E-ISSN: 2788-9297
P-ISSN: 2788-9289
Impact Factor (RJIF): 5.57
www.agrijournal.org
SAJAS 2025; 5(2): 232-237
Received: 07-06-2025
Accepted: 12-07-2025

Rawafid H Al-obaidi
Agronomy Department, College of Agriculture, University of Basrah, Basrah, Iraq

Anhar M Alshummary
Agronomy Department, College of Agriculture, University of Basrah, Basrah, Iraq

Lamiaa M Al-Freeh
Agronomy Department, College of Agriculture, University of Basrah, Basrah, Iraq

Sundus A Alabdulla
Agronomy Department, College of Agriculture, University of Basrah, Basrah, Iraq

Correspondence Author:
Rawafid H Al-obaidi
Agronomy Department, College of Agriculture, University of Basrah, Basrah, Iraq

Evaluation of the performance of four genotypes of wheat (*Triticum estivum* L.) under the effect of nitrogen fertilization at two locations in southern of Iraq

Rawafid H Al-obaidi, Anhar M Alshummary, Lamiaa M Al-Freeh and Sundus A Alabdulla

Abstract
The field experiment was conducted in the winter season of 2019-2020 to evaluate the performance of wheat varieties (Bengal, Baraka, Dajlat alkhayr, and Adana) under the effect of four nitrogen rates (0, 80, 160, 240 and 320 kg N ha-1). At the two locations, one is clay soil in the Al-Qurna, and the other is in the Al-Zubair district, a sandy loam watered by well water. The experiment used split plots in R.C.B.D. design with three replicates; cultivars were added to the subplots while nitrogen fertilizers were added to the main plots. The results indicated significant differences among wheat varieties at the two locations for all parameters studied. Adana variety is the highest value of most studied traits. In addition, nitrogen concentrations had significant effects on all characteristics studied. In the Al-Zubair location, it was found that applying N up to 240 kg N ha-1 significantly increased grain yield. In comparison, Al-Haritha location achieved the highest grain yield at 160 kg N ha-1, Al-Qurna location achieved the highest grain yield of 4.538 tons ha-1 through an interaction between Adana and 160 kg N ha-1. Hence, it may be concluded from this study that this interaction might be indicated for suitable wheat production under environmental conditions.

Keywords: Wheat cultivars, level of nitrogen, location

Introduction
In many parts of the world, winter wheat is the major grain crop, which provides reliable nutrition for people in both rural and urban areas and an important supply of straw for livestock to consume. According to the United States Department of Agriculture (USDA, 2022), wheat produced globally was 778.52 million tons, with a production rate of 3.51 tons ha^{-1}, While production in Iraq reached 4234 thousand tons, with a production rate of 1.789 tons ha^{-1} for the 2020/2021 season (Directorate of Agricultural Statistics, 2021), to successfully cultivate new varieties and determine which of these varieties is optimal in terms of suitableness for various environments, they must be environmentally normal and stable in terms of growth characteristics and yield across environments and seasons. (Tsenov *et al*., 2023) [14]. Finding suitable varieties for the region in which the wheat crop is grown is essential for cultivating this crop and achieving a quantitative and qualitative improvement in its production. It is important to understand the suitability of these wheat varieties to the climate in South Iraq, given the extensive work that many research institutions have put into developing new wheat varieties through breeding and enhancement efforts and putting them through multiple tests due to its hot climate and irrigation water with a salinity level that is higher than what is permitted for agriculture. This region has different environmental and soil characteristics than the rest of Iraq. Nitrogen is the primary nutrient that limits the growth of durum wheat. Yield, according to Belete *et al.*, (2018) [3], nitrogen shortages can have a significant role in determining grain yield in rained environments. The development of varieties of wheat with high nitrogen utilization efficiency will assist farmers economically and contribute to a decrease in the environmental damage caused by the excessive application of nitrogen fertilizers (Soofizada *et al*., 2023) [12]. Wheat breeders recognize the need to increase yield potential while reducing the environmental impact of fertilizers by creating N-efficient genotypes. The objective of the current study was to investigate the response of four wheat varieties to the addition of four rates of nitrogen in two locations in the south of Iraq.

