Response of Groundnut Genotypes to Sowing Dates in Fatty Acids, Oil, and Protein Content

Mohammed J. Habeeb Al-Hiti[1*] and Sinan A. Abas Al-Salmani [2]

[1, 2] Department of Field Crops, College of Agriculture, University of Anbar, Iraq

*Corresponding author's email : moh23g3004@uoanbar.edu.iq
Email addresses of coauthors: ag.sinan.abdullah@uoanbar.edu.iq.

Abstract

A field experiment was conducted during the summer season of 2025 in one of the agricultural fields in Al-Mashatal area, belonging to Hit District in Anbar Governorate, on the right bank of the Euphrates River, located at longitude 42.82 and latitude 33.63, in sandy loam soil, This study aimed to investigate the response of the newly introduced peanut varieties NC7 and Ausa Hanim, compared to the local variety Saadiya, to three planting dates: April 15, May 1, and May 15. This was achieved by evaluating several seed quality characteristics, including oil content, protein content, and fatty acid composition (oleic, linoleic, palmitic, and stearic acids). The experiment was conducted using a randomized complete block design (RCBD) with a split-plot system and three replications. Planting dates were assigned to the main plots, while the genetic varieties occupied the subplots. The main findings of the study can be summarized as follows: Plants of the groundnut genotypes grown at different sowing dates showed significant differences Regarding seed quality traits and fatty acid content. Plants sown on April 15 were superior in protein percentage, reaching 22.50%, oil percentage, reaching 45.40%, oleic acid percentage, reaching 54.64%, and palmitic acid percentage, reaching 12.55%. In contrast, the May 1sowing date recorded superiority in linoleic acid and stearic acid contents, reaching 31.72% and 2.74%, respectively. The NC7 genotype was superior in protein percentage, reaching 23.28%, oleic acid percentage, reaching 57.07%, linoleic acid percentage, reaching 32.56%, palmitic acid percentage, reaching 12.99%, and stearic acid percentage, reaching 2.66%. In contrast, the Ausa hanim genotype was superior in oil percentage, reaching 45.40%. A significant interaction occurred between sowing dates and the groundnut genotypes included in the study.

Keywords: groundnut, sowing dates, genotypes, fatty acids, Seed protein.

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the important leguminous crops and one of the major economic crops in the world, ranking 13th among food crops [1]. Globally, 50% of groundnut production is used for oil extraction, 37% for confectionery, and 12% for seed production [2]. In the United States, peanut butter accounted for 56% of consumption in 2021, whereas confectionery products accounted for 17% and snacks for 19% [3]. The seeds contain approximately 38–50% oil, 26% protein [4]. They are also considered rich plant sources of unsaturated fatty acids, containing 50% oleic acid and 30% linoleic acid, which possess anti-inflammatory properties and reduce the risk of diseases such as cardiovascular diseases and diabetes. [5]. Therefore, they are preferred in nutrition for reducing harmful cholesterol in the blood. Groundnut flour is used for medical purposes, particularly for diabetic patients, because of its low carbohydrate content, which is less than 12% [6]. It also contains calcium, potassium, phosphorus, magnesium, and vitamins B, E, and K [1].

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The percentages of oil, protein, and fatty acids vary according to cultivars and their interaction with environmental conditions, in addition to nutrition with major and micronutrients. Groundnut also improves the nitrogen content of the soil, which makes this plant highly valuable in crop rotation [7].The United States is responsible for 5% of global groundnut production and is the fourth-largest producer worldwide [8]. According to the statistics of the Food and Agriculture Organization (FAO) [9], the total area planted with groundnut reached 31.6 million hectares, producing more than 53.7 million tons. Asia and Africa accounted for approximately 90% of total world production, while the remaining production was in the Americas. China and India are among the largest groundnut producers. China's production reached 18 million tons, making it the largest producer of groundnut, accounting for 37% of global production [10], followed by India with 10 million tons.

