Minimizing Mineral Nitrogen Fertilizers Losses to Mango Trees Using Urea-formaldehyde Slow Release Fertilizer and Nitrobein Biofertilizer Under New Valley Conditions

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ABSTRACT

A significant amount of chemical fertilizers are lost due to their widespread use in regions with high temperatures, which also pollute the ecosystem and lower soil fertility. Consequently, using highly nutritious, environmentally friendly fertilizers that are also compatible with the soil and environment is imperative. The application of fertilizers that give macro- and micronutrients to fruit trees is one of the key components of biofertilizer and nitrogen slow release fertilizers in agriculture. A two-year trial was conducted during the 2021 and 2022 seasons in Keitt mango trees orchard about five years old grown in sandy soil under a drip irrigation system from a well at a private orchard, in New Valley Governorate, Egypt. The main objective of this work is to study the effect of three rates of Nitrobein biofertilizer (0.0, 200, and 400 g/tree) and four rates of urea-formaldehyde fertilizer (0.0, 500, 750, and 1000 g/tree) on vegetative growth parameters, yield and fruit quality of Keitt mango trees. Briefly, Nitrobein and urea-formaldehyde treatments enhanced all studied growth, yield, and fruit quality traits. Nitrobein biofertilizer at 400 g/tree combined with urea-formaldehyde fertilizer at 1000 g/tree treatment proved to be the most efficient treatment in this respect.

keywords: Keitt mango; Nitrobein biofertilizer; Urea-formaldehyde slow release; Heat stress.

INTRODUCTION

Mango (*Mangifera indica L.*), the widely acclaimed fruit in Egypt, is known for its delicious taste, excellent flavor, and rich nutritional content, especially vitamins A and C. Mango currently ranks fifth in total production among major fruit crops worldwide (Mansour *et al.*, 2008 and Preethi *et al.*, 2021). Keitt mango cultivar is grown successfully under Egyptian conditions (Mohamed *et al.*, 2016), and its yield production comes in the late season ripening. The fruit generally has typically ripened from August until September and October, making it one of the more valued late-season varieties, especially in the newly reclaimed areas so it had high fertilizer requirements (Baiea *et al.*, 2018). It is well known that many problems face and affect mango tree productivity, especially in the newly reclaimed lands. Such tree growth under soil conditions is poorly yielded with low fruit quality due to a lack of their mineral constituents (Abd EL-Monem *et al.*, 2009). In principle, fertilization management aims to replace or renew the nutritional elements removed by the crop. Intensive fertilization is required to minimize nutrient deficiencies that might induce alternate bearing or stoichiometric stress, which restrict mango productivity. Nitrogen is an essential nutrient that may affect many parameters of mango tree productivity, such as vegetative growth (Raj and Rao, 2006), alternate bearing (El-Motaium *et al.*, 2019), photosynthesis (Urban *et al.*, 2008), quality of shoot bearing and panicles (Singh *et al.*, 1991), embryo abortion (Singh, 2005), fruit color and anthracnose disease (Nguyen *et al.*, 2004). Deficient nitrogen conditions may depress the vegetative and reproductive development of mango trees, whereas excess nitrogen may be harmful because excess vegetative growth impairs floral differentiation (Pinto *et al.*, 2007). The delicate threshold of mango's nitrogen requirements for optimal production is yet to be elucidated. In this respect, previous studies suggested that as much as 40-50% of the applied nitrogen is not available to the tree due to leaching, denitrification, and volatilization (Davies & Albrigo, 1994; Kjonaas, 1999 and EL-Aila *et al.*, 2001). However, the conditions that affect volatilization are relevant across climates and regions. The volatilization of ammonia is the main reaction that decreases the efficiency of nitrogen fertilization in high-temperature regions to reduce losses. High soil pH and high temperatures cause higher rates of volatilization because they increase soil concentrations of ammonia dissolved in soil water and warm soil water cannot hold as much ammonia gas (Rawluk *et al.*, 2001).

So, it is important to improve the efficiency of nitrogen fertilizer by using other nitrogen forms, techniques, and alternative systems under heat-stress conditions in the New Valley Governorate, Egypt. Out of those, the application of controlled release N fertilizers i.e. urea formaldehyde developed mainly to reduce the replication additive number per year, minimize production cost, improve the efficiency of N used by trees, reduce N leaching and control nitrate pollution (Abd EL-Monem *et al.*, 2009 and Soaud *et al.*, 2011). Urea-formaldehyde is one of the slow-release

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nitrogen fertilizers, which contains (38% N), 1.5% as urea nitrogen that provides an immediate available source (Abd EL-Monem *et al.,* 2009). Furthermore, Mohamed and Ebeed (2006) found that fertilizing the trees of mango cvs Figri Kelan and Keitt with N at 1000 g/tree as sulfur-coated urea was beneficial in obtaining an economical yield and improving fruit quality. Merwad *et al.* (2014) mentioned that the application of the dual save bio-fertilizers (VAM fungi at a high rate and N in sulfur coated urea form) to Valencia orange trees is highly recommended to enhance tree growth and consequently produce a high yield with good marketing quality. Also, Abd EL-Monem *et al.* (2009) recommended that using urea-formaldehyde at 750 gm N/tree on Fagri Kalan mango trees enhanced nitrogen and potassium content, number of fruits/tree, and yield, also improved fruit quality as fruit weight and total soluble solids compared with the traditional urea.

Similarly, considerable attention has been attracted to the possibilities of using Nitrobein. It is a commercial nitrogenous bio-fertilizer that contains special bacteria (*Azotobacter choroccocum*) that have the ability for free nitrogen fixation. The use of bio-fertilizers reduced rates of mineral fertilizers (Saber, 1994). It is worth stating that biofertilizers do not replace mineral fertilizers but significantly reduce their application (Ishac, 1989 and Saber, 1993). It is preferred to reduce environmental pollution, and salinity and decrease the amounts of mineral fertilizers, then it reduces the cost of fertilizers and keeps the environment clean for coming generations (Kabeel *et al.,* 2005). Furthermore, many studies and numerous attempts were made by several researchers to replace partially of N, P, and K chemical fertilizers using some biofertilizers, however, they pointed out that the use of biostimulants significantly improved tree growth, leaf nutritional status, and fruit properties and increased tree yield, Ahmed *et al.* (1997) and Akl *et al.* (1997) on grapevine; Fathi *et al.* (2002) on apple; Mahmoud and Mahmoud (1999) on peach and Shddad *et al.* (2005) on apricot.