Materials and Methods

The field experiment was conducted in the winter season of 2019-2020 to evaluate the performance of four wheat varieties (Bengal, Baraka, Dajlat alkhayr, and Adana) under the effects of four nitrogen rates (0, 80, 160, 240 and 320 kg N ha-1) in two locations. One on clay soil in the Al-Qurna location, located 75 kilometers north of the center of Basrah, gets water from the Ghmug River, and the second is located in the Al-Zubair district, which lies 20 kilometers south-west of Basrah, on a sandy loam watered by well water. The soil sample was collected from both locations and analyzed for some of the chemical and physical characteristics of the soil using the methods described in Black (1965) and Page *et al.*, (1982) [4] (Table 1). The experiment used split plots in R.C.B.D design with three replicates; the cultivars were put in the subplots while the nitrogen fertilizers were put in the main plots. All treatments received two doses of nitrogen (urea): the first two weeks after seeding and the second one month after the first dose. At planting, phosphorus was added using triple superphosphate fertilizer (46% P_2O_5) at a rate of 200 kg P_2O_5 ha^{-1}. The plot's size was 2×2 m^2, and it had 10 lines with a 20 cm space between each one. Seeds were planted on November 15th at the two locations with a seeding rate of 140 kg ha^{-1}. Plant height and flag leaf area were calculated at the 50% flowering stage. Whole plants from the middle lines of each replication were harvested at the maturity stage to calculate the number of tillers per meter, yield components, and grain yield. The GenStat program was used to analyze the data, and LSD probability at 0.05 was used to test for differences within treatments (Steel and Torri, 1980) [13].

Table 1: Some of the physical and chemical properties of the soil at the two locations

Properties		Al-Quran	Al-Zubair
pH	-	7.48	7.80
E.C	dSm^{-1}	7.30	4.70
Organic Matter	g kg^{-1}	1.68	0.60
Available N	mgkg^{-1} soil	48	43
Available P		20	16
Available K		127	111
Texture		Clay loam	Sandy loam

Results and discussion

Plant Height (cm)

The results demonstrate that the varieties in both locations significantly varied plant height (Table 2). Results of the Al-Zubair location indicated that variety V4 gave the highest average of 88.02cm at plant height, and the lowest value of plant height (80.07 cm) was obtained with variety V2. Results from the Al-Qurna location showed a similar pattern in the plant height. The plants with the highest heights (103.76 cm) were found at V4, matching the heights of V2 (102.77 cm), while V3 had the lowest height (88.39 cm). These variances in plant height among varieties are due to differences in physiological and biochemical mechanisms, and many of these processes are genetically controlled. These results were found by Soofizada *et al.* (2023) [12] and EL Hag and Shahein (2017) [7]. With increasing nitrogen rates, plant height increased, reaching a maximum at a rate of N4 (86.36cm) at the Al-Zubair location**,** while the minimum plant height (12.07 cm) was recorded at the control (Table 2). Longer plants were observed at a nitrogen rate of N3 (101.13 cm), followed by N4, N2, and N1, which were 100.45, 99.55, and 94.90 cm, whereas shorter plants were observed in the control where no nitrogen was used. These findings are consistent with El-Sorady *et al.*, (2022) [8], who noted that nitrogen fertilization increased plant height. The interaction between varieties and nitrogen rates Figure (1) showed a significant effect when V4 N4 in the Al-Zubair location significantly gave the highest plant height average (91.94 cm), while V1 N0 gave the shortest plant (75.45cm), while results at the Qurna location show that interaction effect was not significant. However, findings at the Qurna location indicate that the interaction effect was not significant.

Flag leaf area (FLA)

Data in Table 2 shows the significant effect of varieties and nitrogen rates on flag leaf area at the two locations; the maximum FLA registered from the V4 variety was 35.59 and 38.88 cm^2 at the two locations, respectively. The minimum value of FLA was recorded in V3, which had 27.02 and 27.39 cm^2 at the two locations, respectively. According to Al-Hade *et al.*'s (2020) [2] genetic structure, the wheat types have different flag leaf areas. In both locations, the N treatments considerably enhanced the flag leaf area compared to the control. FLA reached 33.57 and 35.29 cm2 at Zubair and Al-Qurna locations in the N4 treatments, while the control (N0) gained minimum FLA of 26.35 and 29.26 cm^2, respectively. The larger fertilizer application was attributed to this trend's relatively better growth. These results agree with Youssef *et al.*,. The interaction between varieties and nitrogen rates had a significant effect on FLA in both locations (Figure 2). At the Al-Zubair location, applying N4 resulted in a significant increase in the maximum gain FLA for variety V4 (38.52 cm^2), which was at par with variety V4 with N2 and N3, while variety V3 showed a significantly lower flag leaf area with control (19.36 cm^2), while at the Qurna location, the maximum FLA (40.98 cm2) was found by the interaction V4× N2 that was at par with V4× N3 and V4× N4, while the interaction of V3 × control gained the lowest value of FLA (20.77 cm^2) (figure 2).

