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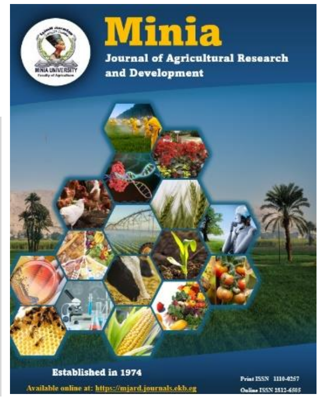

Effects of Urea, Zinc Sulfate, and Gibberellic Acid Applied via Trunk Injection on Productivity and Fruit Quality of 'Barhi' Date Palm

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ABSTRACT

The purpose of this study was to examine the effects of urea, gibberellic acid (GA3), and zinc sulfate (ZnSO4) on the production and quality of 'Barhi' date palm at a private orchard in Wadi Natron, Egypt, over the course of seasons (2021 and 2022). Twenty-year-old 'Barhi' cultivar. Palms were chosen for this study. Under drip irrigation, the planting distances were 8 by 8 meters. Treatments were applied via manual trunk injection one meter above the ground. Three replicates were used in the fully randomized block design experiment. The treatments included a control, several concentrations of GA3 (500, 1000, and 2000 mg/l), and various combinations of urea and ZnSO4 with GA3. According to the results, the highest mean values for all physical fruit attributes (fruit length, diameter, size, and weight) were recorded by the combined treatment of 1 kg urea + 6 g ZnSO4 + 2000 mg/l GA3. The 1 kg Urea + 1000 mg/l GA3 came next, both of which greatly outperformed the control treatments, which had the lowest mean values for these characteristics. Additionally, when compared to the control treatment, which displayed lower values for these advantageous traits while simultaneously recording higher values of total acidity and tannins, the combined treatment of 1 kg urea + 6 g $ZnSO_4$ + 2000 mg/l GA_3 also recorded the highest mean values for all chemical fruit characteristics, including total sugars, reducing sugars, non-reducing sugars, TSS, vitamin C, and mineral elements.
Keywords: Date palm (*Phoenix dactylifera* L.), urea, GA_3, $ZnSO_4$, yield, chemical composition

INTRODUCTION

The Arecaceae family, which includes more than 2500 species and roughly 200 genera, includes the date palm (*Phoenix dactylifera* L.) **(Eoin, 2016).** Date palms are mostly grown in arid deserts that stretch south of the Mediterranean Sea and along the southern boundaries of the Middle East,

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from the Atlantic coast of North Africa in the west to southern Iran in the east. Despite the intense heat of these deserts, an oasis of date palms, providing both shade and water, remains a welcome sight **(Alwahshi *et al.*, 2019).** Egypt produced more than 1.7 million tons of dates in 2021, more than any other country in the world, followed by Saudi Arabia (1.6 million tons) and Iran (1.3 million tons), according to data from the UN Food and Agriculture Organization **(Fleck, 2023).** There are 62.5 million date palm trees in the Arab world, out of an expected 105 million worldwide **(FAOSTAT, 2021).** Iraq ranks sixth worldwide, producing 735,000 tons of dates annually from a total of 17,348,741 palm trees, with each tree averaging 68.2 kg of production **(CSO, 2021).** Date palms serve as a crucial food source for both humans and animals in arid regions globally, and their highly nutritious fruit along with useful byproducts make them an exceptionally important fruit crop **(Suhim *et al.*, 2023**). Dates are a significant traditional crop in Egypt. With over1,130,000 tons produced annually, Egypt is the top producer of dates among the top ten nations **(FAO, 2010).** From Aswan to the northern delta, including oases like Siwa, Bahrya, Farafra, Kharga, and Dakhla, date palms may be found all over Egypt. The Saidy Date Palm is regarded as the national date palm cultivar in the New Valley Governorate. The most significant semi-dry date type is much sought after in both domestic and foreign markets. Understanding the many horticultural practices that affect tree development and production is essential to ensuring high fruit yield **(El Mahdy *et al.*, 2017; Ahmed *et al.*, 2019).** Because of their many essential nutrients and health advantages, dates are regarded as a complete food **(Elleuch *et al.*, 2008; El-Shibli and Korelainen, 2009).** They are abundant in vitamins, minerals, fiber, and carbs. Because they are essential to an integrated food system and contain a variety of minerals, proteins, vitamins, fiber, and substances that make digestion and absorption easier, palm trees have special economic value **(Kshash and Aubied, 2016).**

Dates are considered a fruit with excellent nutritional value because of their high mineral content, which includes significant amounts of vitamins, fiber, flavonoids, copper, zinc, and selenium. As a result, they can provide support for ailments such as kidney stones, anemia, diarrhea, cough, cardiovascular disease, cancer, and renal weakness **(Bentrad and Ferhat, 2020).** Dates are a staple meal for many people in the Middle East, North Africa, Asia, and America because of their high sugar, lipid, mineral, amino acid, vitamin, and dietary fiber content (**Al-Mssallem *et al.*, 2020; Ahmed *et al.*, 2022a; Alyafei *et al.*, 2022).** Additionally, they have anti-mutagenic and anti-carcinogenic qualities due to their high concentration of bioactive components, such as flavonoids, tannins, and other phenolic compounds **(Khalid *et al.*, 2017; Al Shaibani *et al.*, 2022; Alkaabi *et al.*, 2023).**

In tropical and subtropical areas, especially in the Middle East and North Africa, date palms are widely grown **(Qadir *et al.*, 2020).** The gross production value of date fruits has increased significantly worldwide since the 20th century, peaking at around US $14 billion in 2020 **(FAOSTAT, 2022).** The economic and social environments of countries that produce dates are significantly influenced by date palm trees and their fruits **(Mrabet *et al.*, 2020; Ghafoor *et al.*, 2022).** Because the Holy Quran mentions the fruit's nutritional and medicinal properties, Muslims have long used dates to break their fasts during the holy month of Ramadan **(Al-Dashti *et al.*, 2021).** One of the most well-known species in the Arecaceae family is the date palm, a dioecious tree **(Elmeer *et al.*, 2019).** One of the first crops grown in the Middle East was date palm fruit **(Abdul-Hamid *et al.*, 2020).** The date palm is usually propagated by seeds and progeny **(Shah, 2014).** Fresh dates, like the Barhi (Berhi, Barhy, or Barhee) variety, are quite popular during the date-producing season and are eaten in huge quantities when they reach the Khalal stage of maturation. Crispness and sweetness are characteristics of this first edible stage. Nevertheless, they have a tendency to ripen quickly and enter the rutab stage when stored normally.

