Influence of Sprinkler Irrigation and Foliar Nutrients on Traits 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 sprinkler irrigation scheduling and foliar application of nutrients on the traits of wheat (IPA 99). The study carried out in randomized complete block design with strip plots 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 (I_1), depth of irrigation water at 60 % of available (I_2) and depth of irrigation water at 80 % of available (I_3). The sub plots were for foliar application of nutrients included control (N_0), foliar spray of iron and zinc was added with the elongation and booting stages (100 $Mg.L^{-1}$) (N_1) and foliar spray of potassium was added with the elongation and booting stages (3000 $Mg.L^{-1}$) (N_2). The results indicated that the highest plant height, flag leaf area, chlorophyll, grains yield, biological yield and harvest index were found at depth of irrigation water at 40 % of available (107.08 cm, 43.05 cm^2, 48.14 SPAD, 4.92 t ha^{-1}, 14.78 t ha^{-1} and 33.19 %) respectively. Also the highest were found at foliar spray of potassium 3000 $Mg.L^{-1}$ (103.89 cm, 46.10 SPAD, 4.50 t ha^{-1}, 14.43 t ha^{-1} and 30.93 %) respectively, except flag leaf area not significant affected.

Keywords: sprinkler irrigation, nutrients and crop traits of wheat.

Part of Ph.D. for first researcher.

1. Introduction:

Wheat is one of the most important crops worldwide. It's a major source of energy in human nutrition 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. It belongs to the family [8 and 19].

Water is an important natural resource and its increasing scarcity has led to concerns for its efficient use, management, and sustainability. Water shortage is one of the main constraints for economic development in arid and semi-arid areas. However, it is very important for these areas to promote public awareness as regards water-saving measures so as to develop the social sustainability and extension of new cultivated areas [13]. The efficient use of water by modern irrigation systems is becoming increasingly important in arid and semi-arid regions with limited water resources [12].

Sprinkler Irrigation or overhead irrigation is application and distribution of water over the field in the form of spray created by expelling water under pressure from an orifice (nozzle). In effect, sprinkler systems are designed to deliver water to the field without depending on the soil surface for water conveyance or distribution. Sprinkler irrigation is becoming a preferred method for cereal crop cultivation as the water available for irrigation around the world becomes increasingly scarce, especially in arid and semi-arid regions [21 and 25].

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 and 5].

[3] observed that irrigation treatments at 60% and 80 % of available water were significantly differences in reducing plant height and flag leaf area for wheat, and the reduction percentage was 7.01%, 10.51%, 12.10% and 29.48% respectively, compared with the treatment 40% of available water.

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 [22]. Potassium is the third most important nutrient after nitrogen and phosphorus for

better crop growth and development. It is an essential nutrient and its availability controls many biochemical and physiological processes in plants such as enzyme activation, photosynthesis, protein synthesis, osmoregulation, energy transfer, stomatal movement, cation-anion balance and stress resistance [11].

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 [18].

[23] concluded the foliar fertilization of potassium had significant effect most of the studied parameters of wheat crop. [14] reported that concentrations of iron and zinc foliar application increased the plant height, flag leaf area, chlorophyll index, number of tillers and grain yield of wheat compared to control treatment.

Therefore, the aim of this study was to implement the sprinkler irrigation scheduling and foliar application of nutrients on the traits of wheat.

2. Materials and methods

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 [24].

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	

The experiment was conducted using a randomized complete block design with strip plots 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 sprinkler 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.

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. 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 treatments at same time using a basin irrigation method. Thereafter, the sprinkler irrigation scheduling was started according to the experimental treatments after the completion of seedling emergence. 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: Plant height, Flag leaf area, Chlorophyll, Grain yield, Biological yield and Harvest index were observed.

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 [2].

3. Results and Discussion

The results in (Table 2) indicated that the irrigation scheduling, nutrients had high significant effect on plant height, while their interaction did not significant differences on this trait. The highest plant height value (107.08 cm) was obtained through I_1 treatment, the lowest value (95.22 cm) was observed in I_3 treatment. These results are in agreement with these of [7]. Data also explained nutrients (N_2) gave the average highest (103.89 cm) compared with N_0 treatment. These results are in line with [10 and 23].

Table (3) Irrigation scheduling indicated highly significant effect on flag leaf area in the growing season. It is clear from data that the highest value of flag leaf area 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 [7].

