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# Evaluating the Impact of Spraying Nano Potassium and Nano Boron on Productivity and Fruit Quality of Medjool Date Palm

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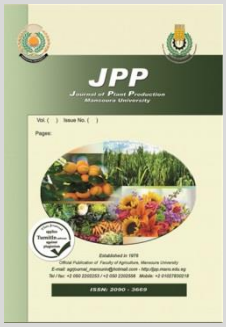


## ABSTRACT

To investigate the effects of potassium (K) and boron (B) applied as nanofertilizers on 'Medjool' date palm productivity and fruit quality, a field experiment was conducted during the 2022 and 2023 seasons. The experiment involved twelve-year-old 'Medjool' date palms grown in newly reclaimed desert lands. Three concentrations from nano-potassium (100, 200 and 300 ppm) and nano boron (10, 20 and 30 ppm) were examined either individually or both element in combinations. The study included 10 treatments from nano-K, nano-B, nano K + nano-B in combination, and mineral K and B (control). The obtained data showed that, spraying nano-K or/and nano-B at different concentrations significantly enhanced fruit set %, fruit retention %, (g) and bunch weight (kg) and contrary decreased fruit drooping %. Both nano-K and nano-B were highly effective in improving all fruit physical properties (i.e. fruit weight(g), fruit dimensions(cm), pulp weight(g) and pulp: seed ratio). Furthermore, the chemical properties (i.e. total soluble solids (TSS%), reducing sugars, non-reducing sugars and total sugars) of Medjool dates was significantly increased as a result of replaced the traditional mineral K and B by using nano-K and nano-B fertilizers. Conversely, total soluble tannins % and total crude fiber were significantly decreased. In addition, the combined application of nano-K and nano-B showed a marked superiority rather than using each one individually. However, the palms sprayed with nano-K at 300 ppm and nano-boron at 30 ppm in combination present the best results in term of fruit set, fruit retention, yield, fruit physical and fruit chemical properties.

***Keywords*:** Date palm, Productivity, fruit quality and Medjool

## INTRODUCTION

The data palm (*Phoenix dactylifera* L.), one of the oldest cultivated tree, belongs to the Family Palmaceae. The genus Phoenix includes all known date palm varieties. Date palm holds a significant historical and nutritional role as one of the main oldest cultivation in North Africa and Arab region (Al-Saif *et al*., 2023). In pomology publications, date palms are classified as tropical and subtropical zone fruit trees. It has a high commercial and nutritional value, it has a high resistance to biotic and abiotic stress (Siddiq and Greiby, 2013; Eshmawy, 2015 and FAO 2020). Date palm originated in the Arabs area and its cultivation remains concentrated in this region today (Eshmawy, 2015 and Al-Bakry, 2020).

Egypt is considered one of the major countries in date palm cultivation and date production. Date palm trees grow successfully under Egyptian climate conditions in both Nile Valley and desert lands. Based on the Egyptian ministry of agriculture (2021) the total area occupied by date palm reached to 134126 feddans (99221 cultivated in Nile valley lands and 34905 cultivated in new reclamation desert lands), it produced nearly 1710603 tons / year. A small amount of this high production is exported to foreign markets, may be due to lowest quality, Consequently the Egyptian government has intensified cultivated other higher quality cultivars, such as Medjool cv., especially in the new reclamation desert lands. Medjool cultivar conceder is considered one of the most famous and popular semi-dry cultivars in the world, some important challenges in fruit trees cultivation under new reclamation lands include: particularly potassium and boron, due to the high soil pH surrounding the root system (Jackson & Volk 1990; Mengle 2007 and Marschner 2012). This problem leads to low pollination ratio, low fruit sett % and low fruit quality. The development of agriculture sector can increase the resources use efficiency with minimal production losses. One of the most effective methods utilizing modern agricultural technologies is using nano-fertilizers. Nano-technology technique has a high potential for sustainable agriculture, especially in developing countries, and hold the promise of revolutionize the agricultural systems (Cummings & Wilcox 1990; Hussein 2005 and Alalaf *et al*., 2020). The use of nano-K and nano-B fertilizers may increase nutrients use efficiency, minimizes the potential negative effects associated with over dosage and reduce the application frequency (Prasad *et al*., 2014; Monreal *et al*., 2016; Peng *et al*., 2016; Abobatta 2019).

