Effect of Spraying With Cal-Boron and Potassium Humate and Maturity Stage on Fruit Quantity, Quality Characteristics of Apricot Prunus Armeniaca L. cv. “Royal”

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Abstract

This study was conducted on apricot trees Royal cultivar 9 years old in a private field located northern Kirkuk city - Iraq during The period 2020-2021, to study the spraying wit Cal-boron and potassium humate on fruit quantity, quality characteristics of apricot with three levels of Cal-boron (0, 1 and 2) mL L−1 and three levels of potassium Humate (0, 3 and 6) g L−1. In addition to the control treatment (untreated plants). Combination of 2 mL L−1 Cal-boron and 3 g L−1 of Potassium humate excelled on leaf area Leaves content of chlorophyll, Vitamin C, and T.S.S. parameter compared with treatment with distilled water (control). A Randomized Complete Block Design (R.C.B.D) was used to implement the experiment, with three replications.

Keywords: Cal-boron, Potassium humate, Apricot, Pomology.

1. Introduction

Apricots (Prunus armeniaca L.) are one of the most popular fruits grown in temperate climate zones [1]. It is one of the stone fruits that belong to the family Rosaceae and is distinguished by a double sigmoid growth curve. Moreover, apricot fruits are very important not only for being inside several manufacturing processes like jam, canned juice, and dried fruits but for considering them wealthy in nutritional value. Fruits are deemed a good source of vitamin A which helps in the enhancement of vision. In addition, apricot fruits are rich in fiber and are considered a treasure chest of natural antioxidants which protect the human body from dangerous diseases such as cancer. Moreover, apricot is a climacteric fruit meaning has high respiratory and metabolic rates and having an ethylene emission [2]. Armenia is believed to be the basic root because it is grown normally fruit, but some studies proved that north China is the source of apricot [3]. It is cultivated in light sandy soils devoid of salts and well-drained and ventilated [4]. Humic (polymeric polyhydroxy acid) was reported as the most significant of organic substances in aquatic systems. Humic acid is highly beneficial to both plants and soil. It is important for increasing microbial activity, plant growth bio-stimulant, effective soil enhancer. It promotes nutrient uptake as a chelating agent and improves vegetative characteristics nutritional status, and leaf pigments [5,6]. Potassium is important for fruit color, winter hardiness, tree growth, and disease resistance. An excessive amount of potassium can lead to a deficiency of magnesium (Mg), so take care when deciding upon potassium rates [7]. Potassium is the most appropriate univalent cation for enzyme activation, not only because of its high concentration but also due to its mobility in the plant. It is one of the essential elements in the nutrition of plants that needs to be added regularly in the fertilization program. It is important for structure and promotes the formation of ATP (plant energy), oxidative poly phosphorylation [8]. Synthesis of amino acid proteins and has an important role in stomatal movement, pH stabilization, cell extension, and it is needed for the enlargement of fruit [9]. Calcium is conceded as one of the most important minerals determining the quality of fruit since it is required for cell elongation and cell division [10]. About 60% of the total calcium in plants is related to the cell wall fraction [11]. Boron is one of the necessary elements of plant nutrition and has received the attention of many researchers in proportion to the physiological importance of the plant, organic material is an essential source of boron, where boron releasing from organic matter, the plant takes advantage of part of it, while the other part is leaching from soil [12,13]. Premature flower and fruit drop of tree crops have been attributed to B deficiency, suggesting that B movement to reproductive structures is restricted or that growth and development of floral structures have a higher demand for B than do vegetative structures [14]. However,
flower buds are a preferential sink for B mobilization after foliar application in especially the Rosaceae family [15,16]. Boron impacts pollen tube growth and thus, fruit yield, and is indirectly responsible for the activation of dehydrogenase enzymes, transport of assimilates, nucleic acids, and metabolic regulation of certain plant hormones [17]. In a study [15], about a study of the effect of yeast, humic acid, fulvic acid, citric acid, potassium citrate, and some chelating small elements on the growth, yield, and content of leaf elements of apricot trees, where the study showed a significant increase in leaf area and chlorophyll content of leaves. When compared with the comparison treatment. [18], found in his study on the use of potassium and calcium and its effect on the growth, yield, and qualitative characteristics of the five-year-old Royal cultivar at a concentration (0, 2000, 4000) mg L-1Significant increase in leaf area and leaf content of chlorophyll. [19], indicated in their study of the effect of nitrogen and boron on the growth and yield of pomegranate with three concentrations (0, 20, 40) mg L-1 to a significant superiority in leaf area, chlorophyll content of leaves, and fruit weight when compared with the treatment Comparison. The study aimed to know the effect of potassium humate and calboron on the growth and yield of apricot trees.