Maintaining the quality of fresh Barhi fruits for as long as feasible after harvest and during the marketing process is one of the main technical obstacles in marketing them at the Khalal maturity stage **(Alhamdan *et al.*, 2015).** When Barhi dates reach the Khalal maturation stage, they are known for their brilliant yellow color, crisp texture, and superb flavor. For efficient marketing, the Barhi Khalal stage must be extended due to its short length **(Atia *et al.*, 2018).** Fresh date palm fruits (cv. Barhi) have attracted a lot of attention because of their sweet flavor and wide market appeal. During the postharvest and marketing stages, it is essential to preserve their quality and extend their storability **(Fekry *et al.*, 2022).** "Barhi" is one of the most often consumed soft fruit types in Egypt. However, date growers continue to have serious worries about fruit quality and poor annual average output. Since silicon and potassium are essential for improving fruit quality and productivity, it is critical to determine the ideal amounts of these minerals for date palm fertilization. In addition to helping fruit trees recover from nutritional and physiological problems, foliar spraying of macro and micronutrients is essential for enhancing fruit set, yield, and quality **(Lalithya *et al.*, 2014).** It is often acknowledged that one of the most important elements affecting tree growth, total productivity, and fruit quality is nutrition **(Kassem and Marzouk, 2010; Kassem, 2012).** One of the most important practices in orchard management is fertilization, which accounts for 20% of overall production costs, of which more than 80% are for nitrogen fertilizers alone. The main ingredients of commercial fertilizers are nitrogen, phosphorous, and potassium all of which are essential for plant nutrition. Maximizing nitrogen uptake is the aim of fertilizer application for palms in order to achieve ideal growth, yield, and fruit quality **(Tung *et al.*, 2009).** However, the high cost and limited use effectiveness of mineral fertilizer present a major obstacle for fruit tree growers **(Raliya *et al.*, 2017).** For healthy growth and a suitable level of economic output, date palm trees need comparatively large levels of macro and micronutrients. Fertilization is therefore a crucial procedure that increases date yield and enhances fruit quality. According to a study on date palms, boosting the quantitative, qualitative, and financial output of date production in palm groves requires the appropriate use of macro and micronutrient fertilizers **(Shaaban and Mahmoud, 2012).** One essential element that all plants need is nitrogen. Tree growth, leaf cover, bloom development, fruit set, and fruit size all depend on adequate nitrogen levels **(Sharma, 2016)**. However, fertilizer additions can both improve fruit quality and greatly increase this output level **(Ibrahim *et al.*, 2013).** Because of its many advantageous qualities, such as its high water solubility, nonpolarity, quick leaf absorption, and low phytotoxicity, urea is the most widely utilized nitrogen source for foliar fertilization **(Fernandez *et al.*, 2013; Etehadnejad and Aboutalebi, 2014).** Spring applications of foliar urea have been proven to have equivalent or even better effects in terms of enhanced fruit output and quality compared to soil applications, even though foliar fertilization is not meant to fully replace soil fertilization **(Hasani *et al.*, 2016).**

Crop growth and photosynthetic efficiency are positively impacted by zinc fertilization **(Khan and Ahmed, 2022; Ahmed *et al.*, 2022).** Zinc is essential for crop growth and production **(Das *et al.*, 2018),** plays a key role in cell division, photosynthesis, and auxin synthesis **(Noulas *et al.*, 2018),** and is a component of various enzymes, such as oxidases, peroxidases, and anhydrases. Plant hormones, which are organic, non-nutritional chemicals that are naturally present in trace amounts within plants to govern physiological processes, are responsible for controlling fruit growth. Plant hormones are classified according to their activity, including growth inhibitors like ethylene and abscisic acid (ABA) and growth promoters like auxins, gibberellins, and cytokinins. Within plant tissues, these hormones exert their physiological effects as they move from their synthesis sites to their action sites **(Suhim *et al.*, 2023).** Exogenous plant growth regulators (PGRs), when used as preharvest sprays, alter the ripening and fruit development processes or trigger particular physiological mechanisms that affect how fruit is stored after harvest **(Khan and Ali 2018).** One such PGR is gibberellic acid (GA_3), which delays fruit ripening and senescence **(Garmendia *et al.*, 2019; Lindo-García *et al.*, 2020),** increases plant cell growth, elongation, and enlargement **(Muniandi *et al.*, 2018; Castro-Camba *et al.*, 2022),** and improves fruit quality characteristics **(Liu *et al.*, 2022).** Additionally, it has been demonstrated that GA_3 increases fruit size, decreases seed size and pericarp thickness, and sometimes induces parthenocarpy to improve the edible sections of fruits **(Pereira *et al.*, 2019; Wang *et al.*, 2020).**

The purpose of this study was to examine how the quality and yield of the Barhi date palm cultivar were affected by different amounts of urea, $ZnSO_4$, and gibberellic acid (GA_3) applied via trunk injection.

MATERIALS AND METHODS

This study was carried out at the private orchard in Wadi Natron, Egypt, over the course of two consecutive growing seasons in 2021 and 2022. Twenty-year-old Barhi was chosen as the cultivar for this investigation. Under drip irrigation, the planting distances were 8 by 8 meters. Robust and healthy palms were selected for the study.

All palms were subjected to the same standard agricultural practices used in the orchard, including irrigation, insect control, and soil fertilization. Treatments were given one week after fruit set and at the slowest period for fruit growth in two consecutive growing seasons. The experiment was arranged in a fully randomized block design, with three palms serving as replicates for each treatment.

The treatments were as follows:

- Control
- 1kg Urea
- 2kg Urea
- 1kg Urea + ½ kg $ZnSO_4$
- 1kg Urea + 1 kg $ZnSO_4$
- 1kg Urea + 3 g $ZnSO_4$
- 1kg Urea + 6 g $ZnSO_4$
- 500 mg/l GA_3
- 1000 mg/l GA_3
- 2000 mg/l GA_3
- 1kg Urea + 100 mg/l GA_3
- 1kg Urea + 200 mg/l GA_3
- 1kg Urea + 500 mg/l GA_3
- 1kg Urea + 1000 mg/l GA_3
- 1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3

Trunk injection method: In January. A 6 mm hole was drilled to the radius of the tree trunk, one meter above the ground, until the xylem was reached. an injector was hammered into the hole, and silicon was used seal the hole. The treatment solution was placed in a tube connected to the injector and allowed to be absorbed by the tree.

Measurements recorded

A) Yield and physical fruit characteristics:

A random selection of fifty ripe fruits was made from each palm. The experimental palms' yield per palm (kg) was then calculated at harvest time, which was mid-September in both seasons. The physical characteristics of the fruit, such as its length, diameter, and volume, were also measured.

