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Response of Growth and Productivity of Murcott Tangarine Trees to Organic and NPK Fertilizers

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ABSTRACT

A two-year investigation was conducted at the experimental farm of Sides Horticulture Research Station, Beni-Suef Governorate, Agriculture Research Center, Egypt, to test organic and NPK fertilizers on the growth, yield, and leaf mineral contents of Murcott Tangerine (Citrus reticulata, Blanco). The experiment included 10 treatments;T1 (100% Mineral NPK fertilizers), T2 (50 % of NPK fertilizer + 50 % yeast vinasse), T3 (50 % of NPK fertilizer + 50 % compost), T4 (50 % of NPK fertilizer + 25 % yeast vinasse + 25 % compost), T5 (25 % of NPK fertilizer + 75 % yeast vinasse),T6 (25 % of NPK fertilizer + 75 % compost), T7 (25 % of NPK fertilizer + 37.5 % yeast vinasse + 37.5 % compost), T8 (100% yeast vinasse), T9 (100 % compost) and T 10 (50 % compost + 50 % yeast vinasse). The application of compost and yeast vinasse and its combinations with NPK mineral fertilizers compared with mineral NPK only (control) led to a significantly increased vegetative growth, yield, fruit quality and leaf mineral contents. The highest fruit weight (181.66 g) and yield (72.86 kg/tree) as an average of both seasons were found at (T4). Greatest values of fruit physical and chemical properties were also found with (T4) in both seasonsto improve nodulation and plant growth of leguminous crops.

KEYWORDS: compost, yeast vinasse, NPK, fruit, yield

1. INTRODUCTION

Citrus is one of the most commercial fruits grown in Egypt and around the world, and they are an excellent source of minerals, vitamins, and antioxidants. (Roussos and Tassis, 2011). Egypt is ranked as the world sixth-largest producer. Egypt was third in the world for mandarin production and sixth for citrus and orange production in the FAO (2017) statistics.

Rutaceae is the family of citrus fruits that includes grapefruit, orange, lemon, lime, tangerine, mandarin, pumelo and kumquat. Citrus cultivation area was 493925 feddans and producing 4503226 tons of fruits based on the data from the (M.AL.R., 2021). Mandarin production has increased worldwide because mandarins (*Citrus reticulate* L.) are easy to peel, have excellent flavors and smells, loose skins, and a smaller sized fruit among delicious citrus fruits that divide into segments.

The "Murcott" tangerine, is one of Egypt's newest and most valuable export crops. 'Murcott' tangerine was created in 1916 at the USDA citrus breeding program in Florida through a hybrid of sweet orange and tangerine (Figueiredo, 1991). When the Murcott trees have a reasonable fruit load, they are relatively vigorous. 'Murcott' tangerine fruits are categorized as seedy because they contain 10–20 seeds per fruit (Tucker,*et al.*, 1998), Murcott is the tangor-type fruit that has good quality for the fresh fruit market and matures the latest in January to March, Samra and Shalan (2014).

Fertilizers that involve N, P and K nutrients are essential for the best possible vegetative growth, high fruit production, and citrus fruits with superior quality. Plants desperately need these chemical fertilizers continuously for a long period to replace the nutrients used, this causes the soil's chemical and physical qualities to deteriorate, particularly its fertility, which in turn reduces the quantity of organic matter the soil can contain. Egypt used a lot of chemical fertilizers, which are heavy inorganic fertilizers that are adverse to soil microbial activity and human health (Suhag, 2016), furthermore, horticultural production is continuously influenced by many factors, including the effects of rising environmental pollution (Abobatta, 2020).

The application of organic is becoming more popular because there is a considerable association between the soil's organic matter content and citrus yield. (Ge *et al.*, 2018). Organic fertilizers have the potential to improve soil fertility and stimulate soil microbial activity, improve citrus tree yield, and allow nutrient uptake (Abu-Dief et al., 2021). It also lowers soil salinity and pH and reduces nutrient losses. Additionally, compost increases the microbe's number that generate hormones naturally and antibiotics resistant to harmful microorganisms (Loredana *et al.,* 2015; Adam *et al.,* 2021; Obaid 2021).

Compost enhances the soil's chemical properties by increasing its nutrient concentration and action exchange ability (Shiralipour *et al.,* 1992).

Vinasse is created by anaerobic alcoholic fermentation, which yields (bio)ethanol (Hoarau *et al.,* 2018). It is a residue from the industrial yeast cultured on molasses or on raw sugar liquids. (Leme and Seabra 2017) or alcoholic distilled beverages (Robles-Gonzalez *et al*., 2012) or by aerobic biosynthesis of bakery yeast (Lisičar *et al*., 2017) or amino/organic acids (Bekatorou *et al*., 2006). Despite the differences, all vinasse varieties share a common trait: often between 15% and 20% of glycine betaine, which was developed through the process of refining sugar from the original plant material (Saari, *et al*., 2011). As an osmoprotectant and compatible solute, glycine betaine increases a plant's resistance to abiotic stress, is highly soluble in water, and prevents the denaturation of proteins (Ashraf and Foolad, 2007; Chen, and Murata,2008). Therefore, vinasse was mostly applied as an organic fertilizer for soil. (Sava *et al*., 2005).

