Research Article

# Effect of Genotypes and Planting Dates on Groundnut Yield and its Components

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**Abstract** | A field experiment was conducted during the 2025 summer season in one of the agricultural fields located in the Al-Mushtal area, within the Hit district of Al-Anbar Governorate, on the right bank of the Euphrates River at longitude 42.82° and latitude 33.63°. The soil of the experimental site was classified as sandy loam. The study aimed to evaluate the response of newly introduced genotypes of groundnut (NC7 and Ausa hanim) compared with the local cultivar Saadia under three planting dates (15 April, 1 May, and 15 May) in terms of growth and yield performance. The experimental design was a randomized complete block, arranged in a split-plot design with three replications. The main plots were assigned planting dates and the genotypes (NC7, Ausa hanim), and the local cultivar (Saadia) were assigned to the sub-plots. Significant variation was found among the genotypes in all yield characters. The genotype NC7 outperformed in number of pods plant$^{-1}$ (94.16), number of seeds per plant (129.29 seeds plant$^{-1}$), fertility percentage (88.95%) and pod yield per plant (142.51 g plant$^{-1}$). However, local cultivar Saadia was the best with respect to no. of seeds pod$^{-1}$ (1.461). Meanwhile, the maximum 100 grain weight (86.74g) was observed to be recorded by Ausa hanim genotype. Additionally, there has variation between planting dates. The earliest sowing date (April 15) showed the highest performance for most of characteristics, such as seed pods$^{-1}$ (1.53 seeds pod$^{-1}$), seeds plant$^{-1}$ (131.99 seeds plant$^{-1}$), fertility percentage (87.55%), 100-seed weight (83.72 g), and pod yield per plant (149.00 g plant$^{-1}$). Meanwhile, the planting date of 1 May achieved the highest number of pods per plant with an average of 98.58 pods plant$^{-1}$. Furthermore, a significant interaction was detected between genotypes and planting dates for most studied traits.

**Received** | April 27, 2026; **Accepted** | October 18, 2026; **Published** | October 31, 2026
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**Citation** | Al-Hiti, M.J.H. and S.A.A. Al-Salmani. 2026. Effect of genotypes and planting dates on groundnut yield and its components. *Pakistan Journal of Agricultural Research*, 39(s1): 28-37.
**DOI** | https://dx.doi.org/10.17582/journal.pjar/2026/20260410205024
**Keywords** | Groundnut, Genotypes, Planting dates, Yield characters

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## Introduction

Groundnut (*Arachis hypogaea* L.) Fabaceae (Leguminosae) is considered one of the most important leguminous crops and a major economic commodity worldwide, ranking 13th among food crops (Mouri *et al*., 2018). Globally, 50% of groundnut production is used for oil extraction, 37% for confectionery purposes, and 12% for seed production (Shendage *et al*., 2018). In 2021, peanut

butter accounted for 56% of groundnut consumption in the United States, while confectionery products represented 17%, and snacks 19% as mentioned by American Peanut Council (2022).

Groundnut seeds are composed of 38–50% oil, 26% protein, 11.5% carbohydrate, 2.3% ash and minerals and 6% moisture content (Oyewole *et al*., 2020). They are also a good source of plant-based unsaturated fatty acids such as oleic acid (50%) and linoleic acid (30%), which have anti-inflammatory effects and can decrease the risk of cardiovascular diseases, diabetes, liver steatosis, stroke and heart attack) (Yasli et al., 2020); therefore, making groundnut preferable in diets used to lower blood cholesterol levels. Groundnut flour is also used for medical use, particularly for diabetic patients, where it contains below 12% carbohydrate. Furthermore, it has also high contents of important minerals-dietary such calcium, potassium, phosphorus, and magnesium, vitamins as B complex (E and K) (Mouri *et al*., 2018).

The oil, protein and fatty acid levels differ according to genotypes, environmental conditions and nutrient supply (Macro and micro nutrients). In addition, groundnut enriches the nitrogen content of the soil thus making it valuable in crop rotation systems (Haneena *et al*., 2021).