Hence, this investigation aimed to study the effect of three levels of Nitrobein biofertilizer and four rates of Urea-formaldehyde fertilizer as well as their combinations on vegetative growth parameters, yield, and fruit quality of Keitt mango trees under heat stress conditions.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2021 and 2022 on five years old Keitt mango trees grafted on Succary seedling rootstock and planted 4 x 2 meters apart under sandy soil conditions, irrigated with a drip irrigation system in a private orchard, at New Valley Governorate, Egypt. Physical and chemical analysis of the experimental soil is shown in Table (1). Meanwhile, the chemical analysis of the used water for irrigation is recorded in Table (2).

The present study was a factorial experiment with two factors i.e. the first factor consisted of three levels of Nitrobein (0.0, 200, and 400 gm. /tree), and the second one involved four rate of urea-formaldehyde (0.0, 500, 750, and 1000 gm. /tree). The experiment was designed as a randomized complete block design with three replicates for each treatment and each replicate was represented by two trees. However, the traditional urea dose was divided into three equal doses in (early March, May, and July), while urea-formaldehyde treatments were added as soil application at 20 cm depth and 50 cm from the trunk at one time in early December and covered with soil. Moreover, bio-fertilizer (Nitrobein) was soil added at 15cm depth and 50 cm from the trunk in three equal doses (early December, March, and early June).

The following characteristics were measured

Vegetative measurements

Four main branches well distributed around the tree periphery (each toward one direction) were carefully chosen and labeled then in late September of each season the shoot length, No. leaves/shoot, leaf area using a leaf area meter (model cl – 203, USA), and total chlorophyll contents in fresh leaves using (a Minolta meter SPAD- 502) were measured.

Flowering and fruiting parameters

At full bloom, twenty panicles/trees distributed in the four directions were chosen at random and tagged. The following parameters were determined:

Panicle length and width (cm)

Were measured at the full bloom stage (first week of April).

Fruit set percentage

The number of fruit set/panicles (last week of April) was counted two weeks after petal fall.

Fruit retention percentage

It was determined at harvesting time by the following equation: Fruit retention percentage = (number of mature fruit per panicle ⁄ number of fruit set per panicle) X100.

Yield

Number of fruits/tree

At maturity, the number of fruits that were born on each considered tree was counted.

Table 1. Analysis of experimental soil

Soil Depth(cm)	Texture Class	pH Soil past	EC dS/m	$CaCO_3$ %	Soluble cations (meq/l)				soluble anions (meq/l)		
					Ca^{2+}	K^+	Na^+	Mg^{2+}	Cl^-	SO_4^{2-}	CO_3^{2-} HCO_3^-
0-30	Sand	7.86	2.9	8.05	7.9	1.0	18.0	3.1	20	9.8	0.2
30-60	Sand	7.89	3.1	7.15	8.2	1.2	18.5	3.1	20.8	10.0	0.2

Table 2. Chemical analysis of water used for irrigation

pH	EC dS/m	Soluble cations (meq/l)				soluble anions (meq/l)		
		Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	CO_3^{2-}	HCO_3^-
7.06	0.33	0.58	0.92	1.06	0.60	1.70	-	1.18

Yield (kg/tree)

At harvesting time last week of October, fruits of each tree (replicate) were weighed (kg) per tree.

Fruit physical properties

The average values of fruit weight (g), fruit volume (cm^3), fruit length (cm), fruit diameter (cm), fruit firmness (Ib/$inch^2$) which were determined by using a penetrometer (pressure tester), flesh weight (g), and stone weight (g) were recorded.

Fruit chemical properties

According to Hussein and Youssef (1972), fruit juice was extracted, and the proportion of fruit juice's total soluble solids percentage was determined using a Carl Zeiss hand refractometer. Fruit juice total acidity was estimated as a percentage of anhydrous citric acid according to the method described by A.O.A.C. (1985). The total and reducing sugars of the fruit pulp were determined colorimetrically according to the method described by Dubois *et al.* (1956). Total carbohydrates were determined in mature shoot dry samples (0.1gm) photometrically at 490 Mm according to the method described by A.O.A.C. (1985).

Leaf mineral contents

Leaf samples were taken last week of September from the middle portion of current season shoots. The leaves were thoroughly washed with distilled water, oven-dried at 70 $C^{o,}$ and digested with a sulphuric and perchloric acid mixture (3:1 v/v). The following nutrient elements were determined.

Total nitrogen content was determined by the modified micro-Kjeldahl
method as described by Pregl (1945). Total phosphorus content was determined using a spectrophotometer at 882 UV according to the method described by Murphy and Riely (1962). Furthermore, Leaf K, Fe, Mn, and Zn contents were determined by using an Atomic Absorption spectrophotometer (Perkin – Elmer Model 3300).

Statistical Analysis:

All the obtained data in the first and second seasons of the study were statistically analyzed using the analysis of variance method according to Snedecor and Cochran (1989). However, means were distinguished by Duncan's multiple range tests (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Vegetative growth

Shoot length and No. leaves/shoot

The presented results in Table (3) reveal that, the highest significant value of shoot length and No. leaves/shoots were obtained when the trees were fertilized with Nitrobein biofertilizer at 400g/tree. Meanwhile, the lowest shoot length and number of leaves/shoot were obtained with control treatment in the first and second seasons.

Furthermore, urea-formaldehyde fertilizer treatments, in general increased tree shoot length and number of leaves/shoot as compared with control treatment in both seasons. Generally, 1000g/tree urea-formaldehyde fertilizer treatment proved to be the superior treatment in this respect.

In addition, the interaction between nitrobein biofertilizer and urea-formaldehyde fertilizer on shoot length and No. leaves/shoot, data indicated that the maximum shoot length and No. leaves/shoot was detected with the combination of Nitrobein biofertilizer at 400g/tree combined with urea-formaldehyde fertilizer at 1000g/tree in both seasons.

Leaf area and Total chlorophyll

Table(4) illustrated that nitrobein biofertilizer treatment at 400g/tree induced a high positive effect on leaf area and total chlorophyll of Keitt mango trees as compared with the control treatment in both seasons.