Then, the present investigation aimed to study the effect of spraying nano-potassium and nano-boron on the productivity and fruit physicochemical properties of Medjool data palm grown under El-Minia Governorate conditions, Egypt. Additionally, the study compared the effectiveness of nano-K and nano-B with the traditional forms of potassium and boron.

## MATERIALS AND METHODS

The present investigation was conducted during two consecutive seasons 2022 and 2023 on thirtyfemale Medjool date palms uniform in vigor. These selected palms were twelve years old, cultivated in private orchard located at new

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reclaimed desert lands in western Mallawi district El-Minia Governorate, Egypt. The soil texture was sandy and well drained. The Medjool palms were planted at 7 x 7 meters apart and were irrigated using a drip irrigation system. Pruning was performed to maintain leaf / bunch ratio of 8:1. The number of female spathes was adjusted to 10 spathes/palm after removing excess bunches (earliest, latest and small bunches). The Pollination was achieved by using eight male strands for each female bunch. In order to prevent pollens contamination or cross pollination, female bunches were bagged with paper bags after inserting the mal male strands These bags were lightly shaken to ensure pollen distribution and were removed after four weeks (Hussein et al., 1993 and Dammas, 1998).

The present study was conducted in sandy new reclamation land located in the Western Mallawi district of El-Minia Governorate, where the Medjool orchard was established. The soil texture was sandy (Table 1). Composite samples of soil and irrigation water were collected and subjected to physical and chemical analysis following the methods outlined by Walsh and Beaton (1986).

**Table 1. Physical and chemical composition of soil and irrigation water.**

| Soil analysis | | Water analysis | |
|---|---|---|---|
| **Constituent** | **Value** | **Constituent** | **Value** |
| Sand % | 85.2 | E.C (mmhos/cm) | 2.1 |
| Silt % | 8.5 | Hardness | 16.0 |
| Clay % | 6.3 | pH | 7.71 |
| Texture | Sandy | Ca (mg/L) | 20.2 |
| EC (1 : 2.5 extract) mmhos / cm / 25 ºC | 2.9 | Mg (mg/L) | 12.3 |
| Organic matter % | 0.65 | K (mg/L) | 4.27 |
| pH (1 : 2.5 extract) | 7.89 | Na (mg/L) | 89.7 |
| Active lime % | 8% ($CaCO_3$) | Alkalinity (mg/L) | 174 |
| N (mg/kg) | 152 | Chlorides (mg/L) | 129 |
| Phosphorus (ppm) | 16.8 ppm | Nitrate (mg/L) | 8.1 |
| Available K (meq/100g) | 0.41 | Sulphate (mg/L) | 23.1 |

**Experimental work:** This present investigation included ten treatments from nano-potassium or/and nano-boron as well as the control palms (received the potassium and boron in traditional form). The experiment encompassed the following ten treatments: T1) Control (trees sprayed with traditional fertilizers, 1% K2SO4 and 100 ppm boric acid), T2), Palms sprayed with nano-K at 100 ppm + 100 ppm boric acid, T3) Palms sprayed with nano-K at 200 ppm + 100 ppm boric acid, T4) Palms sprayed with nano-K at 300 ppm + 100 ppm boric acid, T5), Palms sprayed with nano-B at 10 ppm + 1% traditional K2SO4, T6) Palms sprayed with nano-B at 20 ppm + 1% traditional K2SO4, T7), Palms sprayed with nano-B at 30 ppm + 1% traditional K2SO4, T8). Palms sprayed with nano-K at 100 ppm + 10 ppm nano-B, T9), Palms sprayed with nano-K at 200 ppm + 20 ppm nano-B and T10), Palms sprayed with nano-K at 300 ppm + 30 ppm nano-B. Each treatment was sprayed three times: at the end of January, immediately after fruit set, and one month after the second spray. Each treatment consisted of three replicates, one palm per each. Thus, a total of 30 palms were utilized in this experiment. The treatments were arranged in a complete randomized block design (CRBD).

**Hand pollination:** It was conducted just after the beginning of spathe split Five male strands were carefully inserted into the female spathe, using Ghanami pollen grains. To prevent pollen contamination each bunch was immediately bagged after inserting the mal strands, using paper bags. The bags were gently shaken to ensure uniform pollen distribution. Pollination was repeated three times at 5 days intervals (Hussein et al., 1993 and Dammas, 1998)

**Measurements and determinations**: The following characteristics were achieved during the two experimental seasons (2022 and 2023).