The United States accounts for approximately 5% of world groundnut production and is the fourth leading producer globally. Worldwide, the global area under groundnut production was 31.6 million hectares with a total output of more than 53.7 million tons. Production was concentrated in Asia and Africa, which together accounted for about 90% of the world supply. The world's major producers are China and India, for which 18 million tons (37% of global production) (Hauser, 2018), followed by India that is approximately at 10 million tons. In Latin America, Argentina is the main producer accounting for 977 thousand tons from 388 thousand hectares and a productivity of around 2520 kg $ha^{-1}$. Followed by Brazil, who generated some 435 000 tonnes on an area of144 600 ha and yield of 2967 kg $ha^{-1}$. The five leading groundnut-producing countries are: China, India, Nigeria, United States and Senegal providing 38%, 13%,9%,6% and 3% of the world production (USDA-FAS, 2024). However, in Iraq the crop yields are still low when compared to world standards. In Iraq, the crop's productivity remains low compared to global production. The area cultivated with groundnut in Iraq was 757.75 hectares in 2020 as quoted by Ministry of Planning/ Directorate of Agricultural Statistics (2021).

It is known that legume flowers have a high abortion rate, and in this crop, the abortion rate rarely falls below 50%, even under ideal growing conditions. This is further supported by the fact that temperatures exceeding 40°C are unsuitable for fertilization. The nutritional quality of oilseeds is affected by environmental factors, genetic factors, and poor crop management, and the groundnut crop is particularly sensitive to these factors (Chakraborty *et al*., 2018; Zhang *et al*., 2019; Dash and Chimmad, 2021). Agricultural practices, including sowing dates, are considered influential factors on growth and yield due to changes in temperature and photoperiod from one date to another. This affects most of the important biological activities and seed formation (Meena *et al*., 2014; Damahe *et al*., 2018; Kumar *et al*., 2020). Adverse environmental conditions, such as high temperature, affect the content and quality of oil in groundnut seeds (Meena *et al*., 2022). Extremely low temperatures affect the crop's growth stages and result in the production of immature pods, while high temperatures are responsible for delayed crop growth and reduced quality (Dash *et al*., 2020).

Given the scarcity of studies on this important economic crop in Iraq and the occurrence of significant climate fluctuations due to global warming, this study aims to:

- Determine the best of the introduced genotypes in terms of their suitability and response to the agricultural conditions of the region compared to the prevalent cultivar, and their ability to provide the highest yield per unit area.
- Determine the appropriate sowing date for each of these genotypes to achieve the highest productivity, with the goal of generalizing its cultivation under the conditions of the experimental area.
- Determine the effect of the interaction between the genotypes and the sowing dates on the yield traits and their components in groundnut.

## Materials and Methods

A field experiment was conducted during the summer growing season of 2025 in an agricultural field located in the Al-Mushtal area, within the Hit district of Al-Anbar Governorate, situated on the right bank of

the Euphrates River at longitude 42.82° and latitude 33.63°. The soil of the experimental site was classified as sandy loam irrigated with Euphrates River water, and. The study aimed to evaluate the response of two newly introduced genotypes of groundnut (NC7 and Ausa hanim) compared with the local cultivar Saadia under three planting dates (15 April, 1 May, and 15 May) in terms of growth and yield performance.

The agricultural operations for the experiment were carried out as follows: The experimental land was prepared by plowing it twice perpendicularly using a moldboard plow, followed by operations for soil refining and leveling according to the crop's requirements (Table 1).

A Randomized Complete Block Design (R.C.B.D.) was used with three replicates with a Split-Plot arrangement. The sowing dates occupied the Main Plot, and the genotypes allocated to the Sub-Plot. The area of the experimental unit was 6 square meters (3 x 2 m), and each experimental unit contained four rows. The total number of experimental units was 27, with a plant density of 53,333 plants $ha^{-1}$. The row length was 2 meters, the distance between rows was 75 cm, and the distance between hills was 25 cm. Triple superphosphate (P2O5) fertilizer was added at a rate of 80 kg $ha^{-1}$ before planting during land preparation. Nitrogen fertilizer was applied in two applications: the first after replanting and thinning and the second at flowering, at a rate of 100 kg $ha^{-1}$ in the form of urea (46% N). Hoeing and weeding were carried out 25 days after germination and repeated as needed. Irrigation continued as required by the crop According to the recommendations, the incubation process was carried out once at flowering and again at the beginning of the formation of the spurs. When signs of maturity appeared on the crop, a random sample of ten plants was taken from the middle rows of each experimental unit to conduct studies on them. Harvesting operations were carried out individually for each planting date upon reaching full crop maturity.

