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# Effect of Partial Substitution of Mineral Nitrogen with Various Organic Manure Teas on Yield and Fruit Quality of Williams Banana

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**Abstract**: This study investigated the effects of partially replacing mineral nitrogen fertilizers with compost tea and chicken manure tea on the productivity and fruit physico-chemical quality of Williams banana plants grown in clay loam soil in El-Minia Governorate, Egypt, during the 2023 (second ratoon) and 2024 (third ratoon) seasons. A randomized complete block design with five treatments: 100% mineral N (control), and 80/60/40/20% mineral N combined with 10/20/30/40% each of compost tea and chicken manure tea. Results showed that the 60% mineral N + 20% compost tea + 20% chicken manure tea treatment significantly increased bunch weight, hand weight, finger weight, length, diameter, total soluble solids, total sugars, and reduced acidity and starch compared to the control (100% mineral N). This optimal substitution enhanced nutrient uptake, and fruit quality, promoting sustainable banana production by reducing chemical fertilizer reliance.

**Key words**: Mineral nitrogen, organic manure, compost tea, chicken manure tea, banana.

## 1. Introduction

Several high-yielding cultivars, notably the 'Williams' cultivar, were introduced and proliferated in Egypt, which is the focus of the current study. In Egypt, bananas are regarded as one of the most significant commercial and preferred fruits. The 'Williams' fruiting area encompassed 64382 feddans, yielding 995446 tonnes (Agricultural Economic Bulletin 2020, Ministry of Agriculture and Reclamation, Cairo, Egypt (**MALR, 2020**). The Williams banana cultivar is a hybrid of Cavendish, distinguished by its early season maturity and the quickest vegetative development cycle (Ibrahim *et al.*, 2024a). It is regarded as one of the principal banana cultivars in terms of prevalence and commercial significance. The Williams cultivar is distinguished by its robust pseudostem, notable wind resistance, substantial bunch weight, huge fruit heads, and tasty fruit (**Abo-Hamda *et al.* 2020**). It is currently regarded as one of the principal banana cultivars in El-Minia Governorate and other regions of Egypt. The banana plant is classed as very responsive to fertilization, particularly nitrogen fertilization.

Conversely, augmenting mineral fertilization poses significant dangers to human health and the environment. Consequently, it becomes imperative to diminish the mineral fertilization of bananas. The connection between organic fertilization (eco-friendly fertilizers) and human health is a primary issue for consumers. Nevertheless, organic fertilization, which is a natural source of nitrogen fertilization, can be a significant factor in this regard (**Eissa, 2019; Virginie *et al.* 2022; Meya *et al.*, 2023**).

Organic fertilization is an essential agricultural practice during the growing season. Organic fertilization provides an alternate method for delivering the macro and micronutrients vital for plant growth. These natural bio-stimulants' rich content of many nutrients, such as organic matter, organic acids, antibiotics, amino acids, B vitamins, and natural hormones such angiotensin acid GA3, IDAA, and cytokinins, is responsible for their positive effects (**Akl *et al.*, 2017**). Bananas grew more easily and had better nutritional value thanks to organic fertilizer. Additionally, organic substances lower soil pH and increase soil aeration, structure, and moisture retention. It is now imperative to cultivate fruits organically using organic fertilizers instead of chemical fertilizers and stimulants (**Virginie *et al.* 2022; Meya *et al.*, 2023**).

Compost tea is a liquid extract of compost that contains bioactive compounds and soluble nutrients derived from compost and other microorganisms distinct from those present in the original compost. Microorganisms in compost tea can generate chemicals that inhibit the proliferation of harmful fungus and bacteria, while also prompting plants to activate their intrinsic defence systems (**Garg and Rakshit, 2024; Bouchtaoui *et al.*, 2024**). In contrast to compost, which distributes nutrients incrementally, compost tea addresses the nutrient requirements of crops during critical phenological phases (transplanting, blooming, fruit set) when the demand for nutrients is most pressing (**Yin *et al.*, 2025**).

This investigation aims to examine the impact of partially substituting mineral fertilizers with compost and chicken manure tea at varying concentrations on the yield, and fruit physio-chemical quality of 'Williams' banana cultivated in El-Minia Governorate conditions.