Table 3. Effect of Nitrobein, urea-formaldehyde, and their interaction on shoot length and number of leaves/shoot of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Shoot length (cm)				No. leaves/shoot			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season;2021							
Control	19.50f	23.75c-e	25.75c	23.00C	11.50g	15.30d-f	17.20cd	14.67D
Urea-formaldehyde 500 gm/tree	20.75f	25.00cd	25.50c	23.75C	13.75f	16.70cd	17.90c	16.12C
Urea-formaldehyde 750 gm/tree	22.75e	28.25b	28.75b	26.58B	14.50ef	20.00b	21.50ab	18.67B
Urea-formaldehyde 1000 gm/tree	23.25de	30.00ab	31.00a	28.08A	16.00c-e	21.50ab	22.30a	19.93A
Mean	21.56C	26.75B	27.75A		13.94C	18.38B	19.73A	
	Second season; 2022							
Control	20.05g	24.10c-e	25.85c	23.33C	20.50g	15.40d-f	18.40bc	14.43D
Urea-formaldehyde 500 gm/tree	21.25fg	25.60cd	29.10b	25.33B	14.30fg	17.10b-d	18.75b	16.72C
Urea-formaldehyde 750 gm/tree	22.95ef	26.10c	28.90b	25.98B	15.10ef	21.30a	21.90a	19.43B
Urea-formaldehyde 1000 gm/tree	23.70de	30.80ab	31.20a	28.57A	16.50c-e	22.40a	23.05a	20.65A
Mean	21.99C	26.65B	28.78A		14.60C	19.05B	20.53A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level

Moreover, urea-formaldehyde fertilizer increased leaf area and total chlorophyll as compared with the check treatment (control) in the first and second seasons of study. Shortly, urea-formaldehyde fertilizer at 1000g/tree treatment showed superiority in this concern.

However, the interaction between the two tested factors showed that Nitrobein biofertilizer combined with urea-formaldehyde fertilizer enhanced leaf area and total chlorophyll. Briefly, 400g/tree Nitrobein biofertilizer coupled with 1000g/tree urea-formaldehyde fertilizer treatment proved to be the superior treatment in this respect. Other combinations showed an intermediate value in this respect.

The improved effect of Nitrobein biofertilizer on increasing the vegetative growth of Keitt mango trees is due to that Azotobacter is a free-living fixing rhizobacterium, which does not form a symbiotic relationship with plants (Masarirambi *et al.*, 2012).

Furthermore, because Azotobacter can create growth hormones like auxins and gibberellins, which promote root growth, additional root areas may become available for rhizobia to infect. Increased nodulation, Nitrogen fixation, and eventually higher crop yields would follow from this (Verma *et al.*, 2014). These results are in harmony with several reports as Mansour (1998) suggested applying Nitrogen to Anna apple plants since it improved growth measurements. Also, Kabeel *et al.* (2005) found that on "Canino" apricot trees, all treatments with biofertilizers (Nitrobein, Enciabein, and Phosphorene) had a positive effect and significantly increased all measures of vegetative growth, including

Table 4. Effect of Nitrobein, urea-formaldehyde, and their interaction on leaf area and total chlorophyll of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Leaf area (cm^2)				Total chlorophyll			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season; 2021							
Control	57.97g	63.43e	66.38cd	62.59C	43.17f	45.20d	45.42d	44.60C
Urea-formaldehyde 500 gm/tree	60.31f	66.30cd	67.12c	64.57B	43.82e	45.30d	45.52d	44.88C
Urea-formaldehyde 750 gm/tree	61.25f	67.30c	68.21bc	65.59B	44.95d	46.25c	46.70c	45.96B
Urea-formaldehyde 1000 gm/tree	64.34de	70.10ab	71.45a	68.63A	45.05d	47.36b	47.98a	46.80A
Mean	60.96C	66.78B	68.29A		44.25C	46.02B	46.40A	
	Second season; 2022							
Control	58.75h	63.70ef	66.30cd	62.92D	43.38g	45.59e	45.60e	44.86C
Urea-formaldehyde 500 gm/tree	61.40g	64.90de	67.20bc	64.50C	44.15f	45.62e	45.65e	45.14C
Urea-formaldehyde 750 gm/tree	62.05fg	67.15bc	68.55b	65.92B	45.25e	46.33d	46.95c	46.18B
Urea-formaldehyde 1000 gm/tree	65.15c-e	70.80a	71.65a	69.20A	45.28e	47.55b	48.36a	47.06A
Mean	61.84C	66.64B	68.43A		44.52C	46.27B	46.64A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

shoot length, number of leaves per shoot, leaf area, leaf chlorophyll content, shoot thickness, and shoot diameter increment percentage. Furthermore, the advantage of treated Keitt mango trees with controlled-release nitrogen fertilizers, such as urea-formaldehyde, over untreated Keitt mango trees may be ascribed to their ability to control nitrogen release following the needs of the plants. Additionally, because of their low activity index, they provided the highest values of residual nitrogen in the soil as opposed to fast release (urea), which provided the lowest amounts of accessible nitrogen that remained in the soil (Mikkelsen *et al.*, 1994). Moreover, the slow rate of coated urea may be the cause, as this enhanced plant utilization and decreased long-term nitrogen nutrition leaching, ultimately leading to better vegetative development. Furthermore, nitrogen plays a crucial part in the growth and development of every living tissue in plants. It is also thought to be a constituent of chlorophyll, protoplasm, protein, and nucleic acid, which leads to a rise in cell size and number as well as an increase in growth (Said, 1998 and El-Naggar *et al.*, 2002). These results are in line with those stated by Kandil *et al.* (2010) stated that applying the three slow-release N fertilizers to the "Mit Ghamr" peach tree was a better option than using the fast-release one for increasing leaf area and shoot length. Hagagy *et al.* (2023) on Keitt mango transplants found that application of different nitrogen fertilizers in the form of Nitrobein+ urea (combination of bio and chemical fertilizer) followed by coated urea (slow-release fertilizer) enhanced improvement in most parameters of plant dimensions, vegetative growth, and chlorophyll A and B.

Flowering and fruiting parameters

Panicle length and width

Table (5) indicates that a high Nitrobein biofertilizer rate induced a higher positive effect on panicle length and width as compared with other rates in both seasons of the study. Briefly, 400g Nitrobein biofertilizer/tree treatment proved to be the superior treatment in this concern.

Moreover, Urea-formaldehyde fertilizer increased panicle length and width as compared with the control treatment in both seasons of the study. Meanwhile, 1000g/tree Urea-formaldehyde fertilizer treatment showed superiority in this respect.

However, the combination between Nitrobein biofertilizer and Urea-formaldehyde fertilizer led to a significant increase in panicle length and width, as compared with control, in both seasons. Generally, 400g Nitrobein biofertilizer/tree combined with 1000g Urea-formaldehyde fertilizer/tree treatment proved to be the most effective treatment in this respect.

Fruit set (%) and fruit retained (%)

Data of both seasons showed a significant increase in fruit set % and fruit retained % by increasing the Nitrobein biofertilizer rates from 200g/tree to 400g/tree (Table 6). The highest significant trees fruit set (19.31 and 19.60 %) and fruit retained (14.95 and 14.70 %) were obtained by applying 400g Nitrobein biofertilizer/tree in both seasons, respectively. Meanwhile, the lowest significant fruit set (16.30 and 16.54 %) and fruit retained (13.60 and 13.00 %) were obtained with control treatment in the 2021 and 2022 seasons, respectively.

