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Article

Role of Irrigation Scheduling and Potassium Levels on the Growth and Yield of Rice (*Oryza sativa L.*) Anbar 33 cultivar

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ABSTRACT

A field experiment was carried out in the Agricultural Research Office fields / Al Diwaniyah Research Station in 2019 to study the role of irrigation scheduling and potassium levels in the Growth and yield of rice (*Oryza sativa* L.) Anbar 33 cultivar. A Factorial experiment Design in order of split plot with three replicates was used, the main plots occupied with irrigation factor (I) with four levels I1, I2, I3 and I4 representing irrigation every (1,2,3 and 4 days respectively), while the subplots occupied with potassium fertilizer factor (K) with four levels K1, K2, K3 and K4 representing (0, 60, 120 and 180 Kg k ha^{-1} respectively). The Results indicated that the Irrigation scheduling affected Growth and yield traits where I2 treatment was significantly superior in plant height, panicle length, panicle number, the weight of 1000 grains, grain yield and biological yield, which gave 97.3cm, 23.42cm, 100.8m^2, 17.77gm, 2.86Meg ha^{-1} and 10.00 Meg ha^{-1} respectively, which did not different significantly of I1 treatment on plant height, panicle length, panicles number, grain yield and biological yield. The addition of potassium fertilizer significantly affected the studied traits, as K2 was significantly superior on panicle number, grain number/panicle, grain yield and biological yield, which gave 101.9m^2, 60.58, 2.94 Mgh^{-1} and 9.69 Mgh^{-1}, respectively, which did not different significantly than K4 treatment on panicles number, grain number/panicle and grain yield. The interaction indicated that there were significant differences among treatments, as I2K2 was significantly superior on panicle number, grain number/panicle, grain yield and biological yield, which gave 160.0m^2, 55.00, 4.20Meg ha^{-1} and 13.63Meg ha^{-1}, respectively.

Keywords. Potassium fertilizer; Irrigation role; Drought tolerance Rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most widely consumed staple food for the world's population, particularly in Asia [1]. Asia ranks first in terms of production and consumption of rice, according to the report of the Food and Agriculture Organization (2016). The average production of rice is estimated at 5.0 * 10^8 tons, and due to the high population, the requirements are expected to increase to 2.0 * 10^9 tons by 2030. The current and projected global sustenance requires a significant increase in crop yields in less favorable rainfed lands. Climate change, which affects the regularity and level of hydrological fluctuations, is a significant threat to agriculture, especially in developing countries, and causes various abiotic stresses [2]. Among the abiotic factors that led to plant evolution, drought is the most essential and significant limit to rice production in rainfed ecosystems [3; 4]. Agriculturally, a drought is a period with lower average rainfall/weak precipitation or higher evaporation due to deteriorating crops [5]. The severity of drought is very complex and depends on various causes, such as the frequency of rainfall, evaporation and soil [6; 7]. Elements such as nitrogen (N), phosphorus (P) and potassium (K) are the most essential nutrients for plant growth and development [8, 9]. Higher vegetable fabrics typically contain about 1.5% N, 0.2% P, and 1.0% K [(10)]. Plant growth requires large amounts of these macronutrients

[11]. Oversupply of nitrogen, phosphorous and potassium in crop production systems has increased yield over the past decades. However, the overuse of chemical fertilizers has seriously damaged the environment by boosting greenhouse gas levels and promoting eutrophication due to fertilizer exploitation's low efficiency [12,13, 14].

Therefore, maintaining nutritional balance and enhancing fertilizer efficiency is essential to reduce the use of fertilizers in crop and nutrition production systems that protect the environment [15]. K is not covalently attached to organic molecules. However, it is the most abundant cellular cation, regulating stomatal motility, osmotic adaptation, charge homeostasis, steady state enzyme activation, transmembrane potential, and transmembrane protein [16, 17]. The K^+ ion is used as the main solute to maintain turgor and induce irreversible changes in cell size. It also plays an essential role in many metabolic processes. The circulation of K^+ in the phloem acts as a form of decentralized energy storage that can bypass local energy limits [18]. This study focuses on rice's drought tolerance at the best potassium fertilizer level.