2. Material and Methods

This study was conducted on 9-year-old royal cultivars of apricot trees in a private field located in the city of Kirkuk - Iraq during the 2020-2021 season, to study the spraying of boron and potassium humate on the quantity and quality of apricots. Fruits with three levels of boron (0, 1, 2) ml L-1 and three levels of potassium humate (0, 3, 6) g L-1 on total chlorophyll, leaf area, mean fruit weight, volume, soluble solids, vitamin C., data were analyzed according to Duncan's 0.5% test. Study Parameters:

2.1. Leaf area (cm²)

The leaf area was measured according to the (36).

2.2 Leaves content of chlorophyll

Total chlorophyll was measured according to the method of [20], the green fresh leaves were taken from the apricot trees the leaves were cut into small pieces using sterile scissors, then the weight (0.25 g) of the cut leaves was done by an electric balance with a sensitivity of 0.001 g and placed in opaque containers, and (15 ml) of 97% ethanol was added to it. It was stored in a dark place for 24 hours the process was repeated three times, and after 72 hours the solution was measured using an EMC labs-100 Spectrophotometer at wavelengths of 649 and 665 nm.

2.3. Fruit weight

Ten fruits were taken from each tree randomly, and the average weight of one fruit was calculated using a sensitive electric balance.

2.4. Vitamin C

Vitamin C in Apricot was measured using the method [21].

2.5. Total soluble solids (TSS) %

The percentage of total soluble solids in Apricot juice was measured using Hand-Refractometer.

2.6. Total Acidity percentage was calculated according to [22] and following the equation below as

\[ \% TA = \frac{T \cdot N \cdot Eq \cdot Wt}{Vs \cdot Vi \cdot 1000} \times 100 \]

TA = total acidity.
T = Volume of base used when Titration.
N = standard of the base used when Titration 0.1
Eq = equivalent weight of citric acid.
Vt = final volume of juice after dilution of 50 ml.
Vs = volume used upon Titration of 10 ml.
Vi = the volume of juice before dilution 5 ml.
3. Results

Leaf area (cm²). Table (1) has been indicated that Cal-bor is no significant differences in leaf area, while the level 6 g.L⁻¹ Potassium humate has been realized significant differences with other levels. The combination of 2 mL⁻¹ Cal-bor and 3 g.L⁻¹ of Potassium humate has been achieved the highest values as compare to other study combination treatments in the leaf area.

| Table 1. Effect of spraying with Cal-boron and potassium humate and their interactions on leaf area (cm²). |
|---------------------------------|-----------------|-----------------|
| Cal-Bor mL⁻¹ | Potassium humate g.L⁻¹ | Cal-Bor average |
|----------------|-----------------|-----------------|
| 0              | 22.27           | 24.64           | 27.03           | 24.65           |
|                | d               | abcd            | a               | a               |
| 1              | 24.11           | 24.31           | 25.97           | 24.79           |
|                | Bcd             | abcd            | a               | a               |
| 2              | 23.39           | 23.53           | 26.74           | 24.55           |
|                | cd              | C              | a               | a               |
| Potassium Humate average | 23.56     | 24.16           | 26.58           |
| b               | b               | a               |

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple rang under the probability level 0.05.