## 2. Materials and Methods

### 2.1. Experimental location

This study was conducted in 2023 (second ratoons) and 2024 (third ratoons) on Williams banana trees (*Musa cavendishii*) cultivated in a private banana orchard located in West Nile, Mallawi Center, El-Minia Governorate. The soil has a clay loam texture under a flood irrigation system and is well-drained, having a water table level of no less than two meters. The methods described by **Wilde *et al.* (1985)** was used to analyze the soil as indicated in Table (A). 45 stools, each including three uniformly vigorous 'Williams' banana plants, were selected for this trial, planted at intervals of 3 x 3 meters, with three suckers per hole.

### 2.2. Conducting experiment

To investigate the impact of partially substituting traditional mineral-N fertilizer with organic fertilization (as compost tea and chicken manure tea) on the productivity, and physio-chemical properties of 'Williams' bananas. Four substituted dosages of mineral fertilizer, namely 20%, 40%, 60%, and 80% of the prescribed dosage (utilizing Ammonium Nitrate 33.5% N), were replaced with 10%, 20%, 30%, and 40% of both compost and chicken manure tea in comparison to the control (full dose of mineral N-fertilizers).

### 2.3. Experimental treatments:

This experiment employed a complete randomized block design across 3 replicates. Each treatment consisted of three suckers per hole /replicate. The treatments were organized in the following manner:

1. Control (100% N-mineral).
2. 80% N-Mineral+10% compost tea+10% chicken manure tea.
3. 60% N-Mineral+20% compost tea+20% chicken manure tea.
4. 40% N-Mineral+30% compost tea+30% chicken manure tea.
5. 20% N-Mineral+40% compost tea+40% chicken manure tea

Each treatment was applied with the prescribed dosage of nitrogen at 80g N per hole annually, alongside organic manure at four varying concentrations, provided at one-month intervals.

**Table (A). Analysis of the physical and chemical properties of soils in banana orchard**

| Soil characters | | 2023/2024 |
|---|---|---|
| **Particle size distribution (%)** | **Sand** | 3.06 |
| | **Silt** | 35.59 |
| | **Clay** | 61.35 |
| | **Texture class** | Clay loam |
| **EC ppm (1:2.5 extract)** | | 296 |
| **pH (1:2.5 extract)** | | 7.54 |
| **Organic matter %** | | 2.29 |
| **$CaCO_3$ %** | | 2.45 |
| **Soil nutrients** | **Total N (%)** | 0.19 |
| | **Available P (ppm)** | 5.13 |
| | **Available K (ppm)** | 498.0 |
| | **Zn (ppm)** | 2.2 |
| | **Fe (ppm)** | 2.9 |
| | **Mn (ppm)** | 3.2 |
| | **Cu (ppm)** | 0.13 |

## 2.4. Organic manure tea preparation

Fresh compost and chicken manure were obtained from two nearby farms. The manure was stored in hessian sacks, each weighing 2 kg. The bags were then placed in plastic barrels containing 20 litres of water. A boulder was included into the dung to guarantee it stayed submerged and did not buoy. The barrels were then enveloped in plastic wrap to complete the fermentation process. The hessian sacks were physically transported vertically many times daily. After a three-week fermentation period, the two organic manure teas are now ready for application. The chemical analyses of the compost tea and chicken manure tea employed in this investigation are detailed in Tables B and C, respectively (Price and Duddles, 1984). Organic manure tea was utilized as an organic fertilizer for soil enhancement.

**Table (B). Compost tea's chemical composition, as reported by Abd El-Hamied and El-Amary (2015)**

| EC (dS/m) | Ph | N ppm | P ppm | K ppm | Ca ppm | Mg ppm | Fe ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|
| 0.812 | 6.55 | 251 | 7.5 | 212 | 85 | 119 | 64 | 7.1 |

**Table (C). Chicken manure tea's analysis** according to **Akl *et al.* (2017)**

| Parameters | Values |
|---|---|
| O.M. % | 58.26 |
| Organic carbon | 27.90 |
| pH (1 : 2.5 extract) | 10.25 |
| E.C. (ds/m) ( 1: 2.5 extract) | 5.9 |
| Total N % | 2.5 |
| Total P % | 1.12 |
| Total K % | 1.21 |
| Total Fe (ppm) | 18.5 |
| Total Zn (ppm) | 43.22 |

### 2.5. The following criteria were determined:

**Yield and fruit quality:** The punches were selected: when the fingers reached three-quarters, bunches were harvested at the conclusion of November in the 2023 and 2024 seasons: The average bunch weight in kg (before to artificial ripening) and average hand weight in kg.