In Latin America, Argentina is the largest producer, producing 977,000 tons over an area of 388,000 hectares, with a productivity of 2,520 kg ha^{-1} [11]. It is followed by Brazil, which produced approximately 435 thousand tons of groundnut during the 2018/2019 season over an area of 146,600 hectares, with a productivity of 2,967 kg ha^{-1} [11]. The USDA-FAS statistics also confirmed that the five largest groundnut-producing countries in the world are China, India, Nigeria, the United States, and Senegal, accounting for 38%, 13%, 9%, 6%, and 3%, respectively, of global groundnut production. [12]. In Iraq, crop productivity remains low compared with global production. The area planted with groundnut in Iraq reached 757.75 hectares in 2020 [13]

It is well known that legumes exhibit a high rate of flower abortion. In this crop, flower abortion may reach at least 50% even under optimal growing conditions, considering that temperatures above 40°C are unsuitable for fertilization. Therefore, the nutritional quality of oilseed crops is affected by environmental and genetic factors and poor crop management, and groundnut is particularly sensitive to these factors [14,15]. Accordingly, agricultural practices , including sowing dates, are factors affecting growth and production because temperature and photoperiod vary from one sowing date to another, influencing most important biological activities and seed formation [16 ,17] . Adverse environmental conditions, including high temperature, also affect the oil content and quality of groundnut seeds [18]. Extremely low temperatures affect crop growth stages and result in immature pods, whereas high temperatures are responsible for delayed crop growth and reduced crop quality [19]. Given the limited studies on this important economic crop in Iraq and the occurrence of global warming, which has caused considerable climatic fluctuations, this study aimed to:

1. Evaluate the suitability and performance of newly introduced genotypes compared to the local cultivar regarding oil, protein, and fatty acid content under local environmental conditions.

2. Determine the optimal planting date for each genotype to achieve superior seed quality and a distinctive chemical profile.

3. Investigate the interaction between genotypes and planting dates regarding quality traits and the content of major fatty acids.

Materials and Methods

A field experiment was conducted during the summer season of 2025 in one of the agricultural fields in Al-Mashatal area, belonging to Hit District in Anbar Governorate, on the right bank of the Euphrates River, located at longitude 42.82 and latitude 33.63, In sandy loam soil whose physical and chemical properties are presented in Table (1), to determine the response of groundnut genotypes (NC7 and Ausa hanim), compared with the local cultivar Saadia, to sowing dates April 15, May 1, and May 15 regarding seed quality traits, oil percentage,

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protein content, and fatty acid composition . The experimental land was prepared by plowing it twice in perpendicular directions using a moldboard plow, followed by harrowing and leveling operations according to crop requirements. A Randomized Complete Block Design (RCBD) with three replications was used in a split-plot arrangement. The sowing dates occupied the main plots, whereas the genotypes together with the local cultivar occupied the sub-plots. The area of the experimental unit was 6 m² (2 × 3 m). Each experimental unit contained four rows, each 2 m long, with a distance of 75 cm between rows and 25 cm between hills. When signs of crop maturity appeared, a representative random sample of ten plants was taken from the central rows of each experimental unit for the required studies.

Sampling and Chemical Preparation:

Harvested seeds from the ten sampled plants per plot were thoroughly mixed to form a single representative composite sample for each experimental unit. Chemical analyses were subsequently performed in triplicate on these composite samples to ensure analytical accuracy and statistical precision.

Table 1. Some chemical and physical properties of the experimental soil before planting (2025)

Traits	Unit	Value
pH	—	7.9
Electrical conductivity (EC)	ds m^{-1}	1.72
Clay	%	13.1
Silt	%	24.6
Sand	%	62.3
Soil texture	—	Sandy loam
Available calcium	mg kg^{-1}	292
Available phosphorus	mg kg^{-1}	10.6
Available potassium	mg kg^{-1}	131.3
Available nitrogen	mg kg^{-1}	12.43
Available iron	mg kg^{-1}	7.1

Studied Traits

Protein percentage in seeds (%)

The percentage of protein in seeds was estimated after determining the nitrogen concentration in the seeds using a Micro-Kjeldahl apparatus, according to the following equation:

Protein percentage = percentage of nitrogen in the seeds × 6.25 [20]

Oil percentage in seeds (%)

Oil percentage was estimated by weighing 5 g of the ground dry sample and placing it in a Soxhlet fat-extraction apparatus. The oil was extracted using petroleum ether. After evaporation of the solvent, the oil samples were weighed and their percentage was calculated according to the following equation

$$\text{Oil percentage} = \frac{\text{Weight of oil}}{\text{Weight of dry sample}} \times 100$$

[21].

Oleic acid percentage (%).

Linoleic acid percentage (%) .

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Palmitic acid percentage (%).

Stearic acid percentage (%).

