds, which is affected by genetic and environmental conditions. This finding is consistent with Ozturk *et al.* (2017).

Table 8: *Effect of several thiamine spraying concentrations on sunflower growth and genetic structure yield and their interactions in seed yield G/Plant.*

Concentrations compositions genetic	Spring Season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	83.67	88.33	93.00	97.67	90.67
Pan7392	91.33	96.00	105.67	111.00	101.00
Isaac	81.00	84.00	88.67	93.33	86.75
Yourflor	87.67	92.33	97.67	102.67	95.08
Average effect concentrations	85.92	90.17	96.25	101.17	
Sl.S.D 0.05	Concentrations 1.128		Genetic structures 1.128		Concentrations x compositions 2.257

It is noted from Table 9 that there are significant differences for the same characteristic of concentrations gave concentration 150 highest rate of 42.225 g/ plant and gave spraying with distilled water the lowest rate of 40.283 g/plant.

As for the overlap between the genetic structures and concentrations, it is noted from Table 9 There is no importance differences for the interference of this trait.

Table 9: *Effect of several thiamine spraying concentrations on the growth and yield of genetic structures of sunflower and their interactions in the percentage of oil ratio in seeds.*

Concentrations compositions genetic	Spring season 2024				Average effect of genotypes
	0	50	100	150	
Iraq flower	39.667	40.567	41.300	41.933	40.867
Pan7392	41.600	42.567	42.933	43.433	42.633
Isaac	39.200	39.967	40.700	41.233	40.275
Yourflor	40.667	41.833	41.967	42.300	41.692
Average effect concentrations	40.283	41.233	41.725	42.225	
Sl.S.D 0.05	Concentrations 0.2586		Genetic structures 0.2586		Concentrations x compositions N . S

It follows from this that the genotype Pan7392 gave the highest rate for most of the traits studied. The concentration is 150 ppm, as it gave the highest rate in all the studied traits for the two growing seasons.

The overlap between genotypes and concentrations and their interactions gave the overlap between the genotype Pan7392 and the concentration of 150 ppm the highest rate in most traits. Therefore, we recommend the use of the genetic structure Pan7392 with 150 ppm for the spring season when planting.

The enhancement in growth and yield parameters of sunflower due to thiamine application could be on account of the important physiological role that it performs in plant metabolism. Thiamine (vitamin B1) is required as a vital cofactor in the enzymatic steps of central metabolic pathways associated with carbohydrate metabolism and ATP generation that directly influence photosynthetic efficiency and biomass production. Improved LA by higher thiamine concentrations suggests increased light interception and carbon assimilation, resulting in a greater photosynthetic capacity and dry matter production. Similar results were reported in other studies where application of thiamine increased the chlorophyll contents, cell division and nutrient uptake which will contribute to the improvement of vegetative growth and its yield components. Moreover, the differential reaction of genetic structures has underlined the role played by genetic variation in contributing to enhanced efficiency in thiamine usage so that more adapted genotypes proved to be more physiologically responsive and also gave a better yield performance. These findings are also in agreement with previous reports that underline the synergistic effects between genetic potential of plants and metabolic stimulators such as vitamins on productivity (Taiz *et al*., 2015; Bedour and Rawia, 2011).

The present findings highlight the importance of combining suitable genetic structures with appropriate thiamine concentrations to enhance sunflower productivity under local environmental conditions.

Conclusions

The findings of this study reveals that thiamine (vitamin B1) application has a positive impact on growth and yield attributes of sunflower (*Helianthus annuus* L.). Application of thiamine, in particular at 150 ppm, enhanced major vegetative and yield attributes like plant height, leaf area, disc diameter, number of seeds per disc, 1000-seed weight, seed yield and oil %.

Results also showed a significant genetic structure for the studied traits, showing that genetic variation plays an influential role in sunflower responses to thiamine treatment. Pan 7392 was also the best genotype for most other growth and yield attributes associated with the highest thiamine concentration, indicating significant interaction between genetic potential and metabolic enhancement among all genotypes screened.

The improvement in sunflower performance under thiamine treatment can be attributed to its physiological role in enhancing photosynthetic efficiency, energy metabolism, and leaf area expansion, which collectively contribute to increased biomass production and yield formation.

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Novelty Statement

This study demonstrates the positive role of foliar application of thiamine (Vitamin B1) in enhancing growth and yield components of sunflower under Iraqi conditions. The research identifies the combination of genotype Pan 7392 and 150 ppm thiamine as the most effective treatment for improving sunflower productivity.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI or AI-assisted technologies were used in the design, analysis, or interpretation of the research data. AI tools were only used for minor language editing and grammar improvement.

Conflict of interest

The authors have declared no conflict of interest.

References

AOAC, 1980. Official methods of analysis (13th ed.). Association of Official Analytical Chemists, Washington, DC, USA.

Abu-Dahi, Y.M. and Al-Younis, M.A., 1988. Plant nutrition manual. Ministry of Higher Education and Scientific Research, University of Baghdad, Iraq.

Al-Hedari, H.K.M.A., 2018. Splitting of nitrogen application through growth stages in various sunflower cultivars to improve vegetative growth and seed yield. Asian J. Agric. Biol., 6(3): 357–366.

Al-Hilali, K.N.R., 2005. Effect of plant density levels on sunflower (*Helianthus annuus* L.). Master's thesis, College of Agriculture, University of Baghdad, Iraq.

Ali, A.A., 2005. Principles of crop production and genetic improvement. Ministry of Higher Education and Scientific Research, Iraq.