The purpose of this study was to assess the effects of various organic fertilizer sources as safe substitutes or supplementary resources on the vegetative growth, leaf mineral content, yield, and fruit quality of Murcott t tangerine rees.

2. MATERIALS AND METHODS

On the experimental farm of Sides Horticulture Research Station, Beni-Suef Governorate, Horticulture Research Institute, Agriculture Research Center, Five-year-old Murcott trees (Citrus reticulata, Blanco) on the sour orange rootstock (Citrus aurantium, L.) were used in the study for two growing seasons 2021 and 2022. The trees were planted in clay loamy soil with a 5 X 5 m spacing under Surface irrigation. Every tree was given care according to known conventions with the same growth vigor, size, and health. A mechanical and chemical investigation of the orchard soil surface from 0.0 to 60 cm depth was conducted at the start of the

Table 1. Physical and chemical properties of the tested soil.

Physical analysis	Value	Available nutrients	Value
Coarse sand %	7.2	**Total nitrogen (%)**	0.12
Fine sand %	12.8	**P (ppm)**	27.8
Silt (%)	30.4	**K (ppm)**	385.3
Clay (%)	49.6	**Fe (ppm)**	30.31
Texture grade	Clay loam	**Zn (ppm)**	5.15
pH (1-2.5)	7.22	**Mn (ppm)**	17.43
EC (ds m^{-1})	1.21		
Organic matter (%)	1.48		

first season (2021) in accordance with Black et al., (1982), as indicated in Table (1).

Application rate and method for different NPK fertilization sources: Mineral fertilizers included ammonium nitrate (33.5% N), super phosphate (15.5% P2O5), and potassium sulfate (48% K2O). The organic fertilizers were used from compost and yeast vinasse. The recommended doses (RDN) of nitrogen for Murcott mandarin trees were about 600 g / tree / year as advised by Egypt's Ministry of Agriculture and Land Reclamation. The recommended doses (RDN) of nitrogen (100%) equaled 1.791 kg/tree ammonium nitrate (33.5%N) as mineral nitrogen and 37.5 kg/tree compost (1.6 % N) as organic nitrogen. Yeast vinasse (2.83% N) was added as 21.2 kg / tree in both seasons as shown in Table (4).

Organic manure sources (compost and yeast vinasse) were only used once a season, in mid-December, when a trench (30 cm in diameter and 40 cm in depth at a 50 cm distance) was constructed at the end of the tree shade and toward the irrigation furrows for every tree that was chosen. The amount of organic fertilizer added was calculated from the fertilizer sources used in this study on the basis of the percentage of nitrogen in each fertilizer and according to the Tables 2 & 3 and to achieve 660 g N/tree every season. All organic manure sources were acquired from the same location for every season.

Table 2. Analysis of the used composted material.

Parameter	Value	Available nutrients	Value
M3 weight (kg)	752	**Total N (%)**	1.6
Moisture %	28	**Total P %**	0.58
pH (1-10)	8.6	**Total K %**	1.41
EC (ds m^{-1})	3.2	**Total Ca %**	1.88
Organic matter (%)	35.5	**Total Mg %**	0.90
C/N ratio	17.5	**Total Fe (ppm)**	1002
Organic carbon %	26.6	**Total Zn (ppm)**	112
		Total Mn (ppm)	26

Table 3. Analysis of the used yeast vinasse.

Parameter	Value	Available nutrients	Value
pH (1-10)	6.2	**Mg %**	0.5
EC (ds m^{-1})	2.7	**Ca %**	0.84
Organic matter (%)	30.1	**B mg / liter**	7
Total N (%)	2.83	**Fe mg / liter**	60
$NH4^{+}$ N %	1.61	**Zn mg / liter**	94
NO_3 – N %	0.16	**Mn mg / liter**	13.6
P_2O_5 %	2.7		
K_2O	4.3		

Table 4. Rate of applying various NPK and organic fertilization sources

The recommended doses (RDN)	N as Ammonium nitrate (33.5% N)	P calcium super phosphate (15.5 % P2O5)	K Potassium sulphate (48% K2O)	Compost (1.6 %N)	Yeast vinaase (2.83 % N)
100 %	1.791 kg	0.5 kg	0.5 kg	37.5 kg	21.2 kg
50 %	0.895kg	0.250 kg	0.250kg	18.750 kg	10.6 kg
25 %	0.448kg	0.125 kg	0.125 kg	9.375 kg	5.3 kg

2.1.Treatments and experiment design:

Trees received the following treatments :

T1- 100% mineral NPK (as fertilization program adopted at 1.791 , 0.5 , and 0.5 kg/tree from NH_4NO_3, superphosphate and K2SO4, respectively) according to the Ministry of Agriculture and Land Reclamation recommendation (Control).