Table 5. Effect of Nitrobein, Urea-formaldehyde, and their interaction on panicle length and panicle width of Keitt mango trees (2021 and 2022 seasons)

	Panicle length (cm)				Panicle width (cm)			
	Nitrobein biofertilizer							
Urea-formaldehyde fertilizer	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**
	First season;2021							
Control	14.24j	15.35i	15.76hi	15.12D	5.00h	5.31h	5.76g	5.36D
Urea-formaldehyde 500 gm/tree	16.18gh	16.73fg	17.45d-f	16.78C	6.15f	6.45ef	6.78e	6.46C
Urea-formaldehyde 750 gm/tree	17.11ef	17.68de	18.63bc	17.80B	7.23d	7.68c	7.76c	7.55B
Urea-formaldehyde 1000 gm/tree	18.15cd	19.29ab	19.60a	19.01A	7.86c	8.45b	9.16a	8.49A
Mean	16.42C	17.26B	17.86A		6.56C	6.97B	7.37A	
	Second season;2022							
Control	14.80i	15.70h	16.20gh	15.57D	5.40h	5.70h	6.20g	5.77D
Urea-formaldehyde 500 gm/tree	16.65fg	17.20ef	17.85c-e	17.23C	6.70f	6.90ef	7.25e	6.95C
Urea-formaldehyde 750 gm/tree	17.45de	18.15cd	19.20b	18.27B	7.65d	8.05c	7.95cd	7.88B
Urea-formaldehyde 1000 gm/tree	18.50c	19.65ab	20.05a	19.40A	7.90cd	8.75b	9.35a	8.67A
Mean	16.85C	17.68B	18.33A		6.91C	7.35B	7.69A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Table 6. Effect of Nitrobein, Urea-formaldehyde, and their interaction on fruit set % and fruit retained % of Keitt mango trees (2021 and 2022 seasons)

	Fruit set (%)				Fruit retained (%)			
	Nitrobein biofertilizer							
Urea-formaldehyde fertilizer	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**
	First season;2021							
Control	15.33h	17.49de	18.60c	17.14D	13.16f	13.21f	15.01ab	13.80B
Urea-formaldehyde 500 gm/tree	16.03g	17.65d	18.90bc	17.52C	13.78de	13.98d	14.69c	14.15A
Urea-formaldehyde 750 gm/tree	16.73f	18.91bc	19.30b	18.31B	13.85de	13.85de	14.89bc	14.20A
Urea-formaldehyde 1000 gm/tree	17.11ef	20.05a	20.45a	19.20A	13.62e	13.88de	15.20a	14.23A
Mean	16.30C	18.52B	19.31A		13.60B	13.73B	14.95A	
	Second season; 2022							
Control	15.55g	17.67d	18.90c	17.37D	12.52f	12.78e	13.80b	13.03B
Urea-formaldehyde 500 gm/tree	16.25f	17.75d	19.20c	17.43C	13.18d	13.40cd	15.00a	13.86A
Urea-formaldehyde 750 gm/tree	16.95e	19.25c	19.70b	18.63B	13.15d	13.60bc	14.90a	13.88A
Urea-formaldehyde 1000 gm/tree	17.39de	20.35a	20.60a	19.45A	13.16d	13.35cd	15.10a	13.87A
Mean	16.54C	18.76B	19.60A		13.00C	13.28B	14.70A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level

Moreover, urea-formaldehyde fertilizer enhanced fruit set % and fruit retained % as compared with control treatment in both seasons of study. Generally, 1000g/tree urea-formaldehyde fertilizer treatment scored fruit set % (19.20 and 19.45 %) for fruit set against (17.14 and 17.37%) for the control treatment. Meanwhile, no statistical difference was found between the three treatments of urea-formaldehyde for fruit retained % in both seasons.

The interaction between the two tested factors indicated that Nitrobein biofertilizer combined with urea-formaldehyde fertilizer treatments succeeded in increasing fruit set % and fruit retained % in the first and second seasons. Briefly, 400g Nitrobein biofertilizer/tree treatment coupled with 1000g urea-formaldehyde fertilizer/tree treatment proved to be the most efficient treatment in this respect.

Number of fruits/tree and yield (kg/tree)

Table (7) illustrates that the number of fruits/trees and yield (kg/tree) increased significantly with increasing Nitrobein biofertilizer rates. Generally, 400g Nitrobein biofertilizer/tree scored the highest number of fruits/tree and yield as compared with control treatment in the 2021 and 2022 seasons, respectively.

Moreover, Keitt mango tree production as number of fruits/tree and yield (kg/tree) was influenced significantly by urea-formaldehyde fertilizer treatments as compared with the control treatment in both seasons of study. Briefly, 1000g/tree urea-formaldehyde fertilizer scored the maximum number of fruits/tree and yield compared with other treatments including control in the 2021 and 2022 seasons, respectively.

However, the interaction between Nitrobein biofertilizer and urea-formaldehyde fertilizer treatments induced a highly positive effect on the number of fruits/trees and yield in both seasons. Briefly, in both seasons combinations of 400g Nitrobein biofertilizer/tree plus 1000g urea-formaldehyde fertilizer/tree treatment surpassed other treatments in improving the number of fruits/tree and yield as kg/tree.

Fruit physical properties

Fruit weight and fruit volume

Table (8) indicates that fruit weight and fruit volume were significantly affected by increasing the Nitrobein biofertilizer, as 400g/tree proved to be the superior treatment in this respect.

Moreover, urea-formaldehyde fertilizer treatments exerted a high positive effect on fruit weight and fruit volume as compared with control in both seasons of study. Briefly, 1000g/tree urea-formaldehyde fertilizer treatment surpassed other treatments in fruit weight and fruit volume in both seasons.

In addition, the interaction between Nitrobein biofertilizer rates and urea-formaldehyde fertilizer rates treatments showed that Nitrobein biofertilizer at 400g/tree treatment coupled with 1000g/tree urea-formaldehyde fertilizer treatment recorded the maximum value of fruit weight and fruit volume in both seasons of study.