Tillers number (tiller m^{-2})

A number of tillers wheat were affected statistically by varieties and nitrogen rates at the two locations (Table 2). More number of tillers was found at V4 of 356.75 and 440.3 tiller m^{-2} at AL- Zubair and Al-Qurna locations respectively while less number of tillers was recorded 325.34 and 356.5 tiller m^{-2} at V3 andV1 respectively. At a nitrogen rate N4, the greatest number of tillers were gained (357.37 tiller m^{-2}) followed by N3(401.8 tiller m^{-2}) at the two locations respectively (Table 2), while at control minimum tiller values were observed 325.64 and 364.0 tiller m^{-2} at the two locations respectively. The fact that nitrogen is essential for cell structure and function and that protoplasm functions as the place of cell division and plant growth could be responsible for these results which causes an increase in the number of tillers (El-Sorady *et al*., 2022) [8]. These findings confirm those presented by, who noticed that nitrogen

fertilizer increased number of tillers. The interaction effect has shown that the highest number of tillers (373.59 and 471.5 tiller m^{-2}) was obtained at V4 with the rate N4 at the two locations respectively which were significantly higher than all the interactions (figure 3).

Spikes number (spike m^{-2})

Table 2 showed that V4 varieties significantly gave the highest average number of spikes (348.62 and 435.8 spikes m^{-2}) at Al-Zubair and Al-Qurna locations, respectively, while V3 and V1 varieties gave the lowest numbers in both locations. These findings might be due to the high number of tillers. These results were in agreement with those of El-Sorady *et al*., (2022) [8] and Belete *et al*., (2018) [3], and the results in Table 2 showed the effect of nitrogen rates on the spike number of wheat at the two locations. Moreover, increasing the N level from N0 up to N4 resulted in a significant increase in the number in both locations. The highest spike number can be attributed to the highest number of tillers. As shown by the data found in Figure 3 from the interaction results, it was found that the wheat variety V4 × N4 had the highest spike numbers of 365.25 and 468.9 spikes m^{-2} (Figure 4).

Grains $spike^{-1}$

According to the results, the varieties and nitrogen rates of the grains at the two locations were significantly impacted (Table 2). In comparison to the other varieties, wheat variety V4 produced the most grains per spike (34.50) and the least (43.92) at the Zubair and Al-Qurna locations, respectively. Wheat variety V3 produced the fewest grains per spike at both locations. The genetic factor has a great influence in determining the number of grains in a spike, as confirmed by EL Hag and Shahein. (2017) [7] The number of grains per spike increased as the nitrogen rate increased to N4. The rate at which nitrogen N4 produced the highest number of grains was 35.49 and 39.18 grains per spike at the two locations, respectively. The minimum number of grains per spike was recorded in N0, which produced 29.25 and 37.09 grain spikes, according to Usman *et al*., (2013) [15] who also found that nitrogen significantly improved the quantity of grain produced in each spike. On the other hand, it was found that the interaction impact between the various wheat varieties and the application of N fertilizer was significant in both locations (Figure 5). At the Al-Zubair location variety, V4 was superior and recorded a higher value at rates N4 and N3 (37.81 and 36.82 grains $spike^{-1}$), while variety V3 showed a lower value with control (24.18 grain $spike^{-1}$), while at the Qurna location the maximum number of grains per spike (48.43 grain spike-1) was found by interaction V4 with N2 and that was at par with V4× N3 (48.34 grain spike-1), while the interaction of V3 × control grains had the lowest value in both locations (figure 5).

Weight of 1000 grains (g)

Due to a genotypic difference, the weight of 1000 grains of wheat varieties was significantly impacted in both locations (Table 2). On the other hand, the V1 variety achieved the highest average of 31.63 and 36.25g respectively in both locations while the V3 variety gave the lowest of 30.70 and 34.47g respectively in both locations. This result agreed with EL Hag and Shahein (2017) [7]. In both locations, the 1000-grain weight was significantly affected by the nitrogen rate, according to the data in Table 2. However, increasing nitrogen fertilization rates would result in the largest 1000-grain weight. In the Al-Zubair location, the maximum grain weight (31.41g) was gained at the N4 rate, which was on par with the rate of N3 (30.99 g), while in the Al-Qurna location, the plants fertilized with N2 had the highest grain yield (36.90 g). Nitrogen's impacts on grain weight may result from its influence on improving photosynthetic efficiency, which in turn causes more assimilates to be produced and transported to sinks. Litke *et al*., (2018) [9] confirmed our results. According to the data in Figure 6, the interactions between wheat types and nitrogen rates significantly affected the 1000-grain weight in each of the two locations. In the Al-Zubair location, variety V1 was superior and recorded a higher value at rate N3 (34.52 g), while variety V3 showed a lower value with control (24.36g). On the other hand, at Al-Qurna location, the maximum number of 1000 grains (39.38g) was found by the interaction of V4 with N2, while the interaction of V3 and V2 with control gained the lowest value. In both locations, respectively (Figure 6).