Chemical characteristics:

- Twenty uniform fruits were chosen from strands that had been previously marked in mid-August at the rutab stage for total sugars, reducing sugars, and non-reducing sugars. According to the procedure described by **Lane and Eynon (1965)** in **A.O.A.C. (2000),** total sugars and reducing sugars were determined in the fruit flesh, and non-reducing sugars were computed as the difference between total sugars and reducing sugars.
- In accordance with **Alsaed *et al.* (2015),** the total soluble solids (TSS) in fruit juice were calculated as Brix%. Ten grams of fruit flesh were combined with ten milliliters of distilled water to create a homogenous solution. The liquid was filtered through a piece of gauze and squeezing it. A German Krus™ HR Series Manual Handheld Refractometer was then used to test the Brix percentage.
- Acidity: A known weight of the sample was extracted into distilled water, and 0.1N sodium hydroxide was used to titrate it in order to estimate the titratable acidity (represented as citric acid percentage). An indication to a pH 8.1 end-point was phenolphthalein **(AOAC, 2000).**
- Vitamin C titrimetric approach that involved titrating the filtrate against 2, 6-dichlorophenol indophenol was used to measure the ascorbic acid (vitamin C) level. The vitamin C content results were reported in milligrams per 100 grams **(AOAC, 2000).**
- Tannins: Total soluble tannins ($g.100g^{-1}$ FW): were assessed using the method of **Taira (1996**). Six milliliters of distilled water, 0.5 milliliters of 10% Folin-Ciocalteu reagent, and one milliliter of ethanol extract were combined and shaken well. One milliliter of saturated sodium carbonate was added after three minutes and thoroughly mixed. After that, 1.5 mL of distilled water was added, properly mixed, and allowed to sit at room temperature for an hour before the absorbance at 750 nm was measured. Gallic acid was used to measure the amount of soluble tannins from a calibration curve.
- **Mineral Content:** To determine the nutritious content of the fruit, 10g of fresh fruit samples were dried for 72 hours at 70°C in an oven. Hydrogen peroxide and sulfuric acid were used to digest 0.5 g of the fruit's dry weight **(Evanhuis and De Waard, 1980).** The Micro-Kjeldahl method was used to measure the nitrogen content in fruits **(Cunniff, 1997).** An atomic absorption spectrophotometer (Model 305B) was used to measure the phosphorus level, and a flame photometer was used to measure the potassium concentration **(Temminghoff and Houba, 2004).**

Statistical analysis:

Following the full randomized block design, the gathered data were tallied and submitted to the proper statistical analysis of variance. In accordance with the methodology described by **Snedecor and Cochram (1980),** the novel L.S.D test was utilized to determine significant differences among the various treatments.

RESULTS AND DISCUSSION

A) Yield and physical characteristics of fruits

The findings in **Table (1) and Fig. (1)** demonstrated the impact of varying urea, $ZnSO_4$, and GA_3 concentrations on the fruit size, length, and diameter of date palm cv. "Barhi" in the 2021 and 2022 growing seasons. The findings made it clear that the treatment consisting of 1 kg urea + 6 g ZnSO4 + 2000 mg/l GA3trunk injection produced greater fruit length (3.77 and 3.96 cm), fruit diameter (2.65 and 2.68 cm), and fruit size (21.52 and 22.59 cm^3). This was followed by the treatment of 1kg urea + 1000 mg/l GA_3 which recorded fruit length (3.69 and 3.87 cm), fruit diameter (2.54 and 2.62 cm), fruit size (20.87 and 21.91 cm^3), 2000 mg/l GA_3 recorded fruit length (3.67 and 3.85 cm), fruit diameter (2.56 and 2.63 cm), fruit size (20.25 and 21.26 cm^3), in contrast the control treatment recorded the lower values of fruit length (3.22 and 3.38 cm), fruit diameter (2.18 and 2.27 cm), fruit size (14.17 and 14.81 cm^3), respectively.

The findings in **Table (2) and Fig. (2)** demonstrated the impact of varying urea, $ZnSO_4$, and GA_3 concentrations on the fruit weight. The findings showed that the combination of of 1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3 via trunk injection had a significant effect on fruit weight, yield/palm and bunch weight which recorded the higher values of fruit weight (20.59 and 23.06 g), yield/palm (340.26 and 382.27 kg), bunch weight (26.46 and 30.76 kg), This was followed by treatment of 1kg urea + 1000 mg/l GA_3 control treatment which recorded the lower values of fruit weight (14.85 and 16.63g), yield/palm (222.39 and 249.08 kg), bunch weight (16.83 and 18.85 kg), respectively.

Nitrogen fertilizer is one of the most important methods for increasing fruit tree output. Nucleic acids, protoplasm, and chlorophyll all depend on it, making it a vital part of fruit tree nutrition **(Nijjar, 1985; Miller *et al.*, 1990).** The nutritional state of the farmed soil, as well as the amount, sources, and methods of application, all affect the effects of nitrogen fertilizer **(Yogoden, 1990).**

It's possible that the positive benefits of injection fertilization on fruiting traits and yield are due to the components being delivered straight to the plant parts with the rising water rather than wasting fertilizer, which enhances the quality and yield of palm fruit. These results are in line with studies by **Jubeir and Ahmed (2019)** and **Elsayd *et al.* (2018),** which discovered that trunk injection is a more efficient fertilization method that increases date palm vegetable growth and yield. On the other hand, Date Palm Cv. Zahdi, **Alaa, and Rasmi (2023)** discovered that the best results for the nutrient content in the leaves and fruits came from injecting the nutrient solution.

Gibberellic acid is one of the most significant regulators of the translocation of carbohydrates from the source to the sink. Sink tissues multiply as a result of this partitioning, increasing the fruit's size and weight **(Iqbal *et al.*, 2011).** Gibberellin causes three primary actions in plants: expansion, elongation, and cell division. GA_3 may have been crucial in raising sink potential by boosting cell numbers, controlling cell division processes including plastid biogenesis and DNA amplification, or altering the rate or duration of dry mass deposition of growing fruits **Davies (1995).**

Reduced single fruit weight and decreased fruit retention were the causes of the low yield in the control. Fruit size grows and GA_3 alters the composition of the cell wall throughout fruit development processes in many fleshy fruits because of variations in sink-source relations, cell wall changes, and water influx into the cell **(Usenik *et al.*, 2005).** They also suggested that higher hexose concentration and cell wall invertase activity improve fruit size for a greater yield. Consistent with this, we discovered that GA_3 considerably expanded the fruit's length and width, resulting in enhanced panicle weight and yield. **Hussein *et al.* (1976)** found that spraying GA_3 at varying doses significantly increased bunch weight and, in turn, yield weight/palm in an analysis by **Hang and Chau (2020)** on Barhi dates. Additionally, foliar GA_3 application significantly affects fruit length, diameter, and volume. This effect may be explained by gibberellic acid's ability to increase cell elongation as well as the elasticity and permeability of cell walls, which increases the amount of water and nutrients that enter the cells and causes them to swell and enlarge **(Abu Zaid, 2000). Al-Qurash *et al.* (2012)** concur with these findings. Gibberellin (GA_3) slowed the ripening of fruit and increased its weight. Fruit size was raised while fruit aging and chlorophyll breakdown were postponed by benzoyl adenine (BA). Both **Merwad *et al.* (2015) and El-Hamady *et al.* (2014).** According to **Hesami and Abdi (2010) and Kassem *et al.* (2011),** GA_3 reduced fruit set and fruit number as well as bunch and yield weight while increasing fruit weight, diameter, length, volume, and pulp weight.