Aliwi, E.Y. and Najat, H.H., 2021. Response of yield and quality of four sunflower genetic structures to folic acid spraying. Al-Muthanna J. Agric. Sci., 8(3): 1–10.

Bedour, A.A. and Rawia, A.E., 2011. Improving gladiolus growth and flower keeping quality using some vitamin applications. J. Am. Sci., 7(3): 169–174.

Bonner, J. and Greene, J., 1939. Further experiments on the relation of vitamin B to the growth of green plants. Botanical Gazette, 101: 491–500. https://doi.org/10.1086/334884

Chakravarty, H.L., 1976. Plant wealth of Iraq: A dictionary of economic plants (Vol. 1). Ministry of Agriculture and Agrarian Reform, Baghdad, Iraq.

El-Shawqie, M.M. and Elidobas, E.E., 1982. On leaf dimension to estimate leaf area in sunflower. J. Agron., 15: 199–204.

Fadhil, A.H., 2025. Responses of sorghum (*Sorghum bicolor* L.) Varieties to gibberellic acid (GA3). Basrah J. Agric. Sci., 8(Special Issue): 377-386. https://doi.org/10.37077/25200860.2025.38.sp.33

Fatima, S., Khan, M.A., Ahmad, I. and Hussain, A., 2025. Synergistic application of thiamine and bio-stimulants improves growth, physiological traits, and yield of sunflower (*Helianthus annuus* L.). J. Plant Growth Regul., 44: 1–15.

Feng, M., Zhang, Y., Liu, X. and Chen, J., 2025. Genome-wide analysis of the thiamine biosynthesis gene family and its role in plant growth and stress tolerance. Plants, 14(3): 412.

Goksay, A.T., Turan, Z.M. and Acikgoze, E., 1997. Effect of planting date and plant population on seed and oil yield and plant characteristics in sunflower (*Helianthus annuus* L.). Helia, 21: 107–116.

Hamad, H.K. and Ahmed, H.F., 2024. Effect of spraying dates for gibberellic acid and boron on some yield traits of mung bean. IOP Conf. Ser. Earth Environ. Sci., 1371: 052034. https://doi.org/10.1088/1755-1315/1371/5/052034

Hori, K., 2017. Physiological roles of thiamine in plant growth and stress tolerance. Plant Physiol. Rep., 22(4): 389–398.

Jadaan, A.S., Al-Hadithi, M.S. and Hassan, M.A., 1999. Oil quality and fatty acid composition of sunflower genotypes. Iraqi J. Agric. Sci., 30(2): 55–63.

Karim, A.N., 2010. Response of sunflower genotypes to organic fertilizer treatments. Master's thesis, College of Technology, Musayyib, Iraq.

Łuczkiewicz, T. (2004). Differences in flowering time and yield components among sunflower (*Helianthus annuus* L.) genotypes under different environmental conditions. Helia, 27(41), 1–12.

Lüzkiewicz, T. and Zygmunt, K., 2004. Influence of morphological differences between sunflower inbred lines on SCA effects for yield components. J. Appl. Genet., 45(2): 175–182.

Muppidothi, N., Sankarap, R., Aparadian, S. and Rajarathinam, S., 1996. Stability and selection parameters in sunflower hybrids under rainfed conditions. Madras Agric. J., 12: 747–750. https://doi.org/10.29321/MAJ.10.A01099

Naeem, M., and Narrator, A. (1998). Crop Production and Fertilizer Management. Agricultural Research Publications, New Delhi.

Nelson, D.L. and Cox, M.M., 2017. Lehninger principles of biochemistry (7th ed.). W.H. Freeman and Company, New York.

Öztürk, F., Polat, T., and Sefaoglu, F. (2017). Determination of yield and quality parameters of oil sunflower genotypes grown under different ecological conditions. J. Agric. Sci., 23(3), 350–360.

Pande, G. and Srivestane, G.C., 1988. Influence of cycocel on seed yield and oil content of sunflower (*Helianthus annuus* L.). Field Crops

Res., 41: 85–88.

Pérez-Mora, W., 2025. Mechanisms of thiamine-induced plant resistance to biotic and abiotic stresses. Front. Plant Sci., 16: 1189456.

Rahim, M.H. and Hamid, M.M., 2025. Effect of some phosphate fertilizers on heavy element contamination in soil and white maize plants. Mesopotamia J. Agric., 53(3). https://doi.org/10.33899/mja.2025.163291.1675

Rahim, M., Ahmad, N. and Khan, U., 2006. Agronomic performance of sunflower hybrids under agro-climatic conditions of Malakand Division. Pak. J. Arid Agric., 1: 23–27.

Rizk, S.A. and Ali, M.A., 1981. Nutritional value of sunflower meal in animal feeding. Anim. Feed Sci. Technol., 6(2): 123–130.

Sahuke, D.M., Dadheech, R.C., and Mundra, S.L. (1999). Genetic variability and character association in sunflower (*Helianthus annuus* L.). J. Oilseeds Res., 16(1), 90–92.

Shamma, L.M.J. and Bakr, R.H., 2009. Effect of planting dates on yield components of three sunflower genetic structures. Diyala Univ. J., 32: 387–404.

Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A., 2015. Plant physiology and development (6th ed.). Sinauer Associates, Sunderland, MA.

Ul-Haq, A., Al-Rashid, A., Butt, M.A., Choise, M.A., Aslam, M. and Saeed, A.S., 2006. Evaluation of sunflower (*Helianthus annuus* L.) hybrids for yield and yield components in central Punjab. J. Agric. Res., 44(4): 277–285.