The results in (Table 4) indicated that the irrigation scheduling and nutrients had high significant effect on chlorophyll, while their interaction did not significant differences on this trait. The highest chlorophyll value (48.14 SPAD) was obtained through I_1 treatment, the lowest value (42.12 SPAD) was observed in I_3 treatment. Data also explained nutrients (N_2) gave the average highest (46.10 SPAD) compared with N_0 treatment. These results are in line with [10].

Grain yield affected significantly by irrigation scheduling (Table 5). The highest average of grain yield was (4.92 t. ha^{-1}) at I_1 as compared with control treatment. These results were in agreement with [17]. The differences in the values of the grain yield among the nutrients levels were significant in growing season. The N_2 treatment gave the average highest (4.50 t. ha^{-1}) compared with N_0 treatment which gave the lowest average (3.74 t. ha^{-1}). Similar results were reported by [15 and 23].

Data in (Table 6) revealed that the irrigation scheduling and nutrients had high significant effect on biological yield, whereas their interaction did not significant differences on this trait. The maximum biological yield value (14.78 t. ha^{-1}) was obtained through I_1 treatment, while the minimum value (12.93 t. ha^{-1}) was observed in I_3 treatment.

This finding was supported by [17]. Results also explained nutrients (N_2) gave the average highest (14.43 t. ha^{-1}) with increase of 6.306 % compared N_0 treatment. Similar results were noticed by [20 and 27].

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 (33.19 %) was obtained through I_1 treatment, the minimum value (24.34 %) was observed in I_3 treatment. These results are in line with [6]. Data also explained nutrients (N_2) gave the average highest (30.93 %) compared with N_0 treatment. These results are in agreement with those of [16 and 23].

The results of the present revealed that crop wheat irrigated by sprinkler irrigation, responded to study treatments, based on the results above, 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). 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 [26]. Also, the present study's findings explained the important role of the sprinkler irrigation system in the improvement of the growth attributes, this may be due to the fact that in sprinkler irrigation, wheat plants received a uniform distribution of water across the entire field [7].

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 [9]. 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 [4 and 18].

Table 2. Effect of irrigation scheduling, nutrients and their interaction on the plant height (cm) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	102.47	105.97	112.8	107.08
I_2	95.03	98.87	102.7	98.87
I_3	93.77	95.73	96.17	95.22
Mean of effect (N)	97.09	100.19	103.89	
LSD (0.05)			2.669	= I
			4.308	= N
			N.S	= N × I

Table 3. Effect of irrigation scheduling, nutrients and their interaction on the flag leaf area (cm^2) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	41.26	42.48	45.40	43.05
I_2	40.22	40.57	41.07	40.62
I_3	38.50	38.68	39.87	39.02
Mean of effect (N)	39.99	40.58	42.11	
LSD (0.05)			2.353	= I
			N.S	= N
			N.S	= N × I

Table 4. Effect of irrigation scheduling, nutrients and their interaction on the chlorophyll (SPAD) of wheat during the season 2021 / 2022.

Treatments	Nutrients			Mean of effect irrigation (I)
	N_0	N_1	N_2	
I_1	45.17	48.23	51.00	48.14
I_2	41.27	43.46	44.29	43.01
I_3	41.00	42.36	43.00	42.12
Mean of effect (N)	42.48	44.69	46.10	
LSD (0.05)			2.159	= I
			2.542	= N
			N.S	= N × I

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	4.45	4.76	5.54	4.92
I_2	3.82	4.18	4.51	4.17
I_3	2.95	3.06	3.44	3.15
Mean of effect (N)	3.74	4.00	4.50	
LSD (0.05)			0.591	= I
			0.363	= N
			N.S	= N × I

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	14.04	14.69	15.62	14.78
I_2	13.84	14.07	14.42	14.11
I_3	12.68	12.88	13.24	12.93
Mean of effect (N)	13.52	13.88	14.43	
LSD (0.05)			0.894	= I
			0.212	= N
			N.S	= N × I

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	31.67	32.42	35.48	33.19
I_2	27.61	29.67	31.29	29.52
I_3	23.29	23.70	26.02	24.34
Mean of effect (N)	27.52	28.60	30.93	
LSD (0.05)			2.809	= I
			2.118	= N
			N.S	= N × I

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