**Fingers physical parameters:** Samples of two hands were extracted from the central portion of the bunch to assess fruit quality as following: The weight of the finger (in g.) was weighted by using a digital balance, fingers dimensions (length and diameter in cm) and pulp to finger ratio (weight / weight) by weighting the pulp and peel

**Fingers chemical analysis:** After extracting a fresh sample from the pulp of six fingers and blending it with an electric mixer, the following chemical properties were evaluated: TSS% by using handy refractometer (**Ranganna, 2000**), the percentages of reducing, non-reducing, and total sugars, together with the starch %, were determined using the volumetric technique of **Eynon and Lane (1928**), as described in **Ranganna** (**2000**) and the percentage of titratable acidity (expressed as grammes of malic acid per 100 grammes of fruit pulp) was determined using titration with 0.1 N NaOH, utilizing phenol-phthalein as an indicator (**AOAC, 2000**).

### 2.6. Data Analysis

**Mead *et al.* (1993**) employed the NEW L.S.D. approach to evaluate all data at a 5% significance level.

## 3. Results and Discussion

### 3.1. Yield characteristic

Table 1 illustrate the impacts of various doses (10, 20, 30, and 40%) for each of the compost tea and chicken manure tea replacement with N-mineral (20, 40, 60, and 80%) on the yield characteristics of Williams banana plants during the 2023 and 2024 growth seasons.

The data indicated in Table 1 regarding the average bunch weight (kg) and hand weight of Williams bananas in the second and third ratoons, influenced by the addition of two organic manure tea sources (compost and chicken manure) as a partial substitute for conventional mineral-N fertilizers at varying doses (20%, 40%, 60%, and 80%), during the 2023 and 2024 seasons. The acquired data demonstrates that the 'Williams' banana production, measured by bunch weight (kg) ad hand weight (kg), were considerably improved by various organic manure tea treatments (compost and chicken manure) over both experimental seasons. The data in the table indicates that elevating the replacement ratio of mineral nitrogen to 60% significantly enhanced bunch weights (kg) and hande weight (kg) in comparison to using 100% mineral nitrogen fertilization. Moreover, the ratoons treated with 60% N-Mineral, 20% compost tea, and 20% chicken manure tea exhibited the highest bunch weight (kg) and hand weight (kg) over both experimental seasons, followed by the treatment of 80% N-Mineral, 10%

compost tea, and 10% chicken manure tea, relative to the ratoons got the full dose of mineral nitrogen during 2023 and 2024 seasons.

**Table (1). Substituting a portion of traditional mineral nitrogen fertilizers with organic manure tea and its impact on yield of Williams banana plants during 2024 and 2024 seasons**

| Characteristics / Treatments | Bunch weight (kg) | | Hand weight (kg) | |
|---|---|---|---|---|
| | 2023 | 2024 | 2023 | 2024 |
| **Control (100% N-mineral)** | 21.6 | 22.1 | 1.6 | 1.7 |
| **80% N-Mineral+10% CT+10% CMT** | 23.1 | 23.5 | 1.8 | 1.9 |
| **60% N-Mineral+20% CT+20% CMT** | 24.8 | 25.1 | 2.1 | 2.3 |
| **40% N-Mineral+30% CT+30% CMT** | 20.3 | 20.8 | 1.3 | 1.5 |
| **20% N-Mineral+40% CT+40% CMT** | 19.0 | 19.4 | 1.1 | 1.2 |
| **New LSD at 0.5** | **1.3** | **1.3** | **0.2** | **0.2** |

