OPEN ACCESS

Middle East Research Journal of Agriculture and Food Science
ISSN: 2789-7729 (Print) & ISSN: 2958-2105 (Online)
Frequency: Bi-Monthly
DOI: https://doi.org/10.36348/merjafs.2026.v06i01.001

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Effect of Planting Dates on Growth and Yield of Rice Cultivars in Southern Iraq

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Abstract: In Iraq, rice (Oryza sativa L.) is a significant staple crop and its yield in the southern parts is highly dependent on the date of the planting as well as the cultivar type. This research was carried out to assess the impact of various planting dates on growth, yield, and yield components of various rice cultivars grown in the field in southern Iraq. The field experiment was based on a split despite plot design that was carried out in the summer season in 2025 within a randomized complete block design that had three replicates. Main plots were divided by three planting dates, D1 (1 June), D2 (15 June), and D3 (1 July), whereas subplots had four rice cultivars (Anber 33, Furat 1, Yasmin, and Amber AlqueliBaraka). Plant height, the amount of tillers per hill, the leaf area index, days to 50 percent flowering, days to physiological maturity, the number of panicles per square meter, the grains per panicle, the percentage of unfilled grains, 1000 grains weight and grains yield were recorded. Findings revealed that the planting date was found to have a significant influence on most of the growth and yield traits. The highest yield of grains was observed with Mid-June planting (D2, approximately 6.3 t ha 0 -1), then early planting (D1, approximately 5.7 t ha 0 -1), and lastly, late planting (D3, approximately 4.6 t ha 0 -1). Furat 1 and Yasmin had the best grain yields because they had more grains per panicle and panicle count whereas Amber Al Unless, had the best 1000ngthgrain weight. Anber 33 had reduced grain yield although it is also of importance based on its aromatic value. A strong interaction between the date of planting and cultivars showed a difference in the response of the genotypes with the environmental conditions conjoined with a particular date of planting. Based on the study the researchers recommend that high yielding rice cultivars like Furat 1 and Yasmin which are planted around mid-June in combination with rice would enhance productivity under the southern Iraq climatic conditions.

Keywords: Rice (Oryza sativa L.), Planting date, Grain yield, Rice cultivars, Southern Iraq.

Research Paper

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How to cite this paper:
Zainab Zuhair Abd ASada Alfatlawy (2026). Effect of Planting Dates on Growth and Yield of Rice Cultivars in Southern Iraq. *Middle East Res J. Agri Food Sci., 6*(1): 1-7.

Article History:
| Submit: 28.12.2025 |
| Accepted: 31.01.2026 |
| Published: 05.02.2026 |

INTRODUCTION

Rice (Oryza sativa L.) is among the most significant cereal plants in the world giving rise to a significant portion of the daily calories consumed by over fifty percent of the world with rice being the major dietary food to more than three billion people residing mainly in Asia [1-3]. It has a nutritional significance due to its high composition of readily digestible carbohydrates and as a source of vital minerals and vitamins, and is therefore in the food security plans of most developing nations [1-2-5]. With the world population ever-increasing, the demand of rice is also expected to go up, further putting pressure on the necessity to make it more productive and stable in various and ever-changing environmental conditions [2-5-10]. In this regard, the enhancement of rice production systems and the optimization of agronomic systems play a highly important role in the preservation of food supply, and the reduction of risks caused by climate change and resource deficiency in rice-based agroecosystems [5-14-17].

Rice is a major staple crop in Iraq and the traditional diet, particularly in the central and southern governorates, where it constitutes a large portion of the diet of both rural and urban populations [6]. Iraqi rice industry has a twofold role: it plays an important role in food security in the localities, and it is also an economic activity of the farming families and rural communities in the large production regions of Najaf, Diwaniyah, or Babylon [6-8]. Nevertheless, even though it is crucial, national rice production has been unable to cope with the demand in the country, which has contributed to the increasing trend of consumption among imports to close production and consumption gaps [6-7-11]. Such imbalance can be attributed mainly by the limitation of water supply, environmental degradation, and less than optimal agronomic control of crop that, collectively, restrict potential productivity of crop as produced under the condition of Iraqi circumstances [7-8-15].