Fruit setting % and fruit dropped %: Just after manual pollination of female palms, the female bunches were enclosed in paper bags. The paper bags were removed after three weeks of pollination. Then, the number of fallen flowers and fruit set were counted. The % of fruit set was calculated as following equation.

$$Fruit\ set\ \% = \frac{No.\ of\ setting\ flowers}{total\ No.\ of\ flowers} X\ 100$$

The bunches were once again packed again with paper bags. The bags were removed at the end of bisr stage. Then, the number of fallen fruits and fruit set fruits were counted. The percentage of dropped fruit was calculated as following equation.

$$Fruit\ dropped\ \% = \frac{No.\ of\ dropped\ fruits}{retention\ fruit\ number + dropped\ fruit\ No} X\ 100$$

**Bunch weight (kg) and Yield (Kg/palm):** At the optimum commercial harvesting time, bunches were picked. Then, the weight of each bunch was recorded. The yield kg/ palm was calculated by dividing the average bunch weight (kg) by the number of bunches.

**Fruits physical and chemical properties:** samples of fifty fruits from the yield of each palm were randomly selected and the following physical and chemical properties were determined:

**Fruits physical properties:** The average fruit weight (g), seed weight (g) and flesh weight (g) were estimated using a balance with a sensitivity of 0.01g. Subsequently, the flesh/seed ratio was calculated. Fruit dimensions (height and diameter "cm") were assessed using digital vernier caliper.

**Fruits chemical properties:** A sample of 50 gram of fruit pulp was mixed with 50 ml distilled water and left to stand for 6 hours. Subsequently, the samples were minced using a blender for the following chemical parameters determination: Total soluble solids contents (TSS %) was determined by using a hand refractometer (AOAC, 2000). Percentage of total and reducing sugar was determined volumetrically according to the method outlined by Lane and Eynon (in Rangana, 1990), then non-reducing sugars contents was calculated mathematically by subtracting the value of reducing sugars from the value of total sugars. Total acidity was determined as a percentage in term of malic acid content by titration against 0.1 NaOH in presence of phenolphthalein as an indicator (AOAC, 2000). Crude fibers % was determined using a solution of acetic glacial and nitric acids at a ratio of 10: 1, following the protocol outlined by AOAC (2000).

**Statistical analysis of data:** The obtained data were tabulated and subjected to the statistical analysis, using the MSTATC statistical package. Comparisons between means were made using the least significant differences (New L.S.D) at p = 0.05 (Snedecore and Cochran, 1977)

## RESULTS AND DISCUSSION

### 1- Effect of spraying nano-K or/and nano-B on fruit setting, fruit drop and fruit retention:

Data presented in Table 2 showed that, spraying 'Medjool' date palm with nano-K (at 100, 200 and 300 ppm)

and/or nano-B (at 10, 20 and 30 ppm) significantly increased fruit setting percentage and fruit retention % percentage compared to spraying the palms with conventional forms of K and B (K2SO4 at 100 and H3BO3 at 100 ppm). On the opposite site, the percentage of dropped fruit significantly decreased as a result of spraying nano-K or/and nano-B. These findings were true during the two experimental seasons. It is clear from the same table that, using both nano -K and nano-B in combination was more effective than the control or using each nano form alone. The positive effect of nano-K and nano-B was gradual and parallel with increasing the nano-K concentration from 100 to 300 ppm and nano-B from 10 to 30 ppm. However, no-significant differences were observed between the two highest concentrations, either spraying nano-K and nano-B individually or in combination. It is worth to mention that the palms treated with nano-K at 300 ppm in combination with 30 ppm nano-B. Contrary, the palms received both K (at 1%) and B (at 100 ppm) in form of mineral fertilizers (control) presented the highest fruit dropping percentage, the lowest fruit sett percentage and the lowest fruit retention percentage. Similar results were revealed during two experimental seasons. The role of nano-elements fertilizers in improving fruit sett and fruit retention as well as decreasing fruit drop percentage has been mentioned by several authors such as Adams & Shin (2014), Al-Hajjaj&Ayad (2018) and Al-saif et al. (2023).