Total leaf chlorophyll. From table (2) we noticed that 1 mL⁻¹ Cal-boron is significantly different leaves content of chlorophyll, while the level 6 g.L⁻¹ Potassium humate has been realized significant differences with other levels. The combination of 2 mL⁻¹ Cal-bor and 3 g.L⁻¹ of Potassium humate has been achieved the highest values compared to other study combination treatments in Total chlorophyll.

| Table 2. Effect of spraying with Cal-boron and potassium humate and their interactions on Total chlorophyll mg.100gm⁻¹. |
|---------------------------------|-----------------|-----------------|
| Cal-Bor mL⁻¹ | Potassium humate g.L⁻¹ | Cal-Bor average |
|----------------|-----------------|-----------------|
| 0              | 9.49            | 10.50           | 11.97           | 10.65           |
|                | d               | cd              | abc             | b               |
| 1              | 10.50           | 11.60           | 12.49           | 11.53           |
|                | cd              | abc             | a               | a               |
| 2              | 10.88           | 11.15           | 12.28           | 11.43           |
|                | bcd             | abc             | ab              | ab              |
| Potassium Humate average | 10.29     | 11.08           | 12.25           |
| c               | b               | a               |

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple rang under the probability level 0.05.

Fruit weight (gm). 2 mL⁻¹ Cal-boron resulted in significant differences in fruit weight, while the level 6 g.L⁻¹ Potassium humate has been realized significant differences with other levels. The combination of 2 mL⁻¹ Cal-bor and 3 g.L⁻¹ of Potassium humate have been achieved the highest values as for fruit weight, the combination of 1 mL⁻¹ Cal-boron and ripening stage recorded significant differences with other combination treatments. The combination of 6 g.L⁻¹ Potassium humate and ripening stage recorded significant differences with other combination treatments. The combination of 2 mL⁻¹ Cal-boron and 3 g.L⁻¹ Potassium humate and ripening stage was significantly achieved the highest value compared to most of the other combination treatments in fruit’s weight parameter (table 3).

Vitamin C. Table (4) referred that cal-boron is significant differences in V.C, while the level 6 g.L⁻¹ of Potassium humate has been realized significant differences with other levels. While the ripening stage has significant differences in comparison whit the Maturity stage. The combination of 2 mL⁻¹ Cal-boron and 3 g.L⁻¹ of Potassium humate have been achieved the highest values, the combination of 1 mL⁻¹ Cal-boron and ripening stage recorded significant differences with other combination treatments. The combination of 6 g.L⁻¹ Potassium humate and ripening stage recorded significant differences with other combination treatments.

The combination of 2 mL⁻¹ Cal-boron and 6 g.L⁻¹ Potassium humate and ripening stage was significantly achieved the highest value compared to other study combination treatments in vitamin C parameter.
Table 3. Effect of spraying with Cal-boron and potassium humate and maturity stage and their interactions on Fruit weight gm.

| Maturity stage | Cal-Bor ml.L⁻¹ | Potassium humate g.L⁻¹ | Maturity X Cal-Bor | Maturity stage average |
|----------------|----------------|------------------------|--------------------|-----------------------|
|                | 0              | 3                      | 6                  |                       |
| Maturation     |                |                        |                    |                       |
| 0              | 25.58          | 25.70                  | 27.68              | 26.32                 |
|                | bc             | bc                     | abc                | c                     |
| 1              | 24.42          | 29.63                  | 29.00              | 27.68                 |
|                | c              | abc                    | abc                | bc                    |
| 2              | 28.90          | 31.69                  | 30.67              | 30.42                 |
|                | abc            | ab                     | abc                | ab                    |
| Ripening       |                |                        |                    |                       |
| 0              | 26.26          | 27.27                  | 29.84              | 27.79                 |
|                | bc             | abc                    | abc                | bc                    |
| 1              | 25.54          | 31.75                  | 31.31              | 29.53                 |
|                | bc             | abc                    | abc                | a                     |
| 2              | 29.93          | 34.15                  | 32.04              | 32.04                 |
|                | abc            | a                      | ab                 | a                     |

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple rang under the probability level 0.05.