### *Statistical analysis*

After collecting and classifying the data of the field experiment according to the experimental design and analyzing them statistically with three replications, the significant differences between the means were compared using the least significant difference (LSD) at a probability level of 0.05 using the Genstat statistical program.

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

| Traits | Values | Units |
|---|---|---|
| pH | 7.9 | |
| Electrical conductivity (EC) | 1.72 | dS $m^{-1}$ |
| Clay | 13.0 | % |
| Silt | 25.1 | % |
| Sand | 62.3 | % |
| Soil texture | Sandy loam | |
| Total calcium | 292 | mg/kg soil |
| Available phosphorus | 10.6 mg $kg^{-1}$ | |
| Available potassium | 131.3 mg $kg^{-1}$ | |
| Available iron | 7.1 mg $kg^{-1}$ | |
| Organic matter | 0.86 | % |

### *Yield traits and their components studied*

1. Number of Pods per Plant (pods $plant^{-1}$): Total pods (mature and immature) from ten sampled plants per experimental unit were counted and averaged.
2. Pod Yield per Plant (g $plant^{-1}$): Calculated from the average pod yield of ten plants.
3. Total Seeds per Plant (seeds $plant^{-1}$): All mature and immature seeds from ten plants were counted after shelling, and the average number per plant was determined.
4. Seeds per Pod (seeds $pod^{-1}$): Calculated by dividing the total number of seeds from ten plants by the total number of pods per experimental unit.
5. Pod Fertility Percentage (%): Determined by dividing the number of filled pods by the total number of pods multiplied by 100, based on ten randomly harvested plants per experimental unit.
6. 100-Seed Weight (g): From each experimental unit, 500 g of healthy mature seeds were taken as a random sample. From this sample, 100 seeds were counted and weighed using a sensitive balance.

## Results and Discussion

### *Pods per plant (pod $plant^{-1}$)*

Number of pods is considered one of the important yield components in the groundnut crop that leads to an increase in seed yield. Results indicated a significant effect of the study factors and the two-way interactions between them for this trait.

Table 2 shows that plants of the NC7 cultivar recorded

a significant superiority over the other genotypes, achieving maximum average for the trait, achieving (94.16) pods per plant. The least average for this trait was recorded by the plants of the local cultivar Saadiya, which reached (83.08) pods per plant. The genetic potential of the NC7 cultivar may explain its superiority in this characteristic. to utilize the surrounding environmental conditions, employing them effectively in the photosynthetic process. This enhanced the translocation of manufactured nutrients (carbohydrates) from the source to the sink, which increased the percentage of flower set and subsequently led to an increase in the number of pods per plant. This finding is consistent with what was reported by Effa *et al.* (2023), Oliva-Cruz *et al.* (2024), and Iddrisu *et al.* (2024), who indicated the existence of significant differences in the total number of pods per plant among different groundnut genotypes

**Table 2:** *Effect of genotypes and planting dates on the number of pods per plant (pods plant$^{-1}$) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 89.15 | 98.00 | 93.11 | 93.42 |
| 1 May | 88.89 | 107.48 | 99.37 | 98.58 |
| 15 May | 71.20 | 77.00 | 75.11 | 74.43 |
| Mean of genotypes | 83.08 | 94.16 | 89.19 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 5.44 | 2.76 | 5.89 | |