**Table 2. Effect of spraying nano potassium and nano-boron on fruit setting %, fruit dropped % and fruit retention % of Medjool date palm, during 2022 and 2023 seasons.**

| Treatments | Fruit setting % | | Fruit dropping % | | Fruit retention % | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 |
| Control (1% $K_2SO_4$& 100 ppm $H_3BO_3$) | 49.2 | 48.4 | 39.4 | 38.2 | 60.1 | 61.8 |
| 100 ppm nano-K + 100 ppm boric acid | 48.7 | 53.7 | 30.1 | 30.2 | 69.9 | 69.8 |
| 200 ppm nano-K + 100 ppm boric acid | 51.2 | 54.9 | 29.2 | 28.7 | 70.8 | 71.3 |
| 300 ppm nano-K + 100 ppm boric acid | 52.1 | 56.5 | 28.7 | 28.1 | 71.3 | 71.9 |
| 10 ppm nano-B + 1% traditional $K_2SO_4$ | 50.7 | 54.2 | 33.1 | 34.1 | 66.9 | 85.9 |
| 20 ppm nano-B + 1% traditional $K_2SO4$ | 50.9 | 57.1 | 31.5 | 30.1 | 68.5 | 69.9 |
| 30 ppm nano-B + 1% traditional $K_2SO4$ | 52.1 | 57.8 | 29.3 | 28.9 | 69.7 | 71.1 |
| 100 ppm nano-K + 10 nano-B | 54.2 | 55.9 | 27.9 | 26.7 | 72.1 | 73.3 |
| 200 ppm nano-K + 20 nano-B | 54.9 | 58.6 | 25.4 | 24.2 | 74.6 | 75.8 |
| 300 ppm nano-K + 30 nano-B | 55.0 | 59.7 | 24.7 | 24.5 | 75.3 | 75.5 |
| New LSD at 5% | 4.8 | 4.6 | 3.2 | 3.7 | 6.4 | 5.8 |

**2- Effect of spraying nano-K and/or nano-B on fruit weight, bunch weight and yield (kg/palm):**

Data illustrated in Table 3 show the effect of spraying different concentrations of nano-K and nano-B on yield and its components of 'Medjool' date palm, during 2022and 2023 seasons. It is clear from the obtained data that, spraying Medjool cultivar with nano-K at 100 to 300 ppm and/or nano-B at 10 to 30 ppm was followed by stimulating bunch weight (kg) and yield (kg/palm) as well as fruit weight (g) significantly relative to the control (mineral K & B spraying), during the two seasons. This stimulatory effect was related to increases in nano-K or/and nano-B concentrations. Regarding the individual spraying of the two the examined materials (nano K and nano-B), the response of 'Medjool'female palms to spraying nano-K showed superiority in bunch weight, yield "kg/palm" and fruit weight (g) than those of nano-B. The results also showed that spraying both K and B in combination in the form of nano particles was superior to using each one alone. The data also show that the palms treated with nano-K at 300 ppm + nano-B at 30 ppm presented the highest fruit weight (g), bunch weight (kg) and yield (kg/palm). Contrary, untreated palms presented the lowest values of fruit weight, bunch weight and yield (kg/palm). A similar trend was noticed during both seasons.

**Table 3. Effect of spraying nano potassium and nano-boron on bunch weight, yield and fruit weight of Medjool date palm, during 2022 and 2023 seasons.**

| Treatments | Bunch weight (kg) | | Yield (kg/palm) | | Fruit weight (g) | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 |
| Control (1% K2SO4 & 100 ppm H3BO3) | 4.8 | 4.8 | 48 | 48 | 19.5 | 18.9 |
| 100 ppm nano-K + 100 ppm boric acid | 5.0 | 5.1 | 50 | 51 | 20.1 | 21.0 |
| 200 ppm nano-K + 100 ppm boric acid | 5.9 | 6.2 | 59 | 62 | 22.2 | 21.9 |
| 300 ppm nano-K + 100 ppm boric acid | 6.2 | 6.4 | 62 | 64 | 22.7 | 22.6 |
| 10 ppm nano-B + 1% traditional $K_2SO_4$ | 5.5 | 5.4 | 55 | 54 | 21.1 | 21.0 |
| 20 ppm nano-B + 1% traditional $K_2SO4$ | 5.8 | 5.8 | 58 | 58 | 21.6 | 21.8 |
| 30 ppm nano-B + 1% traditional $K_2SO4$ | 6.0 | 6.1 | 60 | 61 | 22.0 | 22.1 |
| 100 ppm nano-K + 10 nano-B | 5.9 | 6.1 | 59 | 61 | 22.5 | 23.1 |
| 200 ppm nano-K + 20 nano-B | 6.6 | 6.9 | 66 | 69 | 24.2 | 24.9 |
| 300 ppm nano-K + 30 nano-B | 7.0 | 7.2 | 70 | 72 | 24.3 | 25.2 |
| New LSD at 5% | 0.5 | 0.4 | 4 | 3 | 0.9 | 0.7 |