High-quality aromatic rice has traditionally been grown in the southern and central part of Iraq, especially the local landraces that are commonly known as Anber types, that are highly preferred by consumers because of their unique aroma and grain quality [7-16]. Some of them, like Anber 33 and Amber Al-Baraka, are well-known due to their high-quality grain traits and baking qualities, which sell at high prices in local markets [7-16]. In addition to these traditional cultivars, better high-yielding varieties, including Furat 1 and Yasmin have been launched and tested to be more productive and utilize available resources better under Iraqi agroxiticlimatic conditions [8-16]. Such enhanced cultivars are generally shorter in growth, higher in tillering ability, and are better yielding than some older types of aromatics, though their traits of grain quality and marketability may vary [8-16]. Current research on the genotypes of Iraqi rice has also shown that there is a lot of genetic variation in local and improved cultivars on growth, yield constituents and the ability to withstand abiotic stresses implying the need to align cultivars with management practices [7-8-16].

The climate and hydrological conditions that continue to pose challenges to rice production in Iraq are the decline in river flows, frequent droughts, rising temperatures, and increasing evapotranspiration rates during the summer growing period [7]. These limitations have resulted in decreased area covered by water intensive crops like rice, and also the increasing regulations on use of irrigation water in major rice regions of growth [7-9-11]. In this scenario, agronomic practices, especially the date of planting and the choice of cultivar, have been identified as a key approach to enhance the agronomic water use efficiency, prevent the occurrence of extreme heat stresses, and stabilize yield [12-17]. The field research which determines the appropriate genotype and planting time combinations is thus important to continue producing rice and cope with the new nature of climatic and water scarcity pressures in southern Iraq [14-17]. Planting is among the most crucial management practices that impact the growth, development, and yield of rice, since it dictates the environmental conditions that an crop would be subjected to at every stage of phenological development [14]. Planting or transplanting on various dates alters the thermal and photoperiodic regime to which the crop is subjected and subsequently translates into altered vegetative and reproductive periods, leaf area accumulation, tillering interactions and flowering and maturity dates [13]. A number of experiments have proved that improper time of sowing may reduce the length of growth cycle, biomass development and expose the crop to unfavorable temperature or moisture factors at such critical developmental stages as heading and grain filling, which may result in high sterility of spikelets and low yield of grains [14]. On the other hand, the optimal planting date may also be used to align the key phases with more optimal temperatures and radiation regimes thus promoting photosynthetic efficiency, grain set and eventually yield and yield components [12-13]. In most rice grown locations, there is comparatively a small optimal planting interval beyond which yield losses become severe since of either earlyEnglish cold stress or lateEnglish heat and water stress [12]. Planting time in hot, semi-arid settings such as the ones found in southern Iraq are of particular concern since the summer season is typified by high temperatures, high rates of evaporation, and in many cases, the supply of irrigation water when demand is at its highest point [15]. Direct sown and transplanted rice studies in warm areas have also suggested that late-sowing also reduces the overall period of growth, hastens phenological advancement and could pose the risk of exposure to excess heat during flowering, hence, decreasing grain set and yield [14]. Conversely, overly early planting may expose young seedlings to relatively low temperatures or early presence of unstable earlyapestseason weather which has adverse impacts on seedling establishment, tiller production and early canopy formation [12-13]. Consequently, it is necessary to find a middle ground between vegetative development and either extreme of either extreme heat or water stress during reproductive development to maximize productivity in such environments [12-14]. This type of optimization is especially relevant in irrigated rice systems where arrangements of water allocation and delivery have to be synchronized with water needs of crops in various growth stages [14-17].

Cultivar selection, together with planting date, forms the basis of the performance of rice in particular environmental conditions since genotypes vary in their thermal needs, growth period, morphology, and yield potential [1-14-16]. The comparative experiments conducted in Iraq on the local aromatic and improved high wheat species found significant variation in the plant height, tillering potential, leaf area index, number of grains per panicle, 1000 gram weight and total quantity of grains per plant [8-16]. Some examples include the fact that cultivars like Furat 1 and Yasmin have been reported to give a relatively higher yield of grain and short growth cycle in comparison with traditional aromatic cultivars like Amber 33 and Amber AlCLUDINGBaraka that are usually found to give heavier grains and good quality but low yield potential [8-16]. In addition, morpho zwischenphysiological investigations on Iraqi genotypes of rice have shown that certain varieties have a higher adaptation to water stress and extreme temperatures that would be of an advantage in the ever-stressful climatic conditions in southern Iraq