The individual fatty acid composition (oleic, linoleic, palmitic, and stearic) was determined using a gas chromatograph (GC-2010, Shimadzu, Kyoto, Japan) equipped with a flame ionization detector (FID). Prior to GC analysis, the fatty acids in the extracted oil samples were converted into fatty acid methyl esters (FAME) following the standard transesterification procedure adopted by the [22]

Briefly, 100 µL of the extracted oil was mixed with 2 mL of n-hexane and 0.2 mL of a 2 N methanolic potassium hydroxide solution. The mixture was vigorously shaken using a vortex mixer for two minutes and then allowed to settle until two distinct layers separated. The clear upper layer containing the FAME was collected for injection into the instrument. Chromatographic separation was performed using a capillary column (DB-Wax, 30 m in length and 0.25 mm in diameter). Nitrogen was used as the carrier gas at a constant flow rate of 1.2 mL min^{-1}. The injector and detector temperatures were set at 250°C and 280°C, respectively. The column oven temperature was initially set at 140°C for 2 minutes, then programmed to rise to 220°C at a rate of 4°C min^{-1}, with a hold at 220°C for 10 minutes. Fatty acid peak areas were identified and calculated by comparing retention times with reference standards (Standard FAME). The concentration of each fatty acid was expressed as a percentage (%) of the total fatty acids in the oil.

Statistical Analysis

The collected data were subjected to analysis of variance (ANOVA) using a split-plot arrangement within a randomized complete block design (RCBD) with three replicates; significant differences between means were compared using the Least Significant Difference (LSD) test at a probability level of 0.05, using the Genstat statistical software (12th edition, VSN International, Hemel Hempstead, UK).". The results were interpreted based on the mean values presented in the tables [23].

Meteorological Data

Agrometeorological data during the 2025 growing season (April to September) were obtained from the nearest meteorological station in Hit District, Anbar Governorate. The recorded parameters included solar radiation (PAR), maximum and minimum temperatures (°C), photoperiod (hours), relative humidity (%), and rainfall (mm), organized across 10-day intervals as presented in Table 2.

Table 2 Agrometeorological data for the experimental site during the 2025 growing season in Hit District, Anbar Governorat.

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Results and Discussion

1. Seed Protein Percentage (%)

Protein percentage in seeds is one of the most important quality traits of interest to specialists in legume crops. The results presented in Table 3 indicated a significant effect of genotypes and sowing dates, whereas their interaction did not have a significant effect on protein percentage.

The same table showed a significant effect of genotypes on seed protein content. The NC7 genotype significantly exceeded the other genotypes in protein percentage, recording 23.28%, whereas the local cultivar Saadia recorded the lowest mean for this trait, 20.11%. The superiority of the NC7 genotype may be attributed to its ability to absorb and accumulate nitrogen in the seeds, thereby producing more amino acids and consequently increasing protein percentage. This result agrees with the findings of [24 ,25 ,26 ,27 ,28] , who reported differences among genotypes in nitrogen uptake and protein formation in groundnut.

The results in Table 3 showed that sowing dates significantly affected seed protein percentage. The 15/4 sowing date gave the highest mean, 22.50%, compared with the lowest mean recorded at 15/5, 21.04%, respectively. This may be attributed to the improvement in soil and agro-climatic conditions associated with the 15/4 sowing date, which led to increased protein formation in plant seeds. This result agrees with [28,29] who found a significant effect of sowing dates on protein content in groundnut.

The results also showed no significant differences in the interaction between genotypes and sowing dates for protein content.

Table 3. Effect of sowing dates and genotypes on protein percentage (%) of groundnut during the 2025 season

The month	Duration)Days(	Rain (mm)	Relative humidity(%)	Photoperiod (hours)	Minimum temperature	Maximum temperature	Light radiation
April	**20 -15**	0.93	36.27	12.95	12.7	26.28	10.88
	30 -21	2.07	35.41	13.20	20.77	34.35	9.34
Mais	**15 -1**	2.26	32.89	13.40	20.86	35.63	11.1
	31 -16	0.02	27.45	13.70	23.15	37.61	11.65
June	**-115**	0	22.24	14.15	24.9	39.6	12.16
	30 -16	0	17.73	14.22	27.82	43.15	12.26
July	**15 -1**	0	20.06	14.18	27.41	40.71	12.36
	31 -16	0	19.91	14.08	30.48	44.74	11.49
August	**15 -1**	0	22.24	13.40	30.65	45.41	11.52
	31 -16	0	18.83	13.20	29.07	44.74	11.09
September	**15 -1**	0	27.18	12.40	27.45	41.16	9.96
	30 -16	0	24.31	11.80	25.69	39.58	9.51

Sowing date	Saadia	NC7	Ausa Hanim	Mean of sowing dates
15/4	20.80	24.53	22.15	22.49

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Sowing date	Saadia	NC7	Ausa Hanim	Mean of sowing dates
1/5	20.37	22.57	21.78	21.57
15/5	19.15	22.75	21.23	21.04
Genotype mean	20.11	23.28	21.72	
LSD 5%	Sowing dates	Genotypes	Interaction	
	0.591	0.605	N.S.	

