Effect of irrigation duration on the growth and yield of thirteen genotypes of rice (*Oryza sativa* L)

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Abstract:

Water has become an impeding source for the agricultural sector, and in Iraq today we suffer from a water crisis that is worsening year after year, and as a result, it has led to a reduction in cultivated areas, especially for the rice crop .The limited water resources and the loss of large amounts of water during traditional irrigation operations prompted many researchers to try to find different methods to determine the quantities of irrigation water needed to be added to agriculture, and thus it became one of the necessities of agricultural progress to use modern irrigation methods. A field experiment was conducted at the rice research station in Al-Mishkhab, which is affiliated to Al-Najaf Research Department - Agricultural Research Department, which is 20 km south of the center of Al-Najaf Governorate, during the summer season 2022. Under the influence of three irrigation levels, the experiment was conducted in a split plot according to the randomized complete block design (RCBD) and with three replicates .The experimental parameters represented irrigation scheduling: daily irrigation, irrigation at intervals of 4 days, and irrigation at intervals of 8 days for thirteen genotypes of rice.The results of the experiment showed that there was a significantly of the KHA2 genotype on the rest of the cultivars under study in traits of plant height and the total number of seeds in the panicles, and it reached 121.22 cm, 174.67 grain. panicles^{-1}, respectively .As for the KHA4 genotype, it excelled in the traits of flag leaf area, weight of 1000, grain yield, harvest index, and water use efficiency, reaching 32.31 cm2, 24.30 g , 6.10 ton. ha^{-1}, 42.73%, and 0.2507 kg m^{-3}, respectively. The results also showed that there was a significantly excelled of the treatment of the daily irrigation interval in all traits of vegetative growth, yield and its components. As for the bi-interactions between genotypes and irrigation periods,The results showed that there is an effect in most of the traits, where the interaction treatment (KHA2 and daily irrigation) excelled in traits of plant height, flowerpot length, and total number of grains in the flowerpot, reaching 131 cm, 26.90 cm, and 205.00 seed grains -1, respectively, and the interaction treatment (KHA4) outperformed and daily irrigation) in traits of flag leaf area, weight of 1000 grains, grain yield, and harvest index, and the values were 35.63 cm2, 25.72 gm, 7.94 tons .The results of the research showed that the water use efficiency was with daily irrigation 0.0945 kg m-3 and at the irrigation interval every 4 days 0.1999 kg m-3, while the irrigation interval every 8 days gave 0.2174 kg m^{-3}, the results indicate that there are significant differences for the effect of efficiency water use,The irrigation treatment every 8 days excelled compared to the daily irrigation schedule, which gave the lowest mean. Water stress negatively affected all vegetative growth traits and yield components.

