Effect of Potassium levels on the growth and yield of wheat varieties (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted in the Um Al-Akf area in the northeast of Al-Muthanna Governorate (in the two seasons (2018-2019) and (2019-2020) to study effect of potassium levels on the characteristics of four varieties of wheat, and the experiment was applied according to the arrangement of the Split plates (split-plots design) Using the R.C.B.D and with three replications, Where the results of the statistical analysis showed that there was a significant effect of potassium levels in some of the studied characteristics, as the Samadhi level exceeded (120 Kg ha\(^{-1}\) ground + 9000 mg L\(^{-1}\) spraying) in the characteristic of plant height for the second season and the characteristic of leaf area (cm\(^2\)) for the first season reached (67.46 cm and 19.12cm\(^2\)) respectively, While the level (120 Kg ha\(^{-1}\) ground + 12000 mg L\(^{-1}\) spraying) for the first season in terms of dry weight (g plant\(^{-1}\)) was 25.57 g plant\(^{-1}\), As for the effect of the varieties, the variety was superior to Babel in the two characteristics, plant height (67.84 and 68.78) cm and spike length (10.91 and 10.87) cm for both season, while the cultivar Abu Ghraib outperformed the chlorophyll content of the first season, it reached 19.55 Spad.

Key words: potassium levels, varieties, grain yield

1. Introduction

The wheat crop, (*Triticum aestivum* L) is one of the most important cereal crops cultivated by man, as its importance is due to the fact that it contains the protein gluten responsible for the distinctive feature of bread [1], Which represents the food source for more than 35% of the world population [2], as it comes first among field crops in Iraq in terms of cultivated area, production and consumption, with production in 2019 reaching about 4343 One thousand tons of acres, with an increase of 99% over the production of the previous year, where it was estimated at 2178 thousand tons of acres [3], The high rate of crop productivity can be reached by providing the production environment suitable for the plant, represented by the development of new varieties with high production capacity and suitable for conditions climate in Iraq. Potassium supplementary method (ground+ spraying) is one of the modern techniques that has been relied upon in the field of crop service, as it is a factor of growth factors linked to the crop and has a direct role in increasing productivity, as many researches have shown that the best way to add plant nutrients to obtain The highest production in quantity and quality is by dividing the fertilizer by adding it to the soil and spraying it on the shoot system of the plant, as this method is used to secure the plant requirements for this element during the critical and sensitive growth stages that the soil and roots cannot provide [4], Where the fertilizer is sprinkled on the shoots with harmless concentrations and at critical stages of crop growth to raise the efficiency of leaves in the photosynthesis process and make the most of potassium because of its interconnected importance in the process of protein formation and filling the grains [5], as potassium is a nutrient. The main one needed by the plant, as it is present in the form of a free ion inside the plant. Moreover, it contributes to the activation of many enzymes necessary for physiological processes [6].

2. Materials and work methods

A field experiment was carried out in the Um Al-Akf area in the northeast of Al-Muthanna Governorate (9 Km from the city center of Al-Samawah) in the seasons (2018-2019) and (2019-2020) the study included two factors: Three potassium treatments are (without addition) and (120 Kg ha\(^{-1}\) ground + 9000 mg L\(^{-1}\) spraying) and (120 Kg ha\(^{-1}\) ground + 12000 mg L\(^{-1}\) spraying) and its symbol (K0, K1 and K2) respectively, and four varieties (Abu Ghraib, Nwewya, Babil and Bora) symbol for them (V1, V2, V3 and V4) respectively. The experiment was carried out using the arrangement (Split plots design) according to R.C.B.D and with three replications, the potassium levels included the (Main-plot), While the categories occupied the secondary panels (Sub-plot). The experiment plot was divided according to the design used into slabs of (1x2=2 m\(^2\)) area that included 5 lines of 2 m length per line with a distance of 20 cm between the lines, and the alignment was distributed...
randomly with each sector thus, the total of the experimental units became (4×3×3=36 experimental units). Plowing, smoothing, leveling and dividing the land were carried out according to the design used, and it was planted on 30/11/2018 for the first season and 22/11/2019 for the second season. Urea fertilizer (46%N) was used as a source of nitrogen at a rate of 200 kg ha⁻¹, with four batches in the stages (Bifurcation, elongation, lining and flowering), triple superphosphate fertilizer (46% P2O5) was used at a rate (100 kg ha⁻¹) and in one batch when planting [20], and potassium sulfate fertilizer (K2SO4 %46) was added to the soil and for all ground addition treatments in two equal batches, the first after emergence and the second in the lining phase, and addition was sprayed after preparing the concentrations used in the spray solution of potassium and on the basis of the amount of water (800 L). Two stages of plant growth were added (branching and elongation), the spraying process was carried out by means of a dorsal sprinkler, taking into account the spraying times in the early morning or evening to avoid high temperatures, and a diffuser (Cleaning Solution) was added to the nutrient solution in an amount of 15 cm³ per 100 L of water to reduce surface tension of water to ensure complete wetness of leaves in order to increase efficiency, spray solution.