When spraying occurs during the fruit's differentiation stage, which begins from the time stage to the maturity stage, gibberellins may also cause a rise in the quantity of stones and microscopic cells. This causes the quantity and size of cells to rise, which in turn causes the fruit's length and diameter to increase, ultimately increasing the fruit's size. Gibberellin has been implicated in lowering the percentage of fruit abortion and raising the percentage of fruit set, according to a number of studies. Gibberellin promotes flower survival and lowers the abortion rate by promoting auxin production and building, lowering the rate of auxin destruction by lowering non-free or bound auxin, and preventing auxin from oxidizing. It also works to decrease the efficiency of certain enzymes that break down auxin, such as peroxidase and I.A.A. oxidase **(Al-Khafaji, 2014).** The findings show that gibberellin spraying increased the weight of fruits and clusters, which in turn was positively correlated with the Barhi cultivar palm trees' increased output. One possible explanation for this is gibberellin's beneficial effects on cell proliferation, expansion, and elongation. This is because of its function in promoting, constructing, and manufacturing the alpha-amylase enzyme, which increases the osmotic pressure within the cell by converting starch into reducing sugars. Additionally, it enhances the cell walls' pliability, which allows more food and water to enter, causing the walls to swell, develop, and expand, ultimately leading to the cell's elongation and growth **(Gupta and Chakrabarty, 2013).**

Table (1): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on fruit length, diameter and size of date palm cv." Barhi" during 2021 and 2022 seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit size (cm^3)	
	2021	2022	2021	2022	2021	2022
Control	3.22	3.38	2.18	2.27	14.17	14.81
1kg Urea	3.33	3.51	2.22	2.32	15.49	15.93
2kg Urea	3.41	3.58	2.29	2.41	17.36	18.22
1kg Urea + ½ kg $ZnSO_4$	3.31	3.43	2.28	2.37	15.64	16.47
1kg Urea + 1 kg $ZnSO_4$	3.45	3.56	2.32	2.42	17.52	18.41
1kg Urea + 3 g $ZnSO_4$	3.56	3.76	2.38	2.49	18.44	19.36
1kg Urea + 6 g $ZnSO_4$	3.62	3.80	2.45	2.57	19.41	20.38
500 mg/l GA_3	3.36	3.51	2.37	2.49	18.27	19.19
1000 mg/l GA_3	3.49	3.66	2.44	2.57	19.23	20.22
2000 mg/l GA_3	3.67	3.85	2.56	2.63	20.25	21.26
1kg Urea + 100 mg/l GA_3	3.32	3.49	2.29	2.42	17.9	18.79
1kg Urea + 200 mg/l GA_3	3.38	3.55	2.36	2.48	18.84	19.78
1kg Urea + 500 mg/l GA_3	3.48	3.66	2.41	2.56	19.83	20.82
1kg Urea + 1000 mg/l GA_3	3.69	3.87	2.54	2.62	20.87	21.91
1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3	3.77	3.96	2.65	2.68	21.52	22.59
$LSD_{(0.05)}$	**0.04**	**0.05**	**0.04**	**0.04**	**0.17**	**0.18**

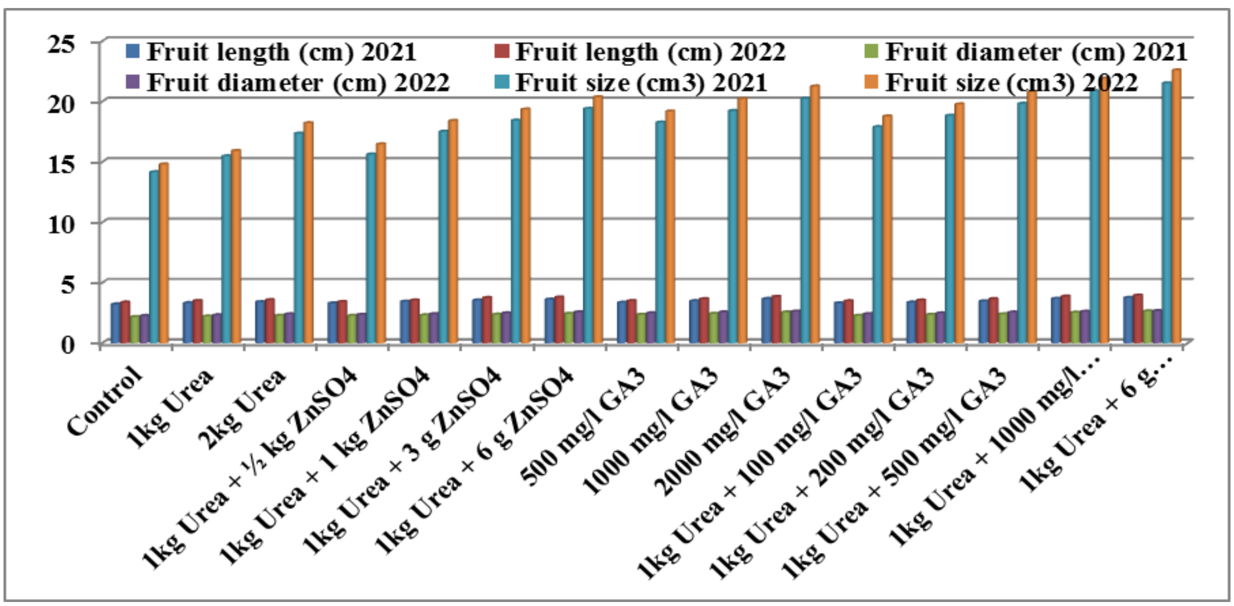

Fig. (1): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on fruit length, diameter and size of date palm cv." Barhi" during 2021 and 2022 seasons.

Table (2): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on fruit weight, yield/ palm and bunch weight of date palm cv." Barhi" during 2021 and 2022 seasons.