MATERIALS AND METHODS

The experiment was performed at Al Diwaniyah Research Station, Agricultural Research Office/ Ministry of Agriculture. The seeds were sown on June 25, 2019. The soil was plowed permanently, And the process of leveling and smoothing was carried out, after which the plots of land were prepared, and the area was divided into experimental units. Anbar33 was soundly direct seeding in plots ($3*3m^2$) at the amount of (140 kg seeds ha^{-1}). As stripes between a line and another 20 cm, the area of each experimental unit was $9m^2$ (3mx3m). Mineral fertilizers were added as DAP (Di Ammonium Phosphate) 200 kgP h^{-1} was added before planting to provide the phosphorous element, and 280 kgN h^{-1} urea was added to supply the nitrogen element, twice, the first one after planting, the second after a month from the first. The deals were randomly distributed according to the Randomized Complete Block Design (RCBD) in an order of split plots with three replicates.

The main plots occupied the irrigation factor (I) with four levels: -

1. I1: - irrigation every day.
2. I2: - irrigation every two days.
3. I3: - irrigation every three days.
4. I4: - irrigation every four days.

Potassium fertilizer factor (K) as potassium sulfate (K_2SO_4) added twice with urea, filled subplots with four levels: -

1. K1: - added 0kgKha^{-1}.
2. K2: - added 60kgKha^{-1}.
3. K3: - added 120kgKha^{-1}.
4. K4: - added 180kgKha^{-1}.

The plants were collected on December 1, 2019, randomly sampled from each experimental unit to measure plant growth and yield properties.

Number of experimental units = 3 * 4 * 3 = 36 units.

RESULTS

Plant high

The results showed in Table (1) a significant difference in irrigation scheduling, where the I2 treatment was significantly superior in plant height compared to the I3 treatment, with an increased ratio of 11.96%, Which did not differ significantly from the I1 treatment. The table results indicated no significant effect when potassium fertilizer levels were added between the experimental treatments. The results indicated statistically significant differences between interaction levels, as treatment of I1K4 was significantly superior to treatment of I4K1, with an increase ratio of 48.62%.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	93.3	100.3	99.0	103.0	98.9
I2	94.3	96.3	99.0	99.7	97.3
I3	90.7	87.3	83.0	86.7	86.9
I4	69.3	75.3	88.3	78.0	77.8
L.S.D(I*K)	14.19				**L.S.D(I) 7.84**
Average (K)	86.9	89.8	92.3	91.8	**N.S**

Table 1. Irrigation scheduling role and potassium levels on Plant high (cm)

Panicle length

The results showed in Table (32) a significant difference in irrigation scheduling, where the I2 treatment was significantly superior in panicle length compared to the I3 treatment, with an increased sed ratio of 8.53%, significantly different from the I1 treatment. The Table showed no significant impact when potassium fertilizer levels were added between the experimental treatments. The results indicated statistically significant differences between interaction levels, as treatment of I2K4 was significantly superior to treatment of I4K1, with an increase ratio of 15.04%.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	22.67	22.67	23.33	23.00	22.92
I2	22.67	22.33	24.33	24.33	23.42
I3	21.67	21.67	21.00	21.33	21.42
I4	20.67	21.00	20.67	20.67	20.75
L.S.D(I*K)	2.63				**L.S.D(I) 1.84**
Average (K)	21.92	21.92	22.33	22.33	**N.S**

Table 2. Irrigation scheduling role and potassium levels on panicle length (cm)