Table 7. Effect of Nitrobein, urea-formaldehyde, and their interaction on the number of fruits/tree and yield (kg/tree) of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Number of fruits/tree				Yield (kg/tree)			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season;2021							
Control	58.50g	60.50de	58.50g	59.17D	13.96h	16.76fg	19.38d	16.70D
Urea-formaldehyde 500 gm/tree	60.00ef	61.00c-e	61.75b-d	60.92C	14.67h	17.83e	22.83c	18.44C
Urea-formaldehyde 750 gm/tree	59.25fg	61.75b-d	64.00a	61.67B	16.01g	19.06d	24.25b	19.77B
Urea-formaldehyde 1000 gm/tree	62.00bc	62.50b	64.25a	62.92A	17.47ef	18.20e	25.25a	20.31A
Mean	59.04C	61.44B	62.13A		15.53C	17.96B	22.93A	
	Second season; 2022							
Control	59.75f	61.75d	59.75f	60.42D	15.52j	18.44g	21.12d	18.36D
Urea-formaldehyde 500 gm/tree	61.25de	62.25cd	63.00bc	62.17C	16.35i	19.60ef	24.67c	20.21C
Urea-formaldehyde 750 gm/tree	60.5ef	63.00bc	65.25a	62.92B	17.59h	20.86d	26.14b	21.53B
Urea-formaldehyde 1000 gm/tree	63.25bc	63.75b	65.50a	64.17A	19.24fg	20.32de	27.66a	22.41A
Mean	61.19C	62.69B	63.38A		17.18C	19.80B	24.90A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Table 8. Effect of Nitrobein, urea-formaldehyde, and their interaction on fruit weight and fruit volume of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Fruit weight (g.)				Fruit volume (cm^3)			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season; 2021							
Control	238.55k	277.101h	331.25d	282.30D	252.10k	287.10h	332.50f	290.57D
Urea-formaldehyde 500 gm/tree	244.55j	292.30f	369.65c	302.17C	268.00j	307.50g	347.00e	307.50C
Urea-formaldehyde 750 gm/tree	270.25i	308.65e	378.90b	319.27B	269.20j	376.00c	356.00d	333.73B
Urea-formaldehyde 1000 gm/tree.	281.75g	291.20f	393.05a	322.00A	273.20i	408.00b	416.00a	365.73A
Mean	258.78C	292.31B	368.21A		265.63C	344.65B	362.88A	
	Second season; 2022							
Control	259.80l	298.60i	353.50d	303.97D	256.00k	297.00h	341.00f	298.00D
Urea-formaldehyde 500 gm/tree	266.95k	314.80g	391.65c	324.47C	276.00j	323.00g	364.00e	321.00C
Urea-formaldehyde 750 gm/tree	290.75j	331.15e	400.65b	340.85B	285.00i	394.00c	371.00d	350.00B
Urea-formaldehyde 1000 gm/tree.	304.20h	318.70f	422.30a	348.40A	288.00i	420.00b	427.00a	378.33A
Mean	280.43C	318.81B	392.03A		276.55C	358.50B	375.75A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level

Fruit length and fruit diameter

Table (9) illustrates that fruit length and fruit diameter were positively affected by increasing Nitrobein biofertilizer rates. The highest fruit length and diameter values were scored with Nitrobein biofertilizer treatment at 400g/tree treatment in both seasons.

Moreover, urea-formaldehyde fertilizer at the rate of 1000g/tree proved to be the best treatment compared with the control treatment in the first and second seasons.

Furthermore, the interaction between Nitrobein biofertilizer rates and urea-formaldehyde fertilizer rates treatments showed that Nitrobein biofertilizer treatment at 400g/tree supplemented with 1000g/tree urea-formaldehyde fertilizer treatment scored the highest values of fruit length and fruit diameter.

Fruit firmness, fruit flesh weight, and stone weight

Table (10) indicates that by increasing Nitrobein biofertilizer rates, the fruit firmness, fruit flesh weight, and stone weight increased significantly. Briefly, the highest Nitrobein biofertilizer rate at 400g/tree had the highest significant fruit firmness, fruit flesh weight, and stone weight in both seasons.

Moreover, urea-formaldehyde fertilizer treatments had a statistically positive effect on fruit firmness, fruit flesh weight, and stone weight in both seasons. Briefly, 1000g/tree urea-formaldehyde fertilizer gave higher fruit firmness, fruit flesh weight, and stone weight compared with the control treatment in the first and second seasons.

However, the interaction between Nitrobein biofertilizer rates and urea-formaldehyde fertilizer rates treatments demonstrated that 400g Nitrobein biofertilizer/tree combined with 1000g urea-formaldehyde fertilizer/tree gave a the highest positive effect on fruit firmness, fruit flesh weight, and stone weight in both seasons.

The increment in yield by Nitrobein biofertilizer and urea-formaldehyde fertilizer and their interaction treatments are aresult of increasing fruit numbers per tree and fruit weight.

The potential effects of Nitrobein biofertilizer and urea-formaldehyde fertilizer on fruit quality and yield are consistent with the findings of Kabeel *et al.* (2005) who concluded that all the treatments under their investigation had a positive and significant impact on fruiting characteristics of "Canino" apricot trees and the best and most effectively were ordinary mineral fertilization plus Nitrobein + Enciabein + Phosphorene and ordinary mineral fertilization plus Nitrobein + Enciabein. El-Alakmy *et al.* (2018) studied Kalamata olive trees and observed that applying 50 g of Nitrobein biofertilizer (N-fixing bacteria) to the trees along with a 1.5% concentration of an amino acid mixture (marketed as Protamine) increased blooming, yield, and fruit quality.