Treatments	Fruit weight (g)		yield/ palm (Kg)		Bunch weight (Kg)	
	2021	2022	2021	2022	2021	2022
Control	14.85	16.63	222.39	249.08	16.83	18.85
1kg Urea	16.88	18.91	252.72	283.05	19.13	21.43
2kg Urea	19.18	21.48	287.18	321.64	21.73	24.34
1kg Urea + ½ kg $ZnSO_4$	13.67	15.31	281.84	315.66	18.64	19.81
1kg Urea + 1 kg $ZnSO_4$	15.94	17.86	305.07	341.69	21.71	24.31
1kg Urea + 3 g $ZnSO_4$	17.72	19.84	314.52	352.26	22.90	25.66
1kg Urea + 6 g $ZnSO_4$	18.64	20.88	318.35	356.55	24.64	27.59
500 mg/l GA_3	15.98	17.90	305.84	342.54	21.76	24.37
1000 mg/l GA_3	17.76	19.89	315.30	353.14	22.96	25.72
2000 mg/l GA_3	18.69	20.93	324.06	364.07	24.70	27.66
1kg Urea + 100 mg/l GA_3	14.39	16.12	296.67	332.27	19.62	20.85
1kg Urea + 200 mg/l GA3	16.78	18.80	321.13	359.67	22.85	25.59
1kg Urea + 500 mg/l GA_3	18.65	20.88	331.07	370.80	24.11	27.01
1kg Urea + 1000 mg/l GA_3	19.62	21.98	335.11	375.32	24.94	29.04
1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3	20.59	23.06	340.26	382.27	26.46	30.76
$LSD_{(0.05)}$	**0.37**	**0.39**	**0.24**	**0.26**	**0.07**	**0.07**

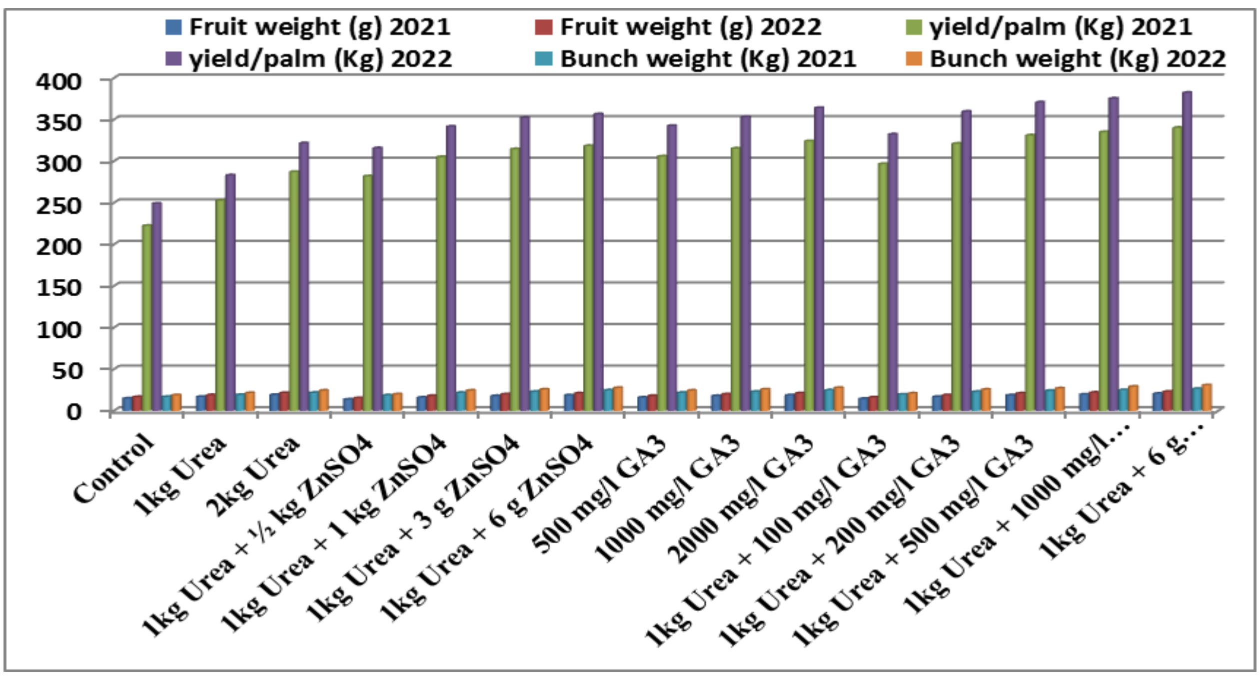

Fig. (2): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on fruit weight, yield/ palm and bunch weight of date palm cv." Barhi" during 2021 and 2022 seasons.

B) Chemical characterizes

The findings in **Table (3) and Fig. (3)** demonstrated the impact of varying urea, $ZnSO_4$, and GA_3 concentrations on the total sugars, reducing sugars, and non-reducing sugars of the date palm cultivar "Barhi" in the 2021 and 2022 seasons. The treatment mixed of 1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3 recorded the higher values of total sugars (43.17 and 48.35 %), reducing sugars (28.06 and 31.43 %), non-reducing sugars (15.11 and 16.92 %), this was followed by the treatment of 1kg urea + 1000 mg/l GA_3 the control treatment recorded the lower values of total sugars (26.88 and 29.13 %), reducing sugars (17.47 and 18.93 %), non-reducing sugars (9.41 and 10.20 %), respectively.

Total soluble solids (TSS), total acidity (TA), vitamin C, and tannins of date palm cv. "Barhi" were all affected by varying amounts of urea, ZnSO4, and GA3, as well as their combination, throughout the 2021 and 2022 seasons. **(Table 4 and Fig. 4).,**The treatment of 1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3 had a significant effect on TSS and VC recording the higher values of TSS (51.68 and 54.21 %) and vitamin c (6.34 and 6.66 mg/ 100 f. w.), while also recording the lower values of total acidity (TA) (0.15 and 0.16%) and tannins (160.26 and 168.27mg/ 100 f. w.), conversely the control treatment recorded the lower values of TSS (36.31 and 40.67 %) and vitamin C (3.61 and 3.92 mg/ 100 f. w.), and higher values of total acidity (0.35 and 0.37 %) and tannins (207.20 and 217.57 mg/ 100 f. w.), respectively.

The impact of varying urea, ZnSO4, and GA_3 concentrations on the N, P, K, and Zn (mg/l) percentages in date palm fruit is evident from **Table (5) and Fig. (5).** The results revealed that the treatment mixed of 1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3 recorded the higher values of N (1.80 and 1.89 %), P (0.49 and 0.52 %), K (1.92 and 2.02 %), and Zn (35.15 and 36.91 mg/l), this was followed by the treatment of 1kg urea + 1000 mg/l GA_3 the control treatment recorded the lower values of N (1.36 and 1.43 %), P (0.38 and 0.40 %), K (1.53 and 1.61 %), Zn (25.27 and 26.54 mg/l), respectively.