Grain yield (ton ha^{-1})

Table 2 showed that wheat varieties and nitrogen rates had significant effects on grain yield in both locations. Among the varieties, V4 gave the highest grain yield with an average of 3.599 and 4.278 tons ha^{-1} at the Al-Zubair and Al-Qurna locations, respectively. This increase in yield is due to the largest number of spikes per meter and the number of grains per spike, both of which were positively correlated with an increase in production, Zhang *et al*., (2021) [16] and Al-Jayashi (2021) [1a] reported similar findings. Increasing the nitrogen rates significantly increased the grain yield in both locations. In the Al-Zubair location, the maximum grain yield (3.611ton ha^{-1}) was found in the N4 rate, which was on par with the rate of N3 (3.598 ton ha^{-1}) at the Al-Qurna location, where the plants fertilized with N3 had the highest grain yield (4.163 ton ha^{-1}). Dagash, *et al*., (2014) confirmed our results. A significant interaction effect between wheat varieties and N rates was only found in the Al-Qurna locations (Figure 7). Variety V4 was superior and recorded a higher grain yield at rate N3 (4.538 tons ha-1), while variety V2 showed a lower value with control (3.009 tons ha^{-1}). This could be a result of the fact that varieties have varied genetic makeup and hence react differently to nitrogen application.

Table 2: Effect of varieties and nitrogen rates on growth and yield characters

Al-Zubair location							
Treatments / Varieties	**Plant height cm**	**FLA cm ^{2}**	**tiller m^{-2}**	**Spikes m^{-2}**	**Grains spike^{-1}**	**1000 grain weight**	**grain yield ton ha^{-1}**
V1	82.99^{b}±1.14	28.71^{c}±0.29	328.30^{c}±2.96	318.90^{c}±2.95	31.45^{c}±0.54	31.63^{a}±0.23	3.510^{b}±0.03
V2	80.37^{c}±1.14	31.79^{b}±0.29	345.09^{b}±2.96	336.16^{b}±2.95	32.22^{b}±0.54	28.47^{b}±0.23	3.494^{b}±0.03
V3	80.94^{b}±1.14	27.02^{d}±0.29	325.34^{c}±2.96	316.94^{c}±2.95	30.70^{c}±0.54	27.63^{c}±0.23	3.469^{b}±0.03
V4	88.02^{a}±1.14	35.59^{a}±0.29	356.75^{a}±2.96	348.62^{a}±2.95	34.50^{a}±0.54	28.53^{b}±0.23	3.599^{a}±0.03
N rates							
N0	80.79^{c}±1.28	26.35^{e}±0.32	325.64^{c}±3.31	316.23^{c}±3.29	29.25^{c}±0.61	26.14^{c}±0.26	3.414^{b}±0.04
N1	81.19^{c}±1.28	30.17^{d}±0.32	329.12^{c}±3.31	320.12^{c}±3.29	29.92^{c}±0.61	28.14^{b}±0.26	3.455^{b}±0.04
N2	82.62^{c}±1.28	31.32^{c}±0.32	339.79^{b}±3.31	330.88^{b}±3.29	32.41^{b}±0.61	28.64^{b}±0.26	3.511^{b}±0.04
N3	84.44^{b}±1.28	32.49^{b}±0.32	342.41^{b}±3.31	334.41^{b}±3.29	34.02^{a}±0.61	30.99^{a}±0.26	3.598^{a}±0.04
N4	86.36^{a}±1.28	33.57^{a}±0.32	357.37^{a}±3.31	349.12^{a}±3.29	35.49^{a}±0.61	31.41^{a}±	3.611^{a}±0.04
Al-Qurna location							
Treatments / Varieties	**Plant height cm**	**FLA cm ^{2}**	**tiller m^{-2}**	**Spikes m^{-2}**	**Grains spike^{-1}**	**1000 grain weight**	**Yield ton ha^{-1}**
V1	95.19^{b}±2.20	31.15^{c}±0.42	356.5^{d}±3.68	350.0^{d}±3.40	34.87^{c}±0.67	36.25^{a}±0.34	3.967^{b}±0.10
V2	102.77^{a}±2.20	36.99^{b}±0.42	393.6^{b}±3.68	388.8^{b}±3.40	38.29^{b}±0.67	34.25^{b}±0.34	4.203^{a}±0.10
V3	88.39^{c}±2.20	27.39^{d}±0.42	364.1^{c}±3.68	359.0^{c}±3.40	34.47^{c}±0.67	36.19^{a}±0.34	3.753^{b}±0.10
V4	103.76^{a}±2.20	38.88^{a}±0.42	440.3^{a}±3.68	435.8^{a}±3.40	43.92^{a}±0.67	34.42^{b}±0.34	4.278^{a}±0.10
N rates							
N0	91.61^{bc}±2.46	29.26^{c}±0.46	364.0^{c}±4.11	355.7^{d}±3.80	37.09^{b}±0.75	33.51^{c}±0.39	3.873^{c}±0.11
N1	94.90^{b}±2.46	34.48^{b}±0.46	381.6^{b}±4.11	377.1^{c}±3.80	37.15^{b}±0.75	35.56^{b}±0.39	4.113^{a}±0.11
N2	99.55^{ab}±2.46	33.90^{b}±0.46	388.0^{b}±4.11	383.3^{b}±3.80	37.11^{b}±0.75	36.90^{a}±0.39	4.019^{b}±0.11
N3	101.13^{a}±2.46	35.09^{a}±0.46	401.8^{a}±4.11	396.6^{b}±3.80	39.01^{a}±0.75	35.62^{b}±0.39	4.163^{a}±0.11
N4	100.45^{a}±2.46	35.29^{a}±0.46	407.7^{a}±4.11	404.2^{a}±3.80	39.18^{a}±	34.80^{b}±0.39	4.084^{b}±0.11