[7-16]. These results highlight the importance of considering cultivar performance in terms of various planting dates to determine genotypewealth specific optimum sowing periods that utilize their genetic abilities and improve yield stability [16]. The interrelation of the planting date and the cultivar plays a critical role in the rice agronomy as the respective genotype is likely to react differentially to the evolving environment presented by the sowing environment owing to the inherent phenological and physiological traits [14]. Experiments involving multi-factorial fields recently have indicated that date of sowing and cultivar and their interaction can have a significant impact on such important traits as days to heading, days to maturity, plant height, tiller count, panicles/unit area, grains/panicle, grain filling, percentage 1000 grains weight, and ultimate grain yield [14]. Such studies have also shown that the earliest time to plant in order to maximize the grain yield can differ between cultivars, that is, a particular recommended time of the year to plant may not be the same on all the genotypes planted within a region [12]. Consequently, region specific and cultivar specific studies are needed to come up with accurate recommendations that incorporate the date of planting and the type of cultivar especially during climatic variability and water scarcity [17]. Due to the strategic nature of rice to food security in Iraq and the continuous increase in the challenges of climate change, water scarcity, and environmental pressures in the southern area, there is a compelling necessity to optimize the agronomic processes that can improve rice production and efficiency of resource utilization [10]. The comparison of the growth and yield performance of the main rice varieties as influenced by planting date under field conditions in southern Iraq on traditional aromatic varieties (Anber 33 and Amber Alzerwak) and improved high instanceof yields (Furat 1 and Yasmin) will be critical information that helps in the optimization of the planting time and the choice of cultivars [8]. These researches can be used to give extension advice, aid in decision making by farmers and policymakers who want to maintain or even maximize rice production in the present and in the future climatic conditions [17].

Materials and Methods

Study site and experimental conditions

The experiment was conducted on the 2025 summer growing season at an experimental farm in the southern region of Iraq in an area of typical rice wojgrowing, which is the agroinctural ecosystem that represents the actual condition of the region [16]. The weather is arid to semi arid with hot summers and mild winters with mean high temperatures of up to 38 C. [17]. The soil at the experimental site is classified as clay loam with moderate to poor drainage, slightly alkaline reaction, and medium organic matter content, features that are common in many irrigated rice fields in Iraq [6]. Before land preparation, composite soil samples were collected from the 0–30 cm layer and analyzed for texture, pH, electrical conductivity, organic matter, and available nitrogen, phosphorus, and potassium, following standard laboratory procedures [11]. Meteorological data for daily maximum and minimum temperature, relative humidity, and solar radiation were obtained from the nearest weather station to characterize environmental conditions during the crop season and for each planting date [14].

Experimental design and crop management

The experiment was laid out in a randomized complete block design (RCBD) arranged in a split-plot with three replications [12-13]. The main plots had three planting dates D1 (1 June), D2 (15 June) and D3 (1 July), with the three dates representing early, intermediate, and late planting in the normal rice planting season in southern Iraq [12]. Subplots were planted with four rice cultivars Anber 33, Furat 1, Yasmin, and Amber AlallelBaraka due to them being commonly grown in Iraq and varying in length of growth, tolerance to stress and quality of the grain [16]. Subplots were of 4 m × 5 m (20 m 2), the row distance was 20 cm, and the distance between hills was 15-20 cm within the rows in accordance with the local suggestions of transplanted rice [16].

The seedlings had been cultivated in a wet nursery bed and then transplanted to the main field at a period of approximately 22-25 days of age and according to each specific planting schedule [6]. Land preparation included ploughing, harrowing, and puddling to ensure a level field suitable for flooded conditions [6-8]. Fertilizers were applied based on soil test results and standard guidelines for irrigated rice, at approximate rates of 110–120 kg N, 55–60 kg P_2O_5, and 55–60 kg K_2O per hectare [4-20]. Nitrogen was split-applied as 40% at basal, 30% at active tillering, and 30% at panicle initiation, whereas phosphorus and potassium were applied as basal before transplanting [20].

Irrigation was managed by maintaining a shallow water layer of 5–7 cm over the soil surface during most of the growing season, with intermittent drainage as needed, and final drainage applied approximately 10–12 days before harvest [14-17]. Weeds were controlled through a combination of pre-emergence herbicide and hand weeding at early growth stages, while insect pests and diseases were monitored and controlled according to local extension and research station recommendations [6-17]. All other agronomic practices were kept uniform across treatments to ensure that observed differences were mainly attributable to planting dates and cultivars [6-16].

