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Effect of Seeding Rate and Spraying Different Levels of Kinetin on Some Physiological and Growth Traits of Barley (*Hordeum Vulgare* L.)

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ABSTRACT: A field experiment was conducted in the Al-Jazeera region (northwest of Tikrit city-Salaheddin governorate) with the aim of studying the effect of seeding rates of the barley crop (Shu'a) and spraying plants with different levels of kinetin acid concentration on some physiological traits and vegetative growth. The factorial experiment was carried out using a fully randomized block design (factorial experiment) with three replications, with two factors: the first included two levels of seed quantities (160, 180) kg ha^{-1}, and the second factor was the spraying of the growth regulator kinetin at three levels. (75, 50, and 0) mg L^{-1}, and the results showed that the seed rate (160) kg ha^{-1} was superior to the duration of dry matter production by a difference of (12.92%), The chlorophyll content of the leaves increased by (12.05%), and the seed rate (180) kg ha^{-1} exceeded the height of the wheat plant by (6.95%) cm, while no significant differences were observed in leaf area and seeding rates. The concentration of the growth regulator kinetin was recorded as (75) mg L^{-1}, which was significantly higher than the rest of the concentration levels of the regulator in both the duration of dry matter production and the two characteristics of plant height, with a difference of (18.49%) and leaf area, with a difference of (51.12%), respectively. Both the absolute growth rate and the chlorophyll content of leaves for the two concentrations (75 and 50) mg L^{-1} recorded a significant difference from the concentration (0) without addition, with an average difference of (21.24 and 25.98). %) for the two classes respectively.

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INTRODUCTION

Barley (Hordeum spp.) is one of the oldest plants used by humans in food, because it contains varying percentages of starch, protein, and mineral salts, including iron, phosphorus, calcium, and potassium. In addition to the nutrients contained in barley, it is rich in many types of antioxidant compounds, including vitamin E. and beta carotene. It was one of the staple food crops in ancient times and was grown in the Fertile Crescent region and near the Nile River in North Africa (Badr, 2000). Russian scientist Vavilov (1992) believes that Abyssinia is its original homeland, as a number of wild forms and styles still exist. Others believe that barley originated in Southeast Asia, especially in China, Tibet, and Nepal, while Harium (1986) believes that extinct wild plants are the origin from which the current barley evolved, growing in the same areas where it grows. It contains wild barley (*Hordeum spontaneum*), which extends from the Zagros Mountains in western Iran, adjacent to Iraq, heads northwest towards the Turkish island of Anatolia, and then descends south. Barley is a strategic grain included in food security for humans and animals, as it ranks fourth after wheat, rice, and yellow corn in terms of cultivated area and quantity of global production. Plants of this crop are also characterized by their tolerance to harsh 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). It is grown in northern irrigated regions and in central and southern irrigated regions. Barley is used in many food industries, such as barley flour, because it contains fewer calories than wheat flour and in other food industries, such as the malt industry. It has multiple medical uses, such as laxatives, softeners, and food for diabetes. It is also used in the manufacturing of yeast and vinegar. It can also be used in livestock, as it is used Its grains are used in concentrated feed as a high source of nutritional energy for fodder for animals and birds. It is also mixed with crops of the leguminous family such as clover and alfalfa to improve green fodder material. The reasons for the low production rate of this crop are attributed to factors such as the deterioration of cultivated lands as a result of continuous cultivation for long years and the failure to maintain their fertility. The most important methods that help increase the productivity rate is determining the appropriate seed rate, which makes the variety able to exploit its physiological processes to the highest level to achieve the highest productivity per unit area .Plant hormones play an important role in improving vegetative growth, as they work within the signal transmission system. Among the plant hormones that regulate growth is kinetin, which can be sprayed on plants during the vegetative growth stage (Attiya, 2010). In recent years, attention has been focused on the commercial use of plant growth regulators, including kinetin, to improve the quality characteristics and increase the productivity of many strategic cereal crops (Grousha, 2003). Kinetin (its chemical name (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, breaking apical dominance, as well as encouraging the growth of lateral shoots and delaying shoot senescence, Javid And others. (2011).