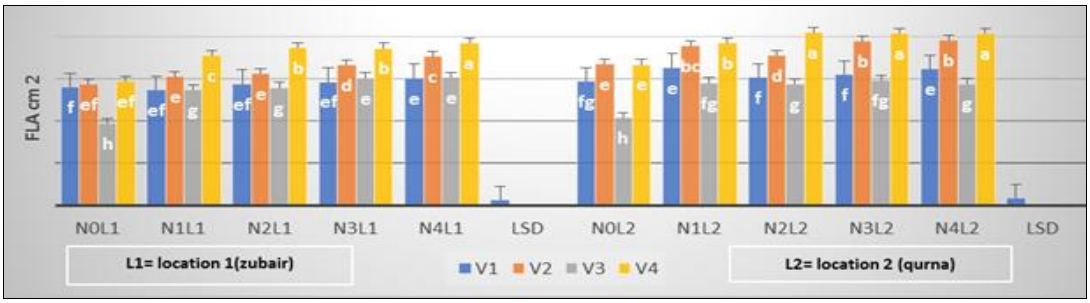

Fig 1: Effect of interaction between varieties and nitrogen rates on plant height in both locations

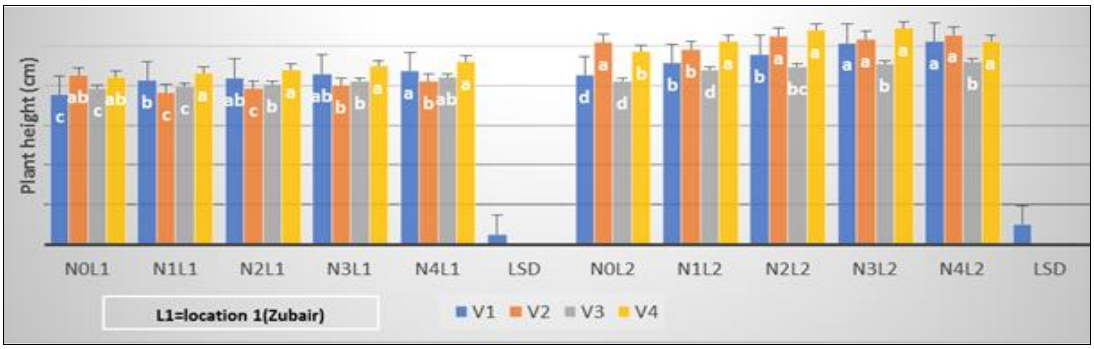

Fig 2: Effect of interaction between varieties and nitrogen rates on leaf area in both locations