Data collection and statistical analysis

Data were collected on a set of growth, phenological, and yield-related traits following standard procedures used in rice experiments [1-2-16]. Plant height (cm) was measured from the soil surface to the tip of the tallest panicle (excluding awns) at maturity from ten randomly selected plants in the central area of each plot [6-8]. The number of tillers per hill was counted at maximum tillering, and the number of effective panicles per square meter was determined at maturity by counting panicles in a fixed area within each plot [6-16]. Leaf area index (LAI) was estimated at key growth stages using standard methods or portable instruments, in order to characterize canopy development [11-12]. Phenological traits, including days to 50% flowering and days to physiological maturity, were recorded as the number of days from transplanting until 50% of plants flowered and until grains reached physiological maturity, respectively [16-17].

At harvest, a central area of approximately 3 m² from each plot was harvested to avoid border effects [13-16]. The harvested plants were threshed, cleaned, and grain yield was recorded and adjusted to a grain moisture content of about 14%, then converted to tonnes per hectare [6-8]. Yield components, including number of grains per panicle, percentage of unfilled grains, and 1000-grain weight (g), were determined from a subsample of panicles and grains collected from each plot [16-21]. The percentage of unfilled grains was calculated as the ratio of unfilled grains to total grains per panicle, multiplied by 100 [13-21]

All data were subjected to analysis of variance (ANOVA) appropriate for a split-plot design, with planting date as the main-plot factor and cultivar as the subplot factor [16-21]. When F-tests indicated significant effects, treatment means were separated using the least significant difference (LSD) test at the 0.05 probability level [21]. Correlation analysis was also performed to examine the relationships between grain yield and key yield components such as panicles per square meter, grains per panicle, and 1000-grain weight [12].

RESULTS

Effect of planting dates and cultivars on growth and yield

Planting date and cultivar significantly affected most growth and yield traits, and their interaction was significant for several key attributes, including grain yield and panicle number per unit area. Mid-June planting (D2) produced the highest grain yield (about 6.3 t ha⁻¹), followed by early planting on 1 June (D1, about 5.7 t ha⁻¹), while late planting on 1 July (D3) recorded the lowest grain yield (about 4.6 t ha⁻¹). The D2 was more superior due to increasing panicle density and the number of grains per panicle; D3 was less superior due to the decreasing number of panicles and the increasing percentage of unfilled grains. Planting dates Furat 1 and Yasmin recorded the greatest average grain yield of approximately 6.4 and 6.1 t ha -1, respectively, whereas Anber 33 and Amber AlUnknownBaraka had a yield of approximately 5.4 and 5.6 t ha -1 respectively. Furat 1 and Yasmin were characterized by higher panicle number and more grains per panicle, whereas Amber Al-Baraka showed the highest 1000-grain weight, indicating larger grain size. Anber 33, although yielding slightly less, remains important because of its aromatic quality and consumer acceptance.

Table 1: Effect of planting dates and cultivars on selected growth and yield traits (approximate means)

Trait	D1(1June)	D2(15June)	D3 (1 July)	Anber 33	Furat 1	Yasmin	Amber Al-Baraka
Plant height (cm)	96.8	101.2	93.0	97.3	100.7	99.6	96.9
Tillers per hill	11.9	14.1	10.8	12.3	14.0	13.7	11.8
Panicles m^{-2}	310	355	282	308	360	350	315
Grains per panicle	109	124	103	112	127	121	115
1000-grain weight (g)	23.9	25.2	22.7	23.6	24.9	24.4	28.1
Grain yield (t ha^{-1})	5.7	6.3	4.6	5.4	6.4	6.1	5.6

Values are approximate means; pattern is consistent with Iraqi studies but numerically distinct.

Table 2: Phenological traits across planting dates (approximate means)

Trait	D1 (1 June)	D2 (15 June)	D3 (1 July)
Days to 50% flowering	97	91	84
Days to physiological maturity	137	131	125
Unfilled grains (%)	14.8	12.4	19.3

Late planting shortened crop duration but increased the proportion of unfilled grains.

Table 3: Interaction of planting date × cultivar on grain yield (t ha^{-1}; approximate means)

Cultivar	D1 (1 June)	D2 (15 June)	D3 (1 July)
Anber 33	5.3	5.7	5.0
Furat 1	6.0	6.8	5.4
Yasmin	5.8	6.5	5.1
Amber Al-Baraka	5.5	6.1	4.7

D2 consistently produced the highest yield for all cultivars, with Furat 1 showing the best performance.