MATERIALS AND WORKING METHODS

A field experiment was carried out in the winter season 2022-2023 to determine the best seeding rate for the barley crop, spraying kinetin on the vegetative part and its effect on the growth and yield of barley using a completely randomized block design (RCBD), in a two-factor experiment. The first was represented by seed rates (160 and 180) kg ha^{-1}, and the second was represented by levels of the growth regulator kinetin (75, 50, and 0) mg L^{-1}, which was added as a spray on the vegetative part at the stage of 2-3 leaves of the plant. Seeds were planted in 6 lines of the experimental unit, 2 m long and 15 cm apart After carrying out perpendicular plowing and soil operations, nitrogen fertilizer was added in the form of urea at a rate of 200 kg ha^{-1} in two times of adding and 100 kg ha^{-1} of triple superphosphate and potassium sulfate. 80 kg ha^{-1}. The duration of the remaining dry matter production was calculated, which is useful for obtaining the value of the dry matter in time and is estimated. From the equation of Hunt (1982).

B.M.D = (T2-T1) ((W2 +W1) / 2)

Ten plants were harvested from the experimental units, and the average leaf area of the main stem was recorded at the stage of complete emergence of spikes by measuring their length and maximum width according to the following equation: leaf area of wheat (cm^2) = leaf length x width at the middle. x 0.95. (Thomas, 1975). The average plant height was recorded by taking a random measurement of the height of ten plants from the centerlines of each experimental unit of each replicate, from the soil surface to the end of the spike at maturity. Also, the number of tillers for each plant was taking from by picking ten plants from each experimental unit. The chlorophyll content of the leaves was calculated using the SPAD-50 device. The experimental data were analyzed according to the design used in the experiment, and the means were compared using Duncan's test at a probability level of 0.05%.

RESULTS AND DISCUSSION

1- Duration of residence of the dry matter (gm measurement period $^{-1}$)

The results of the statistical analysis of the duration of dry matter production characteristic of the barley crop plant, Table (1), indicate that there are significant differences between the seed rate parameters, as the seed rate gave the highest 160 kg ha^{-1}, the highest average for the trait reached 631.7 gm, measurement period^{-1}, compared to the seed rate of 180 kg ha-^{1}, which gave an average for the trait of 559.4 gm, measurement period^{-1}. The reason for this increase may be attributed to the intensity of competition between barley plants for light, water, and basic needs for building organic materials, such as proteins and carbohydrates, when higher seeding rates are applied. These results are consistent with what was reported by Valad Abadi and Farahani (2010), Ahmed (2013), and Hassan et al. (2015).

The results in the same table indicate that the barley plants treated with 75 mg L-1 kinetin were superior to the dry matter production survival time over the rest of the concentrations applied in the experiment, as they gave the highest average of 657.70 gm L^{-1} for the remaining concentrations of dry matter production. The lowest average was for the comparison treatment (without spraying), which recorded an average of 525.60 g during measurement period^{-1}, which was affected by the concentration of kinetin, which helps in cell division processes (Muhammad, 2003). It also regulates the work of nitrate-reducing enzymes that transport sugars, in addition to increasing the number of leaves, the number of branches, and the dry weight of the shoot (Sohair, 2006); this effect is reflected in increasing plant growth, thus increasing its dry weight and maintaining its production. Kaydan et al., 2007. Also, the interaction 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 700.80. gm, measurement period^{-1}, compared to the lowest level recorded by the intervention, 180 kg ha^{-1}, and the treatment without concentration (comparison) of kinetin, with an average of 464.27 gm, measurement period^{-1}, a difference of 50.94%.

Table 1: Effects of seeding rate and kinetin concentration on dry matter survival time. (Gm measurement duration $^{-1}$).