2. Seeds Oil Percentage (%)

The results presented in Table 4 indicated significant differences among genotypes, sowing dates, and their two-way interaction in oil percentage.

The same table showed that the genotypes differed significantly in seed oil percentage. Plants of the Ausa hanim genotype gave the highest mean for this trait, reaching 48.41%, significantly exceeding the other genotypes, whereas the local cultivar Saadia recorded the lowest mean, 40.78%. The variation among genotypes in oil content may be attributed to differences in their genetic composition and genetic nature in their ability to intercept effective light during photosynthesis, resulting in differences in seed oil content. Some genotypes have high oil percentages, whereas others have low oil percentages. These results agree with studies by [26,30,27,31], who indicated that oil content varies according to genotype and temperature in groundnut.

Table 4 showed that the first sowing date, 15/4, gave the highest mean seed oil percentage, 45.40%, with a significant difference from the other sowing dates, whereas the lowest mean oil percentage occurred at the third sowing date, 15/5, reaching 43.69%. This may be attributed to variation in the temperatures experienced by the plants and their increase at the 15/5 sowing date during seed formation, in contrast to plants sown early, which may affect seed oil level. These results are consistent with [32, 28,29], who confirmed significant differences in oil percentage according to sowing date and emphasized the importance of determining the optimum sowing date for groundnut because sowing dates directly affect seed quality traits, including oil percentage.

The results of Table 4 also revealed significant differences in the interaction between genotypes and sowing dates. The Ausa hanim genotype was superior in oil percentage when sown on 15/4, giving an oil percentage of 49.99%, whereas the local cultivar Saadia at the 1/5 sowing date recorded the lowest mean for this trait, 38.94%. This may be due to differences in genotype responses to temperature during seed filling according to sowing date. Early sowing dates provided a longer seed-filling period for some genotypes, allowing more time for oil synthesis and accumulation compared with other genotypes across all sowing dates.

Table 4. Effect of sowing dates and genotypes on oil percentage (%) of groundnut during the 2025 season

Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
15/4	41.76	44.56	49.99	45.44
1/5	38.94	47.08	48.45	44.82
15/5	41.64	42.53	46.79	43.65
Genotype mean	40.78	44.72	48.41	

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Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
LSD 5%	Sowing dates	Genotypes	Interaction	
	0.542	0.605	0.941	

3. Oleic Acid Percentage in Oil (%)

Oleic acid is a monounsaturated fatty acid because it contains one double bond between carbon atoms 9 and 10. Its chemical formula is C18H34O2, and its molecular formula is CH3-(CH2)7-CH=CH-(CH2)7-COOH. Oleic acid belongs to the omega-9 (Omega-9) group because its first double bond is located at carbon atom 9 when counted from the methyl group (CH3-) [34].

The results in Table 5 indicated significant differences among genotypes, sowing dates, and their two-way interactions in oleic acid percentage in the oil.

The results showed that plants of the NC7 genotype recorded the highest content of this trait, 57.07%, compared with plants of the local cultivar Saadia, which recorded the lowest mean, 49.25%. This may be attributed to the genetic nature of the genotypes and their response to prevailing environmental conditions, which was reflected in physiological traits, yield, fatty acids, and the active component responsible for the transport and supply of metabolites from source to sink according to the genetic mechanism prevailing in each genotype. This difference is supported by [35,30,27,31]. who reported significant differences among groundnut genotypes in unsaturated fatty acid content, including oleic acid.

Table 5 shows that different sowing dates significantly affected the trait. Plants sown at the first date (15/4) were superior, giving the highest mean of 54.64%, compared with plants sown at 15/5, which gave the lowest mean of 51.62% for the. The superiority of the 15/4 sowing date may be attributed to favorable environmental conditions, particularly moderate temperatures during seed filling, which enhanced the activity of enzymes responsible for the synthesis of unsaturated fatty acids and increased oleic acid accumulation. This result agrees with [32,33], who found a significant increase in oleic acid percentage in oil with different sowing dates in groundnut.

