Effect of irrigation scheduling and nutrients on yield and its components of wheat crop

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Abstract:

Field experiment was conducted during winter season 2021-2022 at karthiya area / Kut district in Wasit Province, Iraq. Therefore, the aim of this study was to implement the irrigation scheduling and foliar application of nutrients on the yield and its components of wheat (IPA 99). The study carried out in randomized complete block design with split block arrangements and three replications. The main plots were for irrigation scheduling calculated based on depth of irrigation water and the cumulative evaporation from a Class A as follows: Depth of irrigation water at 40 % of available, depth of irrigation water at 60 % of available and depth of irrigation water at 80 % of available. The sub plots were for foliar application of nutrients included control, foliar spray of iron and zinc was added with the elongation and booting stages (100 $Mg.L^{-1}$) and foliar spray of potassium was added with the elongation and booting stages (3000 $Mg.L^{-1}$). The results indicated that the highest No. of spike, No. of spikelets per spike, 1000-grain weight (g), grains yield, biological yield and harvest index were found at depth of irrigation water at 40 % of available (362.80, 21.38, 32.49 g, 4.80 t ha^{-1}, 15.00 t ha^{-1} and 32.06) respectively. Also the highest were found at foliar spray of potassium 3000 $Mg.L^{-1}$ (20.84, 4.40 t ha^{-1}, 14.60 t ha^{-1} and 29.94) respectively, except No. of spike and 1000-grain weight not significant affected.

Key words: irrigation scheduling, nutrients, grains yield and its components of wheat.

Part of Ph.D. for first researcher.

1. Introduction:

Wheat crop *Triticum aestivum L*. is the main cereal crop in the world and more important than other grain crops. This importance is due to its seeds that contain gluten which is essential for producing high quality bread. It is the first strategic crop in Iraq because it is the main source of food and has a role in economic development (15 and 16).

The irrigation process consists of introducing water to the soil profile where plants can extract it to meet their needs, mainly evapotranspiration. An important goal of irrigators is to design and manage their irrigation system to optimize placement and timing of applications to promote growth and yield while protecting against soil erosion, salination, water quality degradation, or other detrimental environmental impacts (13). The efficient use of water by modern irrigation systems is becoming increasingly important in arid and semi-arid regions with limited water resources (8).

Scheduling irrigation' is one of the important processes in water management i.e., when irrigation is to be performed and what quantity of water needs to be fed. It is absolutely necessary to rationalize the use of water as it is an important application to increase the water use efficiency (1).

(2) observed that irrigation treatments at 60% and 80 % of available water were significantly differences in reducing 1000-grain weight, grain yield and biological yield for wheat, compared with the treatment 40% of available water, while harvest index not significant affected. (19) indicated that number of spikes m^{-2} grain and straw yield, harvest index, number of grains/spike and thousand grain weight were affected by different irrigation scheduling.

The method of spraying fertilizer is effective in increasing the quantity, improving the quality, vegetative growth of the plant, and reduce the environmental pollution caused by the addition of fertilizer compounds to the soil and the possibility of addressing the lack of major elements in plants instantly by foliar applications of these nutrients on the vegetative parts (20). Potassium is the third major plant nutrient which is essential for plant metabolic processes. It is known to be involved in the activation of more than 60 enzymes, acts as an osmoticum to maintain turgor pressure and regulates the opening and closing of stomata in plant cells. Its impacts on water relations, photosynthesis, assimilate transport and enzyme activation can have direct consequences for crop productivity (17).

(5) concluded the foliar spray of potassium (3000 $Mg.L^{-1}$) had significant effect on most of the studied parameters of wheat crop.

Fe and Zn contribute to photosynthesis, chlorophyll formation, metabolism of starch formation, and also controls the physiological and biochemical processes. It has a positive influence on the translocation of required metabolites from the source to the sink of plants (14). (9) reported that concentrations of iron and zinc foliar application increased the number of tillers and grain yield of wheat compared to control treatment.

Therefore, the aim of this study was to implement the irrigation scheduling and foliar application of nutrients on the yield and its components of wheat.

2. Materials and methods

2.1. Experimental site

Field experiment was conducted during winter season 2021-2022 at karthiya area / Kut district in Wasit Province, Iraq. Soil samples were taken from depths of 0 – 30 cm prior to sowing of crop and analyzed to determine the physical and chemical properties which are shown in Table (1) by using methods of soil analysis (21).