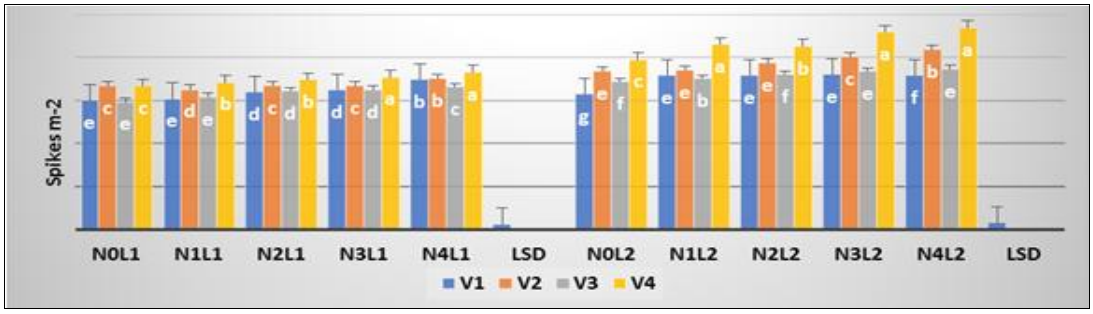

Fig 3: Effect of interaction between varieties and nitrogen rates on the number of tillers in both locations

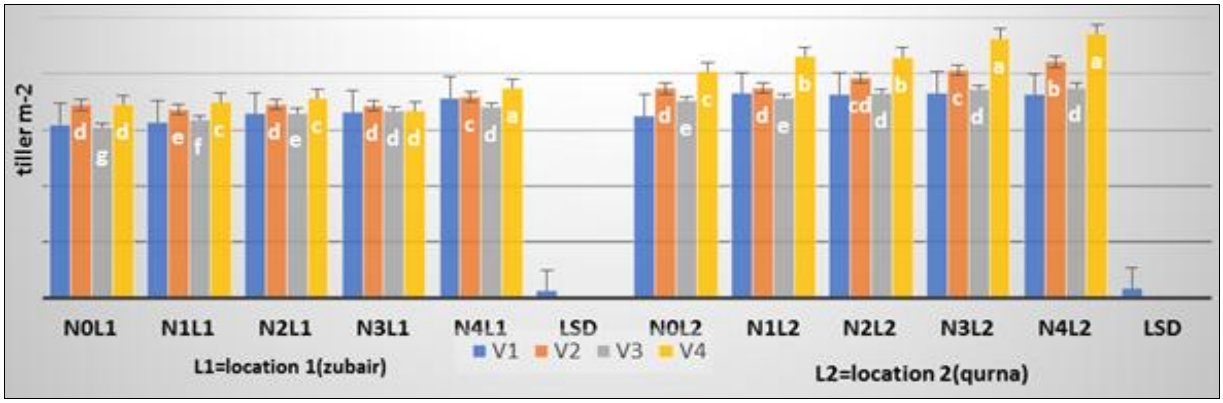

Fig 4: Effect of interaction between varieties and nitrogen rates on number of spikes in both locations

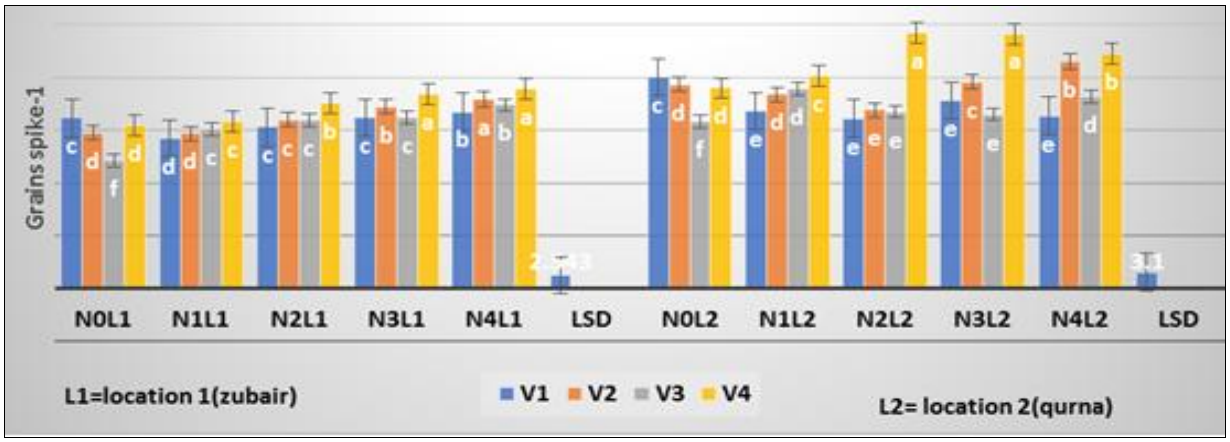

Fig 5: Effect of interaction between varieties and nitrogen rates on Grain spike in both locations