The obtained data concerning the positive effect of Nano-K and nano-B on fruit weight (g), bunch weight (kg) and yield (kg/palm) are in harmony with those obtained by Han *et al.* (2008); Sarrwy *et al.* (2012); Davarpanah *et al.*, (2016); Shareef (2016); Al-hajja & Ayad (2018).The positive effect of spraying nano-K and/or nano-B on yield (kg/palm), bunch weight (kg) and fruit weight (g) of Medjool date palm might be attributed to their role in protecting the palm from biotic and abiotic stress, enhancing the cell to building of amino acids and the biosynthesis and transport of carbohydrates as well as enhance nutrients uptake and localization (Sarrwyet al., 2012;Adams & Shin 2014;Shareef 2016; Al-Hajjaj&Ayad 2018and Al-Saif *et al*., 2023).

**3- Effect of spraying nano-K and/or nano-B on fruit physical properties:**

Data presented in Table 4 show the effect of spraying different concentrations of nano-K and nano-B on fruit physical properties of 'Medjool' date palm, in 2022and 2023

seasons. It is evident from this table that, spraying 'Medjool' palms with nano-K (at 100 to 300 ppm) and/or nano-B (at 10 to 30 ppm) resulted in improved fruit physical properties. These properties include (fruit height, fruit diameter, pulp weight and pulp: seed ratio, except the average weight of seed which did not varied significantly relative to the control treatment (spraying K2SO4 and H3BO3). These findings were true during the two seasons. This positive effect was related to increases the nano-K or/and nano-B concentrations. Regarding the individual spraying of two the examined materials (nano K and nano-B), the response of 'Medjool' female palms to spraying nano-K shows superiority in fruit height (cm), fruit diameter (cm), pulp weight (g) and pulp: seed ratio rather than those sprayed with nano-B. Furthermore, the same table shows that spraying both nano K and B in combination was superior rather than using each one alone. The data also show that the palms received nano-K at 300 ppm + nano-B at 30 ppm present the highest fruit height (cm), fruit diameter (cm), pulp weight (g) and heist pulp: seed ratio. Contrary, untreated palms present the lowest values of fruit height, fruit diameter, pulp weight and pulp: seed ratio. While, no-significant differences in seed weight were obtained. Similar trend was noticed during both seasons.

Potassium fertilization is well known to be fundamental for productivity and fruit quality of all fruit trees. Potassium plays an important role in modulation of membrane potential osmotic pressure regulation, sugars transportation and stress tolerance (Rengel & Damon 2008; shabala 2014; Shareef 2016; Sardans & Penuelas 2021; Johnson *et al*., 2022 and Al-Saif *et al*., 2023). Many previous studies have reported that boron, an essential micronutrient, protects from biotic and abiotic stress, enhancing cell building of amino acids, facilitates the biosynthesis and transport of carbohydrates and improves nutrient uptake and localization (Sarrwy *et al*., 2012; Adams & Shin 2014; Shareef 2016 and Al-Hajjaj&Ayad 2018).