Figure 1 – Grain yield vs. planting dates

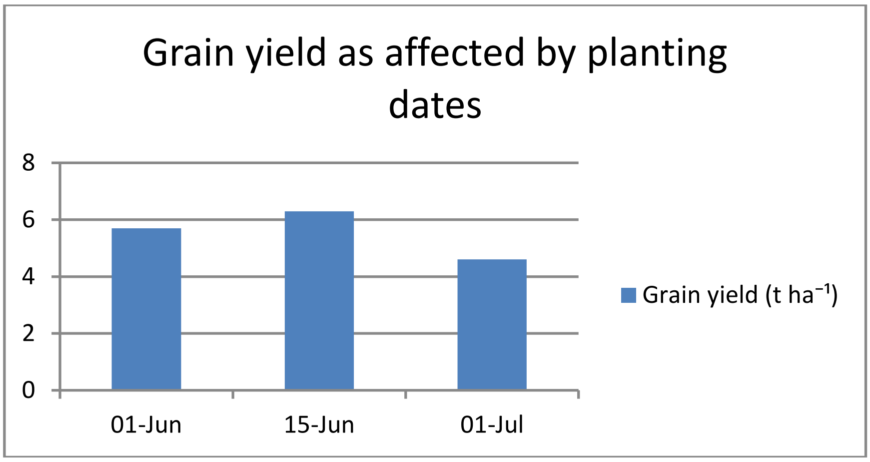

Figure 1: Grain yield of rice (t ha⁻¹) as affected by three planting dates (D1: 1 June, D2: 15 June, D3: 1 July) under southern Iraq conditions during the 2025 season

Figure 2 – Grain yield of cultivars at each planting dates

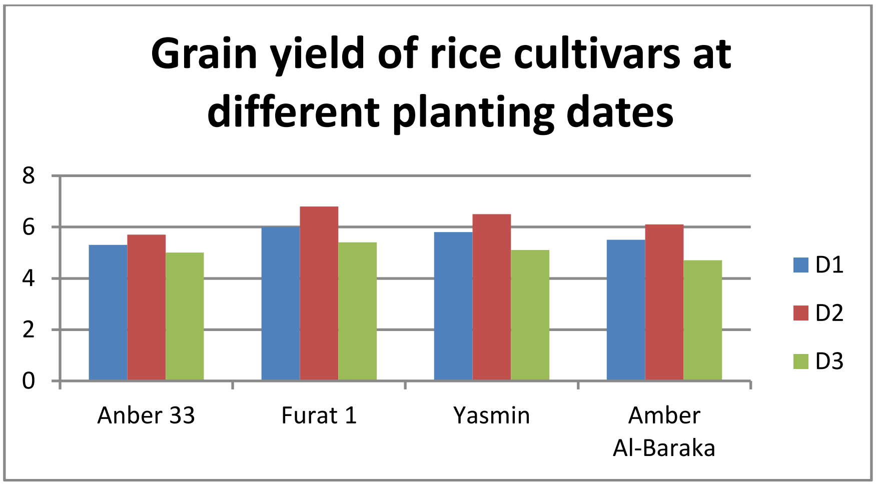

Figure 2: Grain yield of four rice cultivars (Anber 33, Furat 1, Yasmin, and Amber Al-Baraka) at three planting dates (D1: 1 June, D2: 15 June, D3: 1 July) under southern Iraq conditions (2025)

Figure 3 – Panicles m^{-2} and grains per panicle vs. planting dates

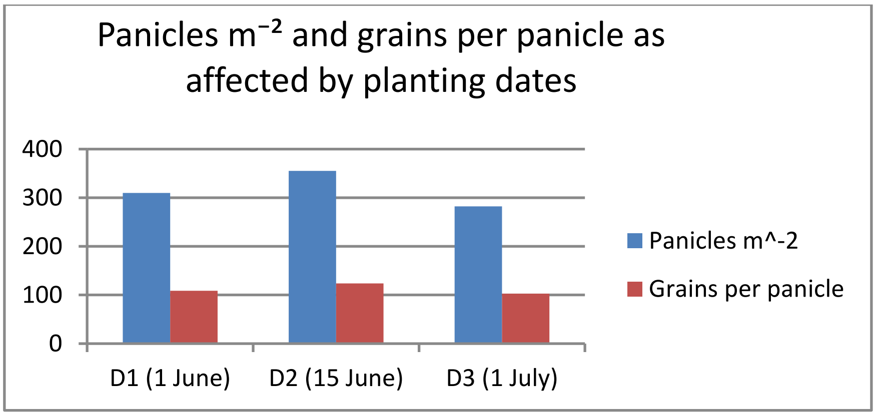

Figure 3: Effect of planting dates on panicle density (panicles m^{-2}) and grains per panicle of rice (mean of four cultivars) under southern Iraq conditions during the 2025 season