T2 – 50 % mineral NPK fertilizers + 50 % yeast vinasse.

T3 – 50 % mineral NPK fertilizers + 50 % compost.

T4 – 50 % mineral NPK fertilizers + 25% yeast vinasse + 25 % compost.

T5 – 25 % mineral NPK fertilizers + 75 % yeast vinasse .

T6 – 25 % mineral NPK fertilizers + 75 % compost .

T7 – 25 % mineral NPK fertilizers + 37.5 % yeast vinasse + 37.5% compost.

T8 – 100 % yeast vinasse .

T9 – 100 % compost .

T10 – 50 % yeast vinasse + 50 % compost.

Thirty healthy 'Murcott' tangerine trees were exposed to the various treatments. in a randomized complete block design with three replications, each replicate was represented by a single tree, and the ten fertilization treatments that were being studied were arranged in this manner, during the two study seasons,

2.2. Measurements.

2.2.1.Vegetative growth parameters:

In late March 2021 and 2022 seasons, four main branches were selected and tagged that were almost identical in terms of growth, diameter, density of foliage, and distribution around each tree periphery. Measurements were made of the number of shoots , shoot length (in centimeters) and leaf area during the fall growth cycle.

The following criteria were followed :

1- Number of shoots was counted after the end of spring growth cycle during both seasons.

2- Shoot length (cm) was measured on 20 shoots per replicate at the ending of spring cycles.

3- Leaf area (cm2): the fifth distal leaf on the shoot was abscised twenty mature leaves three times in December, and the leaf area (cm^2) was estimated using the equation provided by Ahmed and Morsy (1999). Leaf area (cm^2) = 0.49 (Length × Width) + 19.09.

2.2.2.Productivity parameters:

1- Fruit set percentage: During each experimental season, the number of perfect flowers per labeled limb was determined at full bloom. The following formula was used to calculate the percentage of perfect flowers after 75% of petal fall fruit set as described by EL-Khwaga, *et al*., (2021):

$$\textbf{Fruit set \%} = \frac{\textbf{Number of set fruitlets}}{\textbf{Number of perfect flowers}} \times 100$$

2- Fruits retention percentage: According to **EL-Khwaga, *et al.*, (2021),** the percentage of retained fruits at a specific point in December of each experimental season was estimated using the following equation:

$$\textbf{Fruits retention \%} = \frac{\textbf{Number of presented (remained) fruits at a given date}}{\textbf{Number of set fruitlets}} \times 100$$

3- Yield: Fruits from each tree were gathered individually, weighed, and counted on the 15th of February. Tree productivity (yield) was calculated as the number of fruits /tree or the weight (kg) of harvested fruits per tree.

2.2.3.Fruit quality:

Twenty randomly chosen fruits from three trees each (for a total of 60 fruits per treatment) were gathered after the February fruit harvest to determine the following parameters:

1- Fruit physical properties:

- Fruit diameter and height (cm)
- Fruit weight (g)
- Fruit volume (cm3)
- Peel thickness (cm).
- Juice volume / fruit (cm3), Juicing ten fruits from each treatment yielded an estimated measurement of the average juice volume /fruit.

2- Juice chemical characteristics: The following chemical properties were determined after pressing the pulp with an Electric Extractor to extract the juice:

- Total soluble solids (%) measured by the (A.O.A.C. 2016) using a portable hand refractometer in Germany.
- Total acidity (%) was measured and calculated as percentage citric acid according to the (A.O.A.C., 2016).
- TSS/acid ratio was calculated.
- Vitamin C content was measured as (ascorbic acid mg/100ml juice) by titration with 2-6 dichlorophenol indophenol pigment (A.O.A.C, 2016).
- Total sugars were estimated according to (A.O.A.C, 2016).

2.2.4.Leaf mineral composition

In early November of each season, fully expanded mature leaves that were 4-6 months old and from non-fruiting shoots were collected for chemical analysis. Every sample had thirty leaves per tree. After being repeatedly cleaned with tap water, leaves were rinsed with distilled water and dried at 70°C until their weight remained consistent. According to (Chapman and Pratt 1975), 0.2 g of each replicate's finely ground dry leaf matter was digested for 15 minutes in a solution containing 2:1 v/v concentrated sulfuric and perchloric acids until it turned colorless. The digested material was then quantitatively transferred to 50 ml volumetric flasks. The mineral nutrients under consideration were determined in the following:

a. Total Nitrogen: Using the modified micro Keldahl method described by (Pregl 1945), the total leaf (N) was calculated.

b. Total phosphorus: Following the procedures outlined by (Piper 1958), total leaf (P) was ascertained by wet digestion of plant materials using sulfuric and perchloric acid.

c. Total potassium: Total leaf (K) was determined photometrically in the digested material according to the method described by (Brown and Lilliand, 1946).