**Table 4. Effect of spraying nano potassium and nano-boron on fruit physical properties of Medjool date palm, during 2022 and 2023 seasons.**

| Treatments | Fruit height (cm) | | Fruit diameter (cm) | | Pulp weight (g) | | Seed weight (g) | | Pulp:Seed ratio | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 |
| Control (1% $K_2SO_4$& 100 ppm $H_3BO_3$) | 6.5 | 6.5 | 2.1 | 2.2 | 17.5 | 17.0 | 2.0 | 1.9 | 7.8 | 8.1 |
| 100 ppm nano-K + 100 ppm boric acid | 6.8 | 6.9 | 2.3 | 2.3 | 18.8 | 19.2 | 1.9 | 1.8 | 8.4 | 9.1 |
| 200 ppm nano-K + 100 ppm boric acid | 7.1 | 7.1 | 2.4 | 2.5 | 20.4 | 20.2 | 1.8 | 1.7 | 10.1 | 9.4 |
| 300 ppm nano-K + 100 ppm boric acid | 7.2 | 7.3 | 2.7 | 2.7 | 21.0 | 20.9 | 1.7 | 1.7 | 10.3 | 10.3 |
| 10 ppm nano-B + 1% traditional $K_2SO_4$ | 6.8 | 6.8 | 2.2 | 2.4 | 19.5 | 19.2 | 1.6 | 1.8 | 10.0 | 9.1 |
| 20 ppm nano-B + 1% traditional $K_2SO4$ | 7.0 | 7.1 | 2.5 | 2.5 | 20.3 | 20.3 | 1.7 | 1.8 | 9.4 | 9.5 |
| 30 ppm nano-B + 1% traditional $K_2SO4$ | 7.2 | 7.3 | 2.6 | 2.6 | 20.8 | 20.3 | 1.7 | 1.8 | 9.6 | 10.0 |
| 100 ppm nano-K + 10 nano-B | 7.3 | 7.4 | 2.6 | 2.7 | 20.8 | 21.7 | 1.6 | 1.8 | 10.7 | 10.5 |
| 200 ppm nano-K + 20 nano-B | 7.5 | 7.7 | 2.8 | 2.9 | 20.9 | 21.3 | 1.8 | 1.6 | 11.0 | 11.9 |
| 300 ppm nano-K + 30 nano-B | 7.6 | 7.7 | 2.9 | 2.9 | 22.7 | 23.4 | 1.6 | 1.8 | 11.6 | 11.5 |
| New LSD at 5% | 0.4 | 0.5 | 0.1 | 0.2 | 1.4 | 1.2 | NS | NS | 0.6 | 0.5 |

**4- Effect of nano-K and nano-B on fruit chemical properties:**

**TSS% and sugars contents:**

Data illustrated in Table 5 show the effect of spraying nano-K or/and nano-B on 'Medjool' date palms fruit TSS%, reducing sugars%, non-reducing sugars% and total sugars, during the two experimental seasons. It is clear from this table that spraying nano-K and/or nano boron increased TSS%, reducing sugars %, non-reducing sugars and total sugars % in 'Medjool' fruits, these data were true during the two experimental seasons. Furthermore, increasing nano-K concentration from 100 to 300 ppm and nano-B from 10 to 30 ppm was associated with increasing the TSS, reducing sugars and total sugars percentages. However, using potassium in nano particulars was more effective in enhancing TSS and sugars percentages than using nano-B, except in the case of reducing sugars, where non-significant differences were observed between using nano-K or nano-B. These findings were true during the two experimental seasons. The same table shows that the 'Medjool' palms sprayed with a combination of both potassium and boron in form of nano presented the highest TSS%, reducing sugars%, non-reducing sugars and total sugars%. While the palms treated with conventional mineral potassium and boron fertilizers showed the lowest values of TSS%, reducing sugars%, non-reducing sugars and total sugars%, during both experimental seasons.

**Table 5. Effect of spraying nano potassium and nano-boron on fruit TSS%, reducing sugars %, non-reducing sugars % and total sugars % of Medjool date palm, during 2022 and 2023 seasons.**