Table 4. Effect of spraying with Cal-boron and potassium humate and maturity stage and their interactions on Vitamin C mg.100ml⁻¹ Juice⁻¹.

| Maturity stage | Cal-Bor ml.L⁻¹ | Potassium humate g.L⁻¹ | Maturity X Cal-Bor | Maturity stage average |
|----------------|----------------|------------------------|--------------------|-----------------------|
|                | 0              | 3                      | 6                  |                       |
| Maturation     |                |                        |                    |                       |
| 0              | 10.27          | 13.53                  | 13.53              | 12.44                 |
|                | b              | ab                     | ab                 | b                     |
| 1              | 14.00          | 15.40                  | 15.40              | 14.93                 |
|                | ab             | ab                     | ab                 | ab                    |
| 2              | 11.20          | 15.40                  | 15.87              | 14.16                 |
|                | b              | ab                     | ab                 | b                     |
| Ripening       |                |                        |                    |                       |
| 0              | 14.93          | 16.80                  | 19.60              | 17.11                 |
|                | ab             | ab                     | a                  | a                     |
| 1              | 15.40          | 14.00                  | 20.53              | 16.64                 |
|                | ab             | ab                     | a                  | a                     |

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple rang under the probability level 0.05.
The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple range under the probability level 0.05.

Total Soluble Solids (TSS). Table (5) believed that cal-boron is significant differences in Total soluble solids, while the Potassium humate has no significant differences with other levels. While the ripening stage has significant differences in comparison with the Maturity stage. The combination of 2 mL^{-1} Cal-boron and 6 g.L^{-1} of Potassium humate have been achieved the highest values, the combination of 2 mL^{-1} Cal-boron and ripening stage recorded significant differences with other combination treatments except for 1 mL^{-1} Cal-boron and ripening stage combination treatment. The combination of 6 g.L^{-1} Potassium humate and ripening stage recorded significant differences with some of the other combination treatments. The combination of 2 mL^{-1} Cal-boron and 6 g.L^{-1} Potassium humate and ripening stage was significantly achieved the highest value compared to other study combination treatments in T.S.S percentage.

Table 5. Effect of spraying with Cal-boron and potassium humate and maturity stage and their interactions on T.S.S%.

| Maturity stage | Cal-Bor ml.L^{-1} | Potassium humate g.L^{-1} | Maturity X Cal-Bor | Maturity stage average |
|----------------|-------------------|--------------------------|--------------------|-----------------------|
| 0              | 13.23             | 13.30                    | 13.43              | 13.32                |
| 1              | 13.97             | 14.43                    | 14.37              | 14.25                |
| 2              | 14.27             | 14.03                    | 14.37              | 14.22                |
| 1              | 14.50             | 14.97                    | 14.97              | 14.77                |
| 2              | 13.82             | 13.92                    | 14.05              | 13.93                |

Table 6. Effect of spraying with Cal-boron and potassium humate and maturity stage and their interactions on Total Acidity (TA%)

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple range under the probability level 0.05.