Keywords: Oryza sativa, genotypes, water use efficiency

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introduction

Rice is one of the most important staple crops that is considered as a major food source for more than 3.5 billion people around the world, and thus is considered a food security crop [1]. Rice is a vital food crop for most parts of the world [2]. The area of rice cultivated in the world is 162 million hectares, and it produces approximately 756 million tons [3]. The area of rice cultivated in Iraq for the year 2021 is 388 thousand dunums, with an annual production of 155 thousand tons [4].This production must be increased to meet the continuing population growth and the threat of environmental pressures. The current slowdown in production is a cause for concern and must be reversed to meet the population increase. Therefore, it is necessary to exploit genetic resources to maximize production, and the development of drought-tolerant genotypes is imperative in order to maintain global food security[5]. The underlying hypothesis is that The roots of the rice plant are still adequately supplied with water for some time from the previous irrigation [6].In a study conducted in southern Iraq by [7], it was found that irrigation at intervals of (3, 5, 7) days consumed, respectively, (50%, 45%, 36%) of water, compared to the traditional method. And confirmed by [8] in their research on the efficiency of the rice crop for scheduling irrigation, that intermittent irrigation in rice cultivation led to a reduction in the use of irrigation water by 27-37%. They indicated [9] that the weight of 1000 grains decreased significantly as a result of dehydration that occurs during the grain filling stage, which leads to a decrease in grain yield by 50%.[10] In his study, the irrigation period every 3 days excelled in giving the highest average of traits of the number of grains in panicles, weight of 1000 grains, grain yield, biological yield, and harvest index, which amounted to (145.28 grains. panicles^{-1}, 19.38 g, 5675 kg ha^{-1}, 11.71 tons ha^{-1}, . 07 %), while the irrigation period every 5 days gave the lowest average for the above traits and amounted to (114.31 grains . panicles^{-1}, 17.63 g, 3275 kg ha^{-1}, 7.96 tons ha-1, 41.40%). As for the percentage of infertility, it gave The irrigation period is every 5 days, with the highest average of the trait reaching 11.53%.While the irrigation period every 3 days gave the lowest mean for the trait, which reached 5.56%. [11] In a field study on rice crop that lasted for four years, wetting and drying irrigation preserved irrigation water by an average of 73% compared to the traditional continuous immersion method. [12] Alternate irrigation saves water amounts by 57.89% with irrigation interval every 3 days, compared with irrigation intervals 9 and 6 and daily irrigation.This study aims to estimate the performance of thirteen rice genotypes under different levels of water stress

MATERIALS AND METHODS

Sowing was conducted on June 21, 2022, with the aim of evaluating the performance of thirteen genotypes of rice, by cultivating them under the influence of three levels of irrigation. As the second most important factor represented the selected genotypes, and the first factor is irrigation scheduling: the control treatment (irrigation daily), irrigation at an interval of 4 days, and irrigation at an interval of 8 days. Thus, the number of experimental units for one replicate was (39) and with three replications, so the total experimental units for the experiment were (117).) The unit area of the experimental unit is 6 m^2 (1.5×4). The water stress treatment (irrigation scheduling) began two weeks after the seedlings were transferred to the permanent field, on August 1, 2022.The treatment was stressed until the stage of physiological maturity, and then the water was drained from the plates when the plants reached the stage of physiological maturity, when the petioles turned yellow with blackness, the leaves and stems became stiff, and the moisture content of the grain began to decrease. The harvest took place on 12/19/2022. Each experimental unit included

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two lines, the distance between one pit and another (25 cm) and between one line and another (25 cm) By one seedling in the pite. Agricultural service operations were conducted for the crop and soil according to the scientific recommendations of the Ministry of Agriculture[13].The experiment was harvested and the measured traits were estimated as an average of ten randomly selected plants from each experimental unit for the following traits: plant height (cm), flag leaf area (cm^2), number of days to physiological maturity (days), panicles length (cm), weight of 1000 grains (g), total grain yield (ton.ha-1), harvest index (%), water use efficiency (m^3 ha^{-1}). the formula for calculating water efficiency: Water Efficiency $=\frac{Grain\ yield\ kg\ \text{ha}-1}{Added\ water\ volumes\ m-1\ \text{ha}-1} x100$

Table (1) The studied genotypes with their source and origin

Pedigree	genotype	No.	Pedigree	genotype	no
Inferred genotype) Amber33 X ♂ Nemat(♀	NA5	8	Iran	Nemat	1
Inferred genotype) Amber33 X ♂ Nemat(♀	KHA1	9	Iran	Khazar	2
Inferred genotype) Amber33 X ♂ Nemat(♀	KHA2	10	An old local variety	Amber33	3
Inferred genotype) Amber33 X ♂ Nemat(♀	KHA3	11	Inferred genotype) Amber33 X ♂ Nemat(♀	NA1	4
Inferred genotype) Amber33 X ♂ Nemat(♀	KHA4	12	Inferred genotype) Amber33 X ♂ Nemat(♀	NA2	5
Inferred genotype) Amber33 X ♂ Nemat(♀	KHA5	13	Inferred genotype) Amber33 X ♂ Nemat(♀	NA3	6
			Inferred genotype) Amber33 X ♂ Nemat(♀	NA4	7