2.3.Statistical Analysis

According to (Snedecor and Cochran, 1990), analysis of variance was applied to all the data gathered for this experiment during both seasons. Major differences in means were also detected in accordance with Duncan's multiple test range at 0.05 level (Duncan, 1955), where capital letters were used to denote the means of various treatments for each attribute under investigation.

3. RESULTS AND DISCUSSION

3.1. Effect of organic and mineral NPK fertilizers treatments on vegetative growth of Murcott Tangerine trees .

The results indicate that, in comparison to single fertilizer treatments, the number of shoots, shoot length, and leaf area were greatly increased when several fertilizers were combined. Table (5) show that number of shoots, shoot length and leaf area were increased due to all combination fertilizers. The data clearly show that the results followed the same trend during the two seasons studied. Application the combining of 50% mineral NPK+ 25% of yeast vinasse + 25% of compost produced a greater number of shoots (13.22 and 14.27) in both seasons, respectively. While the lowest number of shoots were recorded by applying 100% yeast vinasse (8.85 and 10.78) in 2021 and 2022 seasons, respectively. The highest shoot length was observed with 50% mineral NPK+ 25% of yeast vinasse+ 25% of compost treatment (18.68 and 20.84) in both

Table 5 . Effect of organic and mineral NPK fertilizers treatments on some of vegetative growth characteristics of Murcott Tangerine trees during 2021 and 2022 seasons.

Treatments	Number of shoots		Shoot length (cm)		Leaf area (cm^2)	
	2021	2022	2021	2022	2021	2022
100% mineral NPK	11.60CDE	12.27CD	17.15BC	18.36DE	13.86DE	15.54DE
50% mineral NPK + 50 % yeast vinasse	11.83CD	12.74BC	17.32BC	19.25BC	15.81A	17.73AB
50% mineral NPK + 50 % compost	12.79AB	13.96A	18.11AB	19.79B	16.29A	18.14A
50% mineral NPK + 25 % yeast vinasse + 25 % compost	13.22A	14.27A	18.68A	20.84A	16.34A	18.58A
25% mineral NPK + 75 % yeast vinasse	10.95E	12.04CD	16.94BC	19.17BCD	15.35AB	16.58CD
25% mineral NPK + 75 % compost	11.18DE	13.56AB	17.05BC	19.41BC	15.19ABC	16.79BC
25% mineral NPK + 37.5 % yeast vinasse + 37.5 % compost	12.17BC	13.71AB	17.35BC	19.77B	15.77A	17.08BC
100% Compost	9.94F	11.31DE	16.60C	18.70CDE	13.99CDE	14.90E
100 % yeast vinasse	8.85G	10.78E	15.36D	17.86E	12.84E	14.75E
50 % yeast vinasse + 50 % compost	10.94E	11.59DE	16.77C	18.69CDE	14.19BCD	16.41CD

Means having the same letter (s) in each column are insignificantly different.

seasons, respectively. Significantly least shoot length (15.36 and 17.86) was recorded by100% yeast venasse in 2021 and 2022 seasons, respectively.

The treatment with 50% NPK mineral fertilizers + 25% compost + 25% yeast vinasse yielded the greatest values of leaf area (16.34 and 18.58), followed by fertilization with 50% NPK mineral fertilizers + 50% compost (16.29 and 18.14). When compared to the other treatments, Murcott tangerine trees fertilized with 100% yeast vinasse showed the lowest values of leaf area in both seasons. These results lined up with those of Mansour and Shaaban, (2007); Barakat et al., (2012); Ahmed et al., (2013); Eissa, (2016) and Hazarika and Aheibam (2019).

Fikry *et al*., (2020) and EL-Khwaga, *et al*., (2021), which they found that trees fertilized with inorganic and organic N fertilizers had the highest values of leaves per shoot and leaf area. In summary, the results suggest that organic fertilizers, either alone or in combination with chemical fertilizers, may play a significant role in the growth and development of Murcott tangerine trees. Specifically, the application of organic fertilizers was found to increase nutrient absorption, which in turn enhanced plant growth and the process of photosynthesis (Hegde *et al.*,1999)

3.2. Effect of organic and mineral NPK fertilizers treatments on fruit set, fruit retention percentages and yield.

3.2.1. Fruit set and Fruit retention percentages.

The data shown in Table (6) demonstrated that, in comparison to the control, the treatments involving NPK mineral fertilizers and two organic sources (compost and yeast vinasse) had a significant effects on the percentage of fruit set and fruit retention of Murcott tangerine trees in the 2021 and 2022 seasons. However, the trees that were treated with 50% NPK mineral fertilizers + 25% yeast vinasse + 25% compost had the highest percentage of fruit set (25.62 and 30.51%) and fruit retention (14.32 and 14.97 %) during 2021 and 2022 seasons, respectively. Meanwhile, the Murcott trees fertilized with 100

Table 6. Effect of organic and mineral NPK fertilizers treatments on fruit set %, and fruit retention % of Murcott Tangerine trees during 2021 and 2022 seasons.