Since gibberellic acid and the carbohydrate partitioning of the reproductive organ are strongly correlated **(Wang *et al.*, 2020),** exogenous GA_3 injection probably increased the total soluble solids contents of treated fruits in comparison to control. The lowering of titratable acidity trends in the fruits of GA_3 treated panicles may be due to the conversion of organic acids into soluble sugars during fruit growth and maturation, as reported by **Souza *et al.* (2019)** in cashew. The use of GA_3 probably enhanced the physiological functions of the plant, which sped up the translocation of vital components in the fruits and the photosynthesis that followed in the rambutan fruits **(Ghosh *et al.*, 2009).** This clarifies why the fruits' sugar content increased. Previous studies have demonstrated that applying urea through leaves enhanced the uptake of other materials treated with urea. It is thought to be an essential carrier needed to increase the efficiency of the absorption of other materials **(Saied, 2015).** Gibberellin inhibits fruit ripening, which in turn delays enzymatic conversions and all ripening-related activities, which in turn serves to reduce the fruits' content of total soluble solids and sugars. Gibberellin has been demonstrated to reduce the percentage of reducing sugars, dissolved solids, and total sugars in fruits **(Al-Khafaji, 2014).** $ZnSO_4$ greatly increases fruit production by improving fruit quality and reducing fruit drop. Foliar treatment with 4–12 kg/ha zinc ($ZnSO_4$) increased the fruits' chemical and physical properties; however, the lowest Zn application showed better levels of juice and flavor, total sugar, and vitamin C **(Altaf and Khan, 2008).**

Table (3): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on total sugars, reducing sugars and non-reducing sugars of date palm cv." Barhi" during 2021 and 2022 seasons.

Treatments	Total sugar (g)		Reducing sugar (%)		Non-reducing sugar (%)	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**
Control	26.88	29.13	17.47	18.93	9.41	10.20
1kg Urea	29.13	32.62	18.93	21.20	10.20	11.42
2kg Urea	31.55	34.56	20.51	22.46	11.04	12.10
1kg Urea + ½ kg $ZnSO_4$	27.86	31.20	18.11	20.28	9.75	10.92
1kg Urea + 1 kg $ZnSO_4$	30.55	33.10	19.86	21.52	10.69	11.59
1kg Urea + 3 g $ZnSO_4$	33.10	37.07	21.52	24.10	11.59	12.97
1kg Urea + 6 g $ZnSO_4$	35.85	39.27	23.30	25.53	12.55	13.74
500 mg/l GA_3	31.90	35.73	20.74	23.22	11.17	12.51
1000 mg/l GA_3	35.73	40.01	23.22	26.01	12.51	14.00
2000 mg/l GA_3	39.78	44.55	25.86	28.96	13.92	15.59
1kg Urea + 100 mg/l GA_3	31.66	35.46	20.58	23.05	11.08	12.41
1kg Urea + 200 mg/l GA_3	33. 58	37.61	21.83	24.45	11.75	13.16
1kg Urea + 500 mg/l GA_3	37.61	42.12	24.45	27.38	13.16	14.74
1kg Urea + 1000 mg/l GA_3	41.87	46.89	27.22	30.48	14.65	16.41
1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3	43.17	48.35	28.06	31.43	15.11	16.92
$LSD_{(0.05)}$	**0.12**	**0.13**	**0.06**	**0.07**	**0.18**	**0.18**

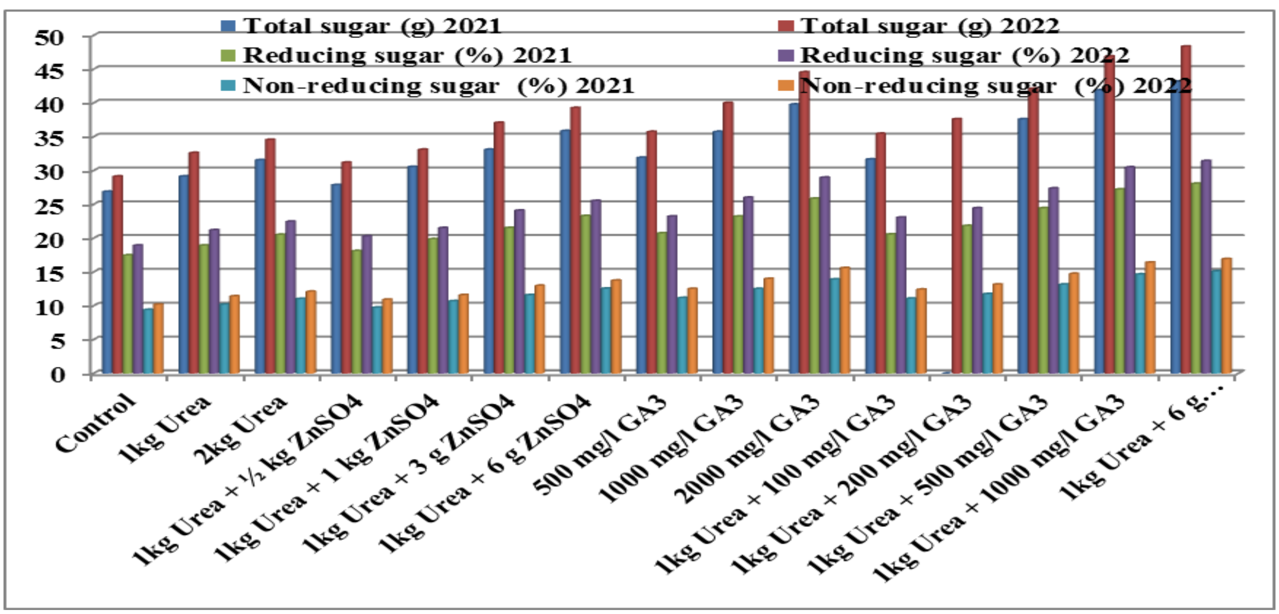

Fig. (3): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on total sugars, reducing sugars and non-reducing sugars of date palm cv." Barhi" during 2021 and 2022 seasons.

Table (4): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on TSS, TA, VC and tannins of date palm cv." Barhi" during 2021 and 2022 seasons.