Table 9. Effect of Nitrobein, urea-formaldehyde, and their interaction on fruit length and fruit diameter of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Fruit length (cm)				Fruit diameter (cm)			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season; 2021							
Control	9.33h	9.49gh	10.07ef	9.63D	6.61e	6.86de	8.06ab	7.18D
Urea-formaldehyde 500 gm/tree	9.42gh	10.26e	10.78d	10.15C	6.97de	7.09d	8.28a	7.44C
Urea-formaldehyde 750 gm/tree	9.75fg	11.09cd	11.47b	10.77B	7.13d	7.78bc	8.12ab	7.67B
Urea-formaldehyde 1000 gm/tree.	9.87f	11.28bc	11.84a	10.99A	7.58c	7.94a-c	8.26a	7.93A
Mean	9.59C	10.53B	11.04A		7.07C	7.41B	8.18A	
	Second season; 2022							
Control	9.48e	10.15d	10.20d	9.94D	6.75g	7.05fg	8.20b-d	7.33C
Urea-formaldehyde 500 gm/tree	9.57e	10.55c	10.85c	10.32C	7.03fg	7.30f	8.45a-c	7.59B
Urea-formaldehyde 750 gm/tree	9.92d	11.35b	11.60b	10.96B	7.35f	7.95de	8.60ab	7.97A
Urea-formaldehyde 1000 gm/tree.	10.05d	11.45b	11.95a	11.15A	7.75e	8.10c-e	8.70a	8.18A
Mean	9.76C	10.88B	11.15A		7.22C	7.60B	8.49A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Table 10. Effect of Nitrobein, urea-formaldehyde, and their interaction on fruit firmness, flesh weight, and stone weight of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Fruit firmness (lb/inch2)				Fruit flesh weight (gm)				Stone weight (gm)			
	Nitrobein biofertilizer				Nitrobein biofertilizer				Nitrobein biofertilizer			
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
First season; 2021												
Control	4.60f	5.85de	6.44bc	5.63C	178.50g	214.75e	238.25c	210.50C	24.80f	26.35ef	29.25c-e	26.80C
Urea-formaldehyde 500 gm/tree	4.85f	6.10cd	6.88ab	5.94B	181.25g	215.75e	270.50b	222.50B	25.80ef	28.55de	32.65bc	29.00B
Urea-formaldehyde 750 gm/tree	4.48e	6.98ab	7.01ab	6.49A	198.50f	223.00d	294.75a	238.75A	29.00c-e	31.65b-d	34.15ab	31.60A
Urea-formaldehyde 1000 gm/tree.	5.85de	7.10a	7.35a	6.77A	202.00f	223.00d	296.25a	240.42A	29.50c-e	33.45b	37.05a	33.33A
Mean	5.19C	6.51B	6.92A		190.06C	219.13B	274.94A		27.28C	30.00B	33.28A	
Second season; 2022												
Control	4.87f	6.18de	6.87bc	5.97C	193.00k	230.75g	255.50d	226.42D	29.30e	29.60e	32.00c-e	30.30C
Urea-formaldehyde 500 gm/tree	5.12f	6.43cd	7.31ab	6.29B	196.90j	232.75g	287.50c	239.05B	30.30de	31.80c-e	35.40bc	32.50B
Urea-formaldehyde 750 gm/tree	5.75e	7.31ab	7.44ab	6.83A	212.25i	240.00f	311.50b	254.58B	33.50b-d	34.90bc	36.90ab	35.10A
Urea-formaldehyde 1000 gm/tree.	6.12de	7.43ab	7.78a	7.11A	217.70h	245.00e	320.50a	261.07A	34.00b-d	36.70ab	39.80a	36.83A
Mean	5.46C	6.84B	7.35A		204.96C	237.13B	293.75A		31.78B	33.25B	36.03A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Table 11. Effect of Nitrobein, urea-formaldehyde, and their interaction on TSS and total acidity of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	TSS (%)				Acidity (%)			
	Nitrobein biofertilizer							
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
	First season; 2021							
Control	16.41d	18.01bc	18.16b	17.53C	1.850a	1.250e	1.050h	1.383A
Urea-formaldehyde 500 gm/tree	17.51c	18.81a	18.75a	18.36B	1.420b	1.150f	0.920i	1.163B
Urea-formaldehyde 750 gm/tree	18.11b	19.09a	19.16a	18.79A	1.380c	1.100g	0.850j	1.110C
Urea-formaldehyde 1000 gm/tree.	18.71a	19.18a	19.27a	19.05A	1.290d	1.090g	0.800k	1.060D
Mean	17.68B	18.77A	18.84A		1.485A	1.148B	0.905C	
	Second season; 2022							
Control	16.57f	18.27d	18.42cd	17.75C	2.000a	1.350e	1.120h	1.490A
Urea-formaldehyde 500 gm/tree	17.68e	19.05ab	18.97a-c	18.57B	1.570b	1.250f	0.990i	1.270B
Urea-formaldehyde 750 gm/tree	18.32d	19.35ab	19.33ab	19.00A	1.530c	1.200g	0.920j	1.217C
Urea-formaldehyde 1000 gm/tree.	18.84b-d	19.48a	19.41ab	19.24A	1.440d	1.190g	0.870k	1.167D
Mean	17.85B	19.04A	19.03A		1.635A	1.248B	0.975C	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Moreover, Abd EL-Monem *et al.* (2009) on mango, they studied the effects of three different urea-formaldehyde dosages (1000, 750, and 500 g/tree) and revealed that when compared to 1000 g/tree of conventional urea, urea-formaldehyde at 1000 and 750 g/tree considerably enhanced fruit set, fruit retention per panicle, yield, and improved fruit quality. El-Aila *et al.* (2001) on Le-Conte pear trees found that fruit quality parameters were more significantly impacted by the slow-release nitrogen fertilizer. Kandil *et al.* (2010) found that applying three slow-release nitrogen fertilizers (urea-formaldehyde, phosphorus-coated urea, and sulfur-coated urea) was more effective at improving the physical and chemical properties of the fruits on the "Mit Ghamr" peach tree than the application of a fast-release fertilizer. Also, Merwad *et al.* (2014) stated that to produce a high yield with good marketing quality, it is highly recommended to apply the dual bio-fertilizers to Valencia orange trees (N in sulfur-coated urea formaldehyde and VAM fungal at a high rate).

Fruit chemical properties

TSS percentage and total acidity percentage

The first and second season's results as shown in Table (11) illustrated that 200 and/or 400g Nitrobein biofertilizer/tree treatment gave similar and higher positive effects on TSS percentage in both seasons. On the contrary, Nitrobein biofertilizer at 400g/tree gave comparatively the lowest value of total acidity percentage compared with other treatments.

Moreover, urea-formaldehyde fertilizer at rates of 750g/tree and 1000g/tree gave statistically similar and high positive effects on TSS percentage in the first and second seasons. On the other hand, 1000g urea-formaldehyde fertilizer/tree scored the lowest total acidity percentage in both seasons of study.

However, the interaction between Nitrobein biofertilizer and urea-formaldehyde fertilizer treatments shows that in the first season, 400g Nitrobein biofertilizer/tree treatment plus 1000g urea-formaldehyde fertilizer/tree treatment produced a similar and high positive effect on TSS percentage. Other treatments showed an intermediate value in this concern. Furthermore, in the second season, 200g Nitrobein biofertilizer/tree treatment combined with 1000g urea-formaldehyde fertilizer/tree treatment had a highly positive effect in this concern. On the contrary, Nitrobein biofertilizer at 400g/tree combined with 1000g/tree urea-formaldehyde fertilizer treatment scored partitively the lowest value of total acidity percentage in both seasons.

Fruit total sugars, reducing sugars and shoots total charbohydrates

As shown in Table (12) indicated that Nitrobein biofertilizer treatment at 200g and/or 400g/tree induced similar and high positive effects on fruit total sugars and fruit reducing sugars in both seasons, while, 400g Nitrobein biofertilizer/tree treatment proved to be the superior treatment on shoot total carbohydrate in both seasons of study.