3. The studied characteristics

plant height (cm): measured as an average of ten readings inside the experimental unit from the plant room at the soil surface to the top of the spike, excluding the sap.

Leaf area (cm²): The leaf area was calculated as an average of ten plants randomly selected according to the formula [7] as follows:

\[ \text{Leaf area (cm}^2\text{)} = \text{maximum length } \times \text{ max width } \times (0.95) \]

Chlorophyll content in leaves (Spad): It was estimated as an average of ten plants randomly taken from the pilot unit at 100% flowering completion using a (Special production analysis division (Spad 520 meter).

The length of the spike (cm): calculated as an average of ten sticks taken randomly from each experimental unit at the harvest stage and on the basis of the length from the area of the spike bearing to the stem (spike holder) to the end of the terminal spike.

Dry weight (vegetable grams): calculated in the stage of 50% flowering of ten branches harvested from the middle lines and dried in an oven at a temperature of 65 °C for a period of 72 hours unit the stability of the weight.

Grain yield: grain yield from the area of the experimental unit and about on a basis (t ha⁻¹).

Bio- yield (t ha⁻¹): It was estimated from the weight of the entire harvested plants (grain + straw) from the experimental unit and on the basis of (t ha⁻¹) as stated in [8].

| Table 1. Some physical and chemical properties of field soil before planting. |
|-------------------|----------|--------|--------|--------|------|-----------|-------|
| Season           |         | N      | P      | K      | PH   | EC Ds.m⁻¹ | CEC Cmol +Kg⁻¹ | Soil tissue | Organic matter | Soil separators (mg kg⁻¹) of soil | Sand | Clay | Silt |
| First            | 25.8    | 16     | 130.7  | 7.22   | 11.5 | 5.98      | 5.11             | Alluvial     | 5.4              | 236  | 204  | 560  |
| Second           | 23.1    | 12     | 129.1  | 7.31   | 8.8  | 5.11      | 5.11             | mixture      | 5.4              | 238  | 212  | 550  |

The data were analyzed statistically using the Genstat statistical program by the method of analyzing the variance and all the studied traits, The arithmetic averages were compared using the lowest significant difference (L.S.D) at the level of 0.05 [9].

4. Results and discussion

4.1. Effect of varieties on growth and yield

The results of Table 2 showed that there were significant differences between the varieties used in the study in the characteristic of plant height, chlorophyll content, spike length, and leaf area for both the first and second seasons, while there were significant differences between the varieties of the second agricultural season only in the recipe of grain yield and biological yield.
It was noted the results of Table 2 that the Babel cultivar was significantly superior to the rest of the varieties by giving the highest average plant height of (67.85 and 68.78) cm for both the first and second seasons respectively, followed by the cultivar Abu Ghraib has an average of (62.87 and 66.97) cm for both seasons respectively, while the lowest average for this characteristic of the cultivar Bora which reached (53.10 and 63.26) cm for both seasons respectively, The difference may be due to the variation of these varieties in the their genotpes and their differences in the lengths of phalanges, especially the upper phalanges, which represent about half of the plant height, This result has agreed with the results of a study [3].

The results of Table 2 showed that there were significant differences between the varieties in the chlorophyll content, as the Abu Ghraib cultivar outperformed by giving the highest average chlorophyll content of 19.55 Spad in the first season, without a significant difference with the average of the two cultivars (Nwewya an Babel), which reached (18.77 and 19.30) spad, while the lowest average for this trait was 15.45 Spad when the cultivar Bora, while the cultivar Bora outperformed by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average spike length of (10.915 and 10.874) cm for both seasons respectively, with no significant difference with the average cultivar Abu Ghraib for the second season, which amounted to 10.699 cm, while the variety gave a lower average spike length of ( 8.442 and 10.346) cm for both seasons respectively, and the reason for the difference in the varieties in the characteristic of the spike length is due to the difference in the genetic makeup between the varieties, as this trait is considered more related to the genetic factor of the variety. This result agreed with the results of [11-15].