Total Acidity (TA). Table (6) has been indicated that cal-boron is no significant differences in Total Acidity, while Potassium humate has no significant differences with other levels. While the maturation stage has significant differences in comparison with the ripening stage. The combination of Cal-boron and Potassium humate has no significant differences. The combination of Cal-boron and ripening stage recorded no significant differences with other combination treatments. The combination of 3 g.L^{-1} Potassium humate and ripening stage recorded significant differences with other combination treatments. The combination of Cal-boron and Potassium humate and ripening stage was not significantly achieved in TA percentage.
creases the percentage of total soluble solids into sugars, and this was due to the role of calcium in the formation of chlorophyll pigment, Synthesis of sugars, amino acids, and proteins, and the maintenance of the balance of its relationship to the absorption and representation of nutrients, photosynthesis, movement, and transport of nutrients in plants. Humic acid contributes to the activation and functioning of the chlorophyll molecule when treated with calcium may be due to the decomposition of various acids in the fruit, leading to an increase in the percentage in fruits treated with calcium preserving the respiration of fruits, thus reducing the consumption of organic acids and sugars in fruits, and reducing the weight of the fruit and the vegetative growth of trees. Thus, the processed food items in the leaves were increased and collected in the fruits, and this reason may be attributed to the role of calcium in the formation of attracting sites and its effect on cell membranes. And juicy vacuoles inside the cell, which affects the increase of carbohydrates in the juice of cells, which in turn leads to an increase in the accumulation of carbohydrates and control of the osmotic pressure. The positive effects of potassium humate may be due to the contents of this acid of organic compounds and amino acids and mineral elements, especially potassium, which actively contributes to many physiological processes. Such as regulating the work of stomata, as its accumulation in the guard cells affects the osmotic pressure. So, along with sugars, it is very important for opening and closing stomata [23]. Humic acid also increases the permeability of cell membranes and the absorption of nutrients. Humic acid contributes to the activation and formation of chlorophyll pigment, Synthesis of sugars, amino acids, and enzymes. The reason for the significant increase in the quantitative yield traits may be due to the improvement of the role of calcium in the synthesis of chlorophyll and the level of activation of some enzyme systems in plants. As well as on the level of its relationship to the absorption and representation of nitrogen, and it is known that nitrogen is included in the composition of the chlorophyll molecule. And that the role of calcium in the synthesis of chlorophyll depends to a large extent on some enzymatic systems, and that the amino acid Glycine enters directly into the formation of the compound S-aminolevulinic acid, and this compound is the starting material for the synthesis of the chlorophyll molecule [25]. The reason for this may be attributed to the role of calcium in the formation of the middle plate of the cell walls in a way that prevents the leakage of organic and mineral substances from the cells. Thus, it causes an increase in the accumulation of carbohydrates and control of the water balance [26,27]. Or, the reason for this may be due to the role of calcium in the formation of attracting sites and its effect on cell membranes. And juicy vacuoles inside the cell, which affects the increase of carbohydrates in the juice of cells, which increases the percentage of total soluble solids [28]. The use of calcium may be attributed to the role of calcium in maintaining the integrity of the cell membranes and preserving the respiration of fruits, thus reducing the consumption of organic acids and sugars in fruits, which led to an increase in this percentage in fruits treated with calcium [29]. The reason for the increase in the percentage of total soluble solids when treated with calcium may be due to the decomposition of various acids in the fruits into sugars, and this was indicated by [30].