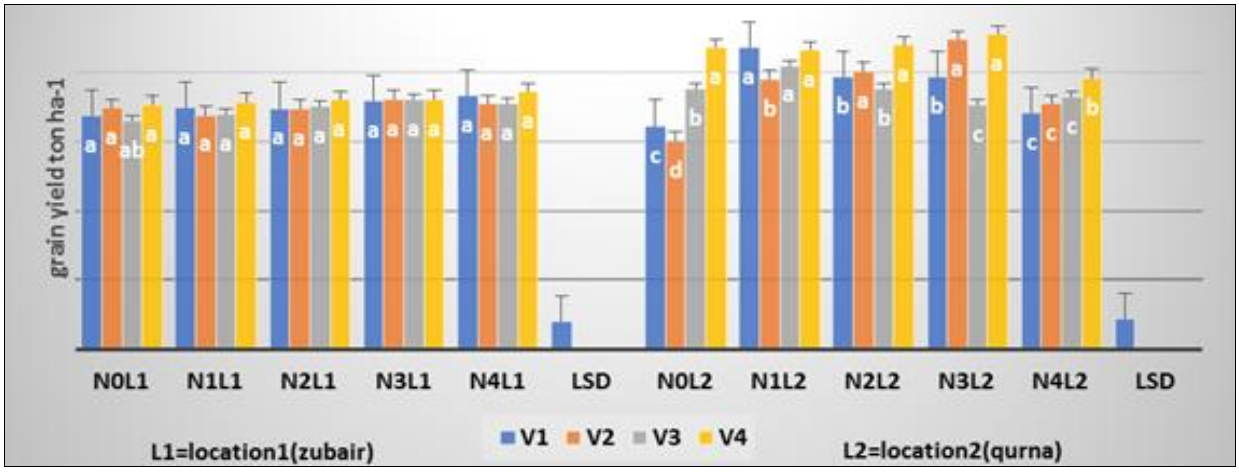

Fig 6: Effect of interaction between varieties and nitrogen rates on 1000 grain weight in both locations

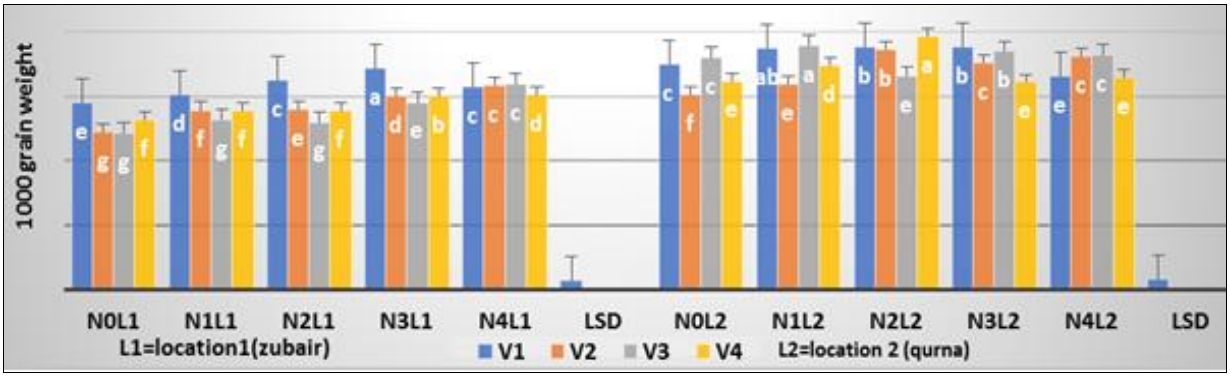

Fig 7: Effect of interaction between varieties and nitrogen rates on Grain yield (ton ha^{-1}) in both locations

Conclusions

Based on the findings of this study, it can assume that yield and its component parts, which were evaluated in this experiment, responded differently to nitrogen fertilization. However, in both environmental conditions, the variety Adana responded very well to nitrogen fertilization and had the highest grain production. In addition, it showed that applying N at a rate of 240 Kg ha^{-1} in the Al-Zubair location and 160 Kg ha^{-1} in the Al-Qurna location increased grain yield in comparison to other nitrogen treatments.

Acknowledgments

The authors are grateful to College of Agriculture and Department of Field Crop for their support. Without their generous contributions, we could never perform this study.

Contributions of authors

- **S.A.A & L.M.A:** project administration, carried out the experiment in the field and collected the data
- **A.M.A:** constructed the idea and hypothesis for research; planned the methodology.
- **R.H.A**.: data analysis; wrote the manuscript

Conflicts of interest

The authors declare no conflicts of interest.