The results of Table 2 showed that there are significant differences between the varieties. If the Babel variety achieved a significant superiority in the first agricultural season by giving the highest leaf area of 19.33cm, while the minimum leaf area was 12.43 cm for the second season, the two varieties (Abu Ghraib and Babel) achieved the highest leaf area of (20.03 and 19.89) cm respectively, while the variety gave Bora the lowest average for this characteristic 15.33 cm, The reason for the discrepancy in the leaf area of the wheat varieties is due to the difference in the genetic nature of these varieties and their ability to benefit from the requirements of growth. This result is consistent with what was mentioned by [10,16,17] who indicated the difference in the varieties in the leaf area as a result of the difference in their genotypes. It is noted from the results of table 2 the superiority of the babel variety in the first season by giving the highest average for this trait, which was 29.30 gm, while the Bora variety was given the lowest average for this characteristic, which was 18.57 gm, while in the second season, the Bora cultivar was significantly superior by giving the highest average for this trait, which was 19.72 gm, while the cultivar Abu Ghraib gave the lowest gry weight of 15.45 gm. The results of table 2 for the second season showed the superiority of the Babel variety significantly by giving the highest grain yield of 3.040 t ha⁻¹, while the rest of the varieties (Abu Ghraib, Nwewya and Bora) gave a mean (2.723, 2.699 and 2.615) t ha⁻¹, respectively. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety reached Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety reached Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety reached Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety reached Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure. The results of Table 2 showed that Babel cultivar significantly outperformed the rest of the cultivars in both seasons by giving the highest average for this characteristic in the second season was 23.23 Spad, while the variety reached Nwewya the lowest average for the chlorophyll content was 19.26 spad. The reason for the variation in the leaves of wheat varieties in their content of chlorophyll is the result is consistent with the results of [2,10] those who indicated that varieties of wheat differ among themselves in the amount of chlorophyll in their leaves because of their difference in the genetic structure.

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| First season 2018-1019 | Adjectives | Plant height (cm) | Chlorophyll content (spad) | Spike length (cm) | Leaf area (cm²) | Dry weight (gm) | Grain yield (t ha⁻¹) | Bio yield (t ha⁻¹) |
|------------------------|-------------|------------------|---------------------------|------------------|----------------|----------------|---------------------|------------------|
| **Varieties**           |             |                  |                           |                  |                |                |                     |                  |
| Abu Ghraib             | 62.86       | 19.55            | 9.712                     | 17.10            | 24.86         | 2.051          | 11.38              |
| Nwewya                 | 59.73       | 18.77            | 9.689                     | 16.19            | 25.71         | 1.964          | 11.94              |
| Babal                  | 67.85       | 19.75            | 10.915                    | 19.32            | 29.30         | 2.076          | 11.48              |
| Bora                   | 55.1        | 15.44            | 8.442                     | 12.43            | 18.57         | 1.920          | 10.76              |
| L.S.D 0.05             | 2.413       | 1.407            | 0.3978                    | 0.938            | 1.137         | N.S            | N.S                 |
| % & Z                   | 66.97       | 19.26            | 10.699                    | 20.03            | 15.45         | 2.723          | 11.43              |

Table 2. Effect of varieties on the growth and yield of wheat crop.
The results of table 3 indicated the significant effect of potassium levels on the characteristic of chlorophyll content and grain yield (t ha$^{-1}$) for both the first and second seasons of cultivation, while the significant effect of potassium levels in the characteristic of plant height and leaf area was limited to the second season, while potassium levels affected the dry weight characteristic of the plant for the first agricultural season only. The results of table 3 showed that the level of K1 addition was superior by giving the highest average plant height for the second season, which was 67.46 cm, while the level of K2 addition recorded the lowest average for this trait, which reached 64.64 cm. The reason for this is due to the role of potassium in improving plant growth through its role in the synthesis of enzymes and cytokines [19], and the accumulation of carbohydrates in the stem and increase the number and thickness of nodes, as well as its role in increasing cell division and elongating phalanges and encouraging the growth of meristematic tissues [19], crop.

This result was consistent with what he mentioned on the mungbean [20]. The results of table 3 indicated that the treatment of potassium fertilization K1 (120 kg ha$^{-1}$) was significant by giving the highest average chlorophyll content in the first season was 19.12 Spad, while the comparison treatment K0 gave the lowest average for this trait, which was 17.45 cm$^{-2}$. The results of the same table for the second season showed that the potassium K0 comparison treatment was significantly superior to that of giving the highest average leaf area of 19.35 cm$^{-2}$ while the K2 level gave the lowest average for this trait, which reached 16.31 cm$^{-2}$. The results of the first season indicated that the K2 level was superior to the average dry weight of 25.57 g, while the comparison treatment gave the lowest average for this characteristic of 23.56 g, the increase in the dry matter that the plant makes when adding potassium is attributed to the increase in the rate of photosynthesis. The level of potassium K2 in this characteristic was superior to its superiority in giving the highest average number of clays and then the highest number of ears, and this led to the plant having the highest dry weight at this level Table 3. The second season gave the highest average for this trait, which amounted to (2.987 and 2.891) t ha$^{-1}$ respectively, compared to the K2 level, which gave the lowest average for this characteristic of 2.674 tons. The results of Table 3 show the superiority of the comparison treatment for K0 significantly by giving the lowest yield (10.76 and 9.43) t ha$^{-1}$ respectively.