Panicles number

The results are shown in Table) a significant difference in irrigation scheduling, where the I2 treatment was significantly superior in panicle number compared to the I4 treatment, with an increased ratio of 32.11%, Which did not differ significantly from the I1 and I3 treatments. The results of the taTablendicated a significant effect between the experimental treatments when potassium fertilizer levels were, as the K2 treatment was significantly superior to the K1 treatment with an increase of 18.21%, Which did not differ significantly from the K4 treatment. The results indicated statistically significant differences between interaction levels, as treatment I2K2 was significantly superior to treatment I4K1, with an increased ratio of 46.25%, Which did not significantly differ from the I3K4 treatment.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	116.3	91.0	102.7	98.0	102.0
I2	81.0	160.0	79.7	82.3	100.8
I3	61.7	89.3	67.0	151.0	92.2
I4	86.0	67.3	85.3	66.7	76.3
L.S.D(I*K)	29.14				**L.S.D(I) 15.79**
Average (K)	86.2	101.9	83.7	99.5	**L.S.D(K) 12.86**

Table 3. Irrigation scheduling role and potassium levels in panicles number (m^2).

Grain number/panicle

The results are shown in Table) a significant difference in irrigation scheduling, where the I1 treatment was significantly superior in Grain number/panicle compared to the I4 treatment, with an increased ratio of 24.38%, Which did not differ significantly from the I3 treatment. This Table indicates a significant impact between the experimental treatments when potassium fertilizer levels were, as the K2 treatment was significantly superior to the K1 treatment with an increase of 18%, Which did not differ significantly from the K4 treatment. The results indicated statistically significant differences between interaction levels, as treatment I2K4 was significantly superior to treatment I4K1, with an increased ratio of 45.5%, Which did not significantly differ from the I3K4 treatment.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	50.67	74.00	64.00	53.33	60.50
I2	51.33	55.00	41.00	63.00	52.58
I3	56.33	60.33	45.33	69.33	57.83
I4	40.33	53.00	39.33	50.33	45.75
L.S.D$_{(I*K)}$	7.59				L.S.D$_{(I)}$ 4.77
Average (K)	49.67	60.58	47.42	59.00	L.S.D$_{(K)}$ 3.76

Table 4. Irrigation scheduling role and potassium levels on Grain number/panicle

Weight of 1000 grain

The results in Table) showed a significant difference in irrigation scheduling, where I2 treatment was significantly superior in weight of 1000 grains compared to I4 treatment, with an increased ratio of 12.15%. Table 5 indicates no significant impact between the experimental treatments when potassium fertilizer levels. The results indicated statistically significant differences between interaction levels, as treatment I2K3 was significantly superior to treatment I3K3, with an increased ratio of 25.34%.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	17.11	15.46	15.91	17.04	16.38
I2	16.66	17.07	19.45	17.92	17.77
I3	16.37	16.58	14.52	16.06	15.89
I4	15.59	15.12	15.61	16.11	15.61
L.S.D$_{(I*K)}$	2.73				L.S.D$_{(I)}$ 1.31
Average (K)	16.43	16.06	16.37	16.78	N.S

Table 5. Irrigation scheduling role and potassium levels on weight of 1000 grain (gm)

Sterility percentage

The results are shown in Table) There was no significant impact on irrigation scheduling. The results of the taTablendicated showed a significant effect between the experimental treatments; when pota potassium fertilizer levels were added, the K4 treatment was significantly superior to the K3 treatment with a decrease of 31%, Which significantly differed from the K2 treatment. The results indicated statistically significant differences between interaction levels, as treatment I3K2 was significantly superior to treatment I4K1, with a decrease ratio of 56.75%.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	34.2	32.6	45.8	24.0	34.2
I2	28.2	37.5	33.2	36.7	33.9
I3	31.9	24.0	41.6	25.7	30.8
I4	55.5	42.4	50.9	32.1	45.2
L.S.D(I*K)	19.37				N.S
Average (K)	37.5	34.1	42.9	29.6	L.S.D(K) 8.48

Table 6. Irrigation scheduling role and potassium levels on sterility percentage (%)