**Compost tea: CT Chicken manure tea: CMT**

Substituting a portion of traditional mineral nitrogen fertilizers with organic manure or compost sources consistently improves yield components in Williams banana plants, including bunch weight and hand weight. The positive effects of organic fertilizers on yield, as bunch and hand weight (kg) can be attributed to their ability to supply banana plant with essential nutrients (both macro and micro elements) over an extended period. This, in turn, enhances the nutritional status of the trees (Table 3) and supports vegetative growth (Table 1), ultimately benefiting yield weight (**Nijjar, 1985**). According to **Rajput *et al.* (2017**) and **Zhang *et al.* (2019**), this beneficial effect can be linked to raising the availability and uptake of essential nutrients, lowering the pH level of the soil, producing certain plant growth regulators through the breakdown of compost in the soil, and strengthening the plants' resistance to harsh environmental conditions. In a study conducted by (Ibrahem *et al.*, 2024a), under El-Minia conditions, replacing 25%, 50%, or 75% of mineral nitrogen with plant compost substantially augmented bunch weight (kg/plant) and overall yield (kg/plant), with the 50% substitution treatment yielding the highest values across two seasons, attributed to optimized mineral status (N, P, K) and vegetative growth. Similarly, **Hosam El-Dein and Boshra, (2008**), on Williams banana using cattle manure or town refuse compost as partial substitutes (up to 75%) showed gradual increases in yield and yield components like hand weight, with 75% organic + 25% mineral N producing superior results compared to 100% mineral N alone. **Hakimi *et al.*, (2024**) supports that compost tea applications improve soil nutrient levels (N, P, K), indirectly boosting banana productivity through better root health and sustained nutrition. Overall, moderate substitution rates (25–50%) with organic manure tea or compost maximize branch/bunch and hand weights by promoting balanced fertilization, reducing chemical dependency, and enhancing fruit set and size without compromising quality.

### 3.2. Fingers physical characteristics

Table 2 illustrate the morpho-physical properties of "Williams" banana plant fruits, encompassing finger weight, length, diameter, and pulp-to-finger ratio. The morpho-physical characteristics were compared to control treatments throughout the 2023 and 2024 seasons to evaluate the effects of organic manure fertilization (compost tea and chicken manure tea) at different concentrations, substituting mineral-N applications relative to the 100% recommended dose of mineral-N.

The results showed that using compost in place of 20% or 40% of mineral nitrogen fertilizers significantly increased the finger physical quality parameters of "Williams" banana plants in the 2023 and 2024 growing seasons. Raising the replacement ratio 80% organic+ 20% N-Mineral failed to affect the parameters considerably throughout the two study seasons. It is evident that throughout the 2023 and 2024 trial seasons, the ratoons of "Williams" bananas that were given 60% N-Mineral+20% compost tea+20% chicken manure tea generated the best finger weight, length, diameter, and pulp-to-finger ratio.

Followed by the plantes fertilized with a mixture of 80% N-Mineral, 10% compost tea, and 10% chicken manure tea. Conversely, the ratoons that got 100% mineral nitrogen yielded intermediate results. Compared to other treatments in both seasons, the lowest values were recorded with 20% N-Mineral, 40% compost tea, and 40% chicken manure tea.

**Table (2). Substituting a portion of traditional mineral nitrogen fertilizers with organic manure tea and its impact on physical parameters of Williams banana plants during 2024 and 2024 seasons**

| Characteristics / Treatments | Finger weight (g) | | Finger length (cm) | | Finger diameter (cm) | | Pulp/finger ratio | |
|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 |
| **Control (100% N-mineral)** | 85.5 | 87.1 | 13.2 | 13.3 | 5.0 | 5.3 | 72.6 | 72.9 |
| **80% N-Mineral+10% CT+10% CMT** | 93.6 | 96.2 | 13.9 | 14.1 | 5.3 | 5.7 | 72.9 | 73.2 |
| **60% N-Mineral+20% CT+20% CMT** | 102.8 | 105.4 | 14.4 | 14.6 | 5.7 | 6.0 | 73.3 | 73.6 |
| **40% N-Mineral+30% CT+30% CMT** | 77.3 | 79.0 | 12.7 | 12.8 | 4.6 | 4.9 | 72.3 | 72.5 |
| **20% N-Mineral+40% CT+40% CMT** | 70.1 | 71.0 | 12.1 | 12.3 | 4.3 | 4.6 | 72.0 | 72.3 |
| **New LSD at 0.5** | **7.1** | **8.0** | **0.5** | **0.5** | **0.3** | **0.3** | **0.2** | **0.2** |