| Treatments | TSS (%) | | Reducing sugars (%) | | Non-reducing sugars (%) | | Total sugars (%) | |
|---|---|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 |
| Control (1% $K_2SO_4$& 100 ppm $H_3BO_3$) | 61.5 | 61.8 | 12.2 | 12.4 | 47.0 | 47.1 | 59.2 | 59.5 |
| 100 ppm nano-K + 100 ppm boric acid | 63.7 | 64.7 | 14.3 | 14.3 | 47.9 | 48.4 | 62.2 | 62.7 |
| 200 ppm nano-K + 100 ppm boric acid | 64.8 | 65.9 | 14.5 | 14.6 | 48.2 | 48.9 | 62.7 | 63.5 |
| 300 ppm nano-K + 100 ppm boric acid | 66.0 | 66.4 | 14.6 | 14.6 | 49.3 | 50.1 | 63.9 | 62.6 |
| 10 ppm nano-B + 1% traditional $K_2SO_4$ | 63.9 | 64.3 | 13.9 | 14.2 | 47.9 | 48.0 | 61.8 | 62.2 |
| 20 ppm nano-B + 1% traditional $K_2SO_4$ | 64.5 | 65.1 | 14.4 | 14.5 | 48.0 | 48.4 | 62.4 | 62.9 |
| 30 ppm nano-B + 1% traditional $K_2SO_4$ | 65.4 | 65.8 | 14.2 | 14.5 | 49.1 | 48.6 | 63.3 | 63.1 |
| 100 ppm nano-K + 10 nano-B | 66.1 | 67.1 | 14.2 | 14.3 | 49.8 | 49.2 | 64.0 | 63.5 |
| 200 ppm nano-K + 20 nano-B | 68.5 | 68.9 | 14.1 | 14.6 | 50.2 | 51.3 | 64.3 | 65.9 |
| 300 ppm nano-K + 30 nano-B | 68.9 | 69.3 | 14.7 | 14.8 | 51.1 | 52.1 | 65.8 | 66.9 |
| New LSD at 5% | 1.9 | 2.1 | 1.6 | 1.5 | 1.1 | 1.0 | 1.6 | 1.4 |

**Total acidity, total soluble tannins and crude fiber percentages:**

Data illustrated in Table 6 show that all potassium and boron treatments failed to significantly affect the total acidity % in either the first seasons or in the second seasons. Contrary, the total soluble tannins% and total crud fibers% significantly decreased when mineral potassium and boron fertilizers were replaced with by nano-K and nano-B fertilizers. In this concern,

nano-K were more effective than nano-B treatments, these findings were true in both seasons. The obtained data indicate that 'Medjool' palms sprayed with nano-K at 300 ppm combined with nano-B at 30 ppm produced the lowest total soluble tannins and crude fibers in fruit pulp during the two seasons. Conversely, the palms treated with the conventional potassium and boron fertilizers produced the highest levels of total soluble tannins and total crude fibers in the fruit pulps.

**Table 6. effect Effect of spraying nano potassium and nano-boron on fruit total acidity%, total soluble tannins % and total crud fibers %of Medjool date palm, during 2022 and 2023 seasons.**

| Treatments | Total acidity (%) | | Total soluble tannins (%) | | Total crud fibers (%) | |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2022 | 2023 | 2022 | 2023 |
| Control (1% $K_2SO_4$& 100 ppm $H_3BO_3$) | 0.259 | 0.251 | 0.65 | 0.58 | 1.21 | 0.95 |
| 100 ppm nano-K + 100 ppm boric acid | 0.252 | 0.249 | 0.51 | 0.50 | 0.94 | 0.83 |
| 200 ppm nano-K + 100 ppm boric acid | 0.257 | 0.246 | 0.43 | 0.43 | 0.76 | 0.73 |
| 300 ppm nano-K + 100 ppm boric acid | 0.259 | 0.249 | 0.37 | 0.35 | 0.62 | 0.67 |
| 10 ppm nano-B + 1% traditional $K_2SO_4$ | 0.249 | 0.248 | 0.49 | 0.44 | 0.99 | 0.95 |
| 20 ppm nano-B + 1% traditional $K_2SO4$ | 0.251 | 0.252 | 0.48 | 0.45 | 0.88 | 0.82 |
| 30 ppm nano-B + 1% traditional $K_2SO4$ | 0.243 | 0.250 | 0.46 | 0.42 | 0.73 | 0.70 |
| 100 ppm nano-K + 10 nano-B | 0.253 | 0.247 | 0.40 | 0.39 | 0.77 | 0.71 |
| 200 ppm nano-K + 20 nano-B | 0.244 | 0.245 | 0.36 | 0.32 | 0.64 | 0.61 |
| 300 ppm nano-K + 30 nano-B | 0.240 | 0.246 | 0.33 | 0.30 | 0.60 | 0.57 |
| New LSD at 5% | NS | NS | 0.08 | 0.06 | 0.18 | 0.12 |