Grain yield

The results showed in Table (7) a significant difference in irrigation scheduling, where the I2 treatment was significantly superior in Grain yield compared to the I4 treatment, with an increased ratio of 66.27%, Which did not differ significantly from the I1 treatment. The taTablendicated results showed a significant effect between the experimental treatments when potassium fertilizer levels were added, as the K2 treatment was significantly superior to the K1 treatment with an increase of 45.54%. The results indicated statistically significant differences between interaction levels, as treatment I2K2 was significantly superior to treatment I3K1, with an increased ratio of 236%.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	2.22	3.86	4.00	3.50	3.40
I2	2.30	4.20	2.32	2.60	2.86
I3	1.25	2.13	1.75	2.35	1.87
I4	2.30	1.56	1.60	1.40	1.72
L.S.D(I*K)	1.10				L.S.D(I) 0.60
Average (K)	2.02	2.94	2.42	2.46	L.S.D(K) 0.57

Table 7. Irrigation scheduling role and potassium levels on Grain yield (Meg ha^{-1})

Biological yield

The results are shown in Table) a significant difference in irrigation scheduling, where the I2 treatment was significantly superior in biological yield compared to the I4 treatment, with an increased ratio of 50.82%, Which did not differ substantially from the I1 treatment. This indicates a significant effect between the experimental treatments when potassium fertilizer levels were, as the K2 treatment was significantly superior to the K1 treatment with an increase of 20.97%. The results indicated statistically significant differences between interaction levels, as treatment I2K2 was significantly superior to treatment I4K4, with an increased ratio of 153.81%, Which did not significantly differ from the I1K3 treatment.

Levels (I)	Levels (K)				Average (I)
	K1	K2	K3	K4	
I1	7.51	11.70	12.43	10.33	10.49
I2	8.97	13.63	7.31	10.10	10.00
I3	6.48	7.93	5.75	7.00	6.79
I4	9.10	5.51	6.53	5.37	6.63
L.S.D(I*K)	1.36				L.S.D(I) 0.58
Average (K)	8.01	9.69	8.01	8.20	L.S.D(K) 0.74

Table 8. Irrigation scheduling role and potassium levels on biological yield (Meg ha^{-1}).

DISCUSSION

The results indicate that there was a significant effect of irrigation scheduling and the addition of different levels of potassium on Growth and yield of rice (Anbar 33 cultivar), as the level of I2 was significantly superior in both grain and biological yields, and this is due to its superiority in plant height, panicle length, panicles number, and weight 1000 grain, as well as it was not significantly different from I1 in grain yield, biological yield, plant height and panicles number. The tables also showed that the K2 level was significantly superior to the grain yield and the biological yield due to its superiority in panicle number and grain number/ panicle. It did not differ significantly from the K4 level in grain yield, panicle number and the grain number/ panicle. This may be because the irrigation intervals in the field allow for good ventilation and the increase in the activity of microorganisms, which led to the formation of active and healthy roots, which encourages the absorption of nutrients, including potassium, which was reflected in an increase in panicles number and weight of 1000 grain, this agrees with [19, 20. 21]. The interaction results also showed the superiority of I2K2 treatment in grain yield and biological yield due to its superiority in panicle number and the grain number/panicle. This led to the choice of I2 because it reserved 50% of irrigation water. To obtain good Growth and yield of rice cultivar anbar 33, with the level K2 that achieved the best results, the reason may be that irrigation every two days stimulated the level 60Kg K ha^{-1} to be better and saved 50% of the fertilizer recommendation.

CONCLUSION

Irrigation scheduling significantly affected the Growth and yield of rice, with the I2 treatment (irrigation every 2 days) showing superior results in plant height, panicle length, panicle number, weight of 1000 grains, grain yield, and biological yield. The addition of potassium fertilizer also significantly impacted the studied traits, with the K2 treatment (added 60 kg K ha-1) showing superior results in panicle number, grain number/panicle, grain yield, and biological yield. The interaction between irrigation scheduling and potassium levels also showed significant differences, with the I2K2 treatment (irrigation every 2 days and added 60 kg K ha-1) showing superior results in panicle number, grain number/panicle, grain yield, and biological yield. The results indicated that the K4 treatment (added 180 kg K ha-1) was significantly superior to the K3 treatment (added 120 kg K ha-1) in grain yield. The I2 treatment (irrigation every 2 days) was significantly superior to the I4 treatment (irrigation every 4 days) regarding grain yield.

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