Treatments	TSS (%)		TA (%)		VC (mg/ 100 f. w.)		Tannins (mg/ 100 f. w.)	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	36.31	40.67	0.35	0.37	3.61	3.92	207.20	217.57
1kg Urea	38.22	42.80	0.32	0.34	4.21	4.74	200.99	211.03
2kg Urea	40.23	45.06	0.30	0.31	5.49	5.76	194.77	204.51
1kg Urea + ½ kg $ZnSO_4$	38.37	40.29	0.26	0.28	4.45	5.66	190.94	200.48
1kg Urea + 1 kg $ZnSO_4$	41.26	43.32	0.25	0.27	4.68	5.83	188.92	198.37
1kg Urea + 3 g $ZnSO_4$	43.43	45.60	0.23	0.26	5.32	6.02	186.92	196.27
1kg Urea + 6 g $ZnSO_4$	45.72	48.01	0.21	0.22	5.91	6.20	181.39	190.46
500 mg/l GA_3	37.13	40.48	0.20	0.21	5.43	5.71	179.48	188.45
1000 mg/l GA_3	39.93	43.53	0.18	0.20	5.60	5.88	179.19	188.15
2000 mg/l GA_3	42.03	45.81	0.17	0.18	5.90	6.19	177.57	186.45
1kg Urea + 100 mg/l GA_3	44.24	48.23	0.23	0.24	5.50	5.78	173.82	182.50
1kg Urea + 200 mg/l GA_3	44.37	46.59	0.22	0.23	5.67	5.95	172.32	180.94
1kg Urea + 500 mg/l GA_3	46.70	49.04	0.21	0.22	5.84	6.14	168.69	177.13
1kg Urea + 1000 mg/l GA_3	49.16	51.62	0.18	0.19	6.03	6.33	165.12	173.37
1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3	51.68	54.21	0.15	0.16	6.34	6.66	160.26	168.27
$LSD_{(0.05)}$	**0.12**	**0.12**	**0.01**	**0.01**	**0.04**	**0.04**	**0.33**	**0.35**

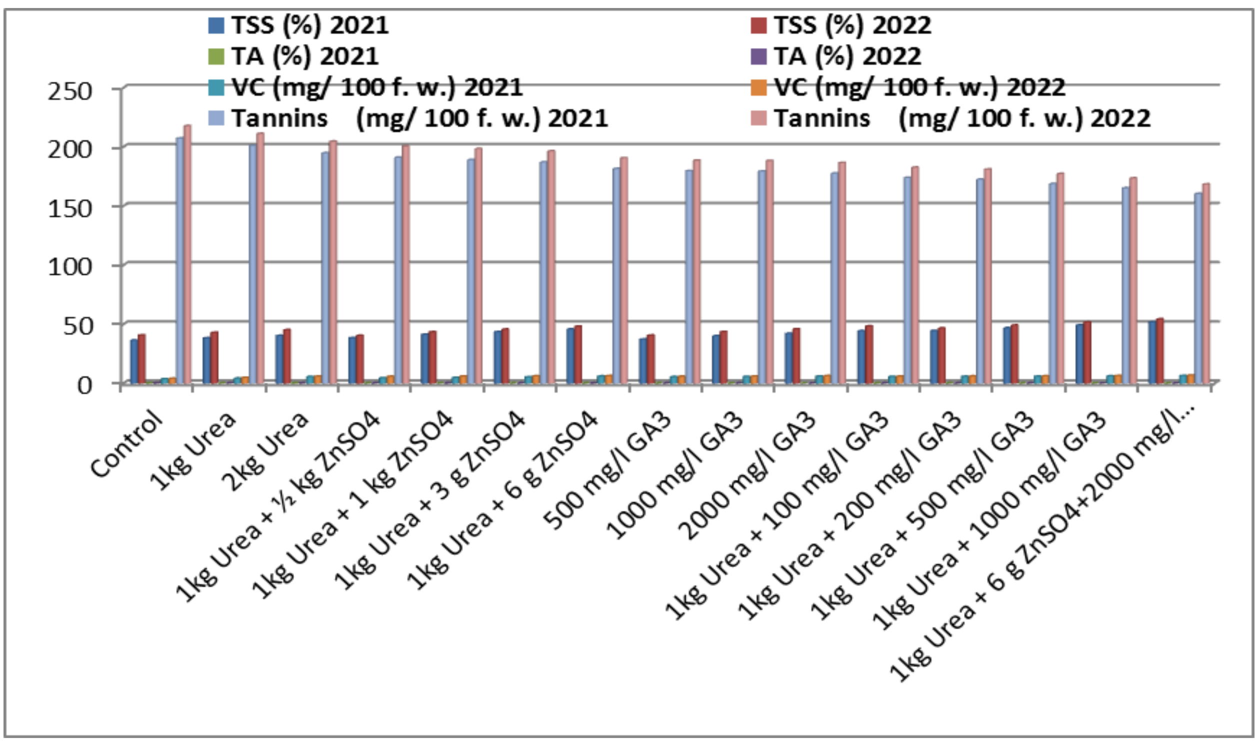

Fig. (4): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on TSS, TA, VC and tannins of date palm cv." Barhi" during 2021 and 2022 seasons.

Table (5): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on N%, P%, K% and Zn (mg/l) of date palm cv." Barhi" during 2021 and 2022 seasons.

Treatments	N (%)		P (%)		K (%)		Zn (mg/l)	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	1.36	1.43	0.38	0.40	1.53	1.61	25.27	26.54
1kg Urea	1.94	2.04	0.41	0.43	1.61	1.69	28.08	29.49
2kg Urea	2.00	2.10	0.42	0.44	1.66	1.75	29.42	30.89
1kg Urea + ½ kg $ZnSO_4$	1.52	1.59	0.41	0.43	1.62	1.70	28.73	30.17
1kg Urea + 1 kg $ZnSO_4$	1.56	1.64	0.43	0.45	1.67	1.75	30.25	31.76
1kg Urea + 3 g $ZnSO_4$	1.61	1.69	0.44	0.46	1.72	1.80	32.88	34.52
1kg Urea + 6 g $ZnSO_4$	1.66	1.74	0.45	0.47	1.77	1.86	34.45	36.17
500 mg/l GA_3	1.58	1.65	0.43	0.45	1.68	1.77	28.70	30.14
1000 mg/l GA_3	1.62	1.71	0.44	0.46	1.73	1.82	31.20	32.76
2000 mg/l GA_3	1.67	1.76	0.46	0.48	1.79	1.88	32.69	34.33
1kg Urea + 100 mg/l GA_3	1.59	1.67	0.43	0.46	1.70	1.79	27.86	29.25
1kg Urea + 200 mg/l GA_3	1.64	1.73	0.45	0.47	1.75	1.84	29.32	30.79
1kg Urea + 500 mg/l GA_3	1.69	1.78	0.46	0.48	1.81	1.90	30.87	32.41
1kg Urea + 1000 mg/l GA_3	1.75	1.83	0.48	0.50	1.86	1.96	33.55	35.23
1kg Urea + 6 g $ZnSO_4$+2000 mg/l GA_3	1.80	1.89	0.49	0.52	1.92	2.02	35.15	36.91
$LSD_{(0.05)}$	**0.004**	**0.004**	**0.02**	**0.02**	**0.01**	**0.01**	**0.75**	**0.78**