Table 12. Effect of Nitrobein, urea-formaldehyde, and their interaction on fruit total sugars, fruit reducing sugars and shoot total carbohydrates of Keitt mango trees (2021 and 2022 seasons)

Urea-formaldehyde fertilizer	Total sugars (%)				Fruit reducing sugars (%)				Total carbohydrates (mg/100g F.W)			
	Nitrobein biofertilizer				Nitrobein biofertilizer				Nitrobein biofertilizers			
	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean	Control	200 g/tree	400 g/tree	Mean
First season; 2021												
Control	10.51f	12.75c	12.78bc	12.01C	9.18d	9.51d	9.65cd	9.45C	9.86h	9.99h	10.05h	9.97C
Urea-formaldehyde 500 gm/tree	11.35e	13.11a-c	13.09a-c	12.52B	9.44d	10.03a-c	10.17ab	9.88B	10.35g	10.66f	10.88e	10.63C
Urea-formaldehyde 750 gm/tree	11.33e	13.35ab	13.41a	12.70AB	9.36d	10.29a	10.31a	9.99AB	10.56f	11.35c	11.88e	11.26B
Urea-formaldehyde 1000 gm/tree.	11.93d	13.19a-c	13.58a	12.90A	9.69b-d	10.43a	10.54a	10.22A	11.16d	11.76b	12.05a	11.66A
Mean	11.28B	13.10A	13.21A		9.42B	10.07A	10.17A		10.48C	10.94B	11.22A	
Second season; 2022												
Control	10.45f	12.88c	12.91c	12.15C	9.49B	10.11g	10.19g	10.20g	10.17D	9.49B	10.11g	10.19g
Urea-formaldehyde 500 gm/tree	11.49e	13.32a-c	13.22bc	12.68B	9.936B	10.60f	10.86de	11.03d	10.83C	9.936B	10.60f	10.86de
Urea-formaldehyde 750 gm/tree	11.51e	13.40a-c	13.66ab	12.86B	10.03AB	10.81e	11.55c	12.03ab	11.46B	10.03AB	10.81e	11.55c
Urea-formaldehyde 1000 gm/tree.	12.09d	13.49ab	13.87a	13.15A	10.27A	11.41c	11.96b	12.20a	11.86A	10.27A	11.41c	11.96b
Mean	11.44B	13.27A	13.42A			10.73C	11.14B	11.37A			10.73C	11.14B

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Table 13. Effect of Nitrobein, urea-formaldehyde, and their interaction on leaf nitrogen, phosphorus, and potassium content of Keitt mango trees (2021 and 2022 seasons)

	N (%)				P (%)				K (%)			
	Nitrobein biofertilizer				Nitrobein biofertilizer				Nitrobein biofertilizers			
Urea-formaldehyde fertilizer	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**
First season; 2021												
Control	2.07g	2.11e-g	2.19cd	2.12C	0.190bc	0.210a	0.210a	0.203A	2.41g	2.89c	3.17b	2.82D
Urea-formaldehyde 500 gm/tree	2.09fg	2.14d-f	2.24bc	2.16BC	0.200ab	0.210a	0.210a	0.207A	2.50f	3.17b	3.18b	2.95C
Urea-formaldehyde 750 gm/tree	2.12e-g	2.15d-f	2.27ab	2.18AB	0.200ab	0.210a	0.180c	0.197A	2.63e	3.22b	3.25ab	3.04B
Urea-formaldehyde 1000 gm/tree.	2.14d-f	2.17de	2.31a	2.21A	0.200ab	0.190bc	0.200ab	0.197A	2.71d	3.30a	3.32a	3.11A
Mean	2.11C	2.14B	2.25A		0.197A	0.205A	0.200A		2.56C	3.15B	3.23A	
Second season; 2022												
Control	2.08g	2.14f	2.22c-e	2.15C	0.200b	0.230a	0.230a	0.220A	2.53g	3.06d	3.30c	2.96D
Urea-formaldehyde 500 gm/tree	2.13fg	2.17d-f	2.26bc	2.19B	0.210ab	0.230a	0.230a	0.221A	2.62f	3.34c	3.31c	3.09C
Urea-formaldehyde 750 gm/tree	2.16ef	2.19d-f	2.29b	2.21B	0.210ab	0.230a	0.200b	0.213A	2.75e	3.39a-c	3.38bc	3.18B
Urea-formaldehyde 1000 gm/tree.	2.18d-f	2.23cd	2.36a	2.26A	0.210ab	0.210ab	0.220ab	0.213A	2.83e	3.45ab	3.47a	3.25A
Mean	2.14C	2.18B	2.28A		0.207B	0.225A	0.220A		2.68C	3.31B	3.37A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level

Table 14. Effect of Nitrobein, urea-formaldehyde, and their combination on fruit reducing sugars and total carbohydrates of Keitt mango trees (2021 and 2022 seasons)

	Fe (ppm)				Zn (ppm)				Mn (ppm)			
	Nitrobein biofertilizer				Nitrobein biofertilizer				Nitrobein biofertilizer			
Urea-formaldehyde fertilizer	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**	**Control**	**200 g/tree**	**400 g/tree**	**Mean**
First season; 2021												
Control	415.2g	326.2i	432.9ef	391.5D	144.5g	145.1g	152.8f	147.5D	84.00f	101.1e	115.6d	100.2D
Urea-formaldehyde 500 gm/tree	442.5d	451.7c	428.9f	441.0B	131.6i	190.8b	138.6h	153.7C	118.8d	101.4e	143.6b	121.3C
Urea-formaldehyde 750 gm/tree	450.7c	407.7h	443.6d	434.0C	159.9e	154.2f	169.2d	161.1B	118.3d	130.6c	151.6a	133.5B
Urea-formaldehyde 1000 gm/tree.	436.6e	483.3b	495.4a	471.7A	177.2c	131.8i	208.7a	172.6A	142.8b	142.2b	144.2b	143.1A
Mean	436.2B	417.2C	450.2A		153.5C	155.5B	167.3A		116.0C	118.8B	138.7A	
Second season; 2022												
Control	417.7g	327.4i	434.3f	393.1D	146.2g	146.4g	154.0f	147.9D	87.21g	103.4f	118.1e	102.9D
Urea-formaldehyde 500 gm/tree	445.0d	452.8c	430.2f	442.7B	133.4i	192.1b	139.8h	155.1C	122.1d	103.7f	146.1b	123.9C
Urea-formaldehyde 750 gm/tree	453.2c	408.8h	445.0d	435.7C	161.7e	155.6f	170.3d	162.5B	121.5d	132.8c	154.1a	136.1B
Urea-formaldehyde 1000 gm/tree.	439.1e	484.4b	496.7a	473.4A	178.9c	133.1i	209.9a	174.0A	146.1b	144.5b	146.7b	145.8A
Mean	438.7B	418.4C	451.5A		155.1C	156.8B	168.5A		119.2C	121.1B	141.2A	

Means having the same letter (s) in each column, row or interaction are not significantly different at a 5% level.