Results and discussion

1- plant height (cm)

Table 2 shows that there is a significant effect of irrigation scheduling on the average plant height, as the daily irrigation treatment gave the highest values of 97.49 cm. While the irrigation treatment with a irrigation interval of 8 days gave the lowest values of 88.49 cm, the genotypes differed significantly in the average plant height characteristic, as the KHA2 genotype gave the highest values and reached 121.22 cm, while the NA5 genotype gave the lowest average plant height of 61.67 cm. This result is consistent with this. with [14]. The results of the same table indicate that there is a significant effect of the bi-interaction between irrigation scheduling and genotypes, as the treatment of daily irrigation interaction with the KHA2 genotype gave the highest values of 131.00 cm.While the treatment of interaction irrigation every 8 days with genotype NA5 recorded the lowest values of 58.33 cm. The reason for the decrease in the height of the rice plant when exposed to water stress is because it is a sensitive plant to lack of water in all stages of vegetative and flowering growth. This result agrees with [15].

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Table 2: The effect of irrigation intervals and genotypes and their interactions on average plant height (cm)

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
78.33 i	76.67	78.00	80.33	NA1
69.22 k	65.67	66.67	75.33	NA2
85.44 h	83.33	84.33	88.67	NA3
91.00 g	83.67	92.33	97.00	NA4
61.67 l	58.33	62.33	64.33	NA5
91.11 g	87.00	90.67	95.67	KHA1
121.22 a	111.00	121.67	131.00	KHA2
112.33 c	110.00	112.00	115.00	KHA3
98.33 f	96.33	98.67	100.00	KHA4
106.67 d	102.00	106.67	111.33	KHA5
103.33 e	101.00	103.67	105.33	Khazar
68.78 k	65.67	68.00	72.67	Nemat
119.33 b	109.67	117.67	130.67	Anber33
	88.49	92.51	97.49	irrigation intervals average
L.S.D 0.05 irrigation intervals 4.875 = genotype = Duncan 0.05 interaction = 11.993				

2- Flag leaf area (cm^2)

Table 3 shows that there is a significant effect of irrigation scheduling on the average area of the flag leaf, where the daily irrigation treatment gave the highest values of 24.55 Cm^2, while the irrigation treatment with an interval of 8 days recorded the lowest values and amounted to 20.29 cm2.The same table indicates that the genotypes differed significantly in the average trait, as the genotype KHA4 gave the highest value for the average trait amounted to 32.31 cm2, while the genotype NA5 gave the lowest value for the average leaf area amounted to 16.48 cm2. The results of the same table indicate that there is a significant effect of the interaction between irrigation scheduling and genotypes, as the treatment of daily irrigation interaction with genotype KHA4 gave the highest values

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of 35.63 cm2.While the treatment of interaction irrigation every 8 days with the genotype NA5 recorded the lowest values of 15.07 cm2, the reason is attributed to the lack of water leading to a reduction in leaf growth and a decrease in the rate of cell division and elongation, which leads to a reduction of the leaf area of the flag leaf and the total leaves of the plant and thus reduces vegetative growth. This result agrees with [16].

Table 3: The effect of irrigation intervals and genotypes and the interaction between them on the mean Flag leaf area (Cm^2**)**

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
18.49 gh	17.33	18.97	19.17	NA1
20.58 f	19.00	21.07	21.67	NA2
17.39 i	16.07	17.83	18.27	NA3
18.51 gh	15.73	19.30	20.50	NA4
16.48 i	15.07	17.03	17.33	NA5
27.71 c	23.50	29.30	30.33	KHA1
28.88 b	28.73	28.83	29.07	KHA2
18.70 g	15.93	20.00	20.17	KHA3
32.31 a	26.60	34.70	35.63	KHA4
23.47 e	20.00	24.93	25.47	KHA5
32.24 a	27.67	33.87	35.20	Khazar
17.53 hi	15.57	18.00	19.03	Nemat
25.49 d	22.60	26.60	27.27	Anber33
	20.29	23.88	24.55	irrigation intervals average
L.S.D 0.05 irrigation intervals 0.444= genotype= Duncan 0.05 interaction = 1.737				