Treatments	Fruit set %		Fruit retention %		Yield (kg / tree)		Number of fruits / tree	
	2021	2022	2021	2022	2021	2022	2021	2022
100% mineral NPK (control)	18.57E	19.34G	9.59E	10.93E	33.03G	35.53H	230.22G	277.82F
50% mineral NPK + 50 % yeast vinasse	23.31B	28.22BC	14.12ABC	14.15BC	62.53C	65.77C	345.51C	421.74B
50% mineral NPK + 50 % compost	23.65B	29.37AB	14.32AB	14.97AB	66.81B	69.13B	359.52B	437.45A
50% mineral NPK + 25 % yeast vinasse + 25 % compost	25.62A	30.51A	16.12A	15.89A	70.69A	75.03A	429.11A	439.75A
25% mineral NPK + 75 % yeast vinasse	20.55CD	23.21EF	12.94BCD	13.09CD	47.44DE	60.58DE	286.87E	404.78C
25% mineral NPK + 75 % compost	20.88CD	26.15D	13.14BCD	13.34BC	52.64D	62.03D	303.63D	408.88C
25% mineral NPK + 37.5 % yeast vinasse + 37.5 % compost	21.11C	26.59CD	13.46BC	13.49BC	64.58BC	63.15CD	366.93B	406.29C
100% Compost	19.26DE	21.28FG	11.12DE	12.55CD	45.00E	47.55F	261.89F	345.34D
100 % yeast vinasse	18.71E	20.32G	10.95DE	11.53DE	39.31F	39.78G	257.69F	304.2E
50 % yeast vinasse + 50 % compost	19.20DE	24.63DE	11.93CD	12.78CD	45.85E	58.74E	292.65E	399.6C

Means having the same letter (s) in each column are insignificantly different.

% NPK mineral fertilizers (control) had the lowest fruit set (18.57 and 19.34 %) and fruit retention (9.59 and 10.93 %) in both seasons, respectively. The results agree with the results that obtained by Elkobbia (1999), Abedel-Sattar et al., (2011), and EL-Khwaga et al., (2021).

3.2.2.Yield (kg/tree) and number of fruits / tree.

The results in Table (6) demonstrated the effects of two investigated organic sources' treatments and application rates, as well as NPK mineral fertilizers, on the yield (kg / tree) and number of fruits produced by Murcott tangerine trees. Data showed that adding compost and yeast vinasse in addition to NPK mineral fertilizers significantly affected both the yield (kg/tree) and the number of fruits/tree when compared to adding NPK mineral fertilizers alone (control). The combination of 50% NPK mineral fertilizers + 25% yeast vinasse + 25% compost produced the highest yield (70.69 and 75.03 kg/tree) and the highest number of fruits/tree (429.11 and 439.75 fruits/tree), respectively, compared to the control treatment, which produced the lowest values (33.3 and 35.53 kg/tree) and (230.22 and 277.82 fruits/tree), in the 2021 and 2022 seasons, respectively. Yields from the other fertilization treatments under study were in the middle. These results partially agree with mentioned by Eissa, (2016) on Balady mandarin trees; Fikry *et al.*, (2020) on Murcott tangerine trees; Medhi *et al.*, (2007); Mansour and Shaaban (2007); Eman *et al.,* (2008); Abedel-Sattar *et al.,* (2011); Ahmed *et al.,* (2013); Khehra and Bal, (2014); Mostafa and Abdel-Rahman, (2015); El-Shazly *et al.*, (2015); Ennab, (2016); El-Salhy *et al.,* (2017) and Hazarika and Aheibam, (2019) they found that adding the combination of mineral and organic fertilizers to citrus trees greatly increased yield.

