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Article

Impact of Seeding Rates and Kinetin Levels on Barley Physiology and Yield

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Abstract: A field experiment was conducted in the Al-Jazeera area, near Tikrit, to investigate the effects of seeding rates and kinetin levels on barley (Hordeum vulgare L.) variety Shu'a. Despite extensive research on barley growth, the optimal seeding rates and kinetin applications remain underexplored. This study aimed to determine the best seeding rate and kinetin concentration to enhance barley's physiological traits and yield. Using a randomized complete block design with three replications, two seeding rates (160, 180 kg ha-1) and three kinetin levels (75, 50, 0 mg L-1) were tested. Results showed that a seeding rate of 160 kg ha-1 significantly improved the absolute growth rate (0.17994 mg day-1), relative growth rate (16.675 mg g-1 day-1), and thousand-seed weight (35.91 g). Kinetin at 75 mg L-1 outperformed other concentrations, enhancing absolute growth rate (0.18781 mg day-1), relative growth rate (16.827 mg g-1 day-1), grains per spike (38.299 spike-1), and thousand-seed weight (39.880 g). The findings suggest that 160 kg ha-1 seeding rate and 75 mg L-1 kinetin concentration optimize barley growth and yield, providing practical implications for barley cultivation practices.

Keywords: Barle, Kinetin, Physiological Characteristics, Barley Yield.

1. Introduction

barley. (Hordeum spp) is one of the oldest plants that humans have used as a source of food because it contains varying percentages of protein and starch, and mineral salts such as iron, phosphorus, calcium and potassium. In addition to nutritional elements, it is also rich in It contains many types of antioxidant compounds, including vitamin E. And beta carotene. It was one of the basic food crops in ancient times that was grown in the Fertile Crescent region and the Nile River in North Africa [1]. The Russian scientist Vavilov [2] stated that Abyssinia is its original homeland, as a number of wild forms and patterns still exist. Others believe that barley originated in Southeast Asia, especially in China, Nepal, and Tibet. Harium believes that extinct wild plants are the origin from which current barley evolved, which were growing in the same areas where it grows. Wild barley is a type of Hordeum spontaneum, as it extends from the Zagros Mountains in western Iran, adjacent to Iraq, heading northwest towards the Turkish island of Anatolia, then descending south. Barley is one of the strategic grain crops that is included in food security for humans and animals, as it ranks fourth after wheat, rice, and yellow corn in terms of cultivated area as well as the amount of global production. Its plants are also characterized by their tolerance of harsh environmental conditions and low nutritional requirements. Barley in Iraq ranks second after wheat in terms of cultivated area and production (Central Agency for Agricultural Statistics, 2022).

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Barley is grown in the northern regions on an annual basis and in the central and southern irrigated regions. Barley is used in many food industries, such as barley flour, because its grains contain fewer calories than wheat, and in other food industries, such as the vinegar industry. It has multiple medical uses, such as a softener, laxative, and food for diabetics. It is also used in the yeast industry, as it can be used in the field of livestock, as Its grains are used in concentrated feed as they are a source of nutritional energy for fodder for animals and birds. It can also be mixed with crops of the leguminous family, such as clover and alfalfa, to improve green fodder. The reasons for the decline in the rate of barley crop production are due to factors, the most prominent of which is the deterioration of cultivated lands as a result of continuous cultivation for long years and the failure to maintain their fertility. The most important means that contribute to increasing the productivity rate is determining the appropriate amount of seeding rate, which makes the variety able to exploit its biological and physiological processes to the highest level to achieve the highest productivity per unit of area. It highlights the importance of plant hormones in improving vegetative growth, and among the plant hormones that regulate growth is kinetin, by spraying it on plants in the vegetative growth stage [3]. Recently, research has focused on the commercial use of plant growth regulators, including kinetin, to improve the quality characteristics and increase productivity of many strategic grain crops. Kinetin, which is chemically known as (6-furfuryl aminopurine), is one of the plant growth hormones that regulates several major physiological processes in plant growth and development, such as stimulating cell divisions and breaking the apical dominance of the plant. It also encourages the growth of lateral shoots and delays shoot senescence. Javid and others [4].

2. Materials and Methods

A field experiment was applied in the winter season 2022-2023 to determine the best seeding rate for the barley crop, and spraying kinetin on the vegetative part and its effect on the growth and yield of barley using a randomized complete block design (RCBD) in a two-factor experiment, the first is seeding rates (160 and 180).) kg ha-1, and the second is represented by levels of the growth regulator kinetin (75, 50, and 0) mg l-1, which was sprayed on the vegetative part at the 2-3 stage. A leaf of a plant. Seeds were planted in 6 lines of the experimental unit, 2 m long and 15 cm apart. After performing perpendicular plowing and soil service operations, nitrogen fertilizer was added in the form of urea at a rate of (200) kg ha-1 in two batches and (100) kg ha-1 triple superphosphate. And potassium sulfate (80) kg ha-1. The absolute growth rate characteristic was calculated. This characteristic indicates the rate at which the crop or plant grows, and whether the crop is growing at a faster or slower rate than normal, and it is estimated from the equation of Hunt [5].