| Nwewya  | 65.65 | 16.67 | 10.485 | 17.98 | 16.05 | 2.699 | 11.39 |
| Babal    | 68.78 | 18.30 | 10.874 | 19.89 | 16.26 | 3.040 | 11.84 |
| Bora     | 63.26 | 23.23 | 10.346 | 15.53 | 19.72 | 2.615 | 9.25  |
| L.S.D 0.05 | 1.947 | 0.397 | 0.3434 | 1.204 | 0.992 | 0.2397 | 0.811 |

### Table 3. Effect of potassium fertilizer levels on the growth and yield of wheat crop.

4.2. Effect of potassium levels on growth and yield:

The results of table 3 indicated the significant effect of potassium levels on the characteristic of chlorophyll content and grain yield (t ha$^{-1}$) for both the first and second seasons of cultivation, while the significant effect of potassium levels in the characteristic of plant height and leaf area was limited to the second season, while potassium levels affected the dry weight characteristic of the plant for the first agricultural season only. The results of table 3 showed that the level of K1 addition was superior by giving the highest average plant height for the second season, which was 67.46 cm, while the level of K2 addition recorded the lowest average for this trait, which reached 64.64 cm. The reason for this is due to the role of potassium in improving plant growth through its role in the synthesis of enzymes and cytokines [19], and the accumulation of carbohydrates in the stem and increase the number and thickness of nodes, as well as its role in increasing cell division and elongating phalanges and encouraging the growth of meristematic tissues [19], crop.

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### Table 3. Effect of potassium fertilizer levels on the growth and yield of wheat crop.

| Adjectives | First season 2016-1019 | Potassium levels | Plant height (cm) | Chlorophyl content (spad) | Spike length (cm) | Leaf area (cm$^2$) | Dry weight (gm) | Grain yield (t ha$^{-1}$) | Bio yield (t ha$^{-1}$) |
|------------|------------------------|------------------|------------------|--------------------------|------------------|-------------------|----------------|--------------------------|---------------------|
|            |                        | K0               | 61.57            | 18.08                    | 9.529            | 16.43             | 23.56         | 2.121                    | 12.01               |
|            |                        | K1               | 61.36            | 19.12                    | 9.822            | 16.05             | 24.70         | 1.945                    | 11.72               |
|            |                        | K2               | 61.23            | 17.60                    | 9.717            | 16.31             | 25.57         | 1.940                    | 10.76               |
|            |                        | L.S.D 0.05       |                 |                          |                  |                   |               |                          |                     |
|            |                        | N.S              | 0.925            |                          | N.S             |                  |               | 0.160                    | 1.231               |
|            |                        | Second season 2016-2020 |                 |                          |                  |                   |               |                          |                     |
|            |                        | K0               | 66.41            | 19.84                    | 10.704           | 19.35             | 17.06         | 2.867                    | 11.79               |
|            |                        | K1               | 67.46            | 19.24                    | 10.554           | 18.27             | 16.05         | 2.783                    | 11.71               |
|            |                        | K2               | 64.64            | 19.01                    | 10.545           | 17.45             | 16.77         | 2.659                    | 9.43                |
|            |                        | L.S.D 0.05       | 2.028            | 0.189                    | N.S             | 1.076             | N.S           | N.S                     | 1.231               |

4.3. Effect of the overlap between potassium levels and varieties on growth characteristics and the outcome

The results of table 4 showed that there were significant differences in the characteristic of plant height when potassium levels overlapped with the varieties, as the highest average plant height was recorded. When the Babel variety overlapped with the K2 level for the second season, it reached 71.01 cm, with no significant difference with the average of the same variety when the comparison treatment, which reached 68.77 cm, while no significant differences were recorded when potassium levels overlapped with the varieties in the first season. The results of Table 4 showed that the overlap of the fertilizer K1 level with Bable variety in the first season was significantly higher by giving the highest average chlorophyll
IOP Conf. Series: Earth and Environmental Science 735 (2021) 012033   doi:10.1088/1755-1315/735/1/012033

content of 20.81 Spad with no significant differences between the mean combinations (K0× Abu Ghrailb) and (K0× Nwewya) and (K1× Nwewya) reached (20.80, 20.06 and 20.25) Spad respectively, while the interaction of the two coefficients K0 and K1 with the variety Bora gave the lowest average for this characteristic, which reached (13.81 and 15.75) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interaction in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interference in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interference in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interference in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interference in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively. The results of the binary interference in table 4 indicate 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively, while the interaction of the cultivar Bora with the level K1 gave the highest average for this trait in the second season of 24.02 Spad, with no significant difference with the average overlap of the same type (Bora) with the two coefficients K0 and K2, where it averaged (23.48 and 22.18) Spad respectively.
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