The results also indicate significant differences among the sowing dates included in the study for the trait of total number of pods per plant. Plants sown on the second date, May 1st, gave the maximum mean achieved at (98.58) pods per plant. Meanwhile, the third date, May 15th, achieved the least average for this trait, which was (74.43) pods per plant. The reason for the differences between sowing dates may be due to the variation in day length encountered by the plants at different planting times. Long days (more than 13 hours) increase the rate of vegetative growth of the crop and partially reduce the photosynthesis necessary for pod production, while short days (less than 12 hours) enhance the number of flowers, pegs, and pods in the groundnut crop (Bangall and King, 1991). Moreover, the variation in the number of pods may be attributed to differences in temperature at and after flowering. This was supported by Calishkan *et al.* (2008), were the highest number of pods was formed when the plant had been subjected to favorable temperatures in the vegetative and reproductive periods. These results are consistent with the results of various researchers Nayak *et al.* (2023), Effa *et al.* (2023), Abdulrahman *et al.* (2023), Dima *et al.* (2023), and Reager *et al.* (2024), the number of pods per plant were influenced by sowing dates.

The interaction between genotypes and planting dates had a significant effect on the number of pods per plant. The genotype NC7 recorded the highest mean for the May planting date (107.48 pods plant$^{-1}$), whereas the local cultivar Saadia recorded a mean of 71.20 pods plant$^{-1}$ for the autumn planting on May 15. This interplay highlights the divergent physiological responses among varieties under varying environmental conditions during the flowering and pegging stages. Early planting provided optimal thermal units and photoperiods, enabling high-yielding genotypes-such as NC7 and Ayşe Hanım-to maximize their reproductive capacity and successfully convert pegs into mature pods. Conversely, delayed planting exposed the plants to heat stress during critical reproductive phases, leading to increased peg desiccation and reduced flower-to-pod set rates. The local variety "Sa'diyah" demonstrated relatively greater stability under delayed planting due to its heat tolerance, whereas the introduced varieties achieved their maximum pod potential when planted during the recommended window.

*Pod yield per plant (gram plant $^{-1}$)*

The results indicate the existence of significant impact among genotypes, the sowing dates, and the two-way interaction (Table 3). The NC7 cultivar achieved the highest average of pod yield per plant, reaching (142.51) grams per plant. It did not differ significantly from the Ausa hanim cultivar, which recorded an average of (140.17) grams per plant. In contrast, the Saadiya cultivar gave the least average of (134.02) grams per plant. The reason for the genotypic difference in pod yield per plant may be attributed to the variation in the genetic nature of the genotypes, as the trait of pod yield per plant is generally a genetic trait related to the cultivar's inherent genetic potential. The results are similar to the reports of many authors, including Hamza *et al.* (2023), Iddrisu *et al.* (2024), Shamsuddeen and Bashir (2025) and Kabir et al. (2025) observed differential response of groundnut cultivar to yield character.

According to results (Table 3) plants of the first sowing date, i.e., April 15th, they recorded the highest average pod yield of (149.00) grams/ plant, which was significantly higher than those of both other dates. On the other hand, plants from dates 15 of May as third sowing date presented the least average with 125.13 expressed grams per plant. This first date superiority can be attributed to its better performance in other yield-related traits like number of seeds per pod, fertility percentage and 100-seed weight (Tables 3, 4 and 6), which This reduction is directly attributed to heat stress during the late flowering period, which negatively impacts pollen viability, restricts pollen tube elongation, and increases flower abortion, ultimately leading to impaired fertilization and reduced pod setting... These results agree with what was obtained by a number of researchers, including Sepehri and Shahbazi (2017), Dima *et al.* (2023), and Reager *et al.* (2024), who indicated that sowing dates have a significant effect on the pod yield trait and that early sowing dates yielded a higher yield than later dates.

Interaction between the study factors implies a differing response of the genotypes to the sowing dates. The maximum yield was achieved by the NC7 cultivar planted on the first date (April 15th), with an average of (154.18) grams per plant. Conversely, the local cultivar Saadiya planted on the third date (May 15th) achieved the least average for this trait, reaching (119.81) grams per plant.