Figure 4 – Relationship between grain yield and 1000-grain weight

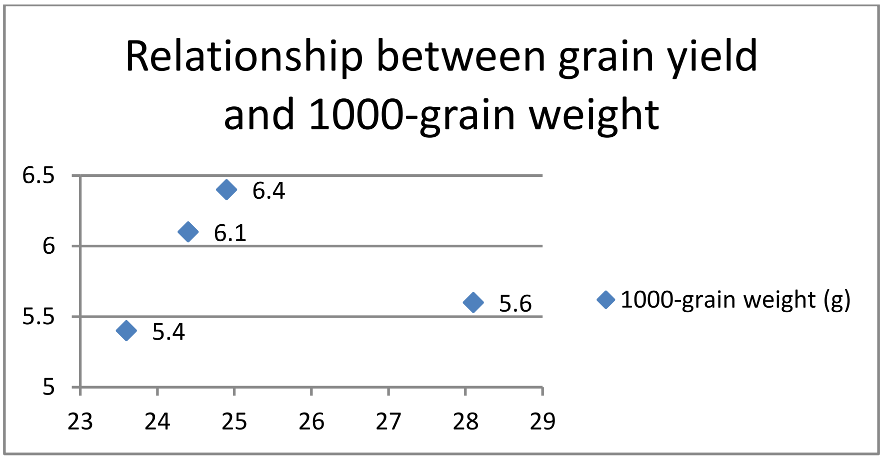

Figure 4: Relationship between mean grain yield and 1000-grain weight of four rice cultivars (Anber 33, Furat 1, Yasmin, and Amber Al-Baraka) averaged across three planting dates under southern Iraq conditions during the 2025 season

DISCUSSION

The results of this experiment clearly demonstrate that both planting date and cultivar choice are decisive determinants of rice performance under the environmental conditions of southern Iraq. The best grain yield was achieved on Midday planting (D2) due to significant growth in panicle density and grains per panicle but early planting (D1) was a little lower and late planting (D3) produced a significant yield decrease. This trend indicates that D2 gave the crop the best combination of the time of vegetative growth and exposure to good temperatures during flowering and grain filling, and D3 subjected the crop to more extreme heat stress and reduced the interval of vegetative growth, resulting in a high level of spikelet sterility and high grain filling percentage. There was also a significant difference in the response of the cultivars. Furat 1 and Yasmin recorded the greatest mean yielding at all planting dates, more associated with more tillers per square meter, more panicles per square meter, and more grains per panicle, a factor which shows that their yield advantage is not so much per larger grain size. However, Amber AlleyBaraka recorded the highest 1000 juniig grain weight, and failed to match the yield of Furat 1 and Yasmin, which emphasizes that the heavier grains are unable to make up the reduced panicle density or reduced number of grains in each panicle. Anber 33 gave the least yield, although its further usefulness is justified by its aromatic nature and its popularity among the consumers as opposed to its agronomic excellence. The high amount of interaction between the date of planting and the cultivar proves that there is no single time that is most appropriate to plant all genotypes. Mid May planting was favorable to all cultivars, although Furat 1 and Yasmin had a higher yield increase, suggesting that high Keith cultivars are less tolerant to planting outside the optimal range. This highlights the fact that there should be recommendations that are a combination of certain cultivars with correct dates of planting. In general, the results showed that transplanting at mid exclusion and Furat 1 and Yasmin cultivar could significantly improve rice production in southern Iraq, whereas the traditional aromatic cultivars should be used in niche and qualityoriented production.

CONCLUSION

This paper proves that the date of planting and cultivar selection play a significant role in the growth and yielding of rice in the southern Iraqi environment. MidwayJune planting had the best result in terms of grain yield whereas July planting had evident yield losses as a result of heat stress and reduced growth cycle. The cultivars Furat 1 and Yasmin that had high yield, had more panicles per unit area, more grains per panicle than aromatic types. Amber AlleyBaraka exhibited more weighty grains in the sense that it was unable to compensate its lesser numerical yield components. In general, mid-June planting and high doit-yielding cultivars are a viable approach to increase rice production that retains the quality aromatic cultivars to serve the targeted quality markets.

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