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3- Number of days from cultivation to physiological maturity (days)

Table 4 shows that there is a significant effect of scheduling irrigation on the average number of days from planting until physiological maturity, where the treatment of irrigation every 8 days excelled in reaching the least period of 138.59 days, while the plants of the daily irrigation method reached the longest period of 144.18 days. The same table indicates that the genotypes differed significantly in this trait, as the genotype NA5 gave the highest value at 149.22 days, while the genotype Amber33 gave the lowest value at 133.56 days. The results of the same table indicate that there is a significant effect of the bi-interaction between irrigation scheduling and genotypes, as the treatment of daily irrigation interaction with genotypes NA4 and NA5 gave the highest values of 151.33 days.While the treatment of interaction irrigation every 8 days with the Anber33 genotype recorded the lowest values of 130.67 days, the reason may be that the spacing of the irrigation periods led to an acceleration of the aging of plant tissues towards maturity as a result of the lack of soluble elements, the high temperature of the plant and its lack of efficiency in supplying the grain with photosynthetic products. Which shortened the number of days stages. These results agree with [17].

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Table 4: The effect of irrigation intervals and genotypes and the interaction between them on the average number of days from sowing to physiological maturity (day)

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
143.00 c	139.67	142	147.33	NA1
141.56 d	138.67	141.33	144.67	NA2
145.00 b	140	146.67	148.33	NA3
148.67 a	143.67	151	151.33	NA4
149.22 a	146.67	149.67	151.33	NA5
141.44 d	137.67	140.33	146.33	KHA1
141.11 d	140.33	140.33	142.67	KHA2
133.89 g	132.67	133.33	135.67	KHA3
141.67 d	139.33	142.67	143	KHA4
139.33 e	136.67	140	141.33	KHA5
143.33 c	142	142.33	145.67	Khazar
136.00 f	133.67	136	138.33	Nemat
133.56 g	130.67	131.67	138.33	Anber33
	138.59	141.33	144.18	irrigation intervals average
L.S.D 0.05 irrigation intervals 0.299 = genotype = Duncan 0.05 interaction = 1.637				

4- The panicles length (cm)

Table 5 shows that there is a significant effect of scheduling irrigation on the average panicles length , where the daily irrigation treatment excelled in the average length of the bucket and gave the highest values of 22.89 cm, while the irrigation treatment every 8 days gave the lowest values of 20.62 cm. The same table indicates that the genotypes differed significantly in this trait, where the genotype KHA3 gave the highest values and amounted

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to 25.13 cm, while the genotype NA5 gave the lowest value for the trait and amounted to 17.86 cm.The results of the same table indicate that there is no significant effect of the bi-interaction between irrigation scheduling and genotypes, as the daily irrigation treatment with the KHA2 genotype gave the highest value of 26.90 cm, while the treatment of irrigation every 8 days with the NA2 genotype gave the lowest value of 17.00 cm. The reason for giving the irrigation treatment every 8 days, the lowest values may be due to the effect of the large water stress in the stages of emergence and formation of the flowering stage and its effect on the vital processes carried out by the plant. These results are consistent with what they reached [18].

Table 5: The effect of irrigation intervals and genotypes and their interactions on the average panicles length (cm)

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
18.64 ef	18.35	18.38	19.19	NA1
18.93 ef	17.00	19.65	20.13	NA2
19.82 e	19.35	19.77	20.35	NA3
21.73 d	20.86	22.13	22.19	NA4
17.86 g	17.21	17.83	18.53	NA5
23.12 bc	21.40	23.17	24.78	KHA1
24.17 ab	22.11	23.51	26.90	KHA2
25.13 a	24.40	25.19	25.81	KHA3
24.35 ab	23.93	24.03	25.09	KHA4
23.64 bc	21.70	23.55	25.67	KHA5
23.27 bc	22.74	23.02	24.04	Khazar
19.69 e	18.55	19.58	20.93	Nemat
22.38 cd	20.41	22.73	24.00	Anber33
	20.62	21.73	22.89	irrigation intervals average
L.S.D 0.05 irrigation intervals = 0 0.79genotype = Duncan 0.05 interaction2.268 =				