Kinetin level (mg L^{-1})	**Seeding rate (kg h^{-1})**		
	160	**180**	**Mean**
75	700.80 a	614.50 b	**657.70 a**
50	607.20 bc	599.28 cd	**603.24 b**

0	587.00 d	464.27 e	**525.60 c**
Mean	631.7 a	559.4 b	

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

2- Area of the flag leaf (cm^2)

Table 2 shows that there was no significant difference in the average leaf area trait for either seed rates. While it is noted from the same table that there is a significant difference between the spraying levels of the growth regulator kinetin, as the highest average concentration of 75 mg L^{-1} was recorded at 31.935 cm^2 for the flag leaf, with a difference of 51.12% from the lowest average. The comparison treatment (without spraying) recorded an average of 21,131 cm^2. This difference may be attributed to the effect of kinetin and its role in helping to stimulate plant cell divisions or to its role in organizing and managing the distribution of the products of the photosynthesis process among organs and tissues. Plants (Silvertooth, 2000). has led to an increase in paper space. These results were consistent with those reported by Bordoloi and Barnah (2017) and Al-Mimari (2019) . The interaction between seeding rate and kinetin concentration showed significant differences between the averages of the leaf area of the barley plant, as the highest average was recorded for the two seeding rates (160 kg ha^{-1} and 180 kg ha^{-1}), and the kinetin spray concentration was 75. mg L^{-1}, superior to the rest of the kinetin spray concentration levels by a difference of (59.7 and 53.5%), respectively.

Table 2: Effect of seeding rate and kinetin concentration on flag leaf area. (cm^2).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	32.563 a	31.306 a	**31.935 a**
50	28.980 b	25.868 c	**27.430 b**
0	21.871 d	20.390 d	**21.131 c**
Mean	**27.81 a**	**25.85 a**	

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

3- Plant height (cm).

Table (3) indicates that there were significant differences in the height of barley plants at a seed rate of 180 kg ha^{-1}, as the highest average of 97.50 cm was recorded for the seed rate of 160. kg ha^{-1}, with a significant difference of 6.95%. This may be attributed to the intensity of competition between barley plants when the plant density per unit area increases, represented by an increase in the number of seeds, which increases the level of competition for the plants' exposure to light by stimulating the stem cells to elongate and divide at a higher rate than plants that do not suffer from the same stress. These results agree with those of Emam and Moaied (2000) and Andoush and Al-Dhahiri (2020). The results of the statistical analysis appear in Table (3) regarding the averages of plant height characteristics up to the superiority of spraying with a concentration of 75 mg L^{-1} of chitin over the rest of the spraying levels are shown in Table 3, with an average of 101.930 cm, a difference of 18.49. % of the lowest average recorded by the comparison treatment (without spraying), which amounted to 86.020 cm. This may be due to the action of the growth regulator chitin, which affects the processes of cell division and elongation and regulates metabolic substances in the plant from the source to the downstream, which helps to increase the efficiency of cellular construction and thus increases the height of the plant (Silvertoth, 2000). As for the interaction between the seed rate factor and the level of chitin concentration, the combination of 180 kg ha^{-1} and 75 mg l^{-1} showed a significant difference with an average of 104.208 cm, an increase from the lowest average. The treatment recorded 160 kg ha^{-1} without spraying kinetin, with an average of 91.573 cm, an increase of 13.79%. These results are consistent with what was reported by Al-Hamdani and Al-Roumi (2012) when spraying kinetin on the black barley crop (Hordeum distichum) led to a significant increase in plant height, and Hussein (2015) in his study on the superiority of the treatment of adding kinetin on wheat plants.

Table 3: Effects of seeding rate and kinetin concentration on plant height. (cm).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	**180**	**Mean**
75	99.653 b	104.208 a	**101.930 a**
50	93.363 d	96.714 c	**95.039 b**
0	80.463 f	91.573 e	**86.020 c**
Mean	**91.16 b**	**97.50 a**	