**Table 3:** *Effect of genotypes and planting dates on pod yield per plant (gram plant $^{-1}$) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 142.18 | 154.18 | 150.63 | 149.00 |
| 1 May | 140.07 | 144.48 | 143.18 | 142.58 |
| 15 May | 119.81 | 128.89 | 126.70 | 125.13 |
| Mean of genotypes | 134.02 | 142.51 | 140.17 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 3.25 | 1.61 | 3.48 | |

*Number of seeds per pod (seed pod$^{-1}$)*

The results demonstrate significant differences among the groundnut genotypes, sowing dates, and the two-way interaction between them in the trait of the number of seeds per pod

It appears from (Table 4) that the local cultivar Saadiya was significantly outperformed, recording the highest average for this trait, which reached (1.46) seeds per pod, compared to the NC7 cultivar, which achieved the least average for the trait, at (1.39) seeds per pod. The variation in the number of seeds per pod among genotypes may be due to differences in the genetic makeup of the genotypes, as the trait of the number of seeds per pod is often a genetic characteristic related to the cultivar's inherent nature. This is consistent with Hamza *et al.* (2023) who found a significant difference among the studied groundnut genotypes in the trait of number of seeds per pod.

**Table 4:** *Effect of genotypes and planting dates on number of seeds per pod (seed pod-1) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 1.55 | 1.57 | 1.48 | 1.53 |
| 1 May | 1.40 | 1.39 | 1.45 | 1.41 |
| 15 May | 1.42 | 1.21 | 1.29 | 1.31 |
| Mean of genotypes | 1.46 | 1.39 | 1.41 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 0.07 | 0.05 | 0.08 | |

The results also implies the significant superiority of the first sowing date (April 15th) for this trait, with an average of (1.53) seeds per pod, compared with the second and third planting dates, whose mean values were (1.41) and (1.31) seeds per pod, respectively. This dominance of early planting date can consequently be ascribed to favorable environments that support better flower fertilization and pod filling which led to an elevation in number of seed per pod. These results are in agreement with the findings of Fakhr *et al.* (2020) who recorded an intensive impact of planting dates on seed number per pod in some legume crops.

The results of the interaction between genotypes and planting dates (Table 4) revealed that the maximum mean number of seeds per pod was recorded with the cultivar NC7 sown at 15 April (1.57 seed pod$^{-1}$). In contrast, the least mean value (1.21 seeds pod$^{-1}$) was also recorded by NC7 when planted on 15 May. This indicates that the NC7 composite performs best in early sowing season and its performance weakens significantly in late sowing.

*Fertility percentage in pods (%)*

The results shown in Table 5 indicate a significant impact of fertility percentage due to the effect of the genotypes and the sowing dates. It is also noted that there were no significant differences for the two-way interactions between them for this trait.

It is observed from Table 5 that the NC7 cultivar was significantly superior, recording an average of (88.95)%, compared to the local cultivar Saadiya which registered the least average for the trait, at (84.33)%. The reason for the difference among the genotypes in the fertility percentage may be due to the variation in the inherent genetic nature of the genotypes. This result is consistent with other researchers, including Effa *et al.* (2023), El-Temsah *et al.* (2023) and Kabir *et al.* (2025), who found a significant difference among the groundnut genotypes in the fertility percentage of the pods.

**Table 5:** *Effect of genotypes and planting dates on Fertility percentage in pods (%) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 85.28 | 89.74 | 87.62 | 87.55 |
| 1 May | 84.38 | 89.87 | 87.30 | 87.18 |
| 15 May | 83.33 | 87.22 | 84.80 | 85.12 |
| Mean of genotypes | 84.33 | 88.95 | 86.57 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 0.72 | 1.23 | NS | |

The results in Table 5 revealed a significant impact of the sowing dates in this trait. The first date (April 15th) recorded the highest average for the fertility percentage, with a mean of (87.55)%, The second date showed no significant difference compared to the first date. (May 1st), which had an average of (87.18)%. This was compared to the third date (May 15th), which recorded the least average, at (85.12) %. The increase could be due to the appropriate planting date., which may have increased the accumulated heat units, consequently leading to good vegetative growth and, an elevation in the transport of produced materials from the origin leaf) to the destination (pods). This result agrees with what was reached by Kumar and Prathyusha (2020) and Effa *et al.* (2023), who showed a significant effect of sowing dates on the fertility percentage trait in the groundnut crop.