5- The total number of grains per(grain. Panicles^{-1})

Table 6 shows that there is a significant effect of irrigation scheduling on the average total number of grains in panicles, where the daily irrigation treatment gave the highest values of 119.89 grain. panicles $^{-1}$,While the irrigation treatment every 8 days gave the lowest values of 88.54 grain. panicles $^{-1}$grains. The same

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table indicates that the genotypes differed significantly in the trait, where the genotype KHA2 gave the highest value of 174.67 grain. panicles $^{-1}$,While the genotype NA5 gave the lowest value for the trait, which amounted to 58.62 grain. panicles $^{-1}$. The results of the same table indicate that there is a significant effect of the bi-interaction between irrigation intervals and genotypes, as the daily irrigation overlap treatment with the genotype KHA2 gave the highest values of 205.00 grain. panicles $^{-1}$, while the treatment of interaction irrigation every 8 days with the genotype NA2 recorded the lowest values amounting to 49.33 grain. panicles $^{-1}$. The reason may be. These results agree with [19].

Table 6: The effect of irrigation intervals and genotypes and the interaction between them on the total number of grains per panicles (grain. panicles $^{-1}$)

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
74.83 fg	65.93	73.67	84.90	NA1
69.90 gh	49.33	74.00	86.37	NA2
63.61 hi	58.57	60.60	71.67	NA3
72.74 fgh	65.67	71.83	80.73	NA4
58.62 i	53.33	57.33	65.20	NA5
129.18 c	118.90	133.43	135.20	KHA1
174.67 a	154.00	165.00	205.00	KHA2
152.00 b	137.00	146.00	173.00	KHA3
128.47 c	112.00	118.33	155.07	KHA4
130.92 c	114.67	136.87	141.23	KHA5
119.21 de	83.97	129.00	144.67	Khazar
98.62 d	83.70	101.97	110.20	Nemat
81.11 ef	54.00	84.00	105.33	Anber33
	88.54	104.00	119.89	irrigation intervals average
L.S.D 0.05 irrigation intervals 5.241 = genotype = Duncan 0.05 interaction = 16.594				

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6- The weight of grains.

Table 7 shows that there are significant differences for the different irrigation schedules in the average weight of 1000 grains g. The daily irrigation treatment gave the highest values amounting to 21.73 g, while the irrigation treatment with an interval of 8 days recorded the lowest values amounting to 20.23 g. The reason for the superiority of the daily irrigation treatment is due to an increase in each From the height of the plant and the area of the flag leaf is a table, and thus the amount of manufactured and transported materials will increase from the source (leaves and stems) to the downstream (grain), and thus the weight of the grain will increase.These results agree with [20]. It is noted from the same table that the genotypes differed significantly in the rate of the trait, as the genotype KHA4 excelled in obtaining the highest rate of 24.30 g, while the genotype KHA2 gave the lowest value of the trait amounted to 19.37 g.The results of the same table showed a significant effect of the binary interaction between irrigation scheduling and genotypes, as the daily irrigation treatment with the KHA4 genotype gave the highest weight of 25.72 g, while the treatment of irrigation every 8 days with the KHA1 genotype gave the lowest values of 19.19 g.