| Maturity stage | Maturity X Cal-Bor | Potassium humate g.L⁻¹ | Cal-Bor ml.L⁻¹ | Maturity stage average |
|---------------|-------------------|------------------------|----------------|-----------------------|
|               | 6                 | 3                      | 0              |                       |
| maturation    |                   |                        |                |                       |
|               | 0.38              | 0.42                   | 0.36           | 0                     |
|               | ab                | ab                     | a              |                       |
|               | 0.40              | 0.40                   | 0.38           | 1                     |
|               | a                 | ab                     | a              | 0.37 a                |
|               | 0.32              | 0.26                   | 0.34           | 2                     |
|               | c                 | cd                     | abc            |                       |
|               | 0.34              | 0.33                   | 0.29           |                        |
|               | bc                | abc                    | bcd            | 0.29 b                |
| ripening      |                   |                        |                |                       |
|               | 0.27              | 0.22                   | 0.22           | 1                     |
|               | d                 | d                      | d              | b                     |
|               | 0.26              | 0.21                   | 0.26           | 2                     |
|               | d                 | d                      | cd             | abc                   |
| Maturity X potassium humate | Cal-Bor average | Potassium humate g.L⁻¹ | Cal-Bor ml.L⁻¹ | Maturity stage average |
|               | a                 | a                      | a              |                       |
|               | 0.36              | 0.26                   | 0.26           | 0                     |
|               | b                 | b                      | b              | a                     |
|               | 0.35              | 0.32                   | 0.40           |                       |
|               | abc               | abc                    | abc            |                       |
|               | 0.31              | 0.30                   | 0.39           |                       |
|               | bc                | bc                     | a              |                       |
|               | 0.30              | 0.31                   | 0.38           |                       |
|               | c                 | c                      | ab             |                       |
|               | 0.23              | 0.30                   | 0.35           |                       |
|               | d                 | d                      | c              | abc                   |
|               | 0.30              | 0.31                   | 0.38           |                       |
|               | b                 | b                      | b              | a                     |

The values with similar letters for each factor or their interactions individually do not differ significantly according to the Duncan multiple rang under the probability level 0.05.

3. Discussion

The positive effects of potassium humate may be due to the contents of this acid of organic compounds and amino acids and mineral elements, especially potassium, which actively contributes to many physiological processes. Such as regulating the work of stomata, as its accumulation in the guard cells affects the osmotic pressure. So, along with sugars, it is very important for opening and closing stomata [23]. Humic acid also increases the permeability of cell membranes and the absorption of nutrients. Humic acid contributes to the activation and formation of chlorophyll pigment. Synthesis of sugars, amino acids, and enzymes [24]. The reason for the significant increase in the quantitative yield traits may be due to the improvement of the role of calcium in the synthesis of chlorophyll and the level of activation of some enzyme systems in plants. As well as on the level of its relationship to the absorption and representation of nitrogen, and it is known that nitrogen is included in the composition of the chlorophyll molecule. And that the role of calcium in the synthesis of chlorophyll depends to a large extent on some enzymatic systems, and that the amino acid Glycine enters directly into the formation of the compound S-aminolevulinic acid, and this compound is the starting material for the synthesis of the chlorophyll molecule [25]. The reason for this may be attributed to the role of calcium in the formation of the middle plate of the cell walls in a way that prevents the leakage of organic and mineral substances from the cells. Thus, it causes an increase in the accumulation of carbohydrates and control of the water balance [26,27]. Or, the reason for this may be due to the role of calcium in the formation of attracting sites and its effect on cell membranes. And juicy vacuoles inside the cell, which affects the increase of carbohydrates in the juice of cells, which increases the percentage of total soluble solids [28]. The use of calcium may be attributed to the role of calcium in maintaining the integrity of the cell membranes and preserving the respiration of fruits, thus reducing the consumption of organic acids and sugars in fruits, which led to an increase in this percentage in fruits treated with calcium [29]. The reason for the increase in the percentage of total soluble solids when treated with calcium may be due to the decomposition of various acids in the fruits into sugars, and this was indicated by [30]. The reason for this is due to the active role of boron in some physiological processes as absorption of water and nutrients, photosynthesis, movement, and transport of nutrients in plants [31]. In addition to the role of boron in the transfer of sugars to the developing peaks, it increases the division of sugars Cells, their elongation, and their positive role in...
auxin, especially IAA (1 and 5) Which led to an increase in plant growth and its positive impact on vegetative growth, as boron has a role in the representation of carbohydrates, proteins, and chlorophyll and led to an increase in the content of chlorophyll in leaves and led to an increase in the leaf area, which led to the formation of a good vegetative group and the accumulation of dry material in the fruits, which led to an increased weighing, as well as collecting sugars, increasing the percentage of total soluble solids, and the percentage of vitamin C.

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