AGR=(W2-W1) / (t2-t1)

W1, W2 are the dry plant weight at time t2 and t1, respectively.

For the relative growth rate of the plant (gm g-1 day-1): Relative Growth rate

It is estimated from the equation of Hunt, [5].

R.G.R = (Lin W2 – Lin W1) / (T2-T1)

LinW1 = natural logarithm of the first dry weight

LinW2 = natural logarithm of the second dry weight

10 plants were harvested from the experimental units, and the average number of grains per spike and the weight of one thousand grains were recorded when the spike was fully mature. The experiment data were analyzed according to the design used in the experiment and the averages were compared using the Duncan test at a probability level of 0.05%.

3. Results and Discussion

1- Absolute growth rate (mg day-1) :

This characteristic expresses the efficiency of the plant's vital activities per unit of time. The results of the statistical analysis of the absolute growth rate characteristic of the barley crop plant, Table 1, indicate that there are significant differences between the seed rate coefficients, as the seed rate gave a maximum of 160 kg. Ha-1 The highest average for the trait was 0.17994 mg day-1 compared to the seed average of 180 kg ha-1. Which gave an average of 0.15814 mg day-1 for the trait. The reason for this increase may be attributed to the intense competition of barley plants with each other for light, water, and basic needs for building organic materials such as proteins, carbohydrates, and others when higher seed rates are applied. The results of the same table indicate that the barley plants treated with kinetin concentrations of 75 and 50 mg L-1 were superior in terms of absolute growth rate to the comparison treatment applied in the experiment, as it gave the highest average of 0.18781 and 0.17024 mg day-1 for the two concentrations, respectively, compared to the lowest average for the comparison treatment (without spraying), which recorded an average of 0.14907 mg day-1, which may have been affected by the concentration of kinetin, which helps in cell division processes [6], and it regulates the work of nitrate-reducing and sugar-transferring enzymes, in addition to increasing the number of leaves, the number of branches, and the dry weight of the shoot [7]. Its effect is reflected in increasing the growth of the plant and thus increasing its dry weight [8], and thus affects the absolute growth rate. The interaction was recorded between the seed rate of 160 kg ha-1 and the concentration of the growth regulator. Kinetin, 75 mg L-1, recorded the highest average for the trait, reaching 0.201000 mg day-1, compared to the lowest level recorded by the intervention, 180 kg ha-1, and the treatment without concentration (comparison) for Kinetin, with an average of 0.131330. mg day-1 with a difference of 53.04%.

Table 1. The effect of seeding rates and kinetin concentration on absolute growth rate (mg day-1).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	0.201000 a	0.174630 b	**0.18781 a**
50	0.172000 b	0.168475 c	**0.17024 a**
0	0.166812 c	0.131330 d	**0.14907 b**
Mean	0.17994 a	0.15814 b	

***Similar letters indicate that there are no significant differences at the 5% probability level.**

2- Relative growth rate of the plant (mg g-1 day-1):

This function represents the amount of increase in the dry weight of the plant relative to the total dry weight at a certain point. Table 2 shows the averages of the characteristic of the relative growth rate of the barley plant. There is a significant difference in the average of the characteristic for the two seed rates, as the average exceeded 160 kg ha-1. With an average trait value of 16.675 mg g-1 day-1, the average value of the trait for seed rate was 180 kg ha-1. Which recorded an average value of 16.264 mg g-1 day-1, a difference of 2.52%. This difference may be attributed to the effect of increasing plant density by increasing the rate of seed quantity, which led to an increase in the intensity of competition for the net rate of photosynthesis and other

nutrients needed for the production of organic materials, and thus affecting the efficiency of production and accumulation of dry matter in the plant during a unit of time. These differences agree the results are consistent with what was reported by Valadabadi and Farahani (2010), Ahmed [9] and Hassan et al. [10]. Who found that the relative growth speed decreases with increasing plant density. The averages of the relative growth rate of barley appear in Table 2. A significant difference was recorded between the levels of spraying the growth regulator Kinetin, as the concentration of 75 mg L-1 recorded the highest average of 16.827 mg g-1 day-1 with a difference of 4.1% compared to the lowest average recorded by the comparison treatment (without spraying), which recorded an average of 16.163 mg g-1 day-1. Kinetin has a role in helping to stimulate the plant to cell divisions and in organizing and managing the distribution of the products of the process. Carbon assimilation between plant organs and tissues [11], leading to an increase in the average dry weight of the plant. These results are consistent with what was stated by Bordoloi and Barnah [12], Al-Momari, and the results of Asaad [13] and Bandar [14].

The interaction between seed rate and kinetin concentration recorded significant differences between the trait averages, as the highest average was recorded for the seed rate, 160 kg ha-1, and the kinetin spray concentration, 75 mg L-1, 17.117 mg g-1 day-1, superior to the rest of the kinetin spray concentration levels, with a difference of 7.22% over the lowest recorded average interference of 15.963 mg g-1 day-1.