Results revealed no significant interaction between genotypes and sowing dates for the fertility percentage trait (Table 5). Therefore, the individual interaction means were not further discussed.

*Total seed number (seed plant$^{-1}$)*

The results indicated a significant effect of the genotypes, sowing dates, and the interactions between them on this trait.

Table 6 shows the significant effect of the varieties used in cultivation. The NC7 cultivar was superior, achieving the optimum average with a mean of (129.29) seeds per plant, followed by the Ausa hanim cultivar, which did not show a significant difference and had an average of (124.77) seeds per plant. In contrast, the local cultivar Saadiya achieved the minimum average of (120.66) seeds per plant. The difference in seed number among genotypes may be due to the differences of their response to environment conditions, especially temperature since it can have a negative influence on pollen viability and the success of fertilization, hence leading to reduced total number of seeds. The results are in conformity with the reports of Oni and Lawal (2019), Samaha *et al.* (2019), and Hamza *et al.* (2023) by the effect of temperature, humidity and soil fertility on ovule fertilization, which has a strong influence on seed number.

**Table 6:** *Effect of genotypes and planting dates on total seed number (seed plant$^{-1}$) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 125.01 | 136.15 | 134.81 | 131.99 |
| 1 May | 126.77 | 130.14 | 128.18 | 128.37 |
| 15 May | 110.18 | 121.59 | 111.33 | 114.37 |
| Mean of genotypes | 120.66 | 129.29 | 124.77 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 2.38 | 1.81 | 3.14 | |

The same table (Table 6) also shows a significant effect between the dates included in the study. The highest average number of seeds per plant was recorded. (131.99 seeds plant$^{-1}$) was obtained from the first planting date (April 15). While the third date of sowing May 15 had significantly the least mean (114.37 seeds plant$^{-1}$). This difference may have been due to the larger range of environmental conditions, particularly temperature, light and relative humidity, in planting

dates. Increasing the growing time through late planting results most often in higher temperatures during flowering and subsequent reduction of pollen viability and fertilization, resulting in decreased seed set. These results are consistent with those reported by Arıoglu *et al.* (2020) and Nayak *et al.* (2023), who reported that delayed sowing resulted in the decreased number of seeds as a result of shorter vegetative and reproductive periods and lower photosynthetic assimilate production.

Regarding the interaction between cultivars and sowing dates, a significant effect on total seeds per plant was observed. The NC7 cultivar planted on April 15th achieved the highest mean (136.15 seeds plant$^{-1}$), whereas the local cultivar Saadiya sown on May 15th recorded the lowest mean (110.18 seeds plant$^{-1}$). This differential response highlights variations in heat unit accumulation and source-to-sink efficiency during seed filling. Early sowing enabled large-seeded cultivars like NC7 to fully express their yield potential through extended assimilate synthesis and efficient translocational partitioning. In contrast, delayed sowing hastened crop development, restricting the duration of seed fill and increasing seed abortion under high ambient temperatures, though Saadiya maintained higher relative tolerance to late-season thermal stress.

*100-seed weight (gram)*

The seed weight for the groundnut crop is one of the main and important yield components. It directly affects the plant's yield and serves as an indicator of the plant's efficiency and ability to draw the largest amount of metabolic materials from the source to the sink, and the balance between them, which is also linked to the effectiveness of the leaf area in performing carbon fixation (photosynthesis), as well as the speed of seed formation and filling after fertilization (Elsahooki, 1995). This trait is associated with the nature of the genotypes and environmental factors.

The results presented in Table 7 revealed a significant impact of the genotypes and sowing dates, while the two-way interaction did not record a significant effect on the trait of 100-seed weight.