3.3. Effect of organic and mineral NPK fertilizers treatments on fruit quality.

3.3.1. Physical fruit characteristics.

The results presented in Table (7) reveal the significant effect of the applications of mineral and N organic fertilizers on the fruit's weight, volume, height, diameter, peel thickness, and juice volume / fruit of Murcott Tangerine trees in the seasons of 2021 and 2022. The highest fruit weight (192.70 and 170.62 g) and fruit volume (238 and 232.3) were obtained with trees fertilized at 50 % NPK mineral + 25 % yeast vinasse + 25 % compost in 2021 and 2022 seasons, respectively. The trees fertilized at 50% NPK mineral + 50% compost and 50% NPK mineral + 50% yeast vinasse, are listed in descending order. Furthermore, no significant differences were found between these treatments. Regarding fruit height and diameter, data in Table (7) showed that, significant differences between the various treatments were obtained in both seasons. Fruit length and diameter were greatly improved by 50% mineral NPK + 25% yeast vinasse + 25% compost, and this effect was also observed in trees supplied at 50% mineral NPK + 50% compost in both studied seasons. Trees fertilized with 100% yeast vinasse had the lowest recorded fruit height and fruit diameter values.

The peel thickness and fruit juice volume were shown to be significantly affected in both seasons. The highest peel thickness and juice volume of Murcott tangerine fruits were those trees that received 50% mineral NPK + 25% compost + 25 % yeast vinasse, followed with descending order by the trees that received 50% mineral NPK + 50% compost. In contrast, the trees that received 100% yeast vinasse and 100% minerals NPK in both seasons had the lowest values in this regard. According to previous results, fertilizing "Murcott" tangerine trees with 50% NPK minerals, 25% yeast vinasse, and 25% compost improved the tangerine fruit weight, size, pulp, and peel in addition to increasing the fruit juice volume. The present results partly agree with those reported by Abedel-Sattar et al., 2011; Abdelaal *et al*. (2013), El-Shazly, et al., 2015; Eissa, (2016); Fikry *et al*., (2020) ; EL-Khwaga, *et al*., (2021) and Fikry *et al*., (2022) they determined the important role of organic fertilizers in increasing citrus fruit quality.

3.3.2. Chemichal properties of Murcott tangerine Fruit

The data shown in Table (8) demonstrated that during the 2021 and 2022 seasons, the fertilization treatments had a significant effect on TSS, total acidity percentage, TSS/acid ratio, vitamin C, and total sugars in the Murccot fruit juice. The results showed that in the 2021 and 2022 seasons, fertilizing Murcott tangerine trees with 50% NPK minerals + 25% yeast vinasse + 25% compost produced the maximum percentage of TSS, TSS/acid ratio, vitamin C, and total sugars, and gave the lowest percentage of total acidity. Fruits from trees treated with 100% NPK minerals had the lowest percentages of TSS, TSS/acid ratio, vitamin C, and total sugars; on the contrary, that treatment had the highest percentage of total acidity. Similarly results reported by Abedel-Sattar *et al*., (2011); El-Shazly, et al., (2015); Eissa, (2016); Noha, Mansour and Nasser, (2021); EL-Khwaga, *et al*., (2021) and Fikry *et al*., (2022) they concluded that trees treated with citrus byproduct compost had higher ascorbic acid values than trees treated with mineral fertilizer. These results may be explained by the fact that organic matter, in all of its forms fresh material, intermediate products, and humus improves the physical, chemical, and biological characteristics of soil, which in turn reflects an increase in soil fertility, which in turn increases fruit quality and yield (Woomer *et al*., 2000).

Table 7. Effect of organic and mineral NPK fertilizers treatments on fruit physical characteristics of Murcott Tangerine trees during 2021 and 2022 seasons.

Treatments	Fruit weight (g)		Fruit volume (cm^2)		Fruit height (cm)		Fruit diameter (cm)		Peel thickness (cm)		Juice volume/fruit (cm^3)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
100% mineral NPK	143.47E	127.89E	214.0E	198.3E	5.14CD	5.29CDE	6.85BCD	6.54BCD	0.371F	0.327DE	94.17D	87.70EF
50% mineral NPK + 50 % yeast vinasse	180.98AB	155.95ABC	227.3B	226.3B	5.48B	5.46ABC	7.24AB	6.75B	0.504C	0.384B	108.73B	95.10BC
50% mineral NPK + 50 % compost	185.83A	158.03ABC	231.0B	228.0AB	5.83A	5.64AB	7.27AB	6.85B	0.567B	0.388AB	113.93A	97.30AB
50% mineral NPK + 25 % yeast vinasse + 25 % compost	192.70A	170.62A	238.0A	232.3A	5.91A	5.73A	7.43A	7.34A	0.609A	0.413A	114.43A	101.0A
25% mineral NPK + 75 % yeast vinasse	165.37C	149.66BCD	215.0DE	206.0D	5.20C	5.32CD	7.01ABCD	6.53BCD	0.415E	0.325E	93.87D	84.20FG
25% mineral NPK + 75 % compost	173.37B	151.71	218.3D	215.0C	5.30BC	5.31CD	7.04ABCD	6.56BCD	0.428E	0.354CD	100.83C	90.0DE
25% mineral NPK + 37.5 % yeast vinasse + 37.5 % compost	176.00B	155.43D	222.7C	222.7B	5.31BC	5.42BCD	7.18ABC	6.67BC	0.458D	0.378BC	104.10C	92.20CD
100% Compost	171.83DE	137.69DE	204.0G	190.3FG	5.09CD	5.14DE	6.76CD	6.21DE	0.354FG	0.285F	89.70DE	78.0H
100 % yeast vinasse	152.55	130.77E	198.3H	185.7G	4.89D	5.00E	6.68D	5.97E	0.347G	0.281F	87.67E	75.20H
50 % yeast vinasse + 50 % compost	156.67D	147.00	209.0F	193.7EF	5.18C	5.24CDE	6.74CD	6.27CDE	0.373F	0.349DE	92.80D	82.10G

Means having the same letter (s) in each column are insignificantly different.

Table 8. Effect of organic and mineral NPK fertilizers treatments on fruit chemical characteristics of Murcott Tangerine trees during 2021 and 2022 seasons.

Treatments	TSS %		Total acidity %		TSS/ Acid ratio		Vit. C		Total sugars	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
100% mineral NPK	13.3E	11.6C	1.38A	1.30A	9.64B	8.92C	36.13G	37.10G	7.60E	7.20G
50% mineral NPK + 50 % yeast vinasse	15.3ABC	12.9AB	1.14C	1.07G	13.42AB	12.06BC	48.07B	40.87D	9.77B	9.40B
50% mineral NPK + 50 % compost	15.5AB	13.7A	1.14C	0.93H	13.60AB	14.73AB	50.63A	45.50B	9.83B	9.57AB
50% mineral NPK + 25 % yeast vinasse + 25 % compost	16.3A	14.1A	1.11C	0.91H	14.69A	15.50A	52.13A	47.17A	10.20A	9.63A
25% mineral NPK + 75 % yeast vinasse	14.4BCDE	12.4BC	1.25ABC	1.21C	11.52AB	10.24C	42.53D	38.50F	9.37C	8.57C
25% mineral NPK + 75 % compost	14.5BCDE	12.8AB	1.21BC	1.12E	11.98AB	11.42BC	44.40C	39.67E	9.50BC	8.67C
25% mineral NPK + 37.5 % yeast vinasse + 37.5 % compost	14.9ABCD	12.9ABC	1.18BC	1.09F	12.62AB	11.83BC	48.33B	43.00C	9.37C	7.63EF
100% Compost	14.0CDE	11.7BC	1.26ABC	1.11E	11.11AB	10.54C	40.87E	37.53G	9.30C	8.30D
100 % yeast vinasse	13.8DE	11.7BC	1.31AB	1.26B	10.15B	9.21C	36.80G	37.53G	7.73E	7.50F
50 % yeast vinasse + 50 % compost	14.3BCDE	12.2BC	1.27ABC	1.18D	11.26AB	10.34C	38.77F	37.50G	8.17D	7.77E

Means having the same letter (s) in each column are insignificantly different.

3.4. Effect of organic and mineral NPK fertilizers treatments on leaf nutrient contents.

The data in Table (9) demonstrate that over the two analyzed seasons, the percentages of nitrogen, phosphorus, and potassium in the leaves of Murcott tangerine trees were significantly impacted by using NPK mineral fertilizers as well as two organic sources (compost and yeast vinasse). The highest percentage of these nutrients was found in the leaves of trees fertilized with 50% NPK mineral fertilizers + 25% compost + 25% yeast vinasse followed by trees fertilized with 50% NPK mineral fertilizers + 50% compost and 50% NPK mineral fertilizers + 50% yeast vinasse. However, in the first and second seasons, the nitrogen, phosphorus, and potassium percentages were lowest in the Murcott tangerine trees that were supplied with 100% yeast vinasse. In general, it should be pointed out that fertilizing trees with various sources such as inorganic fertilizers like ammonium nitrate (33% N) and organic compost fertilizer and yeast vinasse—produced greater values for the percentages of nitrogen, phosphorous, and potassium in the leaves. These results agree with those reported by Mansour and Shaaban, (2007) on Washington Navel orange, Khan and Begum, (2007) on young acid lime; Eman *et al.,* (2008) on Washington Navel orange; Barakat *et al.,* (2012) on Newhall Naval orange; Ahmed *et al.,* (2013) on Balady mandarin; Garhwal *et al.,* (2014) on Kinnow mandarin, Hadole *et al.,* (2015) on Nagpur mandarin; Eissa, (2016) on Balady mandarin; Fikry *et al*., (2020) on Murcott tangerine and EL-Khwaga, *et al.,* (2021) on Washington Navel orange.

Table 9. Effect of organic and mineral NPK fertilizers treatments on nitrogen, phosphorus and potassium leaf contents of Murcott Tangerine trees during 2021 and 2022 seasons.

	N %		**P %**		**K %**	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**
100% mineral NPK	2.85C	2.35D	0.25D	0.22D	1.52C	1.45D
50% mineral NPK + 50 % yeast vinasse	2.90ABC	2.41CD	0.26CD	0.24B	1.48D	1.44D
50% mineral NPK + 50 % compost	2.91ABC	2.53B	0.28AB	0.25A	1.65B	1.54B
50% mineral NPK + 25 % yeast vinasse + 25 % compost	2.94A	2.65A	0.29A	0.25A	1.76A	1.66A
25% mineral NPK + 75 % yeast vinasse	2.70D	2.36D	0.21F	0.21E	1.41F	1.40F
25% mineral NPK + 75 % compost	2.86BC	2.37D	0.27BC	0.22D	1.54C	1.48C
25% mineral NPK + 37.5 % yeast vinasse + 37.5 % compost	2.92AB	2.46C	0.26CD	0.23C	1.46DE	1.44D
100% Compost	2.71D	2.11E	0.21F	0.19G	1.44E	1.41EF
100 % yeast vinasse	2.69D	1.90F	0.20F	0.18H	1.35G	1.40F
50 % yeast vinasse + 50 % compost	2.88ABC	2.14E	0.23E	0.20F	1.46DE	1.42E

Means having the same letter (s) in each column are insignificantly different.

4. CONCLUSION

The data demonstrated that fertilizing trees with 50 % NPK minerals fertilizers as ammonium nitrate (33.5% N) + 50 % organic fertilizers consists of 25 % from compost and 25 % from yeast vinasse / tree /year was the most effective way to improve the development, productivity, and nutritional condition of Murcott tangerine trees.

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الملخص العربي

استجابة نمو وانتاجية اشجار اليوسفي الموركت للأسمدة العضوية والمعدنية

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اجريت هذه الدراسة خلال موسمين متتاليين (٢٠٢١ و ٢٠٢٢) في المزرعة التجريبية لمحطة بحوث البساتين بسدس بمحافظة بني سويف، معهد بحوث البساتين ، مركز البحوث الزراعية، مصر لتقييم مصادرمختلفة من الأسمدة على النمو الخضري والمحصول ومحتوي الأوراق من العناصر المعدنية لأشجار يوسفي ميركوت (Citrus reticulata Blanco.) عمرها خمس سنوات ، مطعومة على أصل نارنج (C. aurantium L.) ومزروعة على مسافة ٥ × ٥ أمتار في تربة طينية تحت نظام الري السطحي. نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة بثلاثة مكررات لكل معاملة. تضمنت التجربة ١٠ معاملات هي :

معاملة ١ : ١٠٠ % سماد معدني من النتروجين والفوسفور والبوتاسيوم (NPK)

معاملة ٢ : ٥٠ % سماد معدني من (NPK) + ٥٠ % من فيناس الخميرة

معاملة ٣ : ٥٠ % سماد معدني من (NPK) + ٥٠ % من الكمبوست

معاملة ٤ : ٥٠ % سماد معدني من (NPK) + ٢٥ % من فيناس الخميرة + ٢٥ % من الكمبوست

معاملة ٥: ٢٥ % سماد معدني من (NPK) + ٧٥ % من فيناس الخميرة

معاملة ٦: ٢٥ % سماد معدني من (NPK) + ٧٥ % من الكمبوست

معاملة ٧: ٢٥ % سماد معدني من (NPK) + ٣٧,٥ % فيناس الخميرة + ٣٧,٥ % كمبوست

معاملة ٨: ١٠٠ % من فيناس الخميرة

معاملة ٩ : ١٠٠ % من الكمبوست

معاملة ١٠ : ٥٠ % من الكمبوست + ٥٠ % من فيناس الخميرة

أظهرت النتائج المتحصل عليها أن إضافة السماد العضوي وفيناس الخميرة مع الأسمدة المعدنية ومقارنتها مع الاسمدة المعدنية فقط (الكنترول) أدى إلى زيادة معنوية في النمو الخضري والمحصول وجودة الثمار والمحتوى المعدني للأوراق. وقد سجلت أعلى القيم في هذا الصدد في الأشجار المسمدة باستخدام المعاملة ٤(٥٠ % اسمدة معدنية + ٢٥ % كمبوست + ٢٥ % فيناس الخميرة) كما لوحظ زيادة معنوية في وزن الثمرة والمحصول حيث بلغ أعلى وزن للثمرة (١٨١,٦٦ جرام) وأعلى إنتاجية (٧٢,٨٦ كجم/شجرة) في متوسط الموسمين كما اعطت أعلي قيم للصفات الفيزيائية والكيميائية للثمرة .