The interaction in Table 5 showed a significant difference between genotypes and sowing dates for this trait. Plants of genotype NC7 grown at the 1/5 sowing date recorded the highest mean, 59.24%, whereas the interaction between the local cultivar Saadia and the 15/5 sowing date recorded the lowest mean, 48.30%.

Table 5. Effect of sowing dates and genotypes on oleic acid percentage (%) in groundnut oil during the 2025 season

Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
15/4	50.52	57.18	56.21	54.64
1/5	48.92	59.24	54.71	54.29
15/5	48.30	54.79	51.15	51.41
Genotype mean	49.25	57.07	54.02	
LSD 5%	Sowing dates	Genotypes	Interaction	
	1.058	0.783	1.370	

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4. Linoleic Acid Percentage in Oil (%)

Groundnut oil contains linoleic acid, which constitutes approximately 30% of the oil components. It is a polyunsaturated fatty acid because it contains two double bonds, the first between carbon atoms 9 and 10 and the second between carbon atoms 12 and 13. The chemical formula of this acid is C18H32O2. Linoleic acid is an essential fatty acid because the body cannot synthesize it. It belongs to the omega-6 group (Omega-6) because its first double bond is located at carbon atom 6 when counted from the methyl group (CH3-) [34].

Table 6 shows significant differences among the study factors and their two-way interactions for linoleic acid content in groundnut.

The same table shows the significant effect of genotypes on this trait. Plants of genotype NC7 had the highest content, 32.56%, compared with plants of the local cultivar Saadia, which recorded the lowest mean, 29.22%. The variation in linoleic acid content among genotypes can be attributed to genetic diversity governing fatty acid biosynthesis-specifically the activity of the oleate desaturase (FAD2) enzyme, which converts oleic acid into linoleic acid-reflecting the inverse relationship typically observed between oleic and linoleic acids in peanut genotypes. [36] Furthermore, a strong negative correlation ($r = -0.84$) was observed between oleic and linoleic acids, quantitatively confirming their inverse biochemical relationship. .These results agree with [37, 38, 35 ,27] who reported significant differences among genotypes in their contents of unsaturated fatty acids, including linoleic acid, in groundnut.

Table 6 shows that the second sowing date, 1/5, significantly affected the trait by giving the highest mean, 31.72%, which did not differ significantly from the 15/4 sowing date, with a mean of 30.53%, but significantly exceeded the third sowing date, 15/5, which recorded the lowest mean, 29.86%.The superiority of the second sowing date (1/5) in linoleic acid percentage may be attributed to synchronization of the seed-filling stage with relatively favorable thermal conditions, which contributed to improving the efficiency of metabolic processes associated with the synthesis of unsaturated fatty acids. Its lack of significant difference from the first sowing date (15/4) indicates similarity in prevailing environmental conditions during critical growth stages in both dates, whereas the lower percentage at the late sowing date (15/5) may be due to exposure of plants to higher temperatures during seed filling, which negatively affected linoleic acid accumulation. These results are consistent with [32,33],who reported significant differences among sowing dates in the content of unsaturated fatty acids, including linoleic acid, in groundnut.

Table 6 shows that the interaction between genotypes and sowing dates was significant for the trait. Plants of genotype NC7 sown on 1/5 recorded the highest mean, 34.65%, whereas the interaction between the local cultivar Saadia and the third sowing date, 15/5, recorded the lowest mean, 28.72%.

Table 6 . Effect of sowing dates and genotypes on Linoleic Acid Percentage in Oil (%) in groundnut during the 2025 season

Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
15/4	28.97	31.77	30.86	30.53
1/5	29.97	34.65	30.54	31.72
15/5	28.72	31.26	29.59	29.86

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Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
Genotype mean	29.22	32.56	30.33	
LSD 5%	Sowing dates	Genotypes	Interaction	
	0.959	0.363	0.967	

5. Palmitic Acid Percentage in Oil (%)

Palmitic acid is a saturated fatty acid present in groundnut oil. It contributes to energy storage and supports lipid structure within plant cells, thereby affecting oil quality and its nutritional components. Table 7 indicates significant differences due to the study factors and the two-way interaction between genotypes and sowing dates in palmitic acid percentage in groundnut.

The NC7 genotype had the highest mean for this trait, 12.99%, whereas the Saadia cultivar gave the lowest mean, 11.26%. This difference in palmitic acid percentage among genotypes may result from differences in their genetic nature and their responses to prevailing environmental conditions, which were reflected in physiological traits, yield, fatty acids, and the active component. These results agree with [39,30] , who reported significant differences among groundnut genotypes in their fatty acid contents, including palmitic acid.