ORCID

- **R.H.A.:** https://orcid.org/0000-0002-4036-7363
- **A.M.A:** https://orcid.org/0000-0001-9802-1704
- **L.M.A:** https://orcid.org/0000-0001-5256-5917
- **S.A.A:** https://orcid.org/0000-0002-6860-7365

References

1. Al-Jayashi MT, Hawal AAS and Adham A M. Effect of Planting Dates on Growth and Yield of Four Cultivars of Wheat, IOP Conf. Series: Earth and Environmental Science 923;2021. 012064 doi:10.1088/1755-1315/923/1/012064.
2. AL-Hade MQS, Ameer ANA, Hasaen SA, & Jawad NN. Effect of Nitrogen Fertilizer Application Dates on Growth and Yield of Six Wheat Cultivars (*Triticum aestivum* L.). Journal of Kerbala for Agricultural Sciences, 7(1);2020;10-20.
3. Belete F, Dechassa N, Molla A, & Tana T. Effect of nitrogen fertilizer rates on grain yield and nitrogen uptake and use efficiency of bread wheat (*Triticum aestivum* L.) varieties on the Vertisols of central highlands of Ethiopia. Agriculture & Food Security, 7(1);2018;1-12. https://doi.org/10.1186/s40066-018-0231-z.
4. Black CA. Methods of Soil Analysis. Part 1 physical and mineralogical properties. ASA, SSSA.Madison, Wisconsin, USA, 1965.
5. Dagash YMI, Ahmed IS, & Khalil NA. Effect of nitrogen fertilization, sowing methods and sowing dates on yield and yield attributes of wheat (*Triticum aestivum* L). Universal Journal of Plant Science, 2(6);2014;108-113. DOI: 10.13189/ujps.2014.020603
6. Directorate of Agricultural Statistics. Ministry of Agriculture. Secondary Crops and Vegetable Production Report, Central Statistical Organization - Iraq, 2021.
7. Elhag D and Alaa MEA Shahein. Effect of different nitrogen rates on productivity and quality traits of wheat cultivars. Egyptian Journal of Agronomy, 39(3); 2017;321-335. DOI: 10.21608/agro.2017.1405.1070
8. El-Sorady GA, El-Banna AA, Abdelghany AM, Salama EA, Ali HM, Siddiqui MH, & Lamlom SF. Response of bread wheat cultivars inoculated with azotobacter species under different nitrogen application rates. Sustainability, 14(14);2022;8394. https://doi.org/10.3390/su14148394
9. Litke L, Gaile Z, & Ruža A. Effect of nitrogen fertilization on winter wheat yield and yield quality. Agronomy Research 16(2); 2018;500 509 https://doi.org/10.15159/AR.18.064
10. Page AL, RH Miller, and DR Keeney. Methods of soil analysis. Part 2, 2nd edition. ASA Inc. Madison, Wisconsin, U.S.A, 1982.
11. Rakaščan N, Dražić G, Živanović L, Ikanović, J, Jovović Z, Lončar M, & Popović V. Effect of genotypes and locations on wheat yield components. Poljoprivreda umarstvo, 65(1);2019;233-242. DOI: 10.17707/AgricultForest.65.1.23.
12. Soofizada Q, Pescatore A Atefi R, Grassi C, Orlandini S, & Napoli M. Evaluation of Nitrogen and Phosphorus Responses on Yield, Quality and Economic Advantage of Winter Wheat (*Triticum aestivum* L.) under Four Different Agro-Climatic Zones in Afghanistan. Agronomy, 13(2);2023;345. https://doi.org 10.3390/agronomy13020345 .
13. Steel RG & JH Torrie. Principles and Procedures of Statistics. A Biometrical Approach. McGraw-Hill, New York, 1980.
14. Tsenov N, Gubatov T, & Yanchey I. Environmental influence on grain quality stability of common wheat cultivars. Zemdirbyste-Agriculture, 110(1);2023.
15. Usman K, Khan EA, Khan N, Khan MA, Ghulam S, Khan S, & Baloch J. Effect of Tillage and Nitrogen on Wheat Production, Economics, and Soil Fertility in Rice-Wheat Cropping System. American Journal of Plant Sciences. 4;2013;17-25. doi: 10.4236/ajps.2013.41004.
16. Zhang H, Zhao Q, Wang Z, Wang L, Li X, Fan Z, & Chen F. Effects of nitrogen fertilizer on photosynthetic characteristics, biomass, and yield of wheat under different shading conditions. Agronomy, 11(10);2021 (1989).