**Compost tea: CT** **Chicken manure tea: CMT**

The beneficial impact of substituting mineral nitrogen with compost to enhance the physical attributes of 'Williams' banana fruit has been previously investigated by various authors, including **Baiea and El-Gioushy, (2015**) on 'Grande Naine' banana ratoons cultivated in sandy soil conditions; **Abdel-Hafiz *et al.* (2016**) on 'Williams' banana subjected to heat stress in Aswan Governorate, Upper Egypt; and **Adriano *et al.* (2012**) on banana. It is generally known that compost contains a larger proportion of organic matter, which enhances soil physical and chemical qualities, as well as the microbial population in the root rhizosphere. Moreover, compost enhances the solubilization and absorption of mineral nutrients, increases water retention capacity, and improves cation exchange capacity (**El-Aidy *et al.*, 2018; Rahman *et al.*, 2021**). Thus, moderate substitution (25–50%) with organic manure tea enhances these physical traits by promoting sustained nutrition, healthier fruit filling, and superior quality without excess mineral inputs.

### 3.3. Fingers chemical characteristics

The chemical quality features (TSS%, total acidity, reducing sugars, non-reducing sugars, total sugar, and starch%) of Williams banana trees are detailed in Table 3. The results stem from the application of organic manure (compost tea and chicken manure tea) at different concentrations, which substituted the mineral-N dose in contrast to 100% mineral-N throughout the 2023 and 2024 seasons.

In contrast to applying N via inorganic N alone (100% RD), it is clear from the findings in Table (2) that, the Williams banana plants treated with N as 20 to 80% inorganic N plus soil addition of compost tea and chicken manure tea each at 10 to 40% was very effective in improving pulp chemical quality. The promotion of pulp TSS%, sugars, reduction in total acidity % and starch% was associated with a decrease in inorganic nitrogen percentages and a simultaneous increase in organic manure tea percentages. The optimal outcomes for pulp chemical quality were achieved with a mixture of 60% N-Mineral, 20% CT, and 20% CMT (19.5 - 20.0% for TSS%), (0.280 - 0.272% for total acidity), (6.2 - 6.9% for reducing sugar), (12.9 - 12.31% for non-reducing sugar), (19.1 - 19.2% for total sugar) and (0.72 - 0.77% for starch). Followed by 80% N-Mineral, 10% CT, and 10% CMT, throughout two

seasons. Compared to the control, which documented the median values (18.0 - 18.5 % for TSS%), (0.309 - 0.304% for total acidity), (5.8 - 6.0% for reducing sugar), (11.6 - 11.3% for non-reducing sugar), (17.4 - 17.3% for total sugar) and (1.03 - 1.01 % for starch). The lowest values were obtained with using a mixture of 20% N-Mineral, 40% CT, and 40% CMT. Comparable results were shown over both seasons.

**Table (3). Substituting a portion of traditional mineral nitrogen fertilizers with organic manure tea and its impact on chemical parameters of Williams banana plants during 2024 and 2024 seasons**

| Characteristics / Treatments | TSS% | | Total acidity% | | Reducing sugar% | | Non-reducing | | Total sugar% | | Starch% | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 |
| **Control (100% N-mineral)** | 18.0 | 18.5 | 0.309 | 0.304 | 5.8 | 6.0 | 11.6 | 11.3 | 17.4 | 17.3 | 1.03 | 1.01 |
| **80% N-Mineral+10%** | 18.7 | 19.3 | 0.295 | 0.289 | 6.0 | 6.4 | 12.2 | 11.8 | 18.2 | 18.2 | 0.89 | 0.80 |
| **60% N-Mineral+20%** | 19.5 | 20.0 | 0.280 | 0.272 | 6.2 | 6.9 | 12.9 | 12.3 | 19.1 | 19.2 | 0.72 | 0.77 |
| **40% N-Mineral+30%** | 17.4 | 17.8 | 0.313 | 0.319 | 5.6 | 5.7 | 11.1 | 10.8 | 16.7 | 16.5 | 1.17 | 1.16 |
| **20% N-Mineral+40%** | 16.9 | 17.1 | 0.326 | 0.331 | 5.5 | 5.0 | 10.7 | 10.4 | 16.2 | 15.4 | 1.31 | 1.32 |
| **New LSD at 0.5** | **0.5** | **0.6** | **0.009** | **0.010** | **N.S** | **0.3** | **0.4** | **0.4** | **0.7** | **0.8** | **0.14** | **0.15** |