The same table shows that plants at the first sowing date, 15/4, were significantly superior, with a mean of 12.55%, whereas the third sowing date, 15/5, recorded the lowest mean for this trait, 11.62%. This may be attributed to differences in the environmental conditions surrounding the experimental plants. These results agree with [32,33], whose studies indicated differences in genotype responses to sowing dates in palmitic acid percentage in groundnut.

The same table also shows a significant interaction between genotypes and sowing dates. Genotype NC7 sown at the first date, 15/4, was superior and gave the highest palmitic acid percentage, 13.40%, compared with the Saadia cultivar sown at the third date, 15/5, which recorded the lowest acid percentage, 11.09%.

Table 7. Effect of sowing dates and genotypes on palmitic acid percentage (%) in groundnut during the 2025 season

Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
15/4	11.51	13.40	12.73	12.55
1/5	11.17	13.21	11.71	12.03
15/5	11.09	12.36	11.39	11.61
Genotype mean	11.26	12.99	11.94	
LSD 5%	Sowing dates	Genotypes	Interaction	
	1.058	0.269	0.501	

6. Stearic Acid Percentage in Oil (%)

Stearic acid forms part of the saturated fatty acids in groundnut oil and contributes to stabilizing the oil structure and giving it relative firmness, thereby affecting the physical properties and nutritional quality of the oil. The results in Table 8 showed a significant effect of genotypes and sowing dates, whereas their two-way interaction did not have a significant effect on this trait.

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The results of Table 8 showed an effect of genotypes on stearic acid percentage. Plants of genotype NC7 significantly exceeded the other genotypes, giving the highest mean for stearic acid, 2.66%, whereas the lowest mean for this trait was recorded by plants of the Saadia cultivar, 2.12%. This difference in stearic acid percentage may be attributed to genetic variation among genotypes and also to its superiority in palmitic acid content, as shown in Table 7. These results agree with [37,35,27], who indicated significant differences among genotypes in their fatty acid contents and active components, including stearic acid percentage in oil.

The results in Table 8 indicate significant differences among the sowing dates included in the study in stearic acid percentage. Plants sown on 1/5 gave the highest mean, 2.74%, significantly exceeding the third sowing date, 15/5, which gave the lowest value, 2.19%.This may be attributed to the fact that sowing on 1/5 provided favorable conditions during seed formation and filling, which improved photosynthetic efficiency and increased the transfer of photosynthetic products to the seeds, thereby increasing stearic acid percentage. In contrast, late sowing may have exposed plants to heat stress and shortened the growth period, limiting oil accumulation and consequently reducing the percentage of this acid. These results were consistent with [32,33].

The same table shows no significant effect of the interaction between genotypes and sowing dates on stearic acid percentage

Table 8. Effect of sowing dates and genotypes on stearic acid percentage (%) in groundnut during the 2025 season

Sowing date	Saadia	NC7	Ausa hanim	Mean of sowing dates
15/4	2.02	2.65	2.29	2.32
1/5	2.37	3.02	2.84	2.74
15/5	1.97	2.33	2.27	2.19
Genotype mean	2.12	2.66	2.47	
LSD 5%	Sowing dates	Genotypes	Interaction	
	0.269	0.134	N.S	

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Study Limitations and Future Perspectives

It should be noted that this investigation was conducted over a single growing season (2025) at a single geographical location. While these findings provide crucial baseline insights into the physiological and biochemical responses of newly introduced groundnut genotypes under the agro-climatic conditions of Anbar Governorate, multi-season and multi-location field trials are recommended in the future to further validate the stability of genotype × sowing-date interactions across fluctuating environments

Conclusions

It can be concluded that planting dates significantly influenced seed quality traits and fatty acid composition in groundnut. The early planting date (15/4) was optimal for maximizing seed protein, oil, and palmitic acid content, whereas the second date (1/5) yielded the highest values for oleic, linoleic, and stearic acids. Significant variation was also observed among the genotypes; the NC7 genotype consistently outperformed the others in most of the studied traits (protein and fatty acid content), while the Ausa hanim genotype recorded the highest seed oil percentage, contrasting with the lowest values recorded by the local cultivar Saadia. Overall, combining optimal planting dates (15/4 or 1/5) with superior, high-yielding genotypes, such as NC7 and Ausa hanim, represents an effective strategy for enhancing crop quality and fatty acid accumulation under field conditions.

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