Moreover, urea-formaldehyde fertilizer increased fruit total sugars, fruit reducing sugars and shoot total carbohydrates in both seasons. Additionally, urea-formaldehyde fertilizer at 1000g/tree treatment showed superiority in this respect.

However, the interaction between the two factors showed that Nitrobein combined with urea-formaldehyde enhanced fruit total sugars, fruit reducing sugars and shoot total carbohydrates. Briefly, 400g Nitrobein/tree combined with 1000g urea-formaldehyde/tree treatment proved to be the superior treatment. While other combinations showed a intermediate values in this concern.

Leaf mineral content

Nitrogen, phosphorus and potassium (percentage)

Data in Table (13) showed that Nitrobein biofertilizer treatment at 400 g/tree induced a positive effect on the concentration of leaf nitrogen and potassium percentage of Keitt mango trees as compared with the control treatment in both seasons, while there was no significant difference in the treatments used for Nitrobein biofertilizer on leaf phosphorus percentage during the first season. Moreover, Nitrobein biofertilizer rates at 200 g/tree and 400 g/tree gave statistically similar and high positive effects on the concentration of leaf phosphorus percentage in the second season.

Moreover, urea-formaldehyde fertilizer at rates of 1000 g/tree significantly increased the concentration of leaf nitrogen and potassium percentage in both seasons, while there was no significant difference among the doses used for urea-formaldehyde on leaf phosphorus percentage in the first and second seasons.

Furthermore, the interaction between Nitrobein biofertilizer rates and urea-formaldehyde fertilizer treatments showed that Nitrobein biofertilizer treatment at 400 g/tree supplemented with 1000 g/tree urea-formaldehyde fertilizer treatment scored the highest values of leaf nitrogen and potassium percentage in both seasons. Meanwhile, Nitrobein biofertilizer at 200 g/tree combined with (0.0, 500 and 750 g/tree) gave the highest positive effect on leaf phosphorus percentage in the first season, while Nitrobein biofertilizer at 400 g/tree coupled with 0.0 and/ all urea-formaldehyde fertilizer treatments gave the similar and higher positive effect on leaf phosphorus percentage in the second season.

Leaf iron, zinc and manganese content (ppm)

Table (14) demonstrates that leaf iron, zinc, and manganese were improved by Nitrobein biofertilizer rates. Meanwhile, the maximum concentration of leaf iron, zinc, and manganese was obtained by Nitrobein biofertilizer rate at 400 g/tree followed by 200 g/tree. Finally, the minimum concentration of leaf iron, zinc, and manganese was obtained with the lowest Nitrobein biofertilizer rate (control) in both seasons of the study.

Moreover, urea-formaldehyde fertilizer increased leaf iron, zinc, and manganese as compared with check treatment (control) in both seasons. Briefly, 1000 g/tree urea-formaldehyde treatment showed the most effective treatment in this concern.

However, the interaction between Nitrobein biofertilizer and urea-formaldehyde fertilizer treatments illustrated that 400 g/tree Nitrobein biofertilizer treatment coupled with 1000 g/tree urea-formaldehyde fertilizer gave the highest concentration of leaf iron and zinc in both seasons, while in the first and second seasons, Nitrobein fertilizer at 400 g/tree combined with 750 g/tree urea-formaldehyde fertilizer gave the highest concentration of leaf manganese in this respect.

The obtained results of Nitrobein biofertilizer and urea-formaldehyde fertilizer regarding their positive effect on leaf mineral content are in agreement with the findings of Hagagy *et al.* (2023) observed that while the addition of Nitrobein + urea (a mixture of chemical and biological fertilizer) after coated urea (a slow-release fertilizer) was advised for improving N level and both P and K levels in Keitt mango transplants, the application of Nitrobein + urea and coated urea treatments increased Fe, Mn, Zn, and Cu content. Also, Silber *et al.* (2022) in order to examine the effects of applying urea-formaldehyde at the same or half dose of the traditional urea on growth parameters and leaf mineral content, they applied urea-formaldehyde (38% N) as a slow-release nitrogen fertilizer on four fruit seedling species (grape, mango, banana, and date palm). Their results showed that urea-formaldehyde treatments, either as full or half dose, enhanced leaf mineral content in the leaves, especially in grape and date palm seedlings. Furthermore, compared to standard urea, it is seen that urea-formaldehyde treatments boosted the accessible forms of N, P, and K in the soil of the four crop seedlings.

CONCLUSION

In conclusion, results obtained in the current study reveal that soil application of Nitrobein biofertilizer at a rate of 400 g/tree and urea-formaldehyde fertilizer at a rate of 1000 g/tree alone or in combination had a positive influence on tree growth as well as enhanced fruit yield and quality of the Keitt mango trees under heat stress conditions.

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الملخص العربي

تقليل الفاقد من الأسمدة النيتروجينية المعدنية على أشجار المانجو بإستخدام سماد اليوريا فورمالدهيد بطيء التحلل والمخصب الحيوي نيتروبين تحت ظروف الوادى الجديد

فهمى إبراهيم فهمى، أمين محمد جلال الدين، سحر على فريد

تفقد كمية كبيرة من الأسمدة الكيماوية بسبب استخدامها على نطاق واسع في المناطق ذات درجات الحرارة المرتفعة، مما يلوث النظام البيئي ويقلل من خصوبة التربة. وبالتالي، فإن استخدام أسمدة ذات قيمة غذائية عالية وصديقة للبيئة ومتوافقة أيضًا مع التربة والبيئة أمر ضروري. لذلك أجريت هذه التجربة خلال موسمي ٢٠٢١ و٢٠٢٢ على أشجار مانجو كيت عمرها خمس سنوات مزروعة في تربة رملية تحت نظام الري بالتنقيط فى مزرعة خاصة بمحافظة الوادي الجديد، مصر. وكان الهدف الرئيسي من هذه التجربة هو دراسة تأثير ثلاثة معدلات من السماد الحيوي النتروبين (٠,٠، ٢٠٠، ٤٠٠ جرام/شجرة) وأربعة معدلات لسماد اليوريا فورمالدهيد (٠,٠، ٥٠٠، ٧٥٠، ١٠٠٠ جرام/شجرة) على النمو الخضري والمحصول وجودة الثمار لأشجار المانجو كيت. وقد أدت معاملات النيتروبين واليوريا فورمالدهيد إلى تحسين جميع صفات النمو والإنتاج وجودة الثمار المدروسة. وكانت أفضل النتائج هى معاملة الأشجار بالنتروبين بمعدل ٤٠٠ جم/شجرة مع سماد اليوريا فورمالدهيد بمعدل ١٠٠٠ جم/شجرة في هذا الصدد حيث أدت إلى تحسين صفات النمو الخضرى والمحصول وصفات جودة المحصول تحت ظروف الوادى الجديد.