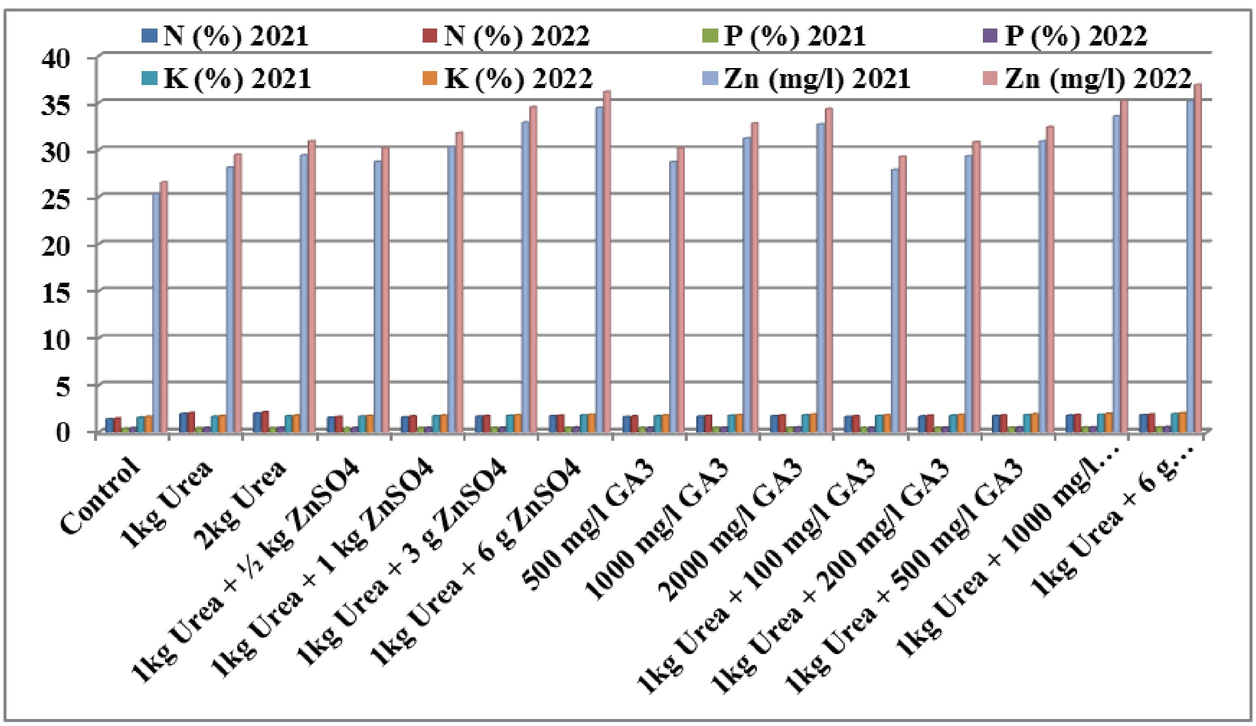

Fig. (5): Effect of different concentrations of urea, $ZnSO_4$ and GA_3 on N%, P%, K% and Zn (mg/l) of date palm cv." Barhi" during 2021 and 2022 seasons.

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الملخص العربي

محاولات لتحسين إنتاج وإثمار نخيل التمر من صنف برحي باستخدام بعض الأسمدة الكيميائية وتقنية الحقن في الجذع

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تم إجراء هذه التجربة خلال موسمين متتاليين 2021 و 2022 في بستان خاص في وادي النطرون، مصر .الصنف المستخدم في هذه الدراسة هو البارحي، الذي يبلغ من العمر 20 عامًا، وتم اختياره خلال موسمين زراعيين متتاليين .كانت مسافات الزراعة 8 في 8 أمتار تحت ظروف الري بالتنقيط .تمت عملية الحقن يدويًا على ارتفاع متر واحد من جذع النخلة، وتمت الإضافة مع الري .تصميم التجربة هو تصميم القطاعات كاملة العشوائية مع ثلاث مكررات .كل مكررة تحتوي على المعاملات: الكنترول، 1كجم يوريا، 2 كجم يوريا،1كجم يوريا + ½ كجم سلفات الزنك، 1كجم يوريا +1 كجم سلفات الزنك، 1 كجم يوريا +3 جم سلفات الزنك، 1كجم يوريا + 6 جم سلفات الزنك، 500 مجم/ لتر GA_3، 1000مجم/ لتر GA_3، 2000مجم/ لتر GA_3،1كجم يوريا + 100مجم/ لتر GA_3، 1كجم يوريا + 200 مجم/ لتر GA_3،1 كجم يوريا + 500 مجم/ لتر GA_3،1كجم يوريا +1000 مجم/ لتر GA_3، 1كجم يوريا + 6 جم سلفات الزنك + 2000 مجم/ لتر GA_3. أشارت النتائج إلى أن المعاملة الخليط من 1 كجم يوريا + 6 جم سلفات الزنك+ 2000 مجم/ لتر GA_3 سجلت أعلى متوسط قيم لجميع الخصائص الفيزيائية للثمار والمحصول/ نخلة، (طول الثمرة، قطر الثمرة، حجم الثمرة، وزن الثمرة، المحصول/ النخلة ووزن bunch)، تليها معاملة 1 كجم يوريا + 1000 مجم/ لتر GA_3، مقارنة بمعاملة الكنترول التي سجلت أقل متوسط قيم لهذه الصفات. في هذا الصدد، سجلت المعاملة الخليط من 1 كجم يوريا + 6 جم سلفات الزنك+ 2000 مجم/ لترGA_3 سجلت أعلى متوسط قيم لجميع الخصائص الكيميائية للثمار (السكريات الكلية، السكريات المختزلة، السكريات غير المختزلة، TSS، فيتامينC ، والعناصر المعدنية، النيتروجين، الفوسفور، البوتاسيوم، الزنك)، مقارنة بمعاملة الكنترول التي سجلت أقل القيم لهذه الصفات، بينما سجلت القيم الأعلى للحموضة الكلية والتانينات، على التوالي.

الكلمات المفتاحية : نخيل البلح ، اليوريا ، الجبيربيلين ، سلفات الزنك ، المحصول، التركيب الكيمائي.