Table.1. Some chemical and physical properties of soil field experiment (depth 0 - 30 cm) for the season 2021/2022.

Measured Character	Value	Measuring unit
pH	7.8	
Electrical conductivity (EC)	2.4	$dS\ m^{-1}$
Available Nitrogen	16	$mg\ kg^{-1}$
Available Phosphorus	10.6	$mg\ kg^{-1}$
Available Potassium	114	$mg\ kg^{-1}$
Soil texture	Silt Loam	

2.2. Experimental design and treatments

The experiment was conducted using a randomized complete block design with split block arrangement and three replications, the area of each plot was 18 m^2. The treatments considered in the study were as follows:

First factor: The irrigation scheduling comprised of three levels were calculated based on depth of irrigation water and the cumulative pan evaporation:

1- Depth of irrigation water at 40 % of available (I_1).

2- Depth of irrigation water at 60 % of available (I_2).

3- Depth of irrigation water at 80 % of available (I_3).

Second factor: Foliar application of nutrients:

1- Control (only received distilled water) N_0.

2- Foliar spray of iron and zinc was added with the elongation and booting stages (100 $Mg.L^{-1}$) N_1 (for both iron and zinc).

3- Foliar spray of potassium was added with the elongation and booting stages (3000 $Mg.L^{-1}$) N_2.

2.3. Agronomic practices

Wheat variety (IPA 99) was planted on 13th Dec, 2021 growing season, the distance between rows was 20 cm. The phosphate fertilizer was added at one time before planting with the reality of (100 Kg. ha^{-1} P_2O_5), whereas recommended dose 200 kg. ha^{-1} of urea (46% N), was applied in two equal doses at during tillering and flowering (5). Potassium was applied in the form of potassium sulfate (K 41.5). While iron and zinc were applied as $FeSO_4$ and $ZnSO_4$ (Fe 20 %, Zn 33 %) respectively in the experiment as per treatments.

Water were applied to all irrigation treatment plots at same time using a basin irrigation method. Thereafter, irrigation treatments was started according to the prescribed irrigation rates. Irrigation intervals and irrigation scheduling were calculated based on depth of irrigation water and the cumulative evaporation from a Class A Pan during the growth period.

Plants per square meter in each experimental unit were harvested on 14 May in 2022. The data of the following parameters: No. of spike, No. of spikelets per spike, 1000-grain weight, grain yield, biological yield and harvest index were observed.

2.4. Statistical analysis

The data analysis were performed using GenStat program and mean comparison were carried out by using the least significant difference (LSD) test at probability levels of 0.05.

3. Results and Discussion

Table (2) Irrigation scheduling indicated highly significant effect on No. of spike in the growing season. It is clear from data that the highest value of No. of spike was observed with I_1 treatment and the lowest value was obtained with I_3 treatment, while nutrients and their interaction did not show significant effect on this trait. Similar result was concluded by (2 and 11).

The results in (Table 3) indicated that the irrigation scheduling and nutrients had high significant effect on No. of spikelets per spike, while their interaction did not significant differences on this trait. The highest No. of spikelets value (21.38) was obtained through I_1 treatment, the lowest value (18.13) was observed in I_3 treatment. These results are in agreement with those of (4 and 12). Data also explained nutrients (N_2) gave the average highest (20.84) compared with N_0 treatment. These results are in line with (10 and 14).

Table (4) Irrigation scheduling indicated highly significant effect on 1000-grain weight in the growing season. It is clear from data that the highest value of 1000-grain weight was observed with I_1 treatment and the lowest value was obtained with I_3 treatment, while nutrients and their interaction did not show significant effect on this trait. Similar result was concluded by (2 and 7).

Data in (Table 5) revealed that the irrigation scheduling and nutrients had high significant effect on grain yield, whereas their interaction did not significant differences on this trait. The maximum grain yield value (4.80 t. ha^{-1}) was obtained through I_1 treatment, while the minimum value (3.12 t. ha^{-1}) was observed in I_3 treatment. This finding was supported by (22 and 25). Results also explained nutrients (N_2) gave the average highest (4.40 t. ha^{-1}) with increase of 16.59 % compared N_0 treatment. Similar results were noticed by (3 and 23).