Table 7: The effect of irrigation intervals and genotypes and the interaction between them on the average weight of 1000 grains (gm)

genotype average	irrigation intervals			Genotype
	8day	4day	Two day	
20.23 ef	19.96	20.08	20.63	NA1
21.19 bc	20.61	21.25	21.70	NA2
21.92 a	21.41	21.99	22.36	NA3
20.84 cd	19.70	21.39	21.45	NA4
20.85 cd	19.22	21.32	22.00	NA5
19.92 f	19.19	19.97	20.61	KHA1
19.37 g	19.32	19.24	19.56	KHA2
21.38 b	20.73	21.76	21.66	KHA3
24.30 a	22.51	23.87	25.72	KHA4
20.61 d	19.58	21.08	21.16	KHA5
20.07 f	19.27	20.45	20.49	Khazar
23.08 a	21.73	23.81	22.72	Nemat
20.49 de	19.73	20.32	21.42	Anber33
	20.23	21.27	21.73	irrigation intervals average
L.S.D 0.05 irrigation intervals 0.213 = genotype = Duncan 0.05 interaction0.607 =				

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7- Total grain yield, ton ha^{-1}

Table 8 shows that there are significant differences between the irrigation interval treatments in the average yield of rice grains, by recording the daily irrigation interval treatment the highest rate of grain yield amounted to 5.75 ton ha-1, while the treatment gave an 8-day irrigation interval the lowest rate for this traits amounted to 2.85 ton ha-1 ,The reason for the decrease in grain yield, when the rice plant is exposed to water stress for a period of 8 days, is due to the decrease in most of the vegetative growth traits, especially the plant height, the flag leaf area, the length of the panicle, the total number of grains in the panicle, and the weight of 1000 grainsThe results also showed that there were significant differences between the genotypes in the average grain yield, as the KHA4 genotype gave the highest grain yield amounting to 6.22 ton ha^{-1}, while the Khazar genotype gave the lowest value amounting to 2.82 ton ha^{-1}. This result agrees with [21].The interaction between the different watering intervals (daily, every 4 days, and every 8 days) and genotypes was not significant. The daily irrigation treatment with the KHA4 genotype gave the highest value of 7.94 ton ha-1, while the treatment of irrigation every 8 days with the Khazar genotype gave the lowest value of 1.18 ton ha-1. These results agree with [22].

Table 8: Effect of irrigation intervals and genotypes and the interaction between them on average total grain yield, ton ha-1

genotype average	irrigation intervals			genotype
	8day	4 day	Two day	
4.24 d	3.01	4.36	5.36	NA1
3.14 fg	1.54	3.34	4.54	NA2
3.82 de	3.07	3.63	4.76	NA3
4.05 d	2.92	4.12	5.10	NA4
3.43 ef	2.31	3.15	4.82	NA5
4.01 d	2.46	3.66	5.89	KHA1
5.85 ab	4.25	5.67	7.62	KHA2
4.92 c	3.49	4.53	6.74	KHA3
6.10 a	4.62	5.74	7.94	KHA4
5.01 c	3.40	5.13	6.50	KHA5
2.82 g	1.18	3.20	4.08	Khazar
5.42 bc	3.53	5.87	6.86	Nemat
2.94 fg	1.25	2.97	4.61	Anber33
	2.85	4.26	5.75	irrigation intervals average
L.S.D 0.05 irrigation intervals 0.276 = genotype = Duncan 0.05 interaction = 0.902				

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8- Harvest index (%)

Table 9 shows that there is a significant effect of irrigation scheduling on the average harvest index%, by recording the daily irrigation treatment with the highest average rate of 40.10%.While the irrigation treatment every 8 days gave the lowest average of the trait amounted to 28.40%. The same table indicates that the genotypes differed significantly, where the genotype KHA4 gave the highest value, amounting to 42.73%.While the Amber33 genotype gave the lowest value of 23.66%. These results agree with [23], who indicated that the differences in harvest index values are due to the nature of the genotype and the nature of its growth. The results of the same table show that there is a significant effect of the binary interaction between irrigation scheduling and genotypes, where the treatment of daily irrigation interaction with the genotype KHA4 gave the highest values of 48.28%, while the treatment of interaction irrigation every 8 days with the genotype Anber33 recorded the lowest values of 13.78%.