The positive effect of potassium and boron nanoparticles fertilizers on chemical composition of 'Medjool' date palm could be explained by the positive effect of potassium and boron on sugars synthesis activity and its transports to fruit cells of plant (Gauch & Dugger 1953, Al-Hajjaj & Ayad 2018) and regulation of photosynthetic enzymes activity (Han et al., 2008; Shareef, 2016 and Al-Hajjaj & Ayad 2018). Furthermore, the role of potassium in tolerances of biotic and abiotic stress, that may be lead led to more carbohydrates productions and accumulations in fruits (Mengel, 2007and Marschner, 2012). Nanoparticles of potassium and boron may be cause an enhancement of vitamins, amino acids as well as antioxidant biosynthesis (Sekhon 2014; Kaphle *et al*., 2018 and Al-Saif *et al*., 2023). Furthermore, it possess the capacity to traverse cell barriers and facility the transport of elements by connecting them with proteins or other organic compounds, these can play an important role in improve fruit chemical properties, i.e. decreasing of total acidity%, total soluble tannins and crude fiber % (Khayatt *et al*., 2007; Rasmia *et al*., 2015; Al-Hajjaj & Ayad2018; and Al-Saif *et al*., 2023). Other In other words, using the both nutritional elements (potassium and boron) in the form of nano particulars can significantly improve the plant absorption and immobilization of these elements, these facts explain their major effects on improving Medjool fruit chemical properties (Rengel & Damon 2008; Adamd & Shin 2014 and Al-Saif 2023).

Conclusion: in order to improve the productivity and fruit quality of 'Medjool' date palm, the results obtained in this investigation recommend spraying Medjool date palm trees with nano-K at 300ppm and nano-B at 30 ppm as an effective alternative to traditional mineral fertilizers.

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# الأنتاجية وجودة ثمار نخيل البلح المجدول وعلاقتها برش النانو بوتاسيوم والنانو بورون

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## الملخص

هدفت هذه التجربة للحالية إلى دراسة تأثير رش أسمدة البوتاسيوم والبورون التى تم اعدادها بتقنية النانو تكنولوجى على أنتاجية نخيل البلح المجدول وجودة ثماره وذلك بالمقارنة برش الأسمدة المعدنية التقليدية لكلا منهما. أجريت هذه التجربة خلال موسمى 2022 و 2023 على نخيل بلح صنف المجدول عمرها 12 عام عند بداية التجربة، نامية فى أرض رملية حديثة الأستصلاح . تم أستخدام ثلاثة تركيزات من كلا من النانو بوتاسيوم وهى 100 و 200 و 300 جزء فى المليون وثلاثة تركيزات من النانو بورون وهى 10 و 20 و30 جزء فى المليون سواءً كان كلا منهم بصورة فردية او تم استخدامهم بصورة مشتركة. وبالتالى اشتملت التجربة على تسعة معاملات من النانو بوتاسيوم او كلاهما معاً بالاضافة الى معاملة الكنترول (وهى رش سلفات البوتاسيوم بتركيز 1% + رش حامض البوريكبتركيز 100 جزء فى المليون). وبالتالى اشتملت الجربة على عشرة معاملات رشا على الأوراق. أوضحت النتائج المتحصل عليها ان رش كلا من النانو بوتاسيوم والنانو بورون او كلاهما معاً بالتركيزات سالفة الذكر كان له تأثير معنوى على تحسن النسبة المئوية لعقد الثمار، النسبة المئوية للثمار الباقية على الشماريخ، وزن السوباطات (الكجم) وكمية المحصو للنخلة (بالكجم). بينما ادت المعاملات الى تناقص معنوى فى نسبة تساقط الثمار. وقد أدى رش النانو بوتاسيوم والنانو بورون او كلاهما معاً إلى تحسن واضح ومعنوى فى المواصفات الفيزيائية للثمار متمثلة فى زيادة متوسط وزن الثمرة بالجرام، وابعاد الثمرة بالسم، ووزن لُب الثمرة بالجرام وكذلك نسبة لُب الثمرة إلى البذرة. بينما لم يكن للمعاملات اى تأثير معنوى على وزن البذرة.الرش بالناو بوتاسيوم او النانو بورون أدى الى تحسن واضح فى الصفات الكيميائية.

**الكلمات الدالة :** نخيل البلح ، إنتاجية ، جودة الثمار و مجدول