Table 2. The effect of seeding rates and kinetin concentration on the relative growth rate of the plant (mg g-1 day-1).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	17.117 a	16.538 b	**16.827 a**
50	16.546 b	16.291 b	**16.419 b**
0	16.363 b	15.963 c	**16.163 c**
Mean	16.675 a	16.264 b	

***Similar letters indicate that there are no significant differences at the 5% probability level.**

3- Number of grains per a spike

Table (3) indicates that there are no significant differences in the trait of the number of grains, spike-1, at a seed rate of 180 kg ha-1 and 160 kg ha-1, as the trait was recorded as average. It is 35.46 and 32.68 spike-1, respectively. These results agreed with Al-Dulaimi et al. (2015). The results of the statistical analysis of the same table for the average number of grains per spike appear to exceed the spraying with a concentration of 75 mg L-1 of kinetin over the rest of the spraying levels, with an average of 38.299 spike-1, a difference of 29.72% from the lowest. The average recorded by the comparison treatment (without spraying) was 29.524 spikes-1. The reason for this may be due to the action of the growth regulator kinetin, which affects the increase in carbon assimilation products and thus reflects positively on the number of grains in the spike. These results are consistent with what was found by Javid et al. [4] and Al-Obaidi [15] who found that the use of regulators Growth has a positive effect on the components of the yield as a result of it containing a number of natural compounds, which in turn encourage vegetative and reproductive growth. Reducing competition between plants with kinetin spraying led to a reduction in spikelet abortion and an increase in the pollination rate, thus increasing the number of grains in the spike. These results agreed with Iqbal and Ashraf [16], Ali et al.[17], and Khaliliagdam et al.

As for the interaction between the seed quantity treatment of 160 kg ha-1 and the kinetin concentration of 75 mg L-1, the highest average was recorded, amounting to 40.222 spike-1, with a difference of 42.52% from the treatment of 180 kg ha-1 of the average Seeds without spraying for kinetin, which recorded the lowest average of 28.222 spike-1.

Table 3. The effect of seeding rates and kinetin concentration on the number of grains per spike.

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	40.222 a	36.377 b	**38.299 a**
50	35.333 b	33.430 c	**34.384 b**
0	30.826 d	28.222 e	**29.524 c**
Mean	35.46 a	32.68 a	

***Similar letters indicate that there are no significant differences at the 5% probability level.**

4- Weight of a thousand grains (gm).

The results of Table (4) indicate that there is a significant difference in the weight of a thousand grains of barley plants at a seed rate of 160 kg ha-1, as the highest average for the trait was recorded at 35.91 grams over the average recorded by the average. The seed yield of 180 kg ha-1 was 30.87 g, a significant difference of 16.32%. The reason for the decrease in the weight of one thousand grains is that the high plant density leads to less deposition of dry matter in the grains due to the presence of intense competition for water and nutrients between plants. These results agreed with the results of Malik, et al., (2009) and Soomro, et al., (2009) and Andush et al., (2020). The results shown in Table 4 showed that there was a significant difference for the spraying treatment with kinetin in the average weight of 1000 grain, as it reached 39.880 g for the concentration of 75 mg L-1 compared to the comparison treatment (without spraying), which recorded an average of 28.210 g. The reason for this is attributed to the increased efficiency of absorption of nutrients and important nutrients for the plant. And the speed of its transfer from leaves to fruits (Abu Zaid, 2000), in addition to its role in increasing the interception of light and the effect of this in increasing the efficiency of photosynthesis and increasing the vital compounds resulting from it, such as sugars, amino acids, protein, and others, and their transfer to grains, which It leads to an increase in the weight of the grain [9]. The results are consistent with what was indicated by Sadak, et al., [18]and Al-Obaidi [15] on wheat plants. As for the interaction between the seed rate treatment and the kinetin concentration, the combination of 160 kg ha-1 and the kinetin concentration of 75 mg L-1 recorded the highest average for the trait, with a value of 44.040 g, compared to the lowest level recorded by the 180 combinations. An average of 24.968 g of kinetin spray per kg ha-1, an increase of 76.38%.

Table 4. The effect of seed rates and kinetin concentration on the weight of a thousand seeds (g).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	44.040 a	35.730 b	**39.880 a**
50	32.260 c	31.920 c	**32.091 b**
0	31.447 c	24.968 d	**28.210 c**
Mean	35.91 a	30.87 b	

***Similar letters indicate that there are no significant differences at the 5% probability level.**

4. Conclusion

In this study concluded that the concentration of the growth regulator kinetin (75) mg liter-1 recorded a significant superiority over the rest of the concentration levels of the regulator in all the traits studied, as the highest average was recorded for the absolute growth rate trait, 0.016827 mg day-1, and the relative growth rate trait. 16.827 mg g-1 day-1 and the number of grains per spike 38.299 spike-1 and the weight of a thousand grains 39.880 gm.

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