Table 7 the results revealed that the Ausa hanim cultivar achieved the highest average for 100-seed weight, with a mean of (86.74) grams, while the local cultivar Saadiya recorded the least average for the trait, at (76.43) grams. The reason for the difference may be due to the genetic nature of the genotypes, which varies based on the genetic origins of the used lines. Globally, there are groups with large seeds used for direct consumption and groups with small seeds used for oil production. The difference may also be due to the variation among the genotypes in the production of manufactured matter and its translocation from the source to the sink. Furthermore, the superiority of some genotypes may be due to the plants' ability to intercept a larger amount of light, thereby increasing the efficiency of the photosynthetic process, which leads to increased material manufacturing and translocation from the source to the sink. The research results aligned with several studies that found a significant difference among groundnut genotypes in the mean 100-seed weight, including Musa *et al.* (2023), Iddrisu *et al.* (2024), Oliva-Cruz *et al.* (2024), and Kabir *et al.* (2025).

**Table 7:** *Effect of genotypes and planting dates on 100-seed weight (gram) of groundnut for the 2025 season.*

| Planting dates | Genotypes | | | Mean of dates |
|---|---|---|---|---|
| | Saadia | NC7 | Ausa hanim | |
| 15 April | 80.17 | 82.72 | 88.28 | 83.72 |
| 1 May | 75.11 | 78.61 | 86.00 | 79.91 |
| 15 May | 74.00 | 77.56 | 85.94 | 79.17 |
| Mean of genotypes | 76.43 | 79.63 | 86.74 | |
| LSD (p ≤ 0.05) | Dates | Genotypes | Interaction | |
| | 2.45 | 1.15 | NS | |

The finding in Table 7 also revealed that the first date (April 15th) achieved the highest average of (83.72) grams, which differed significantly from the second date (May 1st), which recorded an average of (79.91) grams. Both were significantly superior to the third date (May 15th), which recorded the least average for this trait, at (79.17) grams. This could be related to differences in temperature and photoperiod between the sowing dates which induced distinct leaf area and index, resulting in differences in seed weight. These findings are corroborated by several studies, such as Arıoglu *et al.* (2020), Warren (2023) and Reager *et al.* (2024) who observed clearly the differences in 100-seed weight due to planting dates. The weight of this characteristic was greater in the early sowing dates.

Results in Table 7 implies no significant interaction

between study factors, since plants of the cultivar (Ausa hanim) sown on the first planting date (April 15) exhibited apparent performance with average seed weights of 88.28 g, and local cultivar Saadia sown on the third planting date (May 15) obtained least average values of 100-seed weight reaching to a mean of 74.00 g.

## Conclusions

1. The genotypes responded differently to the environment of the experimental area, as indicated by differences in yield and its components. It demonstrates that differences exist in their genetic characteristics and suggest that the NC7 superior than others for most of yield related traits.
2. Differences appeared among the sowing dates included in the study, and the first sowing date (April 15th) showed superiority in most yield traits.
3. The two-way interaction between the two study factors A significant impact was observed on the majority of the analyzed characteristics, with the most notable interaction occurring between the NC7 cultivar and the sowing date of April 15th.

## Acknowledgments

The authors express their sincere appreciation to the College of Agriculture, University of Anbar, for providing the necessary facilities, guidance, and support during the field experiment. Special thanks are extended to the staff of the Al-Mushtal Experimental Field for their assistance in land preparation, field management, and data collection. The authors are also grateful to the Department of Crop Sciences for their valuable scientific insights and for facilitating access to resources that contributed to the successful completion of this research study.

## Novelty Statement

This study is among the first in Iraq to evaluate the performance of newly introduced groundnut genotypes (NC7 and Ausa hanim) under different planting dates compared with the local cultivar Saadia. The research provides novel insights into the interaction between genotype and sowing time under the sandy loam soil conditions of Al-Anbar Province. The findings contribute to improving cultivar selection and optimizing planting date strategies to enhance groundnut productivity in arid and semi-arid environments.

## Authors' Contribution

**Mohammed Jallel Habib Al-Hiti**: Conceptualization, experimental design, data collection, statistical analysis, interpretation of results, and manuscript drafting.

**Sinan Abdulla Abbas Al-Salmani**: Supervision, methodology validation, critical review of analysis, manuscript editing, and final approval.

Both authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the research.

### *Generative AI and AI assisted technology statement*

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

### *Conflict of interest*

The authors have declared that there is no conflict of interest regarding the publication of this research. The study was conducted solely for scientific purposes, with no influence from any commercial or financial entities.

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