Biological yield affected significantly by irrigation scheduling (Table 6). The highest average of biological yield was (15.00 t. ha^{-1}) at I_1 as compared with control treatment. These results were in agreement with (2 and 19). The differences in the values of the biological yield among the nutrients levels were significant in growing season. The N_2 treatment gave the average highest (14.60 t. ha^{-1}) compared with N_0 treatment which gave the lowest average (13.63 t. ha^{-1}). Similar results were reported by (10 and 26).

The results in (Table 7) proposed that the irrigation scheduling, nutrients had high significant effect on harvest index, while their interaction did not significant differences on this trait. The maximum harvest index value (32.06 %) was obtained through I_1 treatment, the minimum value (23.90) was observed in I_3 treatment. This finding was supported by (7 and 12). Data also explained nutrients (N_2) gave the average highest (29.94 %) compared with N_0 treatment. These results are in agreement with those of (10 and 14).

The results of the present revealed that crop wheat irrigated by irrigation basin, responded differentially to study treatments. The increase of crop traits is due to increase of optimum availability of water at crop growth that provides all available nutrients from the soil. Besides this, it maintained chlorophyll content in leaves and plant remain stay-green for longer period of time that helped higher photosynthesis of crop through better assimilation of carbon from atmosphere that favours the growth (24). Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes (18). It was due to timely and adequate supply of water at the crop growth and development stages (22).

On the other hand, Wheat requires potassium for optimal growth and development. Adequate potassium results in superior quality of the whole plant due to improved efficiency of photosynthesis, increased resistance to some diseases and greater water use efficiency (6). Also, Iron and Zinc contribute to photosynthesis, chlorophyll formation. It has a positive influence on the translocation of required metabolites from the source to the sink of plants (14). In addition, studies also showed that an exogenous supply of nutrients plays a crucial role in the enhancement of plant tolerance against various abiotic stresses.

Table 2. Effect of irrigation scheduling, nutrients and their interaction on the No. of spike (m^2) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	337.1	359.6	391.8	362.8
I_2	322.0	331.7	366.1	339.9
I_3	278.0	289.2	310.2	292.4
Mean of effect (N)	312.4	326.8	356.0	
LSD (0.05)	16.52			I=
	N.S			N=
	N.S			I × N=

Table3 Effect of irrigation scheduling, nutrients and their interaction on the No. of spikelets per spike of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	20.66	20.77	22.71	21.38
I_2	19.46	19.74	20.80	20.00
I_3	17.52	17.87	19.00	18.13
Mean of effect (N)	19.21	19.46	20.84	
LSD (0.05)	1.699			I=
	0.720			N=
	N.S			I × N=

Table 4. Effect of irrigation scheduling, nutrients and their interaction on the 1000-grain weight (g) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	30.57	31.70	35.19	10.57
I_2	30.26	30.82	31.85	10.13
I_3	28.78	29.02	30.59	9.44
Mean of effect (N)	29.87	30.52	32.54	
LSD (0.05)	2.156			I=
	N.S			N=
	N.S			I × N=

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Table 5. Effect of irrigation scheduling, nutrients and their interaction on the grain yield (t. ha^{-1}) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	4.38	4.71	5.32	4.80
I_2	3.72	4.04	4.48	4.08
I_3	2.90	3.07	3.39	3.12
Mean of effect (N)	3.67	3.94	4.40	
LSD (0.05)	0.732			I=
	0.328			N=
	N.S			I × N=

Table 6. Effect of irrigation scheduling, nutrients and their interaction on the biological yield (t. ha^{-1}) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	14.45	14.74	15.80	15.00
I_2	13.73	13.90	14.49	14.04
I_3	12.72	12.88	13.52	13.04
Mean of effect (N)	13.63	13.84	14.60	
LSD (0.05)	0.915			I=
	0.653			N=
	N.S			I × N=

Table 7. Effect of irrigation scheduling, nutrients and their interaction on the harvest index (%) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	30.35	32.01	33.81	32.06
I_2	27.13	29.13	30.92	29.06
I_3	22.78	23.83	25.10	23.90
Mean of effect (N)	26.75	28.32	29.94	
LSD (0.05)	0.861			I=
	2.188			N=
	N.S			I × N=

5. Conclusion

Based on the results above of investigation, it can be concluded that the crop traits were recorded maximum with irrigation at (I_1) than other irrigation schedules. And from the results, it may be indicated that wheat plant gave maximum production of crop attributes when treated with (N_2).

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