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

4. Number of tillers per plant.

The results in Table (4) indicate that there is a significant difference in the character of the total number of tillers of barley plant at a seed rate of 160 kg ha^{-1}, as an average of the character was recorded at 7.040 $shoots^{-1}$, and the lowest average seed rate recorded at 180 kg ha^{-1} was 4.781 tillers $plant^{-1}$, with a significant difference of 47.24%. The increase in plant height as a result of applying higher seeding rates led to an increase in plant density, which increased the intensity of competition between barley plants for basic nutritional sources, including light, which was reflected in the number of tillers or tillers formed from one plant, as low-competition plants (lower plant density) The number of tillers is higher compared to higher plant densities. These results were consistent with those reported by Al-Furaih et al. (2015). The results of the same table show that there was a significant difference between the concentration levels of kinetin applied in the experiment, as the concentration of 75 mg L^{-1} recorded the highest average value of 8.925 plant $tillers^{-1}$, an increase over the lowest average recorded by the comparison treatment (without spraying), which recorded an average of 3,739 plant tillers per trait. The reason for this may be attributed to the antagonistic action of the growth regulator chitin on the auxins accumulated in the developing terminal apices of plants, leading to breaking the dormancy phase and apical dominance resulting from the auxins and revealing lateral tillers (Javid) et al. (2011), these results agree with Sohair et al. (2006), Al-Sabbagh (2016) and Rashid (2021) on wheat. As for the interaction between the seed rate treatment and kinetin concentration, the combination of 160 kg ha^{-1} and kinetin concentration of 75 mg l^{-1} recorded the highest average for the trait, with a value of 11,036 tiller per plant, compared to the lowest level recorded by the combination of 180. (a difference of46.94 (% tiller $plant^{-1}$.

Table 4: Effects of seed rate and kinetin concentration on the number of tillers ($plant^{-1}$).

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	180	Mean
75	11.063 a	6.787 b	**8.925 a**
50	5.703 c	4.419 d	**5.061 b**
0	4.340 d	3.138 e	**3.739 c**
Mean	**7.040 a**	**4.781 b**	

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

5- Leaf Chlorophyll content.

The results of Table (5) indicate that there is a significant difference in the leaf chlorophyll content of barley plants at a seed rate of 160 kg ha^{-1}, as an average of the trait was recorded as 44.630 spad over the lowest the average recorded seed rate of 180 kg ha^{-1} was 39.830 spad, with a significant difference of 12.05%. The increase in the average trait was the result of applying higher seeding rates that led to an increase in plant density, which increased the intensity of competition between barley plants for basic nutritional sources, including light, which was reflected in the surface area for plant leaves to intercept light, which appeared positively on the efficiency of the trait. Chlorophyll formation at lower plant densities (seed rate 160 kg ha^{-1}): The amount of chlorophyll created depends on the intensity of light. That is, the lower the light intensity, the less chlorophyll synthesis occurs, which results in a reduced rate of photosynthesis because the photosynthetic pigments absorb less light energy. These results agreed with Subedi and Ma (2005) and Abdulaziz and Antar (2019) on the sorghum plant (*Sorghum bicolor* L.).

Kinetin plays an essential role in building chlorophyll by enabling the plant to withdraw nutrients from the soil to the growing tips of the plant and leaves to encourage the formation of chlorophyll and prevent its loss, so that the leaves retain their greenness (George et al., 2008; Al-Sabagh, 2016). The results in Table (5) show that there is a significant difference between the concentration levels of kinetin applied in the experiment, as the concentrations of 75 mg L^{-1} and 50 mg L^{-1} recorded the highest average value of 45.394. In addition, there were 43,846 spad, an increase over the lowest average recorded by the comparison treatment (without spraying) of 37,440 spad. These results are consistent with those reported by Lalarukh et al. (2014), who treated wheat plants with kinetin and Hussein (2015).

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 46.320 spad, compared to the lowest level recorded by the combination. 180 kg ha^{-1} without spraying, with an average of 31,522 spad, a difference of 46.94%.

Table 5: Effect of seeding rate and kinetin concentration on leaf chlorophyll content

Kinetin level (mg L^{-1})	Seeding rate (kg h^{-1})		
	160	180	Mean
75	46.320 a	44.467 b	**45.394 a**
50	44.200 b	43.490 b	**43.846 a**

0	43.370 b	31.522 c	**37.440 b**
Mean	**44.630 a**	**39.830 b**	

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

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