Table 9: Effect of irrigation intervals and genotypes and the interaction between them on the average harvest index %

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
35.27 bcd	30.71	36.44	38.66	NA1
30.77 d	20.66	32.95	38.68	NA2
31.24 cd	28.22	30.68	34.83	NA3
31.61 cd	27.78	32.13	34.92	NA4
31.61 cd	26.19	31.01	37.61	NA5
33.45 cd	28.42	31.96	39.98	KHA1
40.57 a	36.81	40.88	44.00	KHA2
38.16 ab	32.93	36.43	45.11	KHA3
42.73 a	38.42	41.48	48.28	KHA4
35.97 bc	30.36	37.62	39.93	KHA5
32.25 cd	20.77	35.56	40.43	Khazar
41.93 a	34.19	44.93	46.68	Nemat
23.66 e	13.78	25.00	32.20	Anber33
	28.40	35.16	40.10	irrigation intervals average

L.S.D 0.05 irrigation intervals 2.505 = genotype = Duncan 0.05 interaction7.165 =

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9- Water use efficiency (kg m^3)

Table 10 shows that there is a significant effect of irrigation scheduling on the rate of water use efficiency (kg m-3), as the irrigation treatment excelled every 8 days and gave the highest values amounting to 0.2174 kg m-3, while the daily irrigation treatment recorded the lowest values amounting to 0.0945 kg m-3. This difference between irrigation scheduling in water use efficiency rate,The reason for the high water consumption efficiency of the irrigation treatment every 8 days may be because it gave the lowest grain yield relative to the amount of water consumed compared to the rest of the irrigation treatments. This result agrees with what was reached by [24] who indicated in their study an increase in the water use efficiency when applying the method of alternating wetting and drying of rice plants. The results also showed that there were significant differences between the genotypes, as the genotype KHA4 gave the highest value of 0.2507 kg m-3.While the Khazar genotype gave the lowest value of 0.1024 kg m-3, and the interaction of irrigation with the genotypes was significantly affected. The treatment of interaction irrigation every 8 days with the genotype KHA4 gave the highest values of 0.3524 kg m-3, while the treatment of overlapping daily irrigation with the genotype Khazar recorded the lowest values of 0.0670 kg m-3. The result agrees with [25] who indicated a decrease in the amount of water used in rice fields when applying rotational irrigation.

Table 10: The effect of irrigation intervals and genotypes and the interaction between them on the water use efficiency rate (kg m-3)

genotype average	irrigation intervals			genotype
	8day	4day	Two day	
0.1741 d	0.2300	0.2045	0.0879	NA1
0.1162 fg	0.1173	0.1568	0.0745	NA2
0.1608 d	0.2341	0.1703	0.0781	NA3
0.1666 d	0.2231	0.1932	0.0836	NA4
0.1343 ef	0.1760	0.1477	0.0792	NA5
0.1522 de	0.1880	0.1719	0.0967	KHA1
0.2386 ab	0.3246	0.2662	0.1251	KHA2
0.1965 c	0.2661	0.2126	0.1107	KHA3
0.2507 a	0.3524	0.2694	0.1302	KHA4
0.2023 c	0.2595	0.2407	0.1067	KHA5
0.1024 g	0.0900	0.1502	0.0670	Khazar
0.2193 bc	0.2697	0.2757	0.1126	Nemat
0.1033 g	0.0951	0.1392	0.0756	Anber33
	0.2174	0.1999	0.0945	irrigation intervals average

L.S.D 0.05 irrigation intervals 0.00919 = genotype = Duncan 0.05 interaction0.03687 =

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Conclusions:

It was observed that there was a significantly excelled of the KHA4 genotype by giving the highest values for most of the studied traits under the influence of water stress, especially the flag leaf area, weight of 1000, grain yield, harvest index and water use efficiency, which indicates its tolerance to high levels of drought compared to the rest of the studied structures such as Amber33 and Khazar, which They show poor indicators of tolerating water shortages. The results indicate that there are significant differences in the effect of water use efficiency, where the irrigation treatment every 8 days excelled compared to the daily irrigation schedule, which gave the lowest average and that water stress negatively affected all the characteristics of vegetative growth and yield components.

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