**Compost tea: CT** **Chicken manure tea: CMT**

The advantageous impact of organic fertilizers, such as compost, on the physicochemical qualities of fruit is contingent upon the recycling of organic nutrients provided, which mitigates the adverse impacts of chemical fertilizers. **Hosam El-Dein and Boshra (2008**) reported that using cattle manure or town refuse compost as partial N substitutes (up to 75%) increased total sugars and TSS while lowering acidity, yielding superior fruit quality profiles compared to mineral-only treatments; this improvement stems from better carbohydrate metabolism and nutrient balance. Recent Ibrahim *et al.*, (2024a) worked on organic amendments confirmed higher TSS in banana fruits from organic manures versus inorganic fertilizers, due to enhanced sugar accumulation from protein hydrolysis. Organic manure has been identified as a source of mineral nutrients that enhances fruit quality (**Rahman *et al.*, 2021; Muhidin *et al.*, 2022**). Substantial enhancement of TSS% and total sugar content in Zaghloul dates was achieved by treating the palms with organic fertilizer, either alone or in conjunction with mineral NP K, relative to 100% mineral fertilization (**Marzouk and Kassem, 2011**). Furthermore, fruit trees treated with organic fertilizers find it challenging to attain superior chemical quality properties compared to those achieved through chemical fertilization, as exemplified by kiwifruit (**Rahman *et al.*, 2021**).

## 4. Conclusion

Under the clay loam soil conditions of El-Minia Governorate, partial substitution of mineral nitrogen fertilizers with organic sources such as compost tea and chicken manure tea significantly enhanced the vegetative growth, leaf chemical composition, yield, and physico-chemical fruit quality of the 'Williams' banana cultivar. The treatment consisting of 60% mineral nitrogen combined with 20% compost tea and 20% chicken manure tea produced the best overall growth performance and fruit quality attributes.

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# تأثير الإستبدال الجزئي للنيتروجين المعدني بأنواع مختلفة من شاي السماد العضوي على محصول وجودة ثمار موز وليامز

**محمد أحمد السيد - على حسن على سيد - صبرى عمر محمد**

**قسم البساتين – كلية الزراعة – جامعة المنيا – مصر**

**الملخص**

أجريت الدراسه في عامي ٢٠٢٣ على الخلفه الثانيه و ٢٠٢٤ على الخلفه الثالثه لأشجار موز صنف وليامز المزروع في مزرعه خاصة تقع غرب نهر النيل، مركز ملوى ، محافظة المنيا في تربه طينيه طمييه. تهدف التجربه لدراسة تأثير الإستبدال الجزئي لسماد النيتروجين المعدني التقليدي بالتسميد العضوي (في صورة شاي الكمبوست وشاي زرق الدواجن) على الإنتاجية، وخصائص الجودة الفيزيائية و الكيميائية لثمار الموز صنف "وليامز". صممت التجربه في قطاعات كاملة العشوائية في خمس معاملات من خلال استبدال أربع نسب من السماد المعدني، وهي ٢٠%، ٤٠%، ٦٠%، و٨٠% من الجرعة الموصى بها (في صورة نترات الأمونيوم بتركيز نيتروجين ٣٣,٥%)، بنسب مقدارها ١٠%، ٢٠%، ٣٠%، و٤٠% لكلٍ من شاي الكمبوست وشاي زرق الدواجن، وذلك بالمقارنة مع معاملة الكنترول (١٠٠% من الموصى به من سماد النيتروجين المعدنى). أظهرت النتائج أن إستخدام ٦٠% نيتروجين معدني + ٢٠% شاي الكمبوست + ٢٠% شاي زرق الدواجن أدى إلى زيادة فى وزن العنقود، ووزن اليد، ووزن الإصبع، والطول، والقطر، وإجمالي المواد الصلبة الكلية الذائبة، وإجمالي السكريات، بينما انخفضت الحموضة والنشا مقارنةً بمجموعة الكنترول (١٠٠% نيتروجين معدني). عزز هذا الاستبدال الأمثل امتصاص العناصر الغذائية وجودة الثمار، مما ساهم في إنتاج الموز المستدام من خلال تقليل الاعتماد على الأسمدة الكيميائية.

**الكلمات المفتاحيه**: تسميد نيتروجينى معدنى، تسميد عضوى، شاى الكمبوست